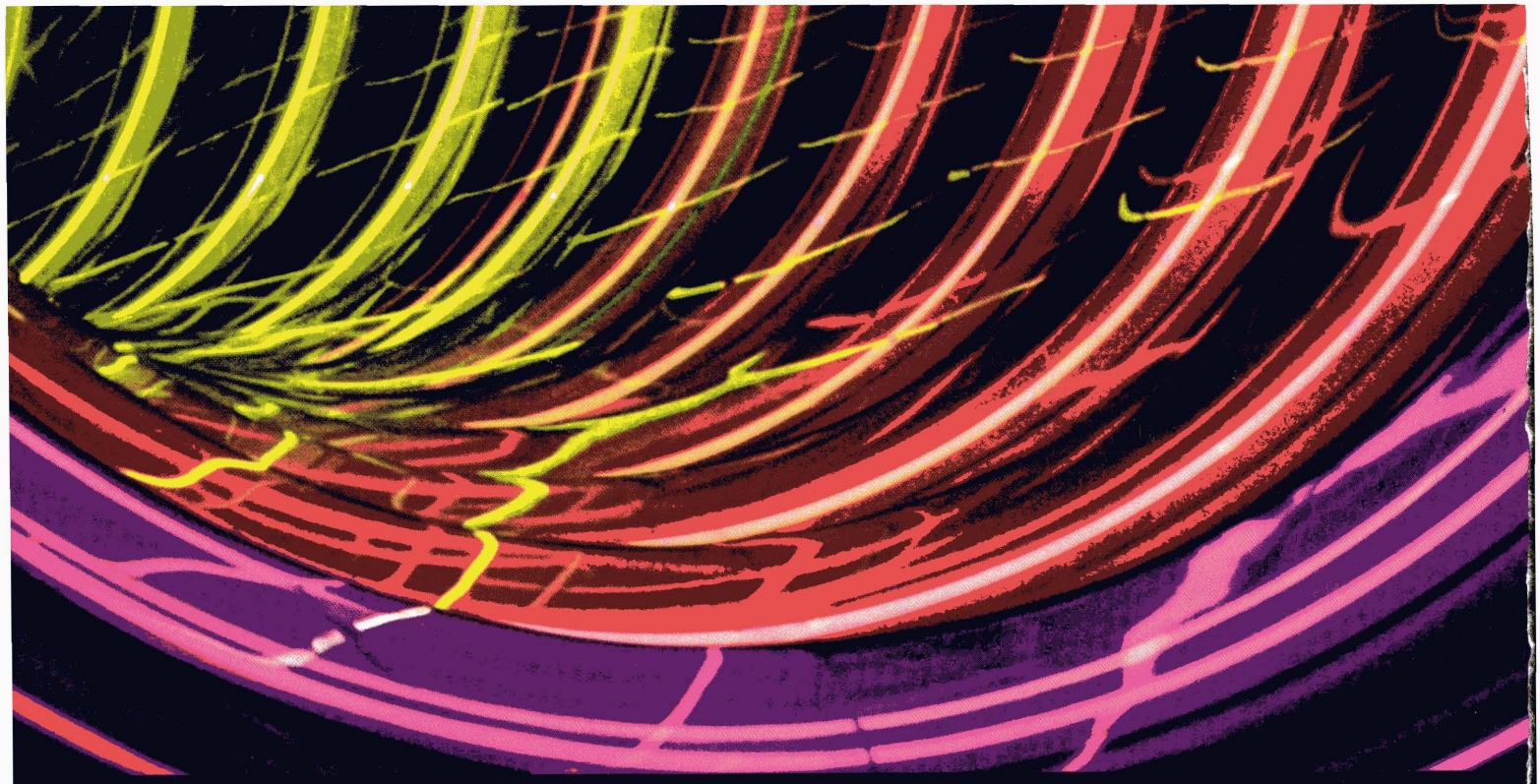

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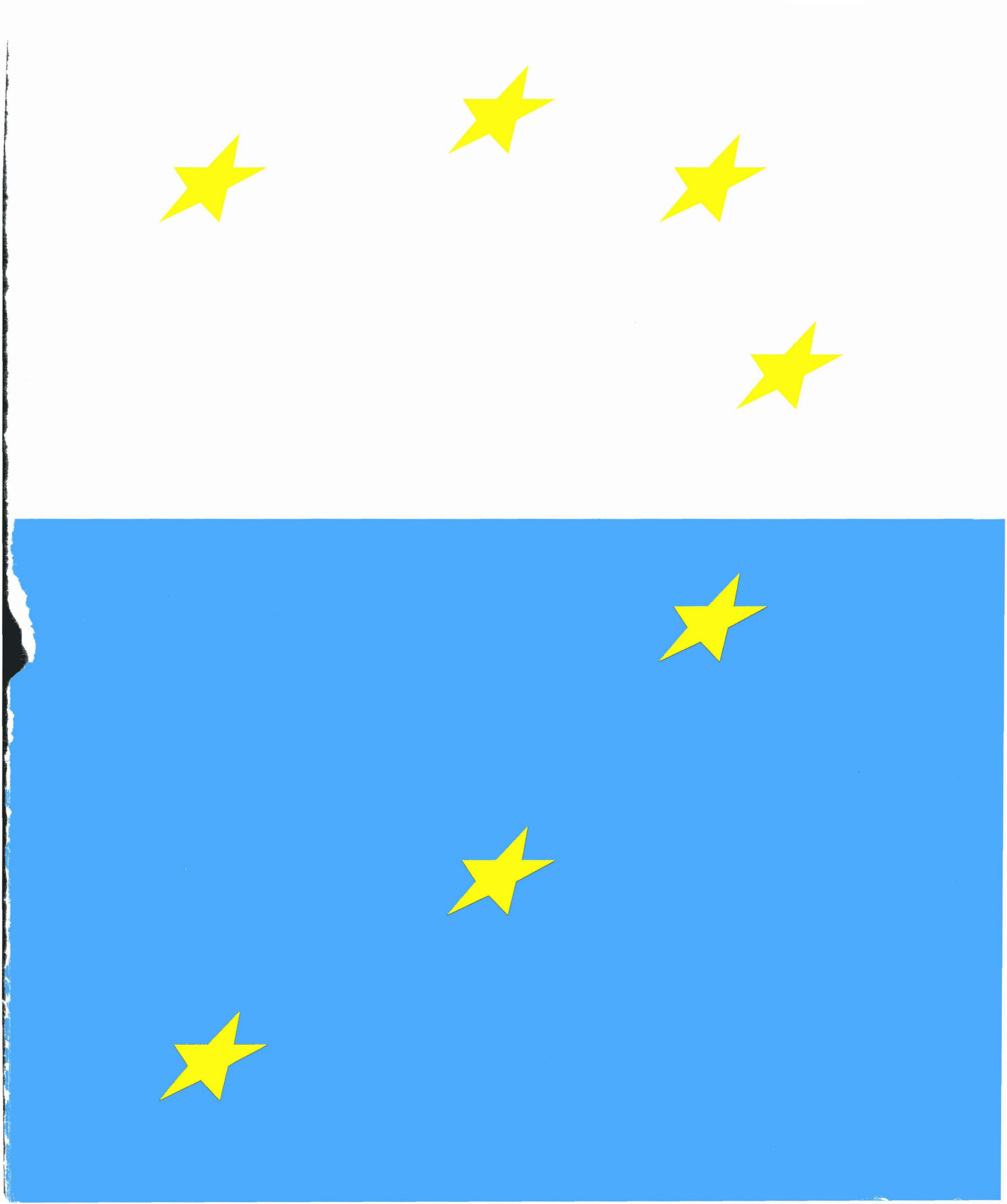

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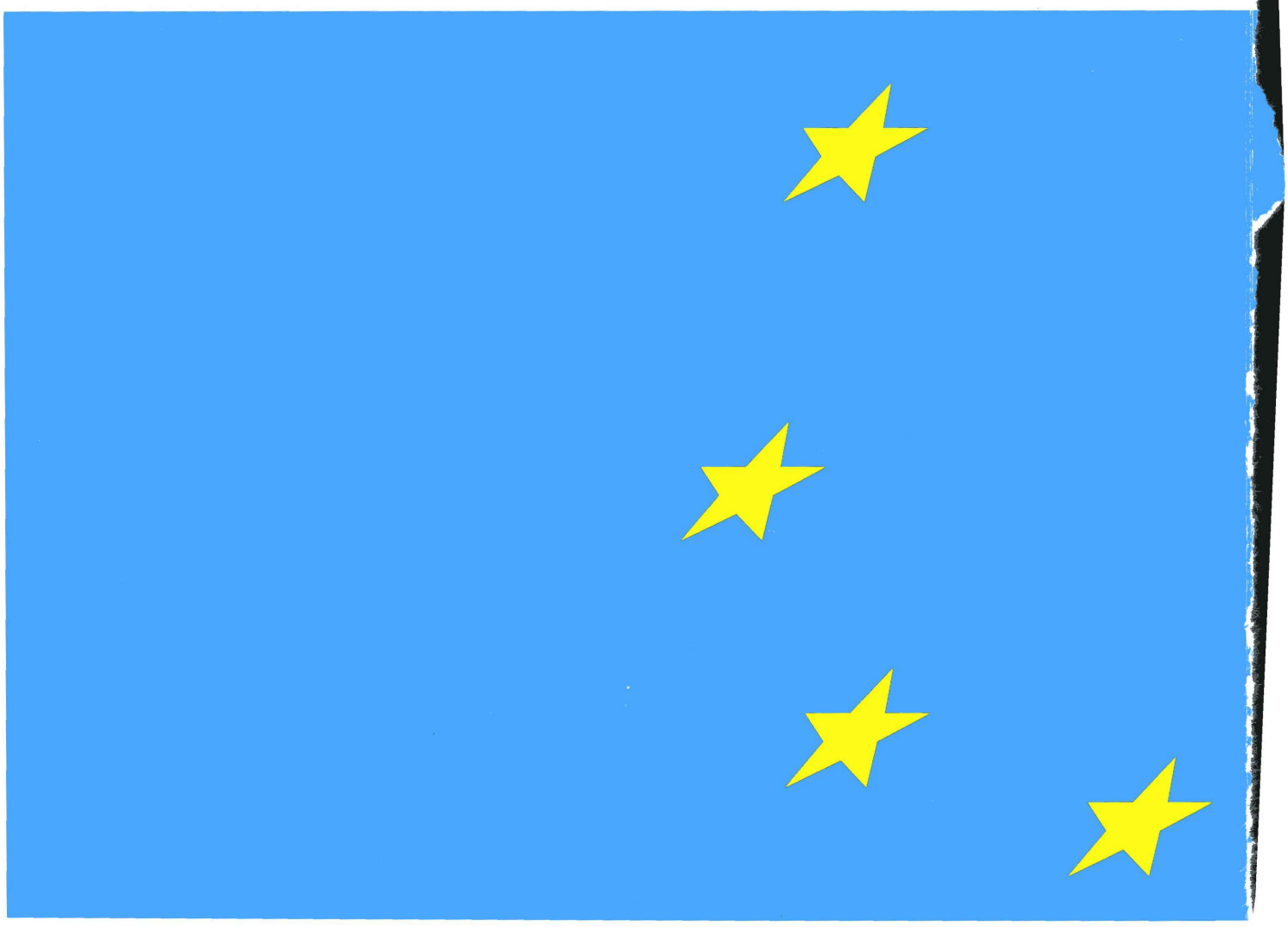

Preface

The EITO members dedicate this edition to Günther E. W. Möller. Günther Möller is one of the fathers of the EITO. He was its Managing Director, from the very beginning until his death in June 1997.

The European Information Technology Observatory – EITO is the established yearbook for the information and communications technology (ICT) industry in Europe. Since its launch in 1993, the EITO has set the standard for market analysis and statistics.

The EITO 98 presents the most comprehensive data currently available about the ICT market in Europe. It also includes special ICT studies on technological trends, standardisation, convergence, the Internet, teleworking, the impact of the Euro, and specific markets such as the home market.

The EITO is a broad and unique European initiative. The EITO members consist of the European associations EUROBIT as representative of the information technology industry and ECTEL as representative of the telecommunications industry, and the European ICT trade fairs CeBIT in Hanover, SIMO in Madrid, and SMAU in Milan.

From the very beginning the EITO has been strongly supported by the Directorate General III Industry of the European Commission, and since 1995 by the Directorate for Science, Technology and Industry of the OECD in Paris.

The EITO 98 has been elaborated with the support of the EITO sponsors, the trade fair SYSTEMS in Munich, European Telework Development (ETD, supported by the European Commission, DG XIII), and the EITO company sponsors Deutsche Telekom and Telecom Italia.

The objective of the EITO is to provide an extensive overview of the European market for information and communications technology and to render services to this industry, to users and public authorities. The idea of a European Observatory originated from the President of SMAU, Enore Deotto, and it has taken an exceptional effort by the original members EUROBIT, CeBIT, SIMO, and SMAU to produce this new compendium.

The EITO 98 has been produced in close cooperation between the EITO Task Force experts and leading market research companies, to discuss and guarantee the quality of the statistics and data.

The copyright for the major parts of the market analysis, data and statistics is held jointly by EITO/GzF and International Data Corporation. The copyright for the four special contributions lies with EITO/GzF and European Telework Development, International Data Corporation, Monitor Company, and GartnerConsulting respectively.

The EITO is an indispensable source of information in marketing and technology for European market players, users of information and communications technology hardware, software and services, for trade organisations and trade fair visitors, for market analysts, for politicians, members of the European Commission and national government representatives, for organisations involved in research and development, standardisation and education relating to ICT, and last but not least, for the media.

Up-to-date and valid information plays an increasingly important role in business and political decision-making. The EITO aims to support the creation of the Global Information Society as well as to make its contribution to the further economic integration and political unification of Europe.

The initiative will be continued with annual editions of the EITO in March and an EITO Update in autumn as a free of charge supplement to the yearbook.

The EITO Members

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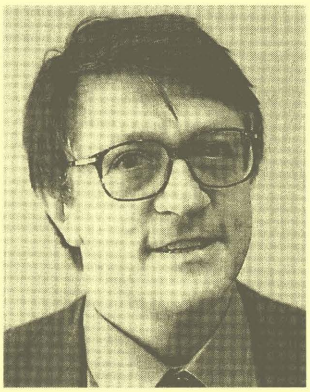
Part One

ICT in Europe: the European Commission's View

The European Information and Communications Technology market continued to have a vigorous growth in 1997, confirming the trend that started three years ago. Growth was 8% over the year, higher than in 1996 and significantly above most other sectors of the economy.



Stefano Micossi,
Director General Industry, EC

In addition to an improved economic climate and the increasing pressure of competition, the most important driving force for ICT market growth has been the rapid pace of developments in Electronic Commerce. The increasing use of Intranets within organisations and the opening of internal company networks to information exchange, through the Internet, with partners, suppliers and customers, have created new opportunities for applications and opened the way to radical restructuring of business processes and new forms of organisation.

Electronic Commerce: the ICT Market Driver

Electronic Commerce has the potential to be a powerful driver for economic progress. Its great importance does not rely only on the opportunities offered to all sorts of organisations for more efficient ways of doing business, but on its ability to create the conditions for new activities and new service organisations to emerge. As this 1998 EITO report and market statistics indicate, the move towards the adoption of Electronic Commerce has started and is progressing very rapidly.

This is just the beginning of a process that is expected to produce radical changes in business, involving more and more economic players and consumers. Electronic Commerce can play a key role in expanding business and opening new markets. It provides small and medium-sized enterprises with distribution mechanisms that would be impossible or too expensive with traditional approaches, offers new forms of direct relations between companies and customers, and drastically reduces the cost of business-to-business and business-to-customers transactions. Electronic Commerce can also have an important impact on the modernisation of public services and the improvement of relations between government and citizens.

The ICT industry has an essential role to play in setting the conditions for the development of Electronic Commerce. By providing the technologies, the infrastructure and the services needed for changes in business practice, the ICT industry is leading a real evolution in the economy. There are several limitations in today's technologies, and substantial advances are required for extending their use in more application areas and obtaining broader acceptance by the average user.

Policy Initiatives for Electronic Commerce

Despite the positive indications of increasing diffusion of Electronic Commerce, there are two critical aspects to consider.

First, *the pace of adoption is not sufficiently rapid:* it is below the rate that could be expected in an advanced economy such as that of Europe. This can be easily illustrated by comparison with the USA. Internet use, Web-generated revenues and penetration of personal computers in Europe are significantly below US levels; this is reflected in a lower IT expenditure/GDP ratio and lower IT expenditure per capita. Also in 1997, total ICT market growth in the US (9% over 1996) was higher than in Europe. Such structural gaps, particularly significant in some regions of Europe, represent critical challenges for the ICT industry and demand political attention.

Second, there are *a number of obstacles hampering progress.* These are of different types: technology, infrastructure, cost, as well as management culture and availability of skills. Among the most significant barriers to ICT investment are uncertainties about the future regulatory environment. The adaptation of the legal and regulatory framework should provide the conditions for increasing confidence in the use of Electronic Commerce and for improving reciprocal trust among the players. At the same time, it is necessary to ensure that inherent cost advantages are not offset by high communication costs or new types of taxation.

In its Communication on Electronic Commerce, adopted in April 1997, the Commission identified the four key areas where action must be taken and implemented by the year 2000 if Europe is to benefit from this new and rapidly developing way of doing business. These are:

1. *Widespread, affordable access to the infrastructure must be ensured, together with secure and easy to use technologies and high-capacity telecommunication networks.* This will be pursued by ensuring full telecommunication liberalisation – since 1 January 1998 in the stage of full implementation – and by harnessing and refocusing R&D efforts, as well as by encouraging a broad consensus on standards and interoperability of electronic market systems.
2. *A coherent regulatory framework within the EU, based on the Single Market principles,* must be established in order to encourage business to invest and give consumers confidence to make use of opportunities in Electronic Commerce. Mutual recognition of each Member State's rules should be used to dismantle barriers and prevent the creation of new obstacles while at the same time ensuring effective protection of recognised general interests. Effective rules are needed to establish trust in critical areas such as electronic payments, digital signature and cryptography. Tax systems must provide clear, transparent and predictable tax obligations, and must be neutral, in the sense of avoiding any extra burden as compared to traditional commerce.
3. A favourable business environment must be fostered by *promoting skills and raising awareness.*
4. There must be a *compatible and coherent regulatory framework at a global level.* Electronic Commerce is global by its nature. Global networks such as the Internet highlight the need for a global approach in setting the rules. These include, in particular, issues such as data protection, data security, taxation and standards.

Convergence of Technologies

The technologies that are central to the Information Society are developing very quickly, and substantial and sustained investment in R&D is required to maintain market competitiveness. Take-up actions need to be integrated with R&D to stimulate the early adoption of ICT and make sure that R&D results meet real market needs. The Internet revolution is concurrent with another huge paradigm shift: the convergence of information and communications technologies. Convergence is now happening everywhere. Users are starting to handle digital data from many different sources – text, image, video, sound, fax, voice, data – in a "single digital space". Cultural and technological barriers which previously separated the worlds of broadcasting, publishing, telecommunications and IT are disappearing. Indeed, 15% of global mergers and acquisitions in 1996 were in the "converging" domains.

The new Information Society Technologies (IST) Programme of the Fifth Framework Programme, proposed by the Commission, fully recognises the convergence of information and communications technology. One key action of the IST Programme aims to create the mass-market technologies and business practices for Electronic Commerce in Europe and to test them in international business pilots. Support for the interlinkage of technology, legal environment and business practice is an important element of the Programme.

Promoting the Competitiveness of the ICT Industry

A number of policy actions having an important impact on the competitiveness of the ICT industry are underway. These include: the liberalisation of the telecommunication market, support for the development of Electronic Commerce and the R&D programmes. These actions, as well as other on-going initiatives concerning telecommunications, regulatory simplification, education and training, etc. will provide essential building blocks and a favourable framework for the development of the ICT industry.

The Commission addressed the issue of the competitiveness of the ICT industry in a Communication of April 1997, which identified a set of additional domains which concern the ICT industry more specifically. In these domains, new specific actions are being defined, in co-operation with the industry and the Member States. These actions include:

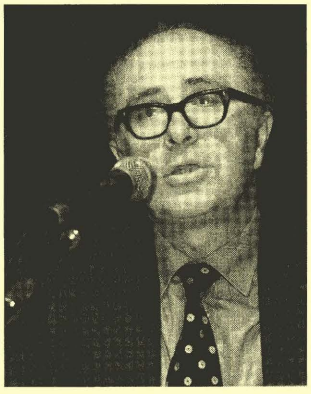
- *Improving global competition.* The Information Technology Agreement (ITA), which entered into force on 1 July 1997, abolishes tariffs on all IT products by the year 2000. ITA will contribute to reducing the costs of production in Europe, while providing European manufacturers with better opportunities for exporting to foreign markets. Action will continue to extend the country coverage of the ITA and to eliminate non-tariff barriers in our main trading partners, notably by pursuing mutual recognition agreements and greater harmonisation of standards.

- *Improving the standardisation process.* The entire European standardisation policy has recently gone through a radical review. ICT standardisation is in principle industry-led and market driven. The critical point is the achievement of a sufficient level of interoperability between networks, services and applications. The main tool for the achievement of this objective is the creation of an efficient platform for consensus building between all economic players: industry, users and public authorities.
- *Accelerating ICT take-up.* Awareness initiatives should draw attention to the competitive advantages offered by ICT investment. At the European level, actions will be undertaken to stimulate change, by disseminating best practice and promoting methods for ICT take-up among decision-makers in SMEs as well as large corporations. ICT products are tools, however, which can help people. People have to be trained to use them. Public education needs to prepare people to use ICT.
- *Developing industrial co-operation.* The European ICT industry must continue to restructure, relocating activities and establishing effective networks of suppliers and subcontractors. Co-operation is particularly important for SMEs, which have more difficulties in developing internationalisation strategies. The Commission supports in particular the facilitation of co-operation between companies in the EU and in the Central and Eastern European countries, in the context of the EU enlargement strategy. Actions will also be aimed at assessing the processes by which SMEs have access to critical resources such as finance, technology, management, and identifying best practices to be promoted and disseminated.
- *Promoting skills.* Skills upgrading is at the heart of the process of providing increased added value in ICT products and processes. Companies are engaged in building a competent workforce, improving performances and defining training programmes. In addition, as discussed elsewhere in this volume, shortages of skilled staff are expected in the coming years, as a result of the increased demand for IT services associated with the change of date at the year 2000 and the adoption of Euro. The Commission will support industry efforts in order to improve the matching between education systems and industry needs.

ICT in Europe: the Industry's View

Successes in WTO Negotiations

Recent trade agreements have played a fundamental role in progress towards the Global Information Society. 1997 brought two major successes for the ICT sector in WTO negotiations: the Information Technology Agreement (ITA) and the Basic Telecommunications Services Agreement. Both are historic events that represent important steps towards the Global Information Society. At the same time, they open the way for further progress in multilateral negotiations in other sectors.



Bruno Lamborghini, President of EUROBIT and Chairman EITO

No More Tariff Barriers through the ITA

The business sector and EUROBIT as well as ECTEL in particular played an important part in the successful completion of the ITA. The original idea for a world-wide agreement abolishing duties on Information and Telecommunications products was placed on the political agenda at the end of 1994, through a joint initiative by EUROBIT and the US association ITIC. Thanks to the numerous submissions presented by EUROBIT and the member associations and participation at national and international meetings, the viewpoint of the European industry is clearly expressed in the final text of the ITA.

A Fundamental Role of TABD

The Transatlantic Business Dialogue (TABD), in which I chair the ITA Issue Group, made a key contribution to the transatlantic consensus reached in Chicago in November 1996. The TABD's fundamental role in promoting real progress in trade liberalisation was confirmed at the Rome Conference in November 1997, which urged the rapid completion of the ITA and the simultaneous dismantling of non-tariff barriers for products covered by the ITA (giving priority to the principle of One Standard-One Test-Supplier's Declaration of Conformity).

For the European industry and users, abolition of ICT duties means an annual saving of more than US$ 1.6 billion. The ITA has already marked up a number of successes, for example on behalf of the European semiconductor sector, which now takes an active part in the industry decision process at world level.

Areas to be addressed by ITA 2 include the automatic abolition of the very low duties that remain, a review of terms for some ITA signatories e.g. South Korea, the extension of product coverage and the inclusion of Mexico, Chile, Brazil, China, Poland and Russia as ITA signatories.

Opening of Telecommunications Markets

On 15 February 1997, at the WTO in Geneva, 69 countries (including more than 40 developing countries) signed an agreement on three key areas: greater market access, increased foreign-investment opportunities, and a set of pre-competitive regulatory principles. The agreement covers more than 90% of international telecommunications markets. Restrictions on access to satellite communications are to be generally abolished. This process should be completed by the year 2005.

Once again, EUROBIT played a significant role, with active contributions to joint position papers drawn up with Quad sister organisations in the USA, Canada and Japan.

Market Opening and Liberalisation

When fully implemented, the WTO agreement should significantly reduce access costs to telecommunications markets for foreign companies. To be effective, market opening should proceed in parallel with modifications in national regulatory structures, to ensure free competition on local markets in line with the key regulatory principles set out in the agreement (competitive safeguards, interconnection, universal service, licensing criteria, independent regulator, allocation of scarce resources).

The next step is to specify the technologies, products and services that come under the provisions of the agreement, in order to avoid any confusion in the distinction between telecommunications services and broadcasting or between enhanced communications services and basic services (e.g. for the Internet).

These WTO agreements are a fundamental achievement in the construction of the Global Information Society. Nevertheless, careful monitoring is necessary to ensure that turmoils on the international financial markets and protectionist pressures do not block or delay the process.

A Major Driver of the GIS: Electronic Commerce

Electronic Commerce is turning the extraordinary benefits of the Internet into new business opportunities, at every level: business-to-business (B2B), business-to-market (B2M) and also government-to-business (G2B). Electronic Commerce is a powerful driver in the creation of new markets, new applications, new business and new jobs. Given the growing interest in this area, in Europe as well as in the US, 1997 can be considered the year of Electronic Commerce.

It is clear from the numerous papers, reports and conferences organised in 1997 (A European Initiative in Electronic Commerce, The Bonn Declaration, The White House Framework for Electronic Commerce, etc.) that Electronic Commerce is destined to become a core element of the new scenario, a motor for new business and new jobs. But several critical issues concerning the regulatory environment and standards need to be resolved. The growth of the Internet and Electronic Commerce could be obstructed by adverse regulatory and fiscal conditions.

Some Basic Principles for Electronic Commerce

For this reason, a number of basic principles need to be clearly established:

- No regulations for regulation's sake;
- Any regulations must respect all the Single Market freedoms (free movement of goods, people, services and capital);
- Any regulations must take account of business realities;
- Any regulations must meet general objectives effectively and efficiently;

- No new taxation on the Internet and Electronic Commerce: tax-neutrality should be the rule;
- No bit tax;
- The growth of Electronic Commerce must be market driven, not government driven;
- Success is possible only with a truly global approach to both regulations and standards;
- Electronic Commerce standards should be technically neutral and geared to interoperability;
- Consumer trust and user trust is vital.

Global Agreement for Standards and Regulation

Global agreement is needed on the following basic Internet/Electronic Commerce issues: digital signatures, data protection and security, encryption and intellectual property rights. Some results were achieved in 1997 at governmental conferences in Europe and at the Transatlantic Business Dialogue Conference in Rome. But divergences still exist (e.g. encryption) and we expect real progress to be made in 1998.

As regards efforts to reach a common ground on global standardisation, the Global Standard Conference for Information Society held in Brussels on 1-3 October 1997 was an important step forward. The four workshops (Electronic Commerce, Services to the Public, Individual Use, Interoperability) confirmed the consensus on the need to give the standardisation process a global focus and to keep standards development closely linked to advances in the regulatory framework.

Progress in Telecom Liberalisation in Europe

1 January 1998 is not just an historic milestone for Europe; it has become a term of reference for the rest of the world. Much progress has already been made, with Europe shedding its old image as a laggard, a defender of public monopolies.

Cellular mobile telephony (notably GSM) has become a success story for the European industry and market competition is growing daily in both wireless and wireline communications. But full competition is still a long way off: key issues such as interconnection charges, universal services, number portability, etc., on which the growth of new entrants depends, are still unresolved in many countries.

Convergence and Multimedia

Other major issues relate to the grey area of convergence: in other words, the regulatory environments for the converging services of telecommunications, videobroadcasting, satellites communications, Internet, online services, digital media, in a word the so-called multimedia environment.

At the beginning of December 1997, the European Commission produced a fundamental Green Paper on Convergence. The intention is to contribute to the definition of a favourable framework for convergence, along the lines of the Open Network Provision Paper in 1987, which set off the liberalisation process in telecommunications.

Debate in 1998 must focus on convergence, which we believe could lead to significant progress in the creation of a truly competitive marketplace in Europe.

A Driving Force for the Information Society: the EURO

By promoting market integration and the harmonisation of administrative procedures, taxation, prices, service quality and salaries throughout Europe, the introduction of the Euro will accelerate the development of the Information Society. It will force a complete rethinking of organisational structures and information processing models. In parallel with Electronic Commerce, the Euro will unify European markets.

If correctly managed, the combined forces of Electronic Commerce and the Euro will achieve extraordinary progress towards a real Single Market and the Information Society. Together, they will foster a "peaceful revolution", taking Europe in the next century into the Information Age, with a single currency, a single communication technology (Internet), a single market.

The Growing Role of Services

Europe has entered the so-called "brainware" cycle, where basic resources are no longer traditional raw materials, but knowledge, where products are no longer traditional hardware, but more and more information/communication-based services. Increasingly, therefore, Europe will become a region of high-value/high-skill services (including hardware products with a growing "intelligent services" content).

The "Skill Race" and the Skill Shortage

To complete the transformation successfully – to which there are no alternatives – Europe has to invest in skills. Global competition in the new century will take the form of a "skills race".

Europe's skills requirements are a matter of concern: it is already woefully lacking in Information and Communication Technology skills. Throughout the region, there is a shortage of skilled people for today's two crucial issues: the "millennium bomb" of the year 2000 and the Euro. The problem will worsen over the next few years and could become a major obstacle to the development of the Information Society and to job creation. Urgent action is needed on the skills issue at both national and European level.

Co-operation between EUROBIT and ECTEL

To strengthen the industry's contribution at a time when the diffusion and convergence of Information Technology and telecommunications are fuelling revolutionary changes in Europe, the two European associations respectively for Information Technology and for telecommunications and professional equipment, EUROBIT and ECTEL, agreed at the end of 1997 to co-operate closely at all levels. A Memorandum of Understanding between EUROBIT and ECTEL provides for close co-operation among working groups to ensure effective representation of the European ICT industry at international level.

Information and Communications Technology (ICT) is the core industry of the 21st Century and therefore needs a strong representation in the decision-making processes that are currently shaping the framework for a market-driven Global Information Society. It needs a focused and co-operative guidance between industry and government at national, European and world level.

Conclusion: a Challenging Time for Europe

This is a very challenging time for Europe: major political changes are taking place, from Monetary Union and completion of market unification to the enlargement of the Union to other countries in the East and possibly also in the South (the Mediterranean region is moving closer to Europe every day). Furthermore, many European countries have to find solutions to the most difficult challenge: how to reduce an unacceptable level of unemployment.

The spread of ICT and the growth of the Information Society can help speed up these processes and resolve the problem of unemployment – as long as everyone accepts change instead of trying to defend the status quo.

The Information and Communications industry is ready to provide the tools to bring about this cultural and social revolution and to build a real Global Information Society in Europe and world-wide.

The ICT Market in Europe

The data and forecasts presented in this paper have been jointly prepared by IDC and the EITO Task Force on the basis of information available at mid-December 1997.

1. Overview

The European ICT market is set for an improvement over the next two years due to the following trends:

General business environment drivers

- Economic recovery across Europe;
- Restructuring initiatives towards adoption of information-centred business strategies to deliver higher value to shareholders and customers;
- Increasing global and cross segment competition;
- Further progress towards a true single European market and increasing economic convergence, forced by the Euro, allowing more transparent economic decisions.

For 1998 and beyond, the next step for companies is the deployment of *Internet technology* as an extension of legacy applications and databases.

ICT deployment drivers

- The *exploding impact of electronic commerce* increasing and improving interactive information exchange and utilisation within the organisation as well as with partners and customers via the Internet;
- The adoption of *Internet Protocol (IP),* gradually becoming the standard, used to expand applications reach for high-level business process and transaction functionality;
- The incorporation of Web browsers and *Web-enabling capabilities into applications;* improved delivery technology making access to the Web more intuitive, relevant and easier for users;
- *Opportunities of communications capability enhancement* created by falling cost of communications, as a result of telecommunication services liberalisation and combined with explosive growth of mobile communications;
- *Cultural change* supported by the European Commission and national governments' Information Society initiatives; the incorporation of Internet access into the everyday life of mainstream users being fostered by easy access capabilities, and relevant services that provide value.

ICT contingent requirements

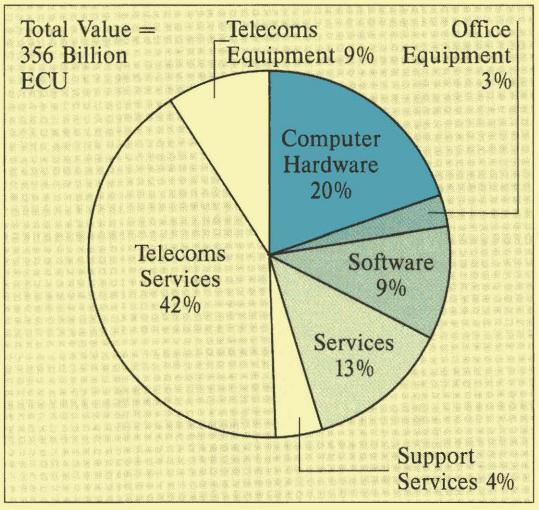
- Double-accounting systems in preparation of Single Currency (Euro);
- Year 2000 date change.

Table 1
Western European Information and Communications Technology (ICT) Market, 1997*
*Billion ECU***

	1997 Value	% of IT/TLC	% of ICT
Total IT	**175**	**100.0**	**49.1**
Computer Hardware and Datacom	71	40.4	19.9
Office Equipment	9	5.4	2.6
Software	34	19.2	9.4
Services	45	26.6	12.8
Support services	16	9.0	4.2
Total Telecommunications	**181**	**100.0**	**50.9**
Telecommunication Equipment	31	16.9	8.6
Telecommunication Services	150	83.1	42.3
Total ICT	**356**		**100.0**

Note: * Western Europe includes the 15 EU and 2 non-EU countries (Switzerland and Norway)
** It should be noted that all figures have been rounded to the nearest billion ECU at 1996 constant exchange rates. Total and percentages may not add up due to rounding.

Figure 1
Western European Information and Communications Technology (ICT) Market by Product. 1997



ICT market perspectives

In the period 1997-99 overall ICT spending in Europe is expected to grow at annual rates of around 8%. However, trends are significantly different for telecommunication and IT sectors. In telecommunications, the growing use of the network (in terms of minutes of communications or quantity of transported information) will be partially balanced by falling tariffs due to the new competitive environment.

By contrast, IT market growth is expected to accelerate, consolidating the recovery of the past year. Demand for software and IT services is stronger. Many companies are shifting IT budget from internal to external expenditure seeking for breeds of Internet technology expertise and skills. Business users are increasingly investing to cope with the Euro and Year 2000 issues.

1.1. IT and ICT Market Size

The Western European ICT market reached 356 billion ECU in 1997, representing some 4.9% of the overall GDP. Information technology categories (including office equipment, electronic data processing equipment, software, professional services, processing services, network services, hardware maintenance and support) contributed 175 billion ECU. Telecommunication equipment and services accounted for the remaining 181 billion ECU of the market.

The Western European ICT market improved its pace of growth in 1997, with a rate of 8.0%, and it is set to continue at a slightly higher pace (8.2%) in the current year. An improving dynamics characterises the IT portion of the market, which grew by 8.2% in 1997, while the telecommunication portion grew by 7.8% in the same year. Contrary to the trends of the previous two years, in 1997 and the follow-

ing two years the pace of growth of the IT market will be higher than telecommunications. The IT market will grow by 9.1% in 1998 and by 9.6% in 1999.

Compared to the US market, IT dynamics continued to remain slower in Europe, widening the gap between the two regions. This gap was further increased by the loss of European currencies against the dollar.

Compared to the worldwide ICT markets, the European share remained almost unchanged, because of a much lower growth performance by Japan. As a result overall worldwide growth was more in line with European average growth. Overall Europe accounted for 30.3% of worldwide ICT consumption in 1997 (29.3% of the worldwide IT market, and 31.3% of the worldwide telecommunicatons market).

ICT market growth in the US recorded a 9.0% rate in 1997. Asia Pacific and Latin American markets provided the strongest support to the growth in the Rest of the World aggregate, which recorded a 12.9% growth in 1997. The Japanese ICT market showed a declining growth trend, with 4.6% in 1997, due to the weak economic cycle and more critical investment perspectives after the Far East financial markets crisis.

The ICT markets of the Four Tigers (South Korea, Taiwan, Hong Kong, and Singapore) continued to grow faster than the worldwide average with a combined 1997 market growth of 13.6% in IT (down from 1996 market growth of 18.6%) and 7.5% in Telecommunications (up from 7.2% in 1996). ICT market growth in these countries is expected to slow down in current year, as 1998 ICT budgets are hit by the 1997 crisis in the stock markets.

	1997 Value	1996 %	1997 %	1998 %
Europe*	182	29.7	29.3	29.0
US	259	41.4	41.7	41.8
Japan	95	16.0	15.3	14.7
4 Tigers**	18	2.8	2.9	3.1
RoW***	67	10.1	10.8	11.4
Total	**621**	**100.0**	**100.0**	**100.0**

Note: * Europe includes Western and Eastern Europe
** 4 Tigers = Hong Kong, South Korea, Singapore, Taiwan
*** RoW = Rest of World

Table 2
Worldwide IT Market by Region: Percentage Breakdown Calculated on Market Values. 1996-1998. Billion ECU

	1997 Value	1996 %	1997 %	1998 %
Europe*	371	30.5	30.3	30.2
US	424	34.6	34.6	34.6
Japan	171	14.5	14.0	13.4
4 Tigers**	48	3.9	3.9	3.9
RoW***	211	16.5	17.2	17.9
Total	**1,225**	**100.0**	**100.0**	**100.0**

Note: * Europe includes Western and Eastern Europe
** 4 Tigers = Hong Kong, South Korea, Singapore, Taiwan
*** RoW = Rest of World

Table 3
Worldwide ICT Market by Region: Percentage Breakdown Calculated on Market Values. 1996-1998. Billion ECU

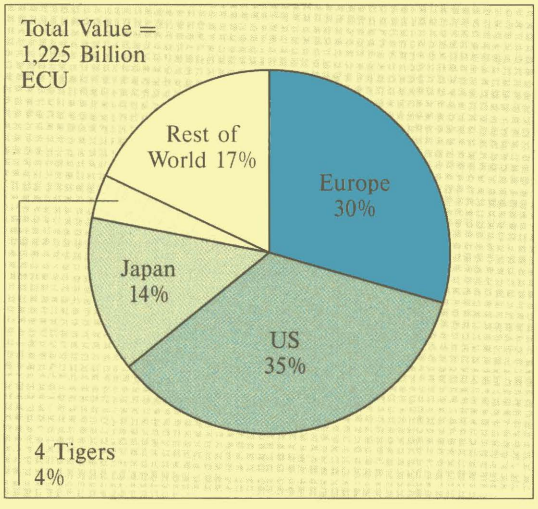


Figure 2
Worldwide ICT Market by Region. 1997

1.2. Current Economic Situation and Prospects in Western Europe

Western European GDP grew by 2.6% in 1997, and is expected to keep an improving pace in 1998 (2.8%). US economic growth has been a sustained 3.8% in 1997, and is set to grow by 2.7% in 1998. After a poor performance in 1997 (0.5%), Japanese GDP is expected to grow by 1.7% in 1998.

Banking on stronger growth in Member States taking part in the final stage of Economic and Monetary Union (EMU), the EMU Member States will record a faster rate of increase in 1998. Apart from Greece and France (whose public deficits will represent 5% and 3.1% respectively of the GDP in 1997), the other EU Member States ensured a strict maintenance of this criterion for participating in the single currency in 1997. An active continuation of structural reforms to make the labour and product markets more competitive and more efficient is ongoing.

Inflation in the European Union reached 1.8% in 1997 (compared with 2.1% in the European Commission's Autumnal forecasts). This economic indicator should rise slightly to reach 2% over the next two years. The UK, the country with the fastest rate of growth, and a level of expansion now reaching maturity, has to be on the lookout for a rapid return of inflation. On the employment front a very slight fall in the rate of unemployment was observed in 1997, to 11.3% of the working population compared with 11.4% in 1996. The trend is expected to accelerate in 1998, when the rate of unemployment should reach 10.9%. This development suggests that the number of people out of work this year is expected to drop by half a million to make a total of 18.3 million.

Table 4
Western European IT Market by Country: Percentage Breakdown and Growth Calculated on Market Values. 1997-1999. Billion ECU

	1997 Value	1997 %	1997/96 %	1998/97 %	1999/98 %
EU	164	93.7	8.2	9.1	9.6
Germany	43	24.4	6.2	7.3	8.4
France	32	18.2	8.3	9.1	9.9
UK	31	18.0	9.8	10.1	10.1
Italy	15	8.5	6.3	8.4	9.1
Spain	7	3.9	10.5	11.9	12.4
Other EU	36	20.6	9.7	10.0	10.0
Non-EU*	11	6.3	7.6	9.0	9.6
Western Europe	**175**	**100.0**	**8.2**	**9.1**	**9.6**

Note: * Switzerland and Norway

The two largest European economies, Germany and France, are expected to record improving performance in 1997 (2.3% GDP growth in France, and 2.4% in Germany), although still striving with unemployment. The Italian economy also appears sluggish at present with extraordinary efforts to meet Maastricht criteria for the EMU. Italy's GDP grew by 1.3% in 1997, and is set to improve to 2.1% in 1998. The UK economy grew by 3.4% in 1997, and is set to record a slower 2.2% growth in 1998. The Spanish economy is set for continuous growth improvement with a 3.2% rate in 1997, and 3.6% in 1998.

1.2.1. IT Trends

i. Trends by country

Germany: uncertainty versus potential

The upturn in domestic investment activity is expected to intensify and help underpin the ongoing recovery in Germany's economy. Since the beginning of 1997, the economic development has gathered in pace, helped by expanding exports and a weakening exchange rate. By contrast, domestic economic activity continued

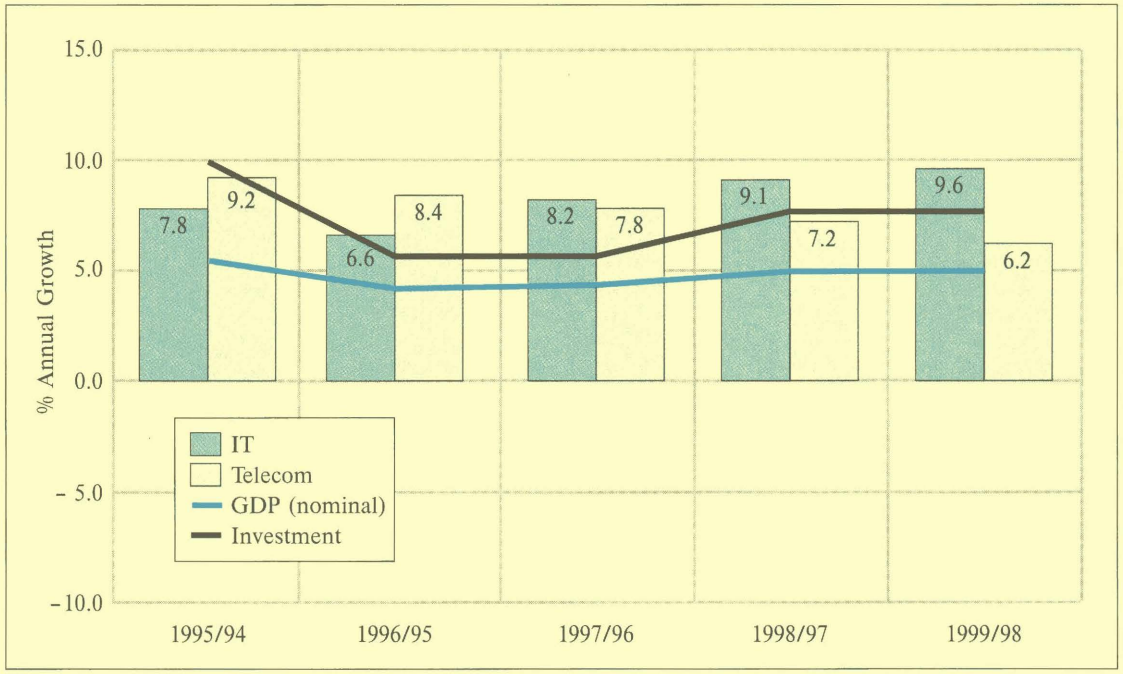


Figure 3
Western European GDP, Investment, IT and TLC Market, 1994-1999

to remain sluggish. Inflation remained under control despite higher import prices, thanks to falling unit wage costs. Overall economic growth was 2.4% in 1997, and is expected to rise to 3.0% in 1998.

The German IT market grew by 6.2% in 1997 and is expected to grow by 7.3% in 1998. The need to cut costs and become more flexible has driven the demand for IT solutions. The German public sector intensified investments in IT, while the financial sector continued to restructure.

The steady performance of the PC segment was driven mainly by the business sector, whereby the sales of notebooks improved.

Services are quickly becoming the most active segment of the German IT market, while the software market has continued to show a solid growth. The Year 2000 issue and the increasing uptake of packaged solutions have con-

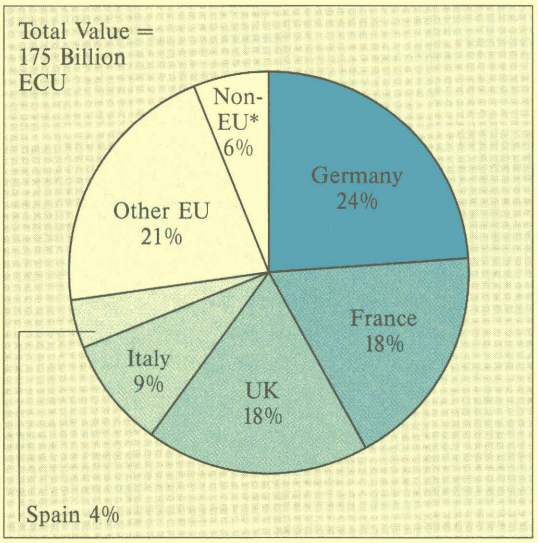


Figure 4
Western European IT Market by Country, 1997

tributed to the development of these segments. Lack of guidelines for the implementation of the Euro has delayed related projects. The growth of outsourcing was relatively small, but it is expected to rise.

France: slow recovery

After a poor 1996, the French economy experienced a slow recovery in 1997, driven by the export market. The domestic demand remained weak, as a consequence of the low public confidence. Overall, the GDP growth was about 2.3% in 1997, and is expected to be 2.0% in 1998.

IT investments were negatively affected by the economic situation. The pursuit of restructuring has been seen in several sectors of activity (banking, insurance, the public sector, health, defence), but on the basis of major rationalisation programs. As a consequence, the perspectives for investments remained weak in these sectors. IT spending was hit by the current restructuring of the public administration and state-owned enterprises. A real take-off in households demand largely depends on the recovery of more positive expectations and confidence in the economic situation. The IT market growth rate was 8.3% in 1997, and is expected to increase to 9.1% in 1998.

In the hardware sector, purchase decisions were complex and increasingly sensitive to product prices. The growth in value of the PC market (excluding servers) slowed down in 1997. The business market increased slightly compared to 1996. Growth was driven by the revitalised investment policy of business encouraged by the aggressive pricing policies of desktop vendors. Rates of growth in PC sales were higher in the home segment but households demand was positively affected by a better price positioning of multimedia PCs, and a partial renewal of the installed base. Home market demand is still slow to take off compared to its potential.

The services market has benefited from a favourable situation, related to the Year 2000 and the Euro issues. The need to integrate and deploy architectures under Unix and NT, and the development of messaging, networking, and groupware applications, were also main drivers of this segment. The French software market has been characterised by a strong reception of DBMS applications and Windows NT. Unix remained strong amongst medium-sized enterprises and large accounts.

UK: record sustained growth

The UK enjoyed a strong economic growth in 1997, but had to face threats of increasing inflation. Domestic spending drove economic growth, while export prospects were affected because of the continuing strength of the pound. Real GDP grew 3.4% in 1997, and is forecast to grow 2.2% in 1998.

The incoming government reconfirmed a strong commitment to information society development and to widespread use of electronic methods in public services and schools.

The UK IT market sustained a 9.8% growth in 1997. Government and education initiatives strengthened this trend. Growth is expected to keep a similar pace of 10.1% in 1998.

Within the PC market, there was a notable increase in the shipments of desktops into the home, confirming the strong trend in consumer spending. The target was the replacement of existing devices. The mid-range and the PC server markets were among the most dynamic.

The packaged software market continues to enjoy strong growth particularly for system-level software and PC applications. The relentless release cycle for desktops and server application products will help ensure this market remains buoyant for the foreseeable future. Internet-enabling of existing applications was one of the key drivers in software development.

In order to meet the change required by the business environment (globalisation, deregulation, and downsizing), companies have increased their demand for business and IT consulting. Systems integration was the most explosive area of the UK services. Outsourcing was also one of the strongest segments. The retail and distribution sector was one of the key areas of growth, with the financial sector being the single largest user of outsourcing services. The increasing complexity of information technology and pressure from business, economic and political issues will help ensure continuous opportunities for services suppliers also in 1998.

In the UK, a particular interest was shown in Network Computing (NC). Early adoption by some major UK companies has lent credibility to the NC. The financial sector was one of the foremost champions of this technology.

Italy: improving investment environment

Despite excellent performance in inflation control and public deficit reduction, Italian economic growth remained constrained in 1997, mainly because of flat internal demand, high unemployment level, delay in economic recovery in central and southern regions and weakening small and medium enterprises' performance in most economic sectors. In 1997, the overall economy grew by 1.3%, but it is expected to be stronger in 1998, reaching 2.1% growth level, as consumer confidence and business climate improve after the achievement of Maastricht targets.

Economic recovery and the process of privatisation of large publicly owned companies in the communications, utilities and finance sectors set a favourable environment to the recovery in the IT market. However, weak demand from some sectors, like public administration and households, hit by restrictive fiscal and budgetary policy, reduced the strength of the recovery. Overall, in 1997 the IT market grew by 6.3%, the highest growth in the last five years, but still below the European average. In 1998, it is expected to improve substantially to 8.4%.

In the PC market, households and small and medium enterprises' demand remained cautious in 1997, as a consequence of the economic uncertainty. Large accounts have driven the recovery of the PC market, while the NT platform catalysed most of the attention. Large contracts in government, telecommunications and financial institutions started to show positive growth dynamics from the second half of 1997, and are set to drive growth throughout the next two years. Meanwhile, the aggressive selling-in policy of many vendors has led channels suffering from some risk of overstocking.

The services segment was characterised by the start of several projects regarding the Euro and the Year 2000 issues among large enterprises. However, the Year 2000 problem will impact the Italian IT market more strongly in 1998. Banks have been increasing the demand for IT consulting, to solve the Euro conversion problem, but also to prepare themselves for electronic commerce and new electronic delivery channels. Systems integration and consulting have been the main drivers of the market.

In 1997 the start-up of many outsourcing projects was slow, despite a huge number of pending negotiations. This was due both to supply scarcity of skills and competence in the economical and technological management of a project and to the immaturity of demand (low in-depth knowledge of outsourcing and reluctance in the externalisation of core and non core areas of activity). Prospects are forecast to improve in the 1998-99 period. Positive growth is also expected for asset and network management services, driven by architectural changes.

The software market recorded a positive growth during 1997, but the application software segment showed a slower growth than the other

major countries. However in the current and next year demand for application software will accelerate thanks to the impact of the Euro and Year 2000 issues.

Spain: outpacing the laggards

Economic activity gained momentum in 1997 with GDP growth at 3.2%. The same trend is forecast for 1998. High levels of demand components have ensured a steady economic growth, while public spending was kept under strict control to meet the Maastricht fiscal target. The highlights were an amazing decline in inflation and a substantial job creation. However, households' purchases were moderate and unemployment rather high. Consumer spending and net exports provide important contributions to growth, although fixed investment remained weak.

IT market growth was 10.5% in 1997, and is anticipated to reach 11.9% in 1998. Banking, transport and communication were the most dynamic sectors. The Spanish home market has been slow to take off, but the good economic climate and the cheaper price of connections to the Internet sustained its growth. Growth in domestic demand also helped small and medium-sized enterprises (SMEs) to accelerate their investments in IT.

In the PC market, both the business and home segments were very dynamic, with an increase in the number of units sold, and a decrease in the commercial margins. Competition between leading companies, and aggressive price strategies characterised both desktop and portable markets. Some vendors focused on notebook shipments, which showed a steady growth.

The services market was boosted by the growth of projects around networking and the need for systems integration. Outsourcing and consulting are increasing in particular in the finance and utilities sectors.

The erosion of the System Level Software segment was faster than foreseen, especially in proprietary systems.

Other countries

A strong economic environment enhanced the IT market in the Nordic regions. Growth in 1997 reached 8.8%, and will slightly improve to 8.9% in 1998.

Cautious investment attitudes put the brake on IT spending growth in Switzerland, which scored a 6.6% growth in 1997. Growth is expected to improve in 1998 to a rate of 9.0%. Austria recorded strong 9.6% growth in IT in 1997, and a better performance is expected for 1998 (10.6%).

The Belgian IT market recovered substantially in 1997. Higher than average growth of IT spending (10.8% in 1997) is expected also for 1998 (11.3%). The Dutch IT market recorded a growth rate of 10.4% in 1997, and is set to keep the same pace in 1998 (10.2%).

The Irish IT market is performing above the European average (10.0% in 1997 and 11.2% in 1998). Greece enjoyed a higher than average growth (11.9% in 1997 and 12.6% in 1998). The IT market in Portugal grew by 11.6% in 1997 and will keep the same growth in 1998.

ii. Trends by product segment

IT hardware: matching platforms to new applications

IT hardware revenues increased by 6.9% in 1997, and a 6.8% growth performance is anticipated for 1998. For the first year over the past decade, growth in the server systems segment has equalled growth in the PC client segment. New business tied to the implementation of Internet and Web-related applications is nurturing growth across all server platforms.

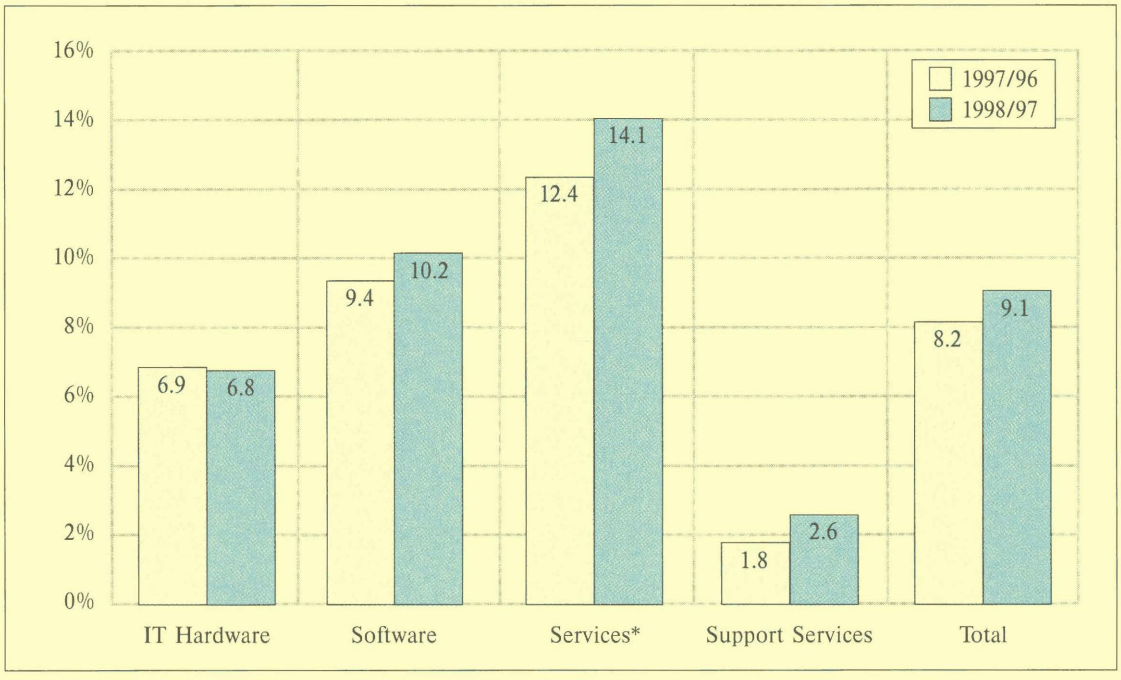


Figure 5
Western European IT Market Value Growth by Product Segments. 1997-1998

* Services include: Consulting, implementation and operations management services

IT spending on servers is set to rise as a percentage of total IT hardware spending. Corporations have found financing for new intranet server and communications platforms from the increasing savings allowed by skinnier and increasingly standard PC configurations. In many ways the server has started to be at the heart of the hardware universe again. It dictates which peripherals can be attached to it, what communications ports are available, and what systems and applications software will run. Although some organisations may use low-end servers as central repositories, the majority of major corporations, Internet service providers, and telecommunications companies are expected to use high-end servers for Internet-based services to customers. The swap out of older software platforms too costly to update for the year 2000 date change or Euro conversion is also boosting new server sales, making the battle for leadership in the hardware server segment even more urgent.

Unix and high-end servers are strongly present on certain applications such as Intranet and Web servers, while Intel and NT servers benefit from rising demand for groupware or Internet-related vertical or horizontal applications, as well as decision support. Personal computer, workstation and low-end server suppliers have been competing fiercely in terms of price, channel dominance and bundled service packages to gain users' preferences. Users have been benefiting from the launch of new technology platforms at sizable price/performance gains across all hardware platforms.

High-end servers have become more price competitive, maintaining an edge in performance and resilience over their more 'open' competitors. An increase in demand in terms of MIPS and of storage per site has occurred but in a highly aggressive context as regards price per

Table 5
Implementation of Client/Server Computing by Vertical Markets. 1997
% of Sites which are Moving/Have Moved or are Planning to Move towards a Client/Server Strategy

	Germany	France	UK	Italy	Netherlands	Western Europe
Manufacturing	55.7	34.6	59.2	48.2	49.4	50.7
Transport/Communication/Utilities	48.7	36.4	48.8	54.8	23.3	42.3
Retail/Wholesale	55.5	33.4	58.5	52.3	39.7	53.0
Finance	62.4	75.3	54.6	66.6	47.4	64.5
Government	31.5	56.9	50.3	53.5	51.1	41.3
Education	54.9	53.4	63.9	41.0	53.1	50.7
All Industries	**51.4**	**44.2**	**55.1**	**50.7**	**45.1**	**50.2**

MIPS. A trend within large corporations to consolidate (and potentially centralise) server investments has also become emerged. The replacement of several smaller LAN servers with fewer more powerful machines will benefit high-end server business. High-end Unix-based servers started to enter this segment as major applications have become available. S/390 servers decreased their pace of decline.

Unix server shipments enjoyed a healthy growth in the *midrange segment,* because of a broadening of comprehensive software solutions offerings, the rising importance of Unix on new applications (such as data-warehouse, management, vertical applications) among large accounts and the initiatives of suppliers to move up-market in order to avoid competing with Intel-based products in the entry server area. Other proprietary platforms declined in the midrange area, whereas Windows NT-based servers improved their growth performance, even if constrained by scalability and application availability.

In the *low-end server* market, volumes continued to be driven by PC servers, while revenues were negatively affected as Intel-based machines encroached on the low-end AS/400, Open VMS and Unix markets on the back of rapid adoption of NT.

In the *PC market,* the upgrade to Intel-Pentium-based desktops and notebooks continued in commercial establishments of all sizes, while renewal demand of existing installations is becoming the almost exclusive component of PC market growth in the business segment. The continued sustained growth in the personal computer market has led it to contribute some 36.6% of the overall IT hardware market in 1997.

PC market accelerators include:

- Continued desktop and mobile PC upgrading;
- Urge for connection to the Internet through media attention;
- Home PCs becoming a "should" for children combined with the adult desire to be able to work at home;
- Employee PC purchase schemes introduced by large and small companies which reduce the amount of disposable income required (where taxation legislation permits) to own a PC;
- Intel new chips speeds: Pentium Pro and Pentium 2;
- Much improved availability and lower pricing of larger TFT screens;

- Continued refining of European logistics amongst main vendors with consequent reduction of prices;
- Rapid price/performance improvement in key peripherals (printers, multi-function peripherals, CD-ROM drives);
- Consumer channels extending their reach.

The longer term outlook for *desktop* demand is largely determined by the speed at which upgrading can be encouraged in business, combined with the strength of consumer desire for a home computing resource.

In 1998, the emerging alternative for the terminal, referred to as the Network Computer, is expected to detract from desktop demand. The compelling proposition of network computing providing universal access to content and applications is expected to raise business user and consumer interest especially in electronic commerce, home computing and vertical specific applications.

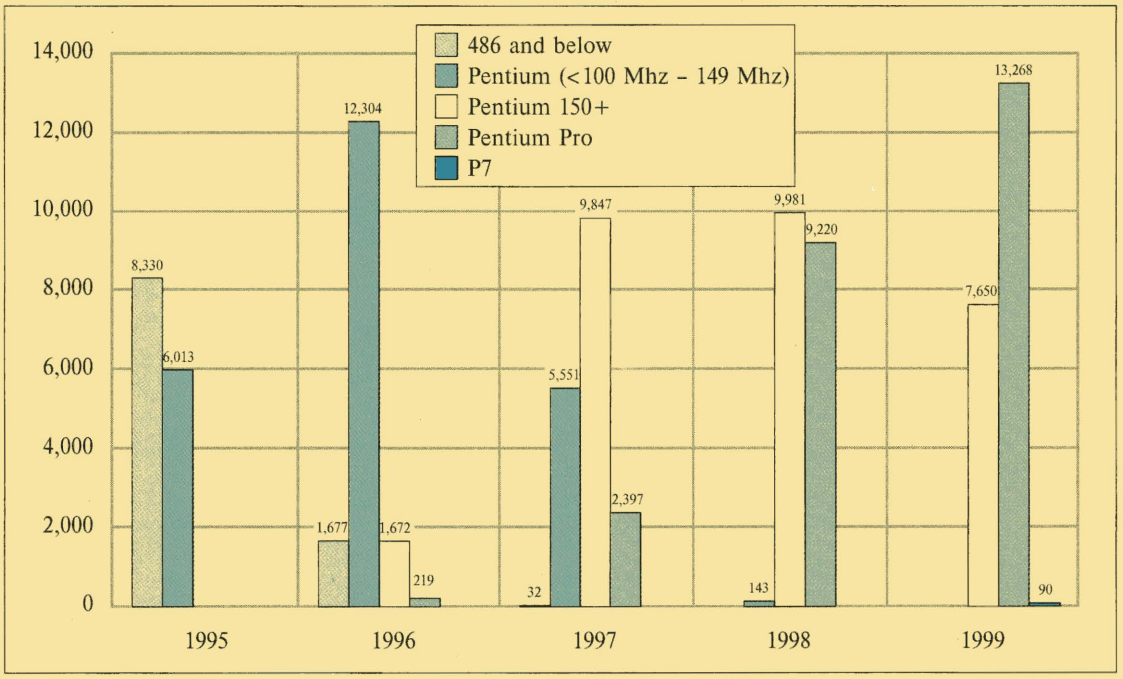
The *portable PC* market continued to expand in 1997, as notebook systems incorporating higher speed Pentium processors (including MMX versions) combined with larger screens and integral CD-ROM drives became available at lower prices. The volume growth for mobile PCs is significantly better than that for desktops in the short and long term, even considering the fact that the vast majority of the home PC purchases are desktops. Business sector growth rates were high as desktop replacement became increasingly popular across companies.

The *traditional workstation market* continued to be hit by the Intel/NT based workstations (personal workstation) in 1997. The traditional workstation suppliers responded to NT with competitively priced systems. High-end applications are forecast to remain strong Unix markets, as the cost to migrate and rewrite internally developed code and scripts will be too high for the market to see a fast migration.

Falling *printers'* prices and increasing commoditisation have made printers accessible to a growing number of buyers. Retail has emerged as the most suitable channel to address the requirements of the home market segment, and of the small and medium-sized enterprises (SMEs) market. The inkjet monochrome and the dot matrix segments continued to suffer decline, while the inkjet colour outperformed the market. The increasing popularity of colour inkjets and their falling prices are acting as major brakes to shipments' growth in the laser printers market. Competition is intensifying in the highest-speed segment and in the colour laser market. Printer manufacturers will definitely feel the impact on the Web's powerful force for interoperability in 1998.

The ongoing process of telecommunications deregulation in Europe had a profound effect on the level of investment in networking equipment in 1997. Increased competition initiated large investments in *LAN* and *WAN* equipment. The massive demand for Internet access, from both the business and residential segments, has also seen tremendous growth in the investments being made by Internet Service Providers (ISPs). However, the European LAN Hub market is expected to slow in the long term. This slow down is due to the increasing maturity of LAN technology and the numbers of PCs connected to a LAN reaching saturation. The LAN switch market was the fastest-growing segment in the internetwork technology market. Switching technologies fit well with end users' needs to future-proof their network without requiring major upgrades of existing LAN equipment. Modem shipments performed well, and are expected to continue to show strong growth. However, the ongoing decline in average sales prices will bring revenue growth for modems down to the low single digits.

Figure 6
Western European Personal Computer Market, 486 Systems versus Pentium, Pentium Pro and P7. 1995-1999. Unit Shipments (Thousands)



The *office equipment* market became increasingly competitive, whereas technology advances and prices continued to fall. As a consequence, a flat growth was recorded in 1997. Though most of the fax machines and photocopiers are standalone units, the major growth market is predicted to be for sophisticated digital devices which interface with office computer systems and incorporate colour functionality. The new market displaying strongest growth potential in 1997 was the small office-home office (SOHO) segment. The SOHO sector received a further boost from large corporations, with the introduction of work-at-home models.

Major trends in the standalone photocopiers areas are:

- Falling unit prices;
- The introduction of multi-functional devices;
- The refurbishment of second-user equipment.

Future generations of "smarter" equipment have been emerging with the incorporation of computer technology into copiers and faxes. Continuous fault-detection and multi-function capabilities are going to have a profound effect on the market. 1997 saw the beginning of the proliferation of "all-in-one" devices, ranging from combined fax/printer/scanners, to copiers which can double as colour printers.

Software products: enhancing information generation and access

Software products were among the strongest drivers of IT market growth. Software sales rose by 9.4% in 1997 and are set to increase by 10.2% in 1998.

The impact of the Internet on software will gradually move from Internet-centric Web servers, firewall and authoring tools, to a wider range of software needed to manage increasingly complex transaction applications. Re-engineering of business processes is being extended to the business network, encompassing the supply chain. The move beyond Internet home pages towards Internet transactions is underway in the areas of customer out-reach, customer self-help, and customer (and supplier) commerce. Delivery and sales of Internet applications are ramping up, with the greatest opportunities in collaborative and supply-chain-related segments. The deployment of large scale applications over an Internet backbone is leading to the integration of new technologies into multi-tier computing architectures. This trend increases the customer need for middleware and system management software to deal with the complexity of the heterogeneous distributed environments and applications.

Similarly to the hardware industry, Euro and Year 2000 issues accelerate the pace of this application renewal process. Solution vendors have been replacing old systems while providing updates to more modern systems currently in place with their clients. Due to continuing price erosion, growth in the solutions market remained fairly consistent. In the tools market upgrades have been occurring gradually.

The Internet strategy driver effects, accelerated by Euro and Year 2000 impact, intertwine with other equally important drivers in packaged software purchases:

- Re-engineering of departmental functions and differentiation in application adoption cycles, motivated by cost control in application purchases;
- Datawarehousing and adoption of business intelligence applications to support the business need of ongoing optimisation, improvement, and performance measurement;
- Enabling of data management of unstructured data and development of search engines to make unstructured data operational;
- Investment in customer retention/call systems to implement enhanced marketing and selling techniques;
- Data warehouse and data mart implementations to increase the profit line and revolutionise product development;
- The continued evolution of object-oriented tools and technologies.

Emerging technology deployment trends enabling the shift towards Internet based platforms include:

- Increasing bundling of Internet protocol into applications to allow wider information and application exchange;
- De-bundling of the distributed application: generic application services such as transactions, data, message, directory, and objects reside on the same server, but can be de-bundled and delivered upon request to clients;
- Componentisation: aimed at promoting re-use, in order to maximise flexibility and minimise costs to change platforms, topologies, and application architectures.

In the *application solutions* segment US based companies are increasingly focusing on stronger presence in Europe, while European companies record improving performance in the US and other regions. Intensifying competition for all parts in the market is increasing the threat to survival for those local software vendors who have not expanded across borders in a strategic and/or focused manner.

The widespread adoption of application packages reflects a growing trend for organisations to buy solutions rather than build them. A major reason is the enhancement of quality, functionality, and breadth of packages. Other major drivers of the application segment are:

- Mounting interest in desktop and NT Server platform applications;
- The continuing desire of organisations to link their business processes more tightly;
- The expansion of applications of supported languages and currencies;
- The industry-specific solutions becoming more critical to buyer organisations, as intense global competition runs rampant across all business sectors (flexibility to adapt to the diverse requirements of many industries).

In the PC application software segment suppliers share the core challenges that a consumer-driven NC explosion brings, including adopting new distribution and support models (greater number of high-volume products), meeting the market requirement for lower price points, and surviving the potential "cannibalisation" of existing business by new products. Although product delivery, and announcements plans are beginning to materialise, the distribution channel is very slow to develop. However, the opportunity to dramatically expand market penetration and revenue is excellent as the various NC device types shift from niche opportunities to volume markets.

In 1997, the *system software* market continued a transformation driven by the need to manage distributed servers in such a way as to provide both an enterprise-wide and a line-of-business-oriented view. The deployment of business-critical applications using client/server architecture continued to drive changes in the systems software market. At the same time, there was a resurgence in respect to the capabilities of the mainframe in meeting the rigorous scalability, availability, and reliability requirements of critical corporate applications.

The major drivers of this market are:

- The emphasis on the problems of managing desktop assets;
- The need for better system management features;
- The need for enterprise-wide data management and access capabilities;
- The shift from the initial focus on systems and databases to include the applications themselves and, in some cases, the middleware;
- Efforts of the vendors to expand their offerings further up in the organisations in an attempt to become "enterprise" players;
- The advent of the World Wide Web driving sales of an entirely new "platform" to be managed in the form of a Web server;
- The shortcomings of Unix security;
- The need to automate the management of the so-called open systems in concert with older existing platforms.

As regards the *applications tools* segment, the drag on market growth was primarily due to per seat price reductions in personal database markets, the maturation of the statistics and

spatial information management markets, and the increased availability of packaged applications more compelling than internal application development. Another inhibitor was the shift in product focus of several leading vendors from supplying generic tools to delivering specialised analytic applications. During 1997, the embedding of information access tools within applications became more prevalent.

Data warehousing adoption continued to be a major user and vendor focus during 1997. The investment of companies in data warehouses drove spending in information access tools, and this trend is confirmed for the near future. During 1997, *data mining* software gained visibility as a fast-growing information access market.

Application tools market drivers are:

- Continued integration with popular enterprise applications;
- The offer of newer tools for data mining (this technology is beginning to be packaged);
- Data warehousing implementation activity persisting and providing attractive returns to many companies;
- E-mail and groupware forming an infrastructure to support data sharing;
- Increased emphasis on gaining competitive advantage through better use of information and intellectual capital at all levels of the organisation.

IT services: demand for new skills

1997 revealed a strong increase in services spending. IT services companies have started to help companies to take advantage of Internet technology to increase their competitiveness. As Internet adoption moves from a "publish" to a "transact" model, there is a growing need for increased depth of integration of Internet front-end applications with enterprise operations, applications, and back-end databases. The lack of staff to support ongoing Internet/Intranet maintenance and development, coupled with integration problems and cost and time overruns, drive demand for outside service providers to help plan and implement solutions. The list of activities on demand includes security design, and firewall implementation, Web page design and creation, Internet/Intranet application development. Increasing demand for application and database access is forecast to characterise Internet service spending as companies increase their depth of integration with their existing infrastructure. The Year 2000 and Euro compliance issues offer an additional incentive to renew and upgrade application topologies towards deeper integration and Internet access. A significant amount of investment is already being made into both investigating and solving the problems they pose.

The *consulting services* market in Western Europe has recorded improving growth. The following trends are driving IT consulting services demand:

- Deregulation/privatisation, downsizing/restructuring, globalisation impact generating demand for consulting services to improve competitiveness;
- The Euro;
- Technological change towards the adoption of electronic commerce and applications for the Internet;
- Need to increase communication and application sharing with partners and customers;
- Projects and implementation of Enterprise Resource Planning (ERP) and supply chain management solutions;
- The growing presence of IT products and services at all levels of business value chain.

These trends usually require very significant and fundamental changes of organisations. As long as the competition remains intense and technologies and other changes continue to accelerate, the consulting market will thrive.

Consulting services continue to be offered either as discrete standalone services or in combination with several other types of services. However, the bundling or integration of services is becoming more typical, and the demand for standalone services is declining. First because IT implementation services have become closely coupled with all types of business consulting services. Second, because the distinction between various services has begun to blur.

The *implementation services* market was driven by complexity, distribution, innovation, and competition. As technologies evolved more rapidly, the opportunity for productivity improvements, through the upgrade, conversion and/or integration of different layers of technologies, increased dramatically. Skills shortages in emerging new technology areas and growing attention to tackling strategically application conversion issues have led to supply shortages and strong charge out rates increases. Despite increasing economies of scope and application engineering development productivity, the overall effect of increasing demand for implementation services is generating strong business growth dynamics.

The training and education segment represents an excellent market opportunity, similarly due to serious skills shortages. Increasing complexity and proliferation of IT, increasing decentralisation of IT, and the move to client/server computing in general are driving growth in IT training.

Growth in the *operation management* market was strongly affected by the widespreading phenomenon of outsourcing. Strong growth was driven across Europe by similar business pressures, such as the globalisation of the economy, and the deregulation of the telecommunications and utilities sectors. However, cultural issues and stringent labour laws are still an inhibitor to market growth. European companies are more open to "collaborative" forms of outsourcing than to "transactional" outsourcing. Currently, most outsourcing contracts are still based on fixed price arrangements, but all providers expect increasingly to work with risk/reward components in their deals, in particular when the agreement contains a significant element of high-value services, such as business consulting.

Outsourcing has began to encompass a full chain of services, including consulting and systems integration activities. Outsourcing arrangements can cover a wide range of technologies, activities and business processes, going far beyond the traditional data centre operations. As a result, consulting, systems integration and outsourcing activities tend to converge in what vendors prefer to call long-term "partnerships" with the client.

Whereas the spectrum of services delivered in a single contract tends to broaden, the spectrum of technologies tends to be narrowed down through "selective outsourcing". Accordingly, many players have developed focused offerings in order to attack selective high-growth segments of the outsourcing market.

The following segments are set to be fast growing and with a high potential for selective outsourcing:

- Business process outsourcing;
- Applications outsourcing;
- Network outsourcing;
- Desktop outsourcing.

In the support services segment, 1997 was characterised by remarkable growth in high availability services, network support, software support and electronic support. In the electronic support market, demand for fax-back services, bulletin boards, Internet services and CD-ROM knowledge bases continued to grow. The most common reason for contacting the publisher has been to resolve a usage-related question. Overall, telephone support has been most required, followed by support via the Internet. Strong decline in traditional hardware maintenance is set to continue, as fierce price pressure has started to hit multi-vendor platform maintenance contracts.

1.2.2. TLC Trends

The Western European telecommunications market recorded a 7.8% growth in 1997, and it is set for continued growth over the next five years. The overall market will grow from ECU 181 billion in 1997, to a value of ECU 194 billion in 1998, by an annual growth rate of 7.2%.

Growth in telecommunications traffic is strong enough to offset the decrease in prices of telecommunication services. As a result the telecommunications services market is growing faster than equipment, mainly because of the increasing demand for ISDN and other higher speed data services. Mobile telecommunications remains one of the fastest growing areas throughout Europe, both as regards services and equipment.

1998 is the year of liberalisation of the telecommunications market with the exception of Greece, Spain, Portugal, Ireland and Luxembourg, which were granted an additional implementation period. Increasing competition and lowering tariffs will continue to characterise the market.

	1997 Value	1997 %	1997/96 %	1998/97 %	1999/98 %
EU	171	94.5	7.9	7.2	6.3
Germany	43	23.8	5.5	4.6	4.3
France	28	15.5	8.8	6.9	5.9
UK	27	14.9	6.7	5.5	4.8
Italy	24	13.3	9.4	10.0	8.6
Spain	12	6.6	6.7	8.6	6.7
Other EU	38	21.0	10.2	9.4	8.0
Non-EU*	10	5.5	7.1	5.9	4.9
Western Europe	**181**	**100.0**	**7.8**	**7.2**	**6.2**

Note: * Switzerland and Norway
** It should be noted that all figures have been rounded to the nearest billion ECU at 1996 constant exchange rates. Total and percentage may not add up due to rounding.

Table 6
*Western European Telecommunications Market by Region: Percentage Breakdown and Growth Calculated on Market Values. 1997-1999. Billion ECU***

i. Trends by country

Germany: high bandwidth availability

The German telecommunications market grew by 5.5% in 1997 and is expected to record a growth of 4.6% in 1998.

Germany is Europe's largest market for mobile telecommunications equipment and services. However, this market was relatively static in 1997. Service providers subsidised purchases of mobile telecommunication equipment, in order to drive customers' purchase of air-time. This marketing strategy resulted in lowering end-user prices for mobile handsets. Although German telecommunications equipment manufacturers hold a top spot among suppliers in both German and international markets, the country's imports of mobile communications equipment exceeded domestic production.

The German telecommunications network services market is estimated to grow. Although falling prices will drive up call volumes, revenues growth is set to be slower than in the past. The growth in mobile telephony should accelerate in 1998, as to date the German market has under-performed compared with the European average.

The growth of ISDN is set to continue driven by the use of the Internet by all sizes of companies. VPN type services and managed services are also forecast to grow at relatively high rates.

Compared with other industrialised countries, paging has not been very popular in Germany, although some of the providers are offering features that allow paging in France, Switzerland, and the UK.

Satellite telephony is not yet widely used in Germany, because of the expensive air-time and hardware and the fact that terminals are considered to be too heavy and not user-friendly. In order to enhance the acceptance of satellite telephony, the involved companies are planning to launch two new series of satellites. They intend to significantly lower the price for air-time, and modify terminals to make them more user-friendly.

In August 1997, Germany's three leading digital players (the Kirch Group, CLT-Ufa, and Deutsche Telekom) agreed to join forces to develop digital TV in Germany. Digital cable TV is available in only two German states, Bavaria and Rhineland-Palatinate. Media authorities in the other 14 states have tentatively agreed to grant pilot licenses for digital cable TV until a firmer legal basis can be established for the new technology. With almost 12 million subscribers, DT is Germany's leading cable network company.

Although competition was limited, Germany is expected to be one of Europe's most hotly-contested markets after liberalisation in January 1998. The third and crucial piece of legislation became law only in July 1996. One of the tenets of the new laws is that new operators can choose in which areas they would like to offer services, from across the nation to a single town. At the end of 1996 the government granted the first set of licenses to companies wishing to provide fixed line telecommunications from January 1998. Some operators were given federal licenses, while others received regional licenses. The government is to hand over control of the telecommunications market after liberalisation on 1 January 1998 to the newly formed regulatory authority.

Interconnection agreements have become the subject of a long-running dispute between Deutsche Telekom and new German competitors. The German Post and Telecommunications Ministry set interconnect prices in September 1997 to come into effect from January 1998.

France: booming mobile services

The French telecommunications market grew by 8.8% in 1997 and is set to grow by 6.9% in 1998.

France is experiencing a mobile/wireless services and equipment "boom". The end-users for this sector include: government, manufacturers, banks, insurance companies, transportation agencies, the military, professionals, and the general public.

The French telecommunications network services market is forecast to perform well in 1998. However, fixed network voice revenues are forecast to grow slowly, as although falling prices will drive up call volumes, this will not be enough to sustain the higher revenue growth rates experienced in the past few years.

After continued underperformance in the past few years, mobile voice revenues are predicted to grow rapidly in the short term. New operators continue to bring down tariffs and open up more service options.

By end September 1997, France Télécom's Itineris GSM 900 (megahertz) digital network hit the two million subscriber mark, compared with 600,000 for all of 1996. Among the growth factors is the launch of its pre-paid card service, known as Mobicarte and the launch of the third operator with a DCS1800 license. Prices for mobile services are decreasing in an effort by all three operators to increase the penetration rate.

Demand for ISDN and network services such as frame relay and higher speed/remote access data services is set to increase.

The market for paging systems in France experienced strong growth as well.

As regards privatisation, in October 1997, 20.9% of the France Télécom was sold in an initial public offering. Under the Telecommunications Act, passed in July 1996, France Télécom remains responsible for universal service, but other operators can contribute to a Universal Fund to help pay for it. A number of regional licenses have been awarded with special conditions attached. All the companies that were allowed to build up or develop their own network in November/December 1996, will have to apply for a license extension in 1998 in order to provide voice telephony outside closed user groups.

The new law also set up the new independent regulatory authority: Autorité de Régulation des Télécommunications (ART), which came into existence on 1 January 1997. Classified as an independent non-ministerial government agency, the ART has official jurisdiction over market and competition conditions through processing license applications, being consulted on regulatory matters, and being involved in international decision-making. Access numbers for competing long-distance and international calls have been agreed upon, allowing customers to select long distance carriers on a call-by-call basis until the year 2000, when automatic selection will be introduced.

The ART gave a deadline to France Télécom to bring the networks used by cable up to standard for the provision of Internet services on cable networks. ART is considering applications from several companies to offer local services.

United Kingdom: strong price competition

The UK telecommunications market grew by 6.7% in 1997, and is expected to grow by 5.5% in 1998.

The telecommunications services market confirms its place among the strongest for traffic growth throughout Europe. However, downward price pressures in all market sectors are squeezing fixed network voice business. Mobile voice revenues are forecast to grow faster, with volume increases offsetting price decline effects, yet not equaling European average value market growth.

Phone calls became cheaper towards mid-year, as BT cut the cost of non-local daytime calls by as much as 10 percent. Competitors have also advertised calls cheaper than BT, and cable companies claimed across-the-board savings, including local calls.

Service enhancements are expected with the launch of new telephone handsets working on two frequencies - 1800 and 900 Mhz - and trials to have the first mobile telephone operating equally well in US, Europe and Asia. Overall, there have been four operators running six networks for some considerable time. The two longest established players have been allocated DCS1800 spectrum for services other than voice. Conventional DCS1800 operations remain the preserve of the UK's two personal communications network (PCN) operators.

Demand for data services, including ISDN will continue to grow relatively quickly, driven by lower costs, and companies looking for greater network efficiencies, value added applications and demand for higher-speed Internet access. ISDN lines contributed to most of increase in the numbers of business lines in 1997. The volume of ISDN calls grew by over 40%.

The UK equipment market is showing a slow decline. This market is characterised by the competitive pressures between manufacturers of telecommunications equipment, from digital switches to modems and mobile phones.

The ending of the duopoly on international traffic was the last milestone in the road to complete deregulation of the UK telecommunications market. Licenses have been granted to over 200 companies to offer a range of services. They include cable television companies with local franchises, metropolitan operators, and long distance operators. As a result, more than 30% of households have a real choice of telecommunications operator, which is a virtually unique situation across Europe at the end of 1997.

A new Communications Act is expected to be published in the UK. This should recognise the convergence between telecommunications, IT and broadcasting, and the changing nature of the telecommunication market. Under increasing cross-border competition, this market is becoming more self-regulating, and more of a commercial sector of the economy than a utility.

Oftel's new proposal for interconnection charges, would change the cost base for interconnection charges from fully allocated historic costs to long-run incremental costs. This would better reflect the basis on which commercial businesses in competitive markets make investment decisions. Removing the need for annual determinations, Oftel has set a broad framework of controls within which BT has the flexibility to set its own charges for the period August 1997-July 2001. Meanwhile, as the market becomes even more competitive, less direct regulation of interconnection charges is expected to come into place.

Italy: performing better than Europe

Growth of the Italian telecommunications market performed better than the European average. The telecommunications market grew by 9.4% in 1997, and is expected to increase by 10.0% in 1998.

The Italian telecommunications services market is predicted to grow at a higher rate than European average. The same trend is expected both for fixed network voice revenues, and mobile voice revenues.

Competition is bringing down tariffs and pushing up demand for higher speed services. ISDN and other services are forecast to grow relatively quickly. Value add network applications and enhanced services are also predicted to grow as base level tariffs fall.

Investments for fixed network and mobile infrastructure picked up, as well as the construction of wireless infrastructure based on DECT technology. In the terminal sector, cellular telephony played the most important role. Satellite communication systems and services are also earmarked for high growth.

In the mobile sector both the two GSM operators, have seen 1997 as another booming year in number of subscriber as well as revenue. Many subscribers were attracted by the prepaid, rechargeable card offer. Further growth will be generated by the award of a third mobile license for a Personal Communication Network (PCN) mobile phone service, operating on the DCS 1800, expected by mid 1998. In 1997 Italy had 11 million cellular subscribers, with the top subscribers' share (a record breaking 21%) in Western Europe. The number of mobile service subscribers is expected to double within the next four to five years.

In August 1997 the government approved the Regulation aimed at implementing EU liberalisation directives in cable TV, mobile communications, open network telephony, as well as the guidelines regarding interconnection, universal service, licensing and data protection. The Italian Parliament finally approved the terms for the constitution of the national Telecommunications Authority, expected to be fully operational by mid 1998. Its chairman was appointed by the government last December. In October 1997, the government disposed of its remaining 44.7% stake in Telecom Italia, raising some $ 15.1 billion, with the initial sale of a nine percent stake to a group of 14 investors, mostly Italian banks and insurers, and most of the remaining stake to over two million small investors. Although the Italian government will hold a golden share in the new privatised Telecom Italia, giving its veto rights, this will disappear in three years.

Last November a Memorandum of Understanding was signed to create a digital platform for broadcasting and receiving pay-TV channels via cable and satellite. Telecom Italia will own 40% of the joint-venture, Canal Plus 30% and RAI, Mediaset and Cecchi Gori 10% each. The agreement is now waiting for approval from the Italian and European antitrust authorities.

Spain: improving the infrastructure

The Spanish telecommunication market expanded by 6.7% in 1997 and is expected to improve to a 8.6% annual growth in 1998.

The Spanish telecommunication services market is forecast to show higher than average growth rates in 1998. Fixed voice revenues are forecast to grow gradually, as PSTN penetration and call volumes continue to climb. Mobile voice revenues are forecast to grow very quickly, as competition gets underway, while 1997 has seen a huge increase in mobile handset penetration. Only one more mobile phone operator will be allowed to compete with the two GSM networks in the short term.

ISDN is predicted to grow as demand for data and voice connections increases, driven by value added applications and, to a lesser extent, Internet access demands.

For fixed networks the Spanish government resolved to introduce limited competition from January 1, 1998, with two national carriers and a third carrier created by cable television operators allowed to link up their networks and offer voice telephony services.

The privatisation of Telefonica was completed in February 1997 with the sale of 20.9% of the shares the Government still had in the group. Telefonica is expected to cut international tariffs around 20 percent in twelve months to face competition of "call back" operators, offering cheaper international phone prices. Its last reduction of around 8.8 percent was effective in April. Telefonica's domestic basic tariffs have been frozen since 1994.

Other countries

In the *Nordic* region, fixed network voice revenues are forecast to grow only slightly, due to a high PSTN penetration and the high penetration of mobile telephones. Mobile voice revenues have grown substantially despite intense competition, and in Denmark and Finland growth rates will soon start to slowdown. Much of the growth will come from the business sector in the areas of enhanced services, data and value-added networks. ISDN and demand for other data and voice connections will continue to grow, driven by value-added applications, demand for higher speed Internet access (especially in Norway), and falling tariffs.

In *Switzerland,* fixed network voice revenues are forecast to grow gradually. Demand for mobile voice services, and ISDN is set to continue to drive growth in 1998. In April 1997 the Swiss Parliament approved full opening of the country's telecommunications market and the partial privatisation of Swiss Telecom.

In the *Netherlands* and *Belgium,* competition is beginning to take effect on local and national call revenues, while mobile voice revenues are predicted to double in the near future. ISDN, frame relay and other managed network services are forecast to grow relatively quickly as tariffs continue to fall. All remaining restrictions on the provision of telecommunication services in the Netherlands were removed on July 1, 1997. An increase in PSTN penetration and call volumes is expected in Belgium for 1998.

Austrian telecommunications services 1997 growth came from a rapid increase in mobile call revenues and data services. This trend is confirmed for 1998. Fixed telephone networks are also set to grow in the next years. Until 1998, fixed voice services remain a monopoly of the state-owned PTA. Potential new operators for the fixed line business are emerging.

The healthy economic environment contributed to the *Irish* telecommunication market growth in 1997. The Commission accepted the Irish government's request for full liberalisation to be set for the year 2000. The liberalisation of alternative infrastructure is set in July 1997, and the liberalisation of direct international connection for mobile networks in January 1999.

In *Portugal* and *Greece,* the telecommunications market grew substantially in 1997. Mobile telephony showed a steady growth. PSTN usage and ISDN demand should accelerate in 1998, due to the underdevelopment of the telecommunication market in both countries. The EU authorised both countries to delay full liberalisation of their telecommunication service market until January 1, 2000.

ii. Trends by product segment

Telecom equipment

European telecommunications equipment providers recorded positive 4.1% business performance growth in 1997, led by technological know-how, research & development and product ranges in the mobile equipment area. However, different product markets are forecast to grow at different rates and many of them will compete against each other.

Public network equipment: enhancements and new licences

The public network equipment market grew by 0.8% in 1997, and is expected to grow by an improved 1.7% in 1998.

Growth in the public equipment sector is mainly due to the development of many GSM networks, the development of cable television telephony networks, and the growing demand for multimedia, and the Internet. Demand for GSM technology included base stations and

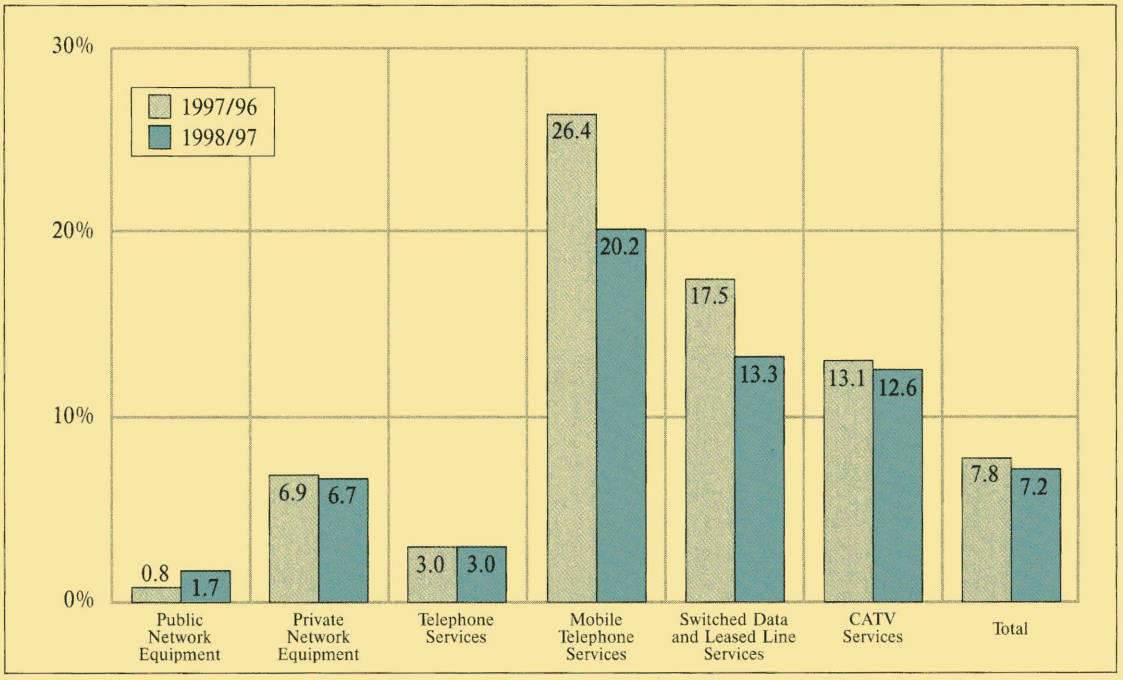


Figure 7
Western European Telecommunications Market Value Growth by Product Segments. 1997-1998

base station controllers, operations and maintenance centres. Mobile infrastructure providers are opening maintenance centres to minimise carriers' initial investments and support incremental capacity increases on GSM networks.

Agreements

The most important agreements within the public telecommunications area include:

- Agreements between private telecommunications equipment and information technology providers to combine office and Internet work-group applications with digital phone technology for unified messaging solutions (voice, fax, e-mail and Internet services) over digital GSM network;
- Agreements between telecommunication equipment providers and Internet technology partners to speed the development of IP/ATM networks for traffic and cost optimisation in future broadband services networks for multimedia;
- Global European Network agreement among major telecommunications operators in Europe to create high quality trans-European digital telecommunications network to improve the quality of trans-European network telecommunications services;
- Co-operation among mobile equipment suppliers to define a common Wireless Application Protocol to bring advanced applications and Internet content to digital "intelligent mobile phones";
- Agreements between telecommunications equipment suppliers and software suppliers on deployment of dial access solutions to route digital cellular phone calls directly to data networks and the Internet;

- Joint research co-operation of telecommunications equipment providers with server technology providers for the use of server technology in multiprocessor high-speed fault-tolerant versions of new switching systems;
- Joint pilot projects of mobile telephone operators, mobile equipment suppliers and large users to evaluate the viability of secure intranet access using GSM technology in a virtual private network.

Investments

The installation of fibre optic cables and fast data transmission systems is pursued by national carriers and telecommunications services operators to achieve unprecedented capacity levels and exploit new services market opportunities emerging with the Internet.

Major investments driving public equipment business growth are strong in those areas affected by:

- *Fixed networks expansion and modernisation programmes* by national telecommunications network providers. These encompass investment in transmission and network access equipment. Asynchronous Transfer Mode and SDH transport networks are in demand as key component for high capacity services such as carrying Internet traffic across regions (Sweden, Belgium). The Nordic countries are investing in the installation of dense WDM (Wavelength Division Multiplexing) technology, in order to handle the increasing amount of services being transported in the fibre networks without the need of laying new fibres on congested long-distance routes. In Spain GSM Fixed Cellular Terminal systems have been delivered to small-business subscribers to provide them with fixed telephony services over radio. Wide area paging networks are also undergoing capacity expansion initiatives;
- *Existing cellular networks expansion,* required to support more traffic and relieve congestion (Portugal, France, Greece). Upgrade of cellular networks for dual band telephones, one band for GSM and one band for DCS, has started to allow better quality and lower prices for cellular phone calls (France, Germany, Denmark, and Sweden);
- *New cellular network infrastructure investments,* especially for DCS1800 GSM mobile telephone network after the granting of new mobile licenses (Italy, Portugal, Austria);
- *Virtual private networks,* soon to become an attractive investment as the coming deregulation is expected to drive prices down.

New products

ISDN and ATM switch manufacturers are enhancing their products to make voice, data and image integration possible over the network. They offer additional advantages in the form of remote site aggregation for Basic Rate applications, multi-site flexibility, aggregation of high-speed applications, integration of voice and data switching. ISDN traffic can also be concentrated to multiple sites, eliminating the need for multiple leased lines and allowing more flexibility on the network. Newly introduced technologies contribute to accelerate upgrades and replacements. They include:

- Copper Broadband Access ADSL systems enabling operators and service providers to offer high-speed Internet access, remote LAN access, switched broadcast video, video conferencing and other services requiring high bandwidth in the access network. The system can be deployed by local exchange carriers, competitive access providers and Internet service providers;
- GSM/DCS microcellular base transceiver stations specifically designed for focused coverage and capacity solutions;

- Optical networks based on dense WDM (Wavelength Division Multiplexing) technology, multiplying the capacity of existing fibre links several times;
- Fixed Cellular Terminal (FCT) systems enabling telecommunications operators to provide fixed telephony services over radio. With subscribers being connected to the network with a fixed terminal, the FCT systems have the advantage of delivering service to a greater number of subscribers in less time, with no need to lay cable to each and every potential subscriber;
- Products based on voice gateways that allow voice calls to be sent over Internet protocol (IP) networks. These products give Internet service providers the ability to offer their customers voice calls through their computers while they are logged onto the Internet;
- Multi-service network switches providing both native ATM and Frame Relay switching to support high-bandwidth backbone applications, such as LAN interconnection, circuit emulation, voice, and video;
- Increasing attention is given to WLL (wireless local loop) technology, based on the DECT (Digital Enhanced Cordless Telecommunications) standard. This technology allows for larger intervals between transmitters for cordless telephones than the traditional 50 to 300 metres of traditional cordless technology.

Private network equipment: adding value to communications

The private network equipment market recorded a 6.9% growth in 1997, and is expected to grow by 6.7% in 1998.

Factors which influence end-user demand patterns for private network equipment include service, new capabilities, and integration.

Users demand new wireless capability for the on-premises telecommunications products they purchase, even if they do not now need it. The same needs exist for PBXs, LANs and on-premises hubs and routers. Users will want to be able to add wireless LANs (radio or infrared) or wireless phones to the systems at a later date.

Integration relates to the ability to connect PBXs, Key Systems, routers, legacy data and video-conferencing equipment to have voice, data and image consolidated into one managed service, is increasingly demanded.

Growth is occurring especially in the following segments:

- Digital hybrid telephone systems;
- Digital cellular technology;
- Video-conferencing solutions;
- Pagers;
- Cordless phones connected to PBXs and key systems.

Growth of mobile telecommunications equipment is strictly related to the development of business-catered services (Internet, e-mail, paging, voice mail). To address this opportunity manufacturers are focusing on the possibility of using GSM-handsets for data transmission. They are equipping new smaller and lighter handsets with fax, PC-board, and stand-by time expansion.

Mobile phone providers focus is particularly strong in the following areas:

- Development of standard handsets;
- Intelligent user-friendly interfaces;
- New applications, such as information services and Internet access;
- Easy connections with laptop computers or special dialing codes;
- Link of mobile phones to company's internal telecommunications system;

- Link of mobile phones to third parties with "loyalty factors";
- Technology miniaturisation;
- PC cards with a built-in GSM phone for portable and network computers;
- Mobile phones integration in vertical solutions.

Among segments with lower growth, fax business dynamics is impacted by falling prices, the introduction of multifunction devices, and by the increase in sales of fax modems connected to computer systems.

Telecommunications services: time to market for Internet access leadership

The telecommunications services market grew by 8.6% in 1997, and is expected to decelerate slightly to a 7.7% growth in 1998.

The telecommunications services competitive environment is undergoing major changes as liberalisation and new technologies contribute to shape new market dynamics and opportunities.

Alliances between national carriers and regional or national electricity utilities are among the most preferred approaches to expand cross borders in Europe by launching regional/national telephone companies.

A growing requirement for advanced, high quality services to meet the increasingly critical nature of the Internet for businesses has driven the growing demand for Internet Services Providers (ISP). The emergence of ISPs is countervailed by the entrance of all major telecommunication network suppliers into the Internet-related business (access services, Internet telephony, value-added services). Competition is particularly keen in Internet phone services as no license is required to run an Internet-based telephone service.

Public networks are focusing on developing long term partnerships with large businesses offering new network services, as well as plans to upgrade their own internal networks as part of their effort to stay competitive.

Phone companies are undergoing initiatives to provide franchise networks with advanced communications infrastructure, while marketing agreements with software suppliers are aimed to promote the online connection interface and software among users.

Mobile telephone services

The mobile telephone services market will be stimulated by strong user demand for all forms of wireless technology. Growth will be driven by privatisation and deregulation of mobile operators, together with an increase in the availability of licenses, lower tariffs and affordable portable devices. Alliances, joint-ventures and international acquisitions are also determining new competitive fronts.

UK and Scandinavian markets have the lowest tariff levels in Europe, as price has become one of the key factors with the introduction of strong competition into the markets since 1996. Increased competition is expected to bring tariffs down in all the other European countries, together with the introduction of subscriber packages aimed at attracting different types of users.

Most national regulators are willing to introduce cost-based principles in mobile interconnection similar to those currently used for fixed-network communication. This will have the effect of reducing of further mobile tariffs and also the price of calls to mobile telephones from fixed networks. The expected integration of mobile and fixed services will bring mobile costs under central control via a common bill and will lead operators to integrate mobile and fixed facilities into a single corporate strategy.

In the short term, increased growth in the mobile market may have other significant implications. Ongoing liberalisation, new technologies and increasing standardisation will permit mobile's operators' wireless infrastructures to compete with fixed networks in Europe, particularly for voice services in the local loop. Wireless local loop can become a reality as it can offer quicker installation time and ensure quicker return on investment for new local loop service providers.

Until now operators have focused on the voice market. As GSM subscribers increase, and margins are squeezed by intensified competition, operators will have to look for added revenue in services other than pure voice, with new applications such as data and multimedia services. Operator differentiation is likely to become a key element to maintain market share. The integration of voice, data and video facilities is expected to drive new market growth in the global business market for mobile communications in 1998.

Meanwhile industry and operators initiatives will be leading soon to the long awaited third generation standards, based on technology enabling the so-called "universal phone" working anywhere and suiting voice, data, multimedia video communications and paging communication. Universal access capabilities will eventually supersede second generation GSM's roaming capabilities, even enhanced through satellite technology. While technology for the third generation of mobile phones is expected to be available soon, its adoption by mobile operators to build universal phone systems will face a number of issues. As far as European operators are concerned, the most important one will be the protection of recent or current investment in GSM platform infrastructure and mobile end-user terminals. European and other countries' operators Alcatel, Bosch, Italtel, Motorola, Nortel, Siemens, and Sony formed the UMTS (Universal Mobile Telephone System) Alliance to develop the third generation of wireless standard. UMTS aims to enable future customers, demanding for combined mobile and multimedia features, to use existing GSM phones for voice and W-CDMA (Wide Band Code Division Multiple Access) for multimedia services. GSM-based third generation systems are backed also by Japanese operators. By contrast most US operators and some Asia/Pacific operators currently back a system that is compatible with narrow-band IS-95 CDMA, the digital standard adopted in those regions. This makes it unlikely that there will be one universal handset and service in the future, but there will be a family of two or three standards possibly internetworking to enable users to use one system.

Switched data services

Online service subscribers growth is also maintaining a high pace (almost in the region of three digits in numbers of subscribers). In a very highly competitive environment online service suppliers are building on the business-sector and focusing on proven consumer segments. They are launching enhanced products and services for the business, technical, and professional sector, and extending both the content and language base.

In the near future, there will be a natural move to ISDN and ATM lines as end-users will require high-quality bandwidth. More investment will be needed for network redesigns including new routers and switches. There is common consensus about ISDN's bright future also in small and medium enterprises, if the rental and equipment costs can be brought down to a reasonable level. As new ATM services start to compete with each other, costs are falling and companies are coming up with more innovative tariff structures.

Table 7
IT Penetration by Country. 1996

	IT/GDP %	IT per Capita ECU	Number of Business PCs per 100 White Collar Workers	Number of PCs per 100 Population
Western Europe	2.26	421	52	17
EU	2.23	405	54	16
Germany	2.10	486	44	19
France	2.41	499	56	16
UK	3.24	490	55	21
Italy	1.44	249	44	9
Spain	1.34	157	48	8
Austria	1.96	438	50	16
Belgium/Luxembourg	2.23	462	51	15
Denmark	2.87	751	64	33
Finland	2.50	476	60	23
Greece	0.86	76	36	12
Ireland	2.04	292	78	15
Netherlands	2.79	548	66	26
Norway	2.53	695	91	32
Portugal	1.36	117	34	13
Sweden	3.36	745	75	29
Switzerland	3.06	1,009	76	32
US	4.08	870	103	46
Japan	2.51	713	18	12

Source: EITO, IDC, OECD

Convergence of Frame Relay and ATM is starting to yield hybrid services combining the best of both technologies. There will be growing demand for hybrid Frame Relay/ATM networks that carry all traffic – including voice and video.

Wireless data: GSM is marking the beginning of the evolution of very flexible wireless data communications. In the marketplace this has meant the realisation that wireless data can be easy to use and reasonably fast, although more fragile connection, slower data speeds, and higher call charges must be taken into account. GSM also provides a baseline for cost and

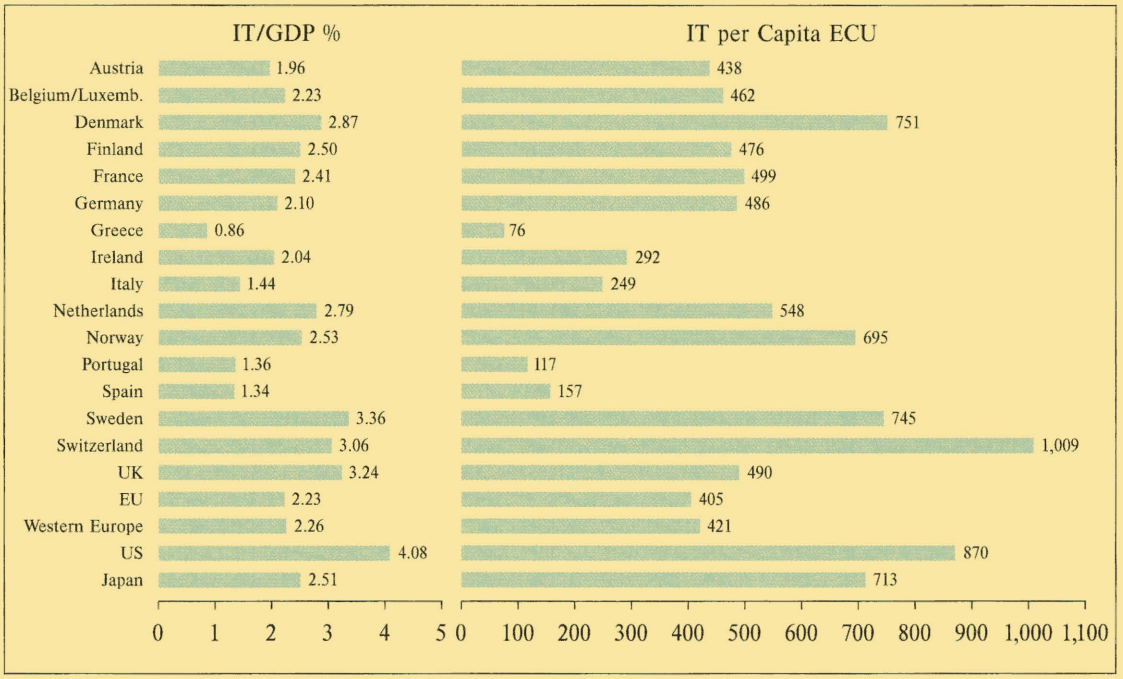


Figure 8
IT/GDP and IT per Capita in Western Europe, the US and Japan. 1996

Figure 9
IT/GDP versus per Capita GDP in Western Europe. 1996

Table 8
Telecommunications Penetration by Country. 1996

	Inhabitants (000)	Households (000)	Main Lines per 100 Inhabitants in %	Mobile Subscribers (%)	CaTV Subscribers per HH (%)	% of Digital Main Lines
Western Europe	384,450	150,459	50.9	9.1	27.7	84.6
Germany	82,140	37,264	53.8	6.7	47.5	81.5
France	58,270	22,385	56.6	4.3	10.2	97.6
UK	58,780	23,192	52.3	11.6	7.3	93.3
Italy	57,250	20,010	44.1	11.2	0.1	85.1
Spain	39,220	11,909	39.3	7.6	15.9	67.4
Austria	8,070	3,081	48.4	7.4	28.2	72.0
Belgium/Lux.	10,530	4,251	47.2	5.0	88.5	73.7
Denmark	5,230	2,389	63.1	26.5	41.0	84.2
Finland	5,130	2,121	55.8	29.1	38.8	95.0
Greece	10,500	3,614	50.8	4.9	0.1	42.6
Ireland	3,590	1,062	38.7	7.4	49.0	83.0
Netherlands	15,600	6,450	54.0	6.5	91.5	80.2
Norway	4,390	1,811	56.9	28.7	39.4	92.0
Portugal	9,820	3,419	38.2	6.8	3.2	78.6
Sweden	8,870	4,171	68.0	28.1	42.4	96.2
Switzerland	7,060	3,330	64.4	9.4	75.4	75.3
Bulgaria	9,016	2,950	29.4	0.4	4.7	6.8
Czech Republic	10,400	4,012	27.1	2.0	19.7	33.0
Hungary	10,239	4,015	26.2	4.6	28.1	71.2
Poland	38,646	12,668	16.6	0.6	24.0	49.4
Romania	22,703	7,093	14.0	0.1	29.7	25.4

Source: EITO Task Force

performance against which other services are compared. Services network are offering full support for three basic data services: short message service (SMS), fax, and switched data.

Cable

The ability to add telephone services to a cable TV package has proved a winner, and is likely to remain crucial for the future of cable. The past two years of progress in cable sub-

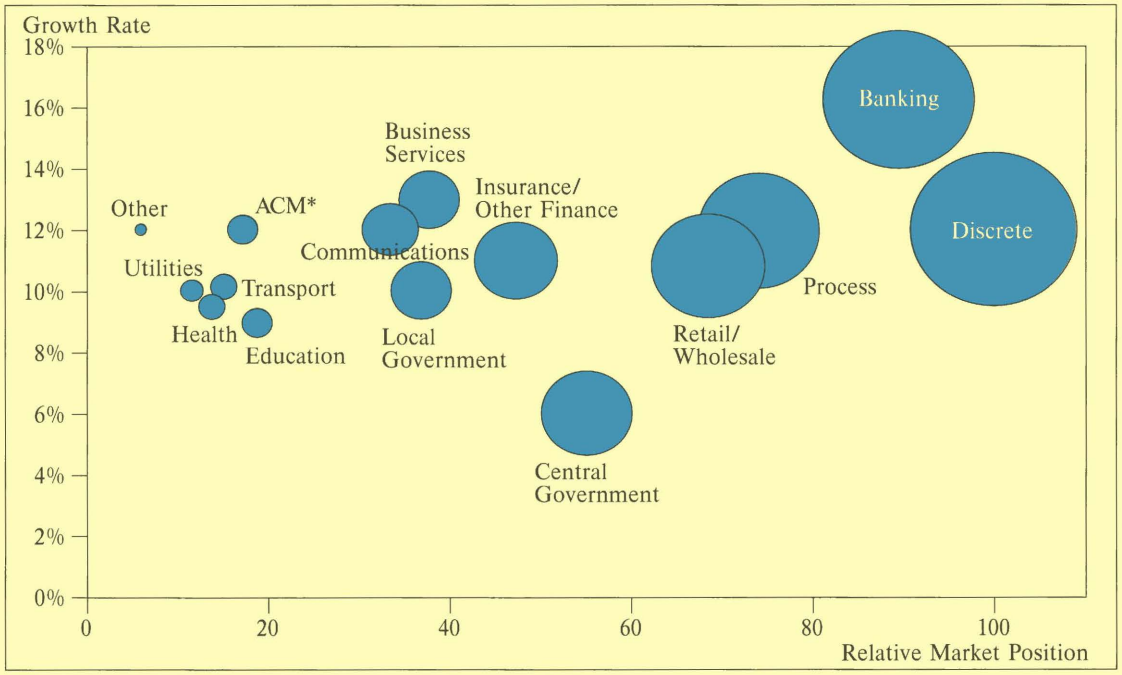


Figure 10
Western European IT Vertical Market, 1997

* ACM: Agriculture, Construction, Mining

scription in the UK coincides with cheap phone deals from cable companies. The growth of online services must also add to cable's attraction, and the prospect of digital transmission of TV and telephone combined makes the future look even brighter. Digital technology will be at its best on cable, giving much capability and flexibility for users.

Cable is expected to hit 40% market penetration by the end of the decade in the UK, and to grow substantially also in the other major countries. However the cable industry is not performing as strongly as in the US, and much of this is related to its take-up effect on pay-TV. For cable companies competing with better-quality established European TV channels is tough especially when programming for multi-channel television is perceived low quality.

1.3. Europe as a Consumption Area

1.3.1. IT and Telecommunications Penetration

For the fifth year in a row the European IT market growth is lower than the global average. Although the recovery in economic and consumer demand profiles have been driving increased growth dynamics in the IT national markets, this is not enough for Europe to overcome the heterogeneity of IT adoption.

Digitalisation of telecommunications infrastructure has progressed across all countries, while penetration of mobile connections continued to increase faster in the most developed and economically stronger regions.

The higher intensity of investment in ICT technology and services by the Nordic countries and the UK is confirmed, as in past years, also for 1997.

1.3.2. ICT Adoption by Industry

Banking is expected to continue leading ICT spending growth throughout 1998, as it led in 1997. Year 2000, Euro and the internationalisation of banking markets are increasing the potential for ICT spending growth in banks, as systems requirements become less localised and country specific. Although low availability of core applications prevents banks from accelerating change of proprietary core systems with new off-the-shelf integrated solutions, pressures from the competitive environment urge application upgrade decisions to be taken within months.

The *manufacturing* sector is undergoing a major restructuring process, with accelerating re-organisation and overhead streamline taking place at all major industrial groups in central Europe. Nordic competitors have already undergone their restructuring a couple of years in advance. This process has reshaped ICT budget priorities with the spin-off of IT functions into private outsourcing suppliers, an increasing focus on core application development, the adoption of Intranets to connect sub-suppliers as well as customers. IT processing needs have increased coupled with accelerated adoption of data-warehouses and work-group applications. The discrete sector suffers from a rather slow take up of IT investment in small enterprises (less than 50 employees) whose ICT purchase intentions are suffering the most from low business confidence and too expensive support and integration services offer from the channel.

Central government ICT spending plans for 1997 have been frozen in most European major economies. The good news continue to come from the UK, despite some controversial learning experiences from the private Finance Initiative outsourcing contracts. Also Mediterranean countries (with the exception of Italy) have started to give some positive signs of growth in ICT spending funded through jointly financed public and private funds. *Local government* projects aimed to put local administration services online are contributing to ICT spending growth.

The increasing pace of outsourcing contracts is shifting increasing shares of spending traditionally held by end-users in different vertical markets in the hands of IT services outsourcing providers. This translates into increasing growth in the *business services* sector, despite the negative influence of other sub-verticals with a low adoption rate of IT, or buying increasing IT capacity at falling prices (SOHO segment, independent consultants, lawyers, etc.).

Retail is showing very interesting experimentation of Internet online shopping combined with advanced marketing techniques based on data-warehouses. With very modest growth in consumer domestic markets across most of Europe, growth is in fact sought and obtained more from the existing customer base than from new customers. Loyalty card initiatives are already being upgraded to give access to new financial services (delivered by retailers in competition or in co-operation with large banks). This is happening across many markets from the UK to Portugal, irrespective of the level of retail industry concentration. However the large number of conservative small to medium retailers is offsetting the positive impact of IT spending growth from the most pioneering retailers, especially in the Mediterranean region, and despite a very high potential, retail still fails to deliver strong ICT spending growth.

The combination of new cellular and satellite technology and direct access to Intranets is helping improve *transport* efficiencies, and opening new ways of delivering up-to-the-minute updates of transport and delivery status.

The deregulation of the airline industry with new operators coming on board is increasing network and processing capacity needs with positive effects on ICT spending, although some economies are sought through co-operation agreements to share information systems. New more accurate transport control systems based on Internet and satellite technology will also accelerate core applications upgrades in the short term. The only warning relates to infrastructure: airports and networks may soon be overcrowded.

Utilities are a small market, but the potential is very high, as they are being privatised across many countries and many of them are considering expanding activities on multiple gas-water-power business. The Year 2000 problem is giving the right-on-time chance to think about it, especially in the UK, where mergers and consolidation across various privatised utilities are driving more demand for systems integration and application development services, especially for accounting and billing systems.

The net result of the evolving tangled web of relationships between *telecommunications* and IT companies is of a very strong business growth, for those suppliers who have been focusing on the telecommunications industry sector. Demand for server hardware, new accounting and billing systems as well as data-warehouses has increased to manage and monitor the delivery of increasingly enhanced voice and data network services. Network computers and jointly marketed products especially in the areas of Internet software access and applications will enable telecommunications operators to provide end-users with an enhanced telecommunications services delivery.

1.4. Europe as a Production Area

1.4.1. Current Status in Employment and Production

Employment in the IT industry declined from 940,000 in 1995 to 935,000 people (or 1.1% of European employees) in 1996. The hardware sector was particularly affected by this decline, mainly due to the headcount downsizing trend of major hardware vendors in Europe. Conservative estimates indicate a reduction of 7% of the hardware segment. Employment went from some 220,000 people in 1995 to 205,000 in 1996.

The software, services, and distribution channel segments showed a slight increase in employment, accounting for 730,000 employees in 1996 (720,000 in 1995). The demand for software applications and tools continued to be strong justifying the setting up or expansion of current R&D, production/localisation or distribution facilities by software providers in Europe. Headcount increase in the services sector resulted from the following trends:

- The Year 2000 and the Euro conversion issues generated more demand for developers and programmes skilled in all types of new or old generation language code development.
- The deployment of Internet-based hardware and software technology started to generate increasing demand for Internet technology skilled staff, rarely available in IT departments.
- The increasing outsourcing of functions (desktop computers build-to-order outsourcing of PC manufacturers to distributors, hardware, network and software services support, marketing and communications functions) had led to an increase in induced labour in the services sector including channel players and software partners.

Rapid expansion in IT, and telecommunication industries has created massive skills shortages and firms offer available talent starting salaries and employment packages that are probably unbeatable. This is particularly true in the IT services sector, where the shortage of skills in emerging technology areas, as well as in discontinued programming techniques (used to develop applications that must be made Year 2000 compliant) has determined relevant increases in charge out rates and payroll. In the UK alone, industry needs 30,000 IT recruits but there are only 10,000 computer science and information systems graduates coming out of UK universities. Companies are not just looking to fill technical vacancies but are prepared to consider more general IT skills for sales and marketing support or consulting. As a result, the ICT sector represents a big employment opportunity for the coming years.

Employment in the telecommunications sector has declined from 1,100,000 in 1995 to 1,050,000 in 1996. The liberalisation and restructuring of the sector has focused attention on cost control, productivity comparisons and the need for corporate competitiveness. This has tended to accelerate the decline in employment in traditional public telecommunication services. However, the increasing demand for new services such as cable services, mobile services, Internet access and online content, have partially offset this trend.

1.4.2. R&D Effort

Increasing competition and higher sophistication of customers needs make ICT companies in Europe more aware of the importance of Research and Development efforts and of close co-operation between industry and universities in the process of enhancing new products. However, R&D requires high capital investments, that are not easily fundable. This may lead to increasing consolidation of ICT industries in Europe in the near future.

Unlike manufacturing, the siting of R&D labs is less about wage-rates and investment grants, but more about finding the skilled people to do the research. The use of information technology and high-speed communications means that labs can be built exactly where the necessary skills are found. Pockets of expertise in technologies like electronics, software as well as genetics and pharmaceuticals have been growing steadily in the UK in the past decade. Typically based around universities, these have been identified and developed by multinational companies.

In 1997 the European Commission harnessed and refocused its research efforts within the context of the Fourth Programme for Research and Development. This include the ESPRIT (European Strategic Programme of Research and Development in Information Technology), ACTS (Advanced Communication Technology), and Telematics programmes on marketable products and services.

Within the context of the ESPRIT programme, a 13 million ECU initiative, aimed at investigating new ways of learning in schools, was launched.

The Fifth Framework Programme for Research and Development for 1999-2003 is expected to be issued in 1998. The Programme brings together and extends the ACTS, ESPRIT and Telematics Applications programmes to provide a single, integrated programme that reflects the convergence of information processing, communications and media, and responds to the need to integrate R&D with take-up actions.

In a paper entitled "Towards the Fifth Framework Programme: Scientific and Technological Objectives", electronic commerce has been picked out as one of the thematic areas for

the channelling of Europe's research and development aid between 1999 and 2003. Tele-medicine, tele-education and multimedia content applications are other areas. The final figures have yet to be settled. The industry welcomed the European Commission's new emphasis on application-centric projects, which add further energy to private investment already available to fund viable projects in those areas.

Major R&D private initiatives are:

- UMTS Alliance (formed by Alcatel, Bosch, Italtel, Motorola, Nortel, Siemens, and Sony) to develop the third generation of wireless standard;
- Co-operation between telecommunication suppliers (manufacturers) and operators;
- Joint effort to develop standard Net telephony, high-speed communications network systems, interactive multimedia application software;
- Strategic alliances to ensure interoperability between telecommunications systems and enterprise data networking systems, and to integrate voice and data communications;
- Co-operation in developing mobile terminals.

1.4.3. Concentration, Mergers, Acquisitions and Co-operation in the ICT Industry

Concentration

In 1996 leadership positions have been turned around and mergers and acquisitions have given birth to new players.

The number of IT companies whose combined market share accounts for some 40% of the Western European IT market increased from eight to nine. The overall Western European figure hides different national dynamics, according to 1996 indicators (figures are for data-processing sector only, excluding office products):

Number of Leading IT Companies with Combined Market Share of 40%

	1992	1993	1994	1995	1996
Austria	3	4	4	4	4
Belgium	7	6	7	8	8
Denmark	5	4	5	5	4
Finland	4	4	5	4	4
France	8	9	10	9	9
Germany	4	6	6	5	7
Greece	4	3	2	5	5
Ireland	4	6	6	7	5
Italy	2	2	3	3	5
Netherlands	6	5	6	7	7
Norway	5	7	8	7	8
Portugal	4	3	3	3	4
Spain	5	5	5	5	5
Sweden	9	8	6	7	7
Switzerland	7	7	6	6	8
United Kingdom	9	10	9	7	11
Western Europe	7	8	7	8	9

These variations stem from differences in the rate and structure of growth, and different alliances and acquisition initiatives that involved major national players across a number of countries.

Mergers, acquisitions and co-operation

The number of merger and acquisition deals in the European ICT industry increased steadily in 1997. This rise was primarily driven by the trend towards globalisation, which has led American companies to buy their European counterparts, as well as by the attempt to increase market leadership and shareholder value. The busiest areas were the telecommunications, software products and services sectors. In the telecommunications sector, 62 were undertaken just in the first half of 1997, while the number of transactions in the software products and services sector increased to 196, in the same period. Mergers and acquisition activity in Europe is

Table 9
EU Trade by Country. Office Machines and EDP Equipment, 1996. Million ECU

		EU	Non-EU	US	Japan	4 Tigers	Row	Total
EU	Import	43,403	630	11,479	6,880	6,667	10,793	79,852
	Export	46,587	2,386	5,087	1,426	1,302	6,091	62,879
	Trade Balance	3,184	1,756	- 6,392	- 5,454	- 5,365	- 4,702	- 16,973
Germany	Import	7,116	222	2,186	2,328	2,421	1,077	15,350
	Export	6,623	672	643	135	183	1,257	9,513
	Trade Balance	- 493	450	- 1,543	- 2,193	- 2,238	180	- 5,837
France	Import	6,470	49	1,502	698	1,412	785	10,916
	Export	6,126	252	452	31	97	1,044	8,002
	Trade Balance	- 344	203	- 1,050	- 667	- 1,315	259	- 2,914
UK	Import	7,102	79	2,898	1,237	2,482	1,546	15,344
	Export	9,771	432	1,920	768	388	1,434	14,713
	Trade Balance	2,669	353	- 978	- 469	- 2,094	- 112	- 631
Italy	Import	4,205	31	543	169	554	387	5,889
	Export	2,829	93	334	69	96	348	3,769
	Trade Balance	- 1,376	62	- 209	- 100	- 458	- 39	- 2,120
Spain	Import	2,045	13	316	89	165	253	2,881
	Export	684	13	162	6	104	156	1,125
	Trade Balance	- 1,361	0	- 154	- 83	- 61	- 97	- 1,756

Note: Non-EU includes Iceland, Norway, Liechtenstein, the Faroe Islands and Switzerland.

expected to continue, driven by the rapid pace of technological change and the growing trend toward convergence, combined with strengthening stock and financial markets which are providing the resources to fund transactions.

In media and information services the number of transactions is increasing, as many of the companies that fall into this category have begun to acknowledge the importance of being allied with the IT industry. Companies that successfully address the convergence of media and information technology will represent highly attractive acquisition candidates.

In the support services market transactions are climbing, generating concentration especially among systems integrators. Key players recognise that scale matters as the world moves to sophisticated, mission-critical networks. This market will continue to have players trying to build mass through consolidation strategies in the short term.

		EU	Non-EU	US	Japan	4 Tigers	Row	Total
EU	Import	6,017	344	2,874	571	772	1,541	12,119
	Export	6,419	491	729	191	496	6,164	14,490
	Trade Balance	402	147	- 2,145	- 380	- 276	4,623	2,371
Germany	Import	767	129	536	153	215	355	2,155
	Export	686	151	152	22	78	1,984	3,073
	Trade Balance	- 81	22	- 384	- 131	- 137	1,629	918
France	Import	603	12	259	59	79	183	1,195
	Export	781	41	52	8	103	837	1,822
	Trade Balance	178	29	- 207	- 51	24	654	627
UK	Import	1,040	72	1,202	131	147	556	3,148
	Export	1,652	75	287	19	130	589	2,752
	Trade Balance	612	3	- 915	- 112	- 17	33	- 396
Italy	Import	542	5	117	27	66	92	849
	Export	599	11	12	2	9	358	991
	Trade Balance	57	6	- 105	- 25	- 57	266	142
Spain	Import	759	10	213	18	23	62	1,085
	Export	165	1	14	0	6	461	647
	Trade Balance	- 594	- 9	- 199	- 18	- 17	399	- 438

Table 10
EU Trade by Country. Telecommunications Equipment, 1996. Million ECU

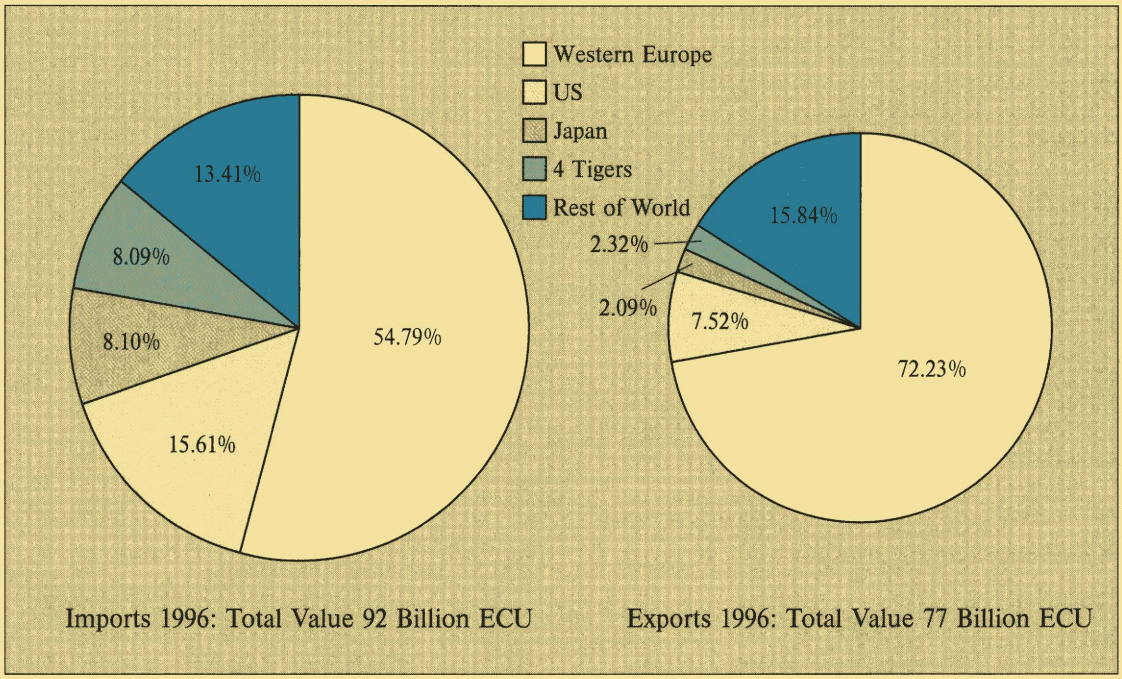
Note: Non-EU includes Iceland, Norway, Liechtenstein, the Faroe Islands and Switzerland.

Hardware deals reflected the industry's move towards Internet/Intranet and remote computing solutions. Among the leading objectives of these deals there are the combination of internetworking with remote access technology, and the provision of complete solutions for Internet Service Providers.

The European telecommunications market will undergo cross-border mergers between major carriers. Telecommunications operators are considering also hostile bids for rival large carriers to achieve critical mass, while takeovers of national telecommunications companies to build geographic presence across Europe continue.

An increasing number of alliances is also driven by IT and telecommunication companies linking with media groups, entertainment producers and software computer companies.

Figure 11
EU Total ICT Equipment Imports/Exports by Region. 1996



1.5. Trade in the European Union

The European Union continues to run a trade deficit in IT and telecommunications products. The negative balance worsened in 1996. It passed from some - 17.7 billion ECU in 1995, to - 18.2 billion ECU in 1996. Extra-EU exports rose by 21.8%, from some 20 billion ECU in 1995 to some 24.4 billion ECU in 1996. The telecommunications market continued to drive exports growth.

1.6. Eastern Europe

1.6.1. General Trends

The region of East/East Central Europe continues to represent one of the largest IT industry opportunities in the world, with overall IT spending reaching an estimated ECU 6.8 billion in 1997 (combined value for Czech Republic, Hungary, Poland, Russia, Slovakia only).

Once largely oriented to hardware sales, the East/East Central European IT market is increasingly focused on other elements of IT spending, as the economies of the region move to quasi stability and growth. While demand for basic hardware remains strong, particularly in the larger markets further east such as Russia, Poland and the Ukraine, a growing amount of annual IT expenditures in the region are now being generated from sales of software, professional services and maintenance/support services. In particular, the markets of several of the larger states of East Central Europe (e.g. Czech Republic, Hungary) are beginning to display characteristics similar to those in more developed markets in terms of IT ratio expenditures.

While spending on information technology has grown remarkably, both the relationship of IT expenditures to GDP and per capita IT spending reveal that expenditures are still con-

siderably lower than that of the average country market of Western Europe. *Table 12* illustrates that only the Czech Republic exhibits spending levels which match those of many Western European countries: the vast majority of East/ East Central European states spend around or less than 1.9 percent of GDP annually on information technology. Similarly, per capita spending across the region is quite low, from the Czech Republic's high of approximately ECU 139 in 1996 to Ukraine's ECU 3 (see *Table 13*). Demand is increasing for telecommunications networks infrastructure (base stations as well as subscriber access equipment) including radio in the local loop.

1.6.2. IT Trends by Product

i. IT hardware

The country markets of Eastern Europe remain heavily oriented to personal computers and PC-related technologies (PC add-ons, peripherals), which accounted for the largest percentage of IT hardware spending in the 1996-1997 period. Similarly, other segments such as the low-end office equipment market, LAN internetworking hardware and the LAN server market have experienced considerable growth over the last several years. Reflecting the regional market's low-end focus, the computer systems (mainframes, servers, workstations) segment has stagnated in several countries in terms of unit sales and value due to reductions in funding for public IT projects, limited demand for high performance mainframes, and a decline in average system values for servers. Increasing demand for Unix servers was recorded in Hungary and Russia, especially in the public administration, finance and telecommunications sectors. PC servers now represent the predominate multi-user platform.

ii. Software and services

Software and services represents one of the fastest growing sectors of the IT market in East/ East Central Europe now that the region has entered a more advanced level of computerisation. Particularly strong growth is being seen in the market for packaged software, such as PC application software, ERP applications and application tools for database development and management, and in the demand for basic services such as IT consulting, contract programming and software design, IT education and training, systems and network implementation. The regional value of the software and services market reached almost ECU 2 billion in 1997, which was up more than 13 percent over the previous year.

Most growth in the software and services sector is derived from large-scale projects in banking/financial services, government administration, telecommunications and industry/manufacturing. Nonetheless, the growing complexity of applications and solutions is driving demand for support in other vertical market segments, and among small and medium-sized companies.

Local firms have confirmed their growing presence as systems integrators, value-added resellers, support providers, software developers and training centres, winning major bids and contracts for hardware and software support and training.

1.6.3. IT Trends by Country

Czech Republic

The strong growth seen in the Czech information technology market in the 1989-1996 period came to an abrupt end during the first part of 1997 as the Crown's devaluation, a high current account deficit for the first quarter of the year and a slowdown in economic growth

undermined IT expenditures. Spending was lower in almost all key sectors, with the sharpest cuts being made in public administration, as the Czech government curtailed expenditures. This situation was further exacerbated by the July floods which required supplementary spending outlays. Moreover, instability in the banking sector, combined with the Ministry of Finance's plans to accelerate the privatisation of several large banks, reduced IT expenditures among finance organisations. Finally, spending was significantly lower among price conscious small businesses, small office and home users.

The combined value of sales of all computer hardware, peripherals, networking, software and services for this country market reached an estimated ECU 1.2 billion in 1997. While much of this figure was derived from hardware sales, software and services have become increasingly more important to the IT market's overall development, accounting for around 43 percent of all local IT expenditures in the 1996-1997 period.

The slowdown in the Czech market has been most evident in the personal computer sector. In 1997, PC sales grew by less than 4 percent to around 247,000 units for an estimated value of ECU 317 million in revenue. Other segments displaying little or even negative growth last year included the markets for servers, peripherals, workstations and hardware add-ons. Sectors which continued to see some growth included IT services and packaged software. Even here, however, the high growth rates reported for previous years were scaled back.

The question now arises as to whether the market's slowdown reflects serious macroeconomic problems, and hence will not return to a path of growth until structural problems in the Czech economy are solved, or whether the current stagnation is only a temporary development. Several factors point to a continuation of the slowdown into 1998. Major inhibitors to market development include:

- Political instability with calls for an early parliamentary election;
- Instability in the debt ridden Czech banking sector;
- A large budget deficit was reported for most of 1997;
- The introduction of an austerity package by the former Klaus government;
- A slowdown in growth in GDP;
- Growing trade and current-account deficits;
- Devaluation of the Crown.

Nonetheless, the Czech Republic remains one of the most advanced IT markets in the region, based on an examination of IT ratios, which are now beginning to reflect spending patterns in Western European markets. Unlike Poland, Romania, Russia and several smaller states in the region, in which 40 percent or more of annual IT expenditures are devoted to personal computer and related hardware, the ratio for the Czech Republic has now fallen below 35 percent, as IT spending is being shifted to implementation services, networking hardware/software, application solutions development and support.

The Czech market also stands out for several other reasons including:

- The country has the highest ratio of IT hardware spending to GDP in the region (1.7% in 1996). While overall spending is still considerably lower than in Western Europe, it exceeds expenditures in all other East/East Central European countries.
- IT spending levels as a percentage of GDP in the Czech Republic are comparable to those of most Western European countries.
- The country's IT services market is the largest in the region in terms of value.

- Demand in the home market segment is growing despite deterioration of the country's economy.
- Increasing interest on Internet usage, with both the number of providers and users growing, and most local IT companies revising product strategies to move into this segment.

Overall, the information technology market in the Czech Republic is expected to increase in value by an annual growth rate bordering on 10.6 percent in the 1997-1999 period. The value of the market will exceed ECU 1.5 billion through the end of the forecast period. While most spending will remain focused on hardware, software and services will comprise an increasingly larger share of annual IT expenditures. Particularly strong areas of growth aside from personal computers include networking hardware/software, LAN servers, networking services (implementation/management), software application development, professional services and customer support services.

Slovakia

Despite growing political instability, Slovakia has one of the best performing economies in East/East Central Europe. Despite a slowdown in 1997, the country's GDP continued to grow, exports were relatively strong, and inflation remained low. Moreover, the Slovak Crown has been one of the most stable currencies in East/East Central Europe.

Slovakia stands out among the smaller countries of East Central Europe for the relative size of its information technology hardware market. In 1997, the total value of all IT expenditures reached an estimated ECU 344 million, consisting largely of sales of personal computers and related technologies. Current IT vendor activity is focused on meeting the requirements of infrastructure development in banking/financial services and government administration sectors as well as large, state run companies. The country's evolving private sector has more recently become an important recipient of IT.

In 1997, the personal computer market in Slovakia comprised around 75,000 units for an estimated value of ECU 110 million. Most leading international name brand vendors have now taken up operations in this market, many of which have established a local subsidiary or representative office in the wake of larger contracts and European Union (EU) funded projects. Name brand vendors are controlling an ever increasing share of the PC market, with 52 percent of shipments in 1996.

The resurgence of Slovakia's manufacturing industry combined with the restructuring of government administration and banking/financial service sectors have driven the demand for computer systems, servers, IT services and packaged software. While sales of high performance mainframes are limited in such a small market, shipments of servers, particularly Unix and LAN systems, have risen substantially in the 1994-1997 period. Total server shipments exceeded 2,300 units for a value of ECU 47 million.

The Slovakian IT market is cyclical with most equipment procurement concentrated in the fourth quarter of every fiscal year. This dynamic reflects a number of factors, the most important of which is the government's annual budgetary process.

Slovakia's information technology is projected to expand at an average rate of 15.2 percent in the 1997-1999 period. Despite a surge in the demand for services, vendor activity will be confined to the low end of the market, in particular for personal computers, peripherals, hardware add-ons and packaged software.

Hungary

Hungary is now rebounding after several years of economic and political stagnation. The country has moved ahead with a combination of rising output and subsiding inflation. GDP is forecast to grow by a further 4 percent this year, on the basis of positive industrial growth, rising exports to its main European trading partners (e.g. Germany, Austria) and higher revenue flows from the privatisation of key large companies. A number of important offerings were made last year, including the oil and gas company (MOL), the national airline (Malev), the vehicle manufacturer (Raba) and at least two banks.

Hungary also remained the regional leading regional recipient of foreign direct investment through the first part of 1997, with approximately ECU 11.8 billion coming into the country during the last six years. The figure reportedly totaled ECU 1.5 billion in 1996, which was down from ECU 3.5 billion in 1995.

Economic developments have had a positive impact on the country's information technology market. Spending on IT continued to recover in 1997, expanding to ECU 759 million after undergoing a decline several years previously, due to the impact of measures incorporated in the Bokros austerity package (first launched in 1994).

As one of the more developed markets of East/East Central Europe, spending on information technology in Hungary is now less focused on hardware. In 1997, expenditures on hardware comprised only 54 percent share of the total market, while spending on software, professional services and support services rose to 46 percent. Much of the growth in hardware has been confined to sales of personal computers, PC LAN servers and LAN inter-networking equipment, as demand for systems (high performance mainframes, Unix servers and SMP servers) has stagnated with a decline in orders from key vertical markets such as government administration and banking/financial services. The PC has become the predominant server platform in this country market.

Software and services has become an important factor in the country's information technology market over the last three years. These two categories currently illustrate the highest level of annual growth, with combined revenue reaching an estimated ECU 351 million for 1997. Professional services and systems integration, in particular, have seen a flurry of activity, with most major international vendors taking up operations in this market. Moreover, several large outsourcing contracts have been awarded over the last year. Hungary also retains a notable local software industry focused on exports.

Hungary's IT market is expected to grow at an annual rate of 10.3 percent in terms of value between 1997 and 1999. Most vendor activity will be confined to the low end of the market, in particular to personal computers, PC servers, software, peripherals, data communications hardware and office equipment items. Market growth through 1998 will stem largely from four vertical markets: the evolving small and medium-sized private company sector, banking/financial services, manufacturing and government administration. Moreover, the energy and telecommunications segments are becoming increasingly more important for higher-end equipment sales.

Poland

Poland appears to have made the successful transition to a parliamentary democracy and market economy. The new coalition government led by the Solidarity group remains committed to the broad economic reform objectives set out under the "Balcerowicz Programme" from the early 1990s. Poland now boasts a steadily falling inflation, climbing bank reserves, annual economic growth bordering on 5 percent and one of the highest gross domestic products in Europe. The government has also improved relations with both the European Union and NATO, having defined membership timetables and goals, while moving forward with the long delayed mass privatisation programme.

Moreover, after several years of delay, Poland is now seeing notable investment in key sectors such as banking/financial services, government administration and manufacturing. Total cumulative foreign direct investment exceeded ECU 9.4 billion in 1996, reflecting a ECU 4 billion rise on the previous year's closing figure. Poland is poised to take the lead in the East European investment race, as the country moves into the privatisation of strategic sectors such as energy and telecommunications. Moreover, a number of international companies have outlined investment projects in the country's manufacturing sector. It is estimated that Poland will have received up to ECU 18.6 billion in direct foreign investment by the year 2000.

Positive economic developments have also carried over into IT spending. Poland now represents the largest IT market in the East/East Central European region after Russia. Overall expenditures on information technology reached an estimated ECU 1.44 billion in this country in 1997, which marked a 15.1 percent increase over the previous year's figure of ECU 1.25 million. Despite the size of its population and GDP, this country market is largely oriented to personal computers and related hardware, which accounted for an average of 43 percent of total IT market value in the 1996-97 period. Aside from basic PC units, the remainder of the market is largely concentrated on PC-related technologies such as peripherals, PC add-ons, office equipment and LAN hardware. Nonetheless, shipments in the country's systems and server market has also shown high growth, on the basis of increased demand in several vertical market sectors such as banking/financial services, government administration and manufacturing. Similarly, the IT services market expanded by more than 40 percent on average in the 1995-1997 period.

Growth in the Polish IT market is being driven by several factors aside from general investment and economic growth including a surge in the demand for LAN inter-networking technology consistent with the proliferation of networking, ongoing strong sales of personal computers and related technologies, an evolving Internet market, increased requirements for IT professional and support services and the implementation of standard packaged application solutions. As the IT hardware market consists largely of PCs and related technologies, most software and services vendor activity is focused on sales and support of packaged software, customised applications development, networking and hardware/software support services.

Polish companies continue to play an important role in the software market in terms of distribution, education/training and customised application development. A number have also become important players in the country's evolving IT services market. Many smaller value-added resellers have ensured themselves a niche

with the creation of software for a specific vertical market, platform or application. Others are focused on providing applications and support for the country's evolving Unix systems and integrated application software markets. Local Unix expertise can be found in a few large software houses and a number of smaller software organisations, the majority of which provide application development support for PCs and workstations, in particular for sectors such as banking. The ongoing consolidation in the Polish PC market has also led a number of local companies to become involved in the emerging market for IT training and educational services.

In the 1993-1997 period, the Polish government has become a major purchaser of information technology, including hardware, software telecommunications and professional services. It has also taken an active role in both the computerisation of the public sector, with the establishment of several organisations to oversee IT procurement. Moreover, its monetary and fiscal policies and regulations have had substantial impact on the evolution of the country's information technology market. Unique for the Eastern European region, Poland has seen the emergence of several official organisations which are now closely involved in the computerisation of the public sector. Most important is the Office for Information Technology at the Bureau for the Council of Ministers (BIURM), the government's steering committee for IT development created in 1991, which is seeking to formulate IT directions and strategies for public administration, in compliance with the standardisation requirements of the European Union, and to supervise the development and application of IT in government ministries, central administration and local authorities. In May 1994, the Polish Prime Minister created an additional body for IT called the Government Plenipotentiary Office for Informatics (Rads ds. Teleinformatyki). The office serves to oversee the activities of the BIURM, as well as general investment and strategy development for the public sector.

Poland's information technology hardware market will continue to develop rapidly in the years ahead, with a projected average growth rate of nearly 11.5 percent between 1997 and 1999 in terms of value. Most shipment activity will take place at the low end of the market, particularly for servers (Unix-based machines, network servers, and client/server technology), personal computers, data communications hardware and other office equipment items.

Russian Federation

Despite ongoing economic and political instability, overall IT expenditures in Russia grew to nearly ECU 3 billion in 1997, marking a 20.1 percent increase over the previous year. Growth was driven by increasing demand for software and increasing investment in the finance sector, while the Russian government still had severe monetary difficulties which undermined spending on information technology projects. Similar to other countries of the region, the Russian market is overwhelmingly oriented to personal computers and related technologies. These categories accounted for close to 55 percent of all outlays for IT last year. Despite weakening home PC demand, PC corporate sales remained healthy, thanks to rapidly falling prices for fifth generation processors, and purchase shift to higher-range Pentium class processors.

Growth drivers in the Russian market include:

- The efforts by a number of large Russian corporate users to roll out major IT investment programmes in the 1997-1998 period, now that the political problems of 1996 are past. These include the Russian Taxation Inspectorate, the Russian Taxation Police, the Savings Bank of Russia, the Central Bank of Russia, the United Energy System of Russia, Yukos, LukOil, Gazprom, the Ministry of Railways, the State Pension Fund, Rostelecom and the State Committee on Land Registration;
- The progress in the ongoing privatisation of most of the large state-owned companies. Once these organisations are in private hands, long term investment can begin to take place. The sale of the State Telecommunications Holding Company Svyazinvest especially should pave the way for major infrastructure investment in Russia's city and inter-city telephone network;
- The Russian banking sector recovery, after undergoing a period of difficulty and consolidation in 1996;
- Monetary reform, scheduled for early 1998, expected to re-value the Russian Rouble by a factor of 1,000. This reform is likely to generate demand for IT consulting services as end-user organisations wrestle with the software issues this reform creates;
- Russian legislative sanctions on intellectual property rights infringement have become significantly harsher to fight software piracy.

While personal computer technology predominates in Russia, this country market has also more recently seen a notable increase in the demand for computer systems and servers. Similarly, expenditures on packaged software and IT services have risen sharply as funding has been released for the large project business. Overall spending on servers reached ECU 278 million in 1997, which represented a 36.4 percent increase over the previous year.

The software and services market in Russia is largely a local one for reasons of price and local attitudes. Estimated activity in these sectors produced ECU 499 million in revenues in 1997. In terms of future developments, the large number of local software specialists will facilitate strong demand for application development tools, particularly for relational database management systems. Other sectors which can be expected to see strong growth through 1999 include ERP software, integrated Unix applications, networking services, professional and support services.

The Russian IT market is projected to increase by a compound annual growth rate of 14.9 percent between 1997 and 1999. In the short term, the most important sectors of IT market growth are represented by financial services, government administration (statistics, tax/customs, revenue collection and central bank operations), basic infrastructure (energy and transportation), social security systems, and manufacturing. Private firms also represent a major recipient of low-end products, such as PCs, printers and office equipment. Russia's evolving banking industry is clearly the most lucrative sector in the short term, despite a range of problems. With significant hard currency profits, banks are the only organisations which are procuring more expensive, sophisticated hardware and software solutions.

Table 11
East vs. West: Overview of Computer Hardware Spending in Eastern Europe by Country 1997-1999. Million ECU

Country	1997	1999	CAGR 1997-99 %
Czech Republic	559	650	7.8
Hungary	316	376	9.1
Poland	762	939	11.0
Russia	1,933	2,673	17.6
Slovakia	196	262	15.4
Western Europe	64,258	73,490	6.9
Germany	16,553	18,561	5.9
France	9,398	10,954	8.0
Italy	5,048	5,669	6.0
United Kingdom	12,303	14,505	8.9
Spain	2,861	3,396	8.6

Table 12
East vs. West: Ratio of IT Spending to GDP. 1996

Country	%
Czech Republic	2.99
Hungary	1.89
Poland	1.19
Russia	0.79
Slovakia	1.91
Western Europe	2.26
Germany	2.10
France	2.41
Italy	1.44
United Kingdom	3.24
Spain	1.34

The Russian market embodies one of the largest single opportunities for IT market development in the world today. Indeed, the sheer size of this combined market and the dearth of computing technology will drive substantial market growth through the year 2000.

Other East/East Central European Countries

Overall spending on information technology in other countries throughout the East/East Central Europe region, such as Bulgaria, the Central Asian states, Croatia, Romania, Serbia, Slovenia, Albania, Macedonia, Central Asia and Ukraine comprised a combined total of only ECU 858 billion in 1997. Spending in most of the smaller states of the region is well below ECU 200 million annually.

Despite the limited level of current investment in IT, several of these country markets hold significant potential, in particular the Ukraine with its 52 million people. Similarly, investment in infrastructure projects is up in Croatia in the aftermath of the Yugoslav civil war. A distinction must be made among countries in terms of the type and levels of spending. Both Slovenia and Croatia represent more developed markets where IT infrastructures and spending levels approximate those of West European countries. Confronted with a host of serious economic problems, Bulgaria, Romania and the Ukraine field IT markets with annual spending in a range below ECU 120 million and largely oriented to personal computers, with only limited spending devoted to higher end systems, networking, software and IT services.

2. The Impact of the Internet

2.1. Internet Usage in Europe

The number of European Internet users is growing rapidly. In 1997 there were almost 24 million Internet users in Western Europe, who will almost triple to some 67 million by 2001. The almost 1 million users in Eastern Europe in 1997 are expected to become more than 5 million by 2001.

However, as a whole, Western Europe lagged both the US and Asia/Pacific in Internet attitudes and activity levels during 1997, for the following reasons:

- The lack of a strong, integrated, and deregulated telecommunications infrastructure;
- The lack of strong regional Internet policies and strategies;
- Big differences between countries as regards Internet usage and perception;
- Requirement of English language to read most of available Internet content;
- US-oriented contents;
- Low Internet access speed.

Some European countries enjoy high sophistication, and very aggressive Internet usage. Nordic countries and the UK were among the early adopters of the Internet, and are very close to the US for growth and penetration of Web servers, and Internet user demographics. They are very strong in all kinds of Internet use and show a high penetration of Internet users compared to the sizes of their countries. In Germany, France, Benelux, Austria, Italy, and Switzerland, the Internet started to take off in 1996. Germany was the largest market for the Internet in 1997, followed by the UK, Sweden and France. In Spain, Portugal, and Greece, the Internet is still in its infancy, even if a great interest is emerging, indicating a strong growth potential for the near future.

Country	1996
Czech Republic	139
Hungary	83
Poland	38
Russia	19
Slovakia	65
Slovenia	123
Bulgaria	12
Romania	7
Ukraine	3
Western Europe	421
Germany	486
France	499
Italy	249
United Kingdom	490
Spain	157

Table 13
East vs. West: per Capita IT Spending by Country 1996. ECU

Category	1995	1996	1997	1998	1999
Multiuser Systems	545	591	661	789	952
Workstations	59	55	62	70	77
Personal Computers and Add-ons	1,694	2,203	2,561	2,890	3,297
Printers	427	434	482	517	573
Total	2,725	3,283	3,766	4,266	4,899

Table 14
Eastern Europe: Computer Hardware Value Category Comparison. 1995-1999. Million ECU

Figure 12
East vs. West: Number of Business PCs Installed per 100 White Collar Workers, 1996

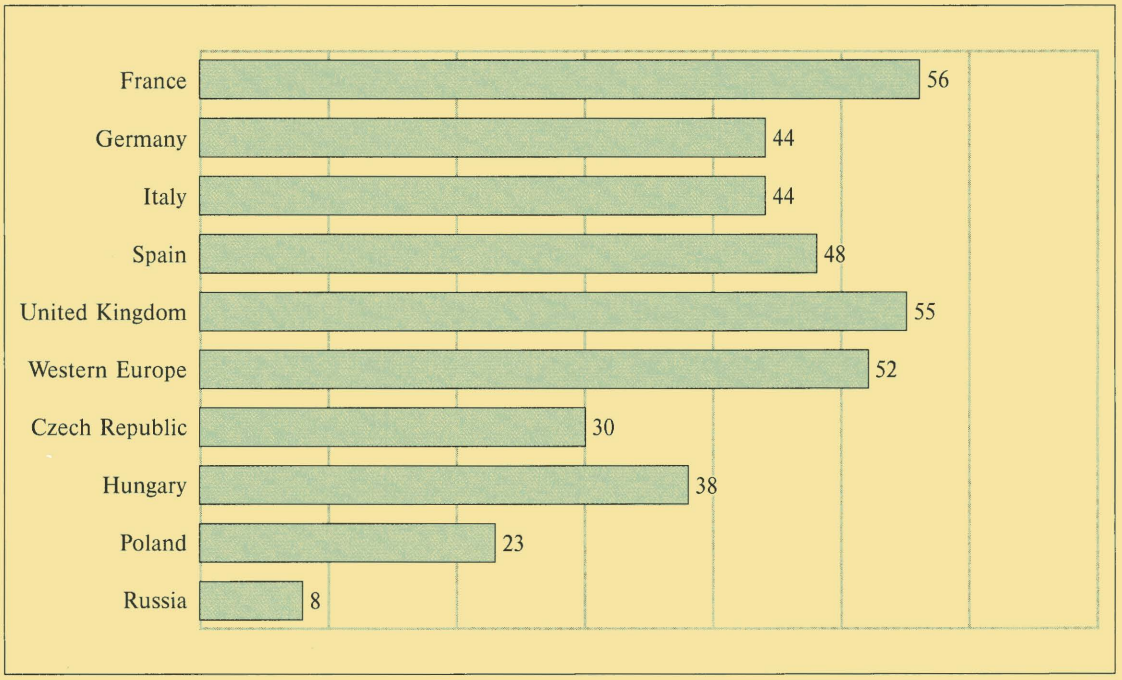


Table 15
Estimated Internet and Online Users in Europe, 1995-2001

	1995	1996	1997	1998	1999	2000	2001
Business Users	6,466	9,226	12,530	13,247	13,904	15,161	16,279
Home Users	5,860	8,663	11,398	18,231	27,007	37,820	50,394
Western Europe[1]	**12,326**	**17,889**	**23,928**	**31,478**	**40,911**	**52,981**	**66,673**

[1] Incl. Turkey

Skills, habits, language and culture have greatly affected the population's desire and/or ability to participate in the Internet community. Clearly education and literacy levels have also played an important part. The importance of languages for the Internet in Europe is proven by the development of local content and its design for local markets by both local and US-based Internet service providers over the past few months.

A further improvement for the European Internet users was increased Internet access speed with the development of faster modems, and the wide-spread installation of ISDN connections. Although the access via 14.4 kbps modems decreased in 1997, differences in access speed across Europe are still crucial. While Germany has the highest amount of access via ISDN in Europe, Greece has still the highest number of 14.4 kbps modems.

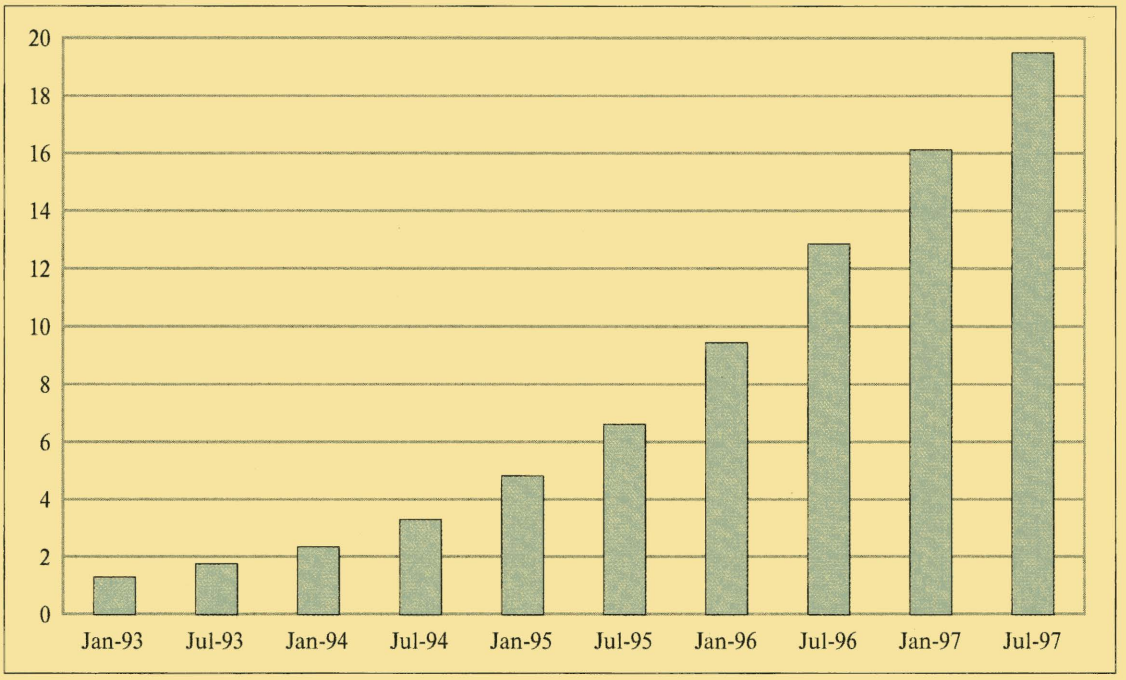


Figure 13
Worldwide Growth in the Use of the Internet: Number of Internet Hosts (Millions), 1993-1997

2.1.1. User Segments

Home users

From 1998 onwards, home users are set to become the prevalent segment in Internet access. Online subscription and Internet access have increased steadily among home users in 1997. This pace is expected to continue with the lowering cost of Internet devices and services. For more details on Internet usage patterns and potential in the home, see Part Two, *ICT for European Homes: Devices, Services and Applications"* in this volume.

Businesses

Overall, more than 60% of medium/large companies in Europe provide their staff with access to the Internet from their corporate wide area networks, with higher peaks in the UK and Nordic regions.

As a business tool, the Internet has largely been limited to e-mail and Web surfing. However, as larger carriers are starting to develop more robust networks in Europe to support Internet traffic, network performance is improving up to the standard expected by corporations operating national and global enterprise networks.

2.1.2. Applications

Electronic commerce

Electronic commerce offers enormous opportunities for consumers and for businesses in Europe in terms of job creation, welfare enhancement, cohesion, integration and competitiveness.

By the year 2000 the value of the global electronic commerce market is estimated to reach 200 billion ECU. With the creation of a strong base of European "appeal" content, the Internet is emerging as a new distribution channel for all kinds of products and services also in Europe. Products purchased are similar throughout Europe. Software is by far the most wanted product, followed by books. All kinds of electronic products are also very popular. A strong interest has also been shown in subscriptions to online magazines on the Internet. On the other hand, such products as food, clothes, cars, real estate are not so common in electronic commerce transactions.

Among services, retail banking is leading the way in adopting Internet commerce solutions. Management services and health care are also expected to lead the way in offering services via the Internet.

Although the branch still holds the majority of all retail banking transactions, the delivery of retail banking through the Internet will become more popular with increasing use of computers, and the advent of digital TV. Internet banking is cheaper than traditional methods and the global computer network is lowering national barriers as well as promoting new markets, in areas ranging from electronic payments to online share trading. Online developments follow the more established computer banking packages available from most of the big banks and building societies. Online trading will be in high demand as the population ages and citizens begin depending more on private investments for retirement income. Customers' concerns on Internet security, payment methods and legal problems are important factors driving the speed with which banks introduce Web products. Credit card companies and the computer industry have promoted pilot projects regarding online payment procedures via the Internet.

Internet telephony

The introduction of features that combine Internet telephony with multimedia functions have helped the enhancement of electronic commerce, collaborative computing, and real-time online product support services. Internet telephony could become the enabling function that drives interactivity among customers, commerce, and public sectors across these networks.

Multimedia telephony applications (MTA) development is favoured by the following drivers:

- Opportunities to offer communications within the enterprise (intranet) and business-to-business;
- New levels of intelligence and services at lower costs than the traditional telecommunication carrier pricing curves;
- Easier and cheaper telephony solution with the introduction of cheap Internet-centric appliances such as network computers (NC);
- Telecommunications deregulation, new entrants, and new business models;
- Attractive niche or speciality markets such as distance learning and medical diagnostics.

Primary requirements for general acceptance of Internet telephony are quality of service, interoperability, reliability, ease-of-use, security.

Internet fax services are also an opportunity. For international transmissions, cost savings can exceed 50% over traditional charges, depending on the destination country, the number of sites covered by the provider, the type of document-handling requirements, and the extent to which the provider passes savings on to the customer. The major appeal for an Internet service provider would be to gain revenue through metered subscriber use, rather than by the month, although the costs associated with customer service and support need to be considered.

Retail	Insurance	Medical	Financial	Software	Travel
Catalogue shopping	Insurance policies, business/personal	Remote diagnostics	Stocks	Demonstrations	Real-time bookings
Music	Travel	Preventive care	Banking	Sales	Tour guides
Entertainment bookings	Disaster recovery	Remote consultation	Loans, mortgages	Software support	Prebooking travel data

The table above shows multimedia telephony applications, industry segments and vertical applications.

2.2. Regulatory Framework

Businesses involved in electronic commerce and communications are calling for a harmonised international legal framework, to reflect the scale of the network. The key purpose of the framework would be to reassure users through security for transactions, international principles governing commerce, and intellectual property.

Cryptographic technologies are largely recognised as essential tools for security and trust on open networks. Two important applications of cryptography are digital signatures (i.e. software keys whose key-holders are identified by certification authorities) and encryption (a way of coding messages so that only authorised people with the right software keys to decode the messages can read them).

While protecting the confidentiality of data, cryptography nevertheless raises other problems. Some Member States have introduced legislation to restrict or control the use of these techniques and others are planning similar measures. Efforts to develop an encryption standard have been slow as any product developed in Europe has to be compatible and accepted by already established leaders. The Secure Electronic Transaction, or SET, developed by credit cards, is undergoing a number of tests.

Greater use of digital signatures requires adjustments and changes in many regulatory areas. The most important legal problems result from different national rules and regulations (or the lack of them). In particular they result from the absence of:

- Common requirements for certification authorities;
- Technical and operational requirements to be met by certain categories of digital signature products;
- Liability rules and legal recognition of digital signatures.

The legal concepts behind signatures and the requirements on form and procedures are different in each of the Member States jurisdictions. These different approaches and the potential lack of mutual recognition of each others regulatory requirements easily leads, due to the inherent cross-border nature of digital signatures, to a fragmentation of the internal market for electronic commerce and online services throughout the European Union.

In the Communication "Ensuring Security and Trust in Electronic Communication", *released last autumn, the European Commission confirmed that a common framework at Community level is urgently needed and should be put in place at the latest by the year 2000, in order to stimulate electronic commerce and the competitiveness of European industry as well as to abolish obstacles to free circulation and to facilitate the use of digital signatures across national borders. According to the Commission, a number of Member States (i.e., Germany and Italy) have already introduced legislation on digital signatures, which are used to provide security and trust on open networks such as the Internet. The introduction of diverging rules by the different Member States would, however, hinder the free circulation of goods and services in the internal market and would prevent electronic commerce from fully developing in the European Union. In particular, the Commission called for common rules on the establishment of the institutions which issue digital certificates (so-called Certification Authorities), mutual recognition of certificates issued in other Member States, rules for legal recognition of digital signatures as well as common technical requirements for digital signature products, if national provisions (e.g., for key generation or storage) are not mutually recognised and hinder the functioning of the Internal Market.*

The Commission declared that rules which limit or prohibit the use of encryption will also hinder the development of electronic commerce in Europe, while any divergence between national regulatory schemes on encryption might result in obstacles to the functioning of the Internal Market. It therefore proposed to adapt the Dual-Use Regulation in order to progressively dismantle the intra-Community controls on commercial encryption products.

Separated by great distances, electronic shoppers will also need the reassurance of brands. A reputation for honest dealing will become even more valuable. Where companies lack it, intermediaries will build consumer trust. For instance, credit card companies already often cut off merchants who incur a lot of complaints from customers. In future, they may be the main arbitrators in cross-border disputes between buyers and sellers. Good self-regulation will become a competitive asset. Just as online share buyers can already decide which exchange's rules to trust, so in future people buying holidays online may compare the guarantees offered by different industry bodies. Governments, too, may compete to be trusted and efficient regulators.

The Internet is also creating new legal questions, such as which country's laws are applied to cross-border transactions and whether a company was responsible for other World Wide Web sites that are linked to its own.

2.3. Impact on the IT Market

2.3.1. Hardware

Internet servers

The driver of Internet adoption in businesses is the perspective of moving administrative work from inside to outside the organisation, as well as the dramatically reduced cost for reaching customers, suppliers and business partners. The technology enabler for the evolution towards more Internet/Intranet-based solutions will be the provision of:

- High-performance networks and standards;
- Higher availability and security requirements on server platforms;
- Appropriate server functionality for different application types.

The point about the Internet is that, by becoming a major channel for mission-critical systems, it increases, and concentrates computing effort on the server platform. Server platforms need to provide ease of use and state-of-the-art electronic commerce capabilities within the platform. The business-to-business computing model will be changing from a "server surrounded by data" model to "a data surrounded by servers model", generating increasing demand for servers. More layers of architecture are required to enable a more complex web of transactions, with dedicated servers targeting different types of workloads.

Enterprise-wide Intranet projects pull demand for large quantities of departmental servers, typically running Windows NT, Netware or OS/2. The Internet server market also offers some opportunities for medium to high-end RISC/Unix systems. Towards the year 2000, shipments of Internet server hardware are expected to grow at CAGR 28%, while Intranet server hardware shipments will grow at CAGR 11%.

Server growth is forecast to maintain a strong pace in the longer term. As the Internet takes hold toward 2000, and more business processes become virtual, IT investment will increase, shifting from decision support and collaborative server towards business processing. This trend will profoundly affect the requirements and topology of servers. Industries that can virtualise their operations (such as banks, insurance companies, government services, some services companies) will see in particular strong server growth.

Enterprise NCs

Network Computers (NCs) emerge as desktop (or portable) devices stripped down to the bare essentials, downloading operating system, applications, and data entirely from a network.

Operating as a peripheral that can be attached to the Internet and to corporate servers, and can access all types of information, the NC has neutral architecture, no hard disk, no local storage. Applications and files are held on the server rather than on the desktop. Major advantages of the NC are purchase and maintenance cost savings and lower costs for simplified network administration, security issues and reliability.

The Network Computer concept makes the fully configured personal computer no longer needed on every desk, but just for well defined tasks. The PC best suits the knowledge worker who needs local storage of secure data, access to a large suite of applications and decision support tools, and windowing capabilities between them. The NC client is geared toward transactional workers who run a limited number of applications, do not require windowing between applications, and do not require large local storage. This option presumes users are fully supported by multiple servers and do not require local security features.

The business community is forecast to gather the first wave of NC users and NetPC users, looking to reduce desktop administration cost. However, a massive wave of conversions of corporate terminals into NCs is not expected. Terminals are generally in place because they met simple functional needs at very low cost. For most companies, terminal replacement is not planned unless the device is falling apart or unless there are plans to significantly upgrade applications. In the latter case terminal replacement would be funded as part of a broader system upgrade project. A set of supporting software will emerge for business users, including operating systems, browsers/selectors, productivity tools, and business applications. The existence of an upgradable applications base makes the corporate market the largest target of opportunity for NCs, but revenue volume

at least through 2000 may be small, for the requirement to offer functional equivalence for terminals, at equivalent low prices.

Information appliances

The large mass of information-seeking consumers represent the next wave of users looking for lower-cost access to the Internet. NC volume success will be connected to the emergence of the networked marketplace as a consumer-friendly environment.

Consumers will chose among different types of relatively inexpensive Internet access devices, such as NetTVs, Internet screen-phones, Internet game consoles, Internet smart handhelds (PDAs, high-end organisers, PC companions, smart phones).

The home market offers the most open opportunity for NCs, as the low cost and simplicity of operation of NCs fit home requirements very well. The software in support of consumers is also emerging, but is not yet widely available. The requirements are an operating system of some form and dial-up browser/selector technology. A whole host of software for commerce, services, information, and entertainment is then possible for running over a Web or downloading. The emergence of the networked marketplace, at the beginning of 2000, will create that base of consumer-oriented, network-centric applications that will allow mass market deployment of network computers in the home.

2.3.2. Software

Taken together the Internet/World Wide Web and the intranet/World Wide Web represent the best opportunity for the software market since client/server computing and the PC/LAN revolution. Among the software markets experiencing significant shifts are desktop and network operating systems, client/server applications, software development tools, and messaging/groupware. In all these markets, the adoption of Web technologies is driving often radical changes in product design, user interface, and pricing/packaging models.

Internet server software

In 1996, *HTTP servers* still dominated the market. In 1997, they became virtually free being included in many suite software products. The HTTP-only market is drying up as a revenue opportunity. This segment will evolve into content servers that offer much more than HTTP can provide in terms of functionality, and manageability. Such servers may be optimised to serve content out of a database, and may include other unique authority capabilities either at the client or the server. Content servers could also include functionality from other servers types, like proxy servers (to replicate content across multiple sites), or certificate servers (to authenticate users' access to content). Increasing prices are set to offset the significant decline in volume.

Revenue opportunities have emerged for *messaging* and *collaborative servers* markets. These segments are the most complex among the Internet server software types. They have the most related legacy installations of "proprietary" systems like cc:Mail or Microsoft Exchange.

The market for *proxy/cache servers* is still in its infancy. It is expected to begin to erode at the low end as vendors add very basic filtering and catching capabilities to their base platforms. At the high end, particularly from a cache perspective, there is a significant demand for products that can help ease the bandwidth crunch, especially at ISPs.

Because most organisations are still in the early stages of Internet and Intranet deployment, in general they are still implementing infrastructure: setting up their Web sites (HTTP) and associated messaging servers, proxy servers, and so on. Meanwhile, *Internet application servers* are just getting started. As enterprises embrace Internet technologies and embed them more thoroughly in their infrastructures, application servers pick up steam. While infrastructure volumes increase, revenues are expected to decline in 2001. By then, the infrastructure build-out will still be happening as the market expands into new market segments and new regions, but the segment will start to commoditise.

Unix was the operating environment of approximately 75% of all Web servers shipped in Western Europe in 1996, followed by Windows NT (20%), and Mac (3%). Windows NT continued to make impressive inroads as a platform for Internet server software market in 1997, and is expected to overtake Unix in 1999. As more organisations set up Internet and intranet sites they will become increasingly mainstream in the market, fueling Windows NT growth as they demand easy-to-use solutions based on the Windows interfaces they already know.

Information access tools (IATs)

Internet technology offers some inherent capabilities that are beneficial to decision support, even if they are irrelevant to transaction-based enterprise applications. Using the Internet as infrastructure has the major advantage of providing wide-area network availability without the installation or maintenance costs of a private wide-area network.

As with most Internet-related deployments, the objective with Internet-based enterprise decision-support products is to provide ease of deployment, administration, and maintenance. Internet-based information-access applications are deployed:

- Internally within enterprises (i.e., on the Intranet);
- Among enterprises (i.e., in that portion of Internet commerce that precedes or follows an actual transaction);
- In various forms of marketing enabled by Internet technology-based enterprise decision-support products.

Browsers can provide easy-to-maintain client software, as long as the users can live within the restrictions of thin-client design. Such client-side software can be deployed with minimal training.

Between 1997 and 1999, incorporation of more aspects of Internet technology will enable:

- Choice of fat or thin clients;
- Publish-and-subscribe capabilities, with or without interactivity and advanced charting.

There are high-level information-access capabilities users cannot yet get via Internet-based tools. For example, sophisticated analysis is generally not available. Such features may be developed as an applet by the user or by IAT provider partners, but they will still not be seamlessly integrated until these features are added by the IAT supplier. Ideally, Internet-based IAT tools should not be looked at as a new method for supporting the old way of doing business. Only new applications will change market dynamics, and thereby possibly change the market growth rate, the mix of leading suppliers, or both. No enterprise decision-support supplier has clearly identified such applications to date.

Management solutions

The influence of Web technologies also extends to network and system management solutions that help users to control more effectively new technologies such as browsers, Web servers, Internet firewalls and Java applications.

Concurrently, developers of network and systems administration tools are evaluating Web technologies as the potential foundation for new generations of management products. The factors that make Web technologies interesting include:

- An OS and management platform-independent development environment that reduces programming costs and time to market;
- An object- and component-based architecture that offers greater levels of interoperability as well as packaging flexibility;
- A low-cost, widely understood user interface for local or remote network and system configuration.

The most significant effects are expected in the following areas:

- Network device configuration;
- Standalone and remote PC configuration and diagnostics;
- Network and systems reporting.

The use of Web technologies in other management products such as high-end network device management, software distribution, and management platforms will roll out over a longer period.

Application components

The trend for applications will be first to Internet-enable their present functions, and then to provide increased functionality through new capabilities by virtue of the Internet. New capabilities provision is coupled with the trend toward unbundling application services (such as transaction, data, message, directory and object), to package them in selected bundles to target specific workloads. On the contrary in the early nineties client/server application environment, presentation services were tied to the client platform, while data management and all other services were tied to the server.

This trend towards application services unbundling, coupled with better Internet-enabled software channels, will accelerate the development of a component application industry. Components will thrive to the extent that users can mix and match components from a variety of tools, applications, system and network management, and middleware vendors. Component assembly environments, tools to facilitate messaging among components, and other component enabling tools are forthcoming, helping users to minimise platform, topologies and application changes through the maximisation of component re-use and component packaging.

2.4. Internet and the Telecommunications Market

The Internet and traditional telecommunication operators business environment differ in three principal areas: technology, pricing, and ownership:

- The Internet is using router-based technology, to compete with telecommunication operators in providing voice telephony.
- The pricing structure of the Internet is putting pressure on the traditional charging methods established by the telecommunication operators. While the Internet is largely built around flat-rate charges, the public switched telephone network (PSTN) employs usage-based tariffs dependent on distance, duration, and volume.
- While most telecommunication operators are still representative of national interests, the Internet transcends national boundaries.

Since the Internet runs across the telephone network, countries with poor telecommunications facilities or low level of telephone penetration may have low levels of Internet use. However, a country's poor past performance in network development may actually prove an advantage in the long term. Because the Internet services rely heavily on network digitisation, countries starting to build their networks will have the advantage of deploying new, digital equipment.

Strong growth in demand for Internet connections is likely to be a major driver of demand for new telephone lines. This trend is already visible in countries such as Sweden, the US, and Finland. Some forward-looking telecommunications operators are now beginning to embrace the Internet, viewing it as a third network which will complement the existing fixed and mobile networks.

Internet service providers

Internet World Wide Web users in all European countries are mostly accessing the Internet via an ISP (Internet Service Provider) or IAP (Internet Access Provider).

The Internet access market is very fragmented, and local ISPs are the most successful. They number over 3,000: these range from very small regional ISPs to large operators offering Internet access for both individuals and businesses across Europe and beyond.

However, in Germany more than 40% of Internet users access the Internet via an online service. Online services are also widespread in the UK, and in France. Germany's online service T-Online offers its 1.9 million clients Internet access and an e-mail address. Telecommunications operator-related service providers are more widespread in Nordic regions. In the UK only 7% of Internet users apply to telecommunications operators. 83% in Greece, nearly 80% in the Netherlands, and 69% in Denmark access the Internet via an ISP.

ISPs offer a variety of services, including storage of the computer program constituting the company's home page, and the provision of information on visits to a client's page. They can also help companies obtain a domain name.

Considerable differences in network topology and spending on data communication equipment exist between ISPs that are focusing on home users and those targeting business users. Home-user-oriented ISPs, on average, spend more on remote access server (RAS) equipment; the main part of business-oriented ISPs' budget is spent on routers. In 1997, some 60% of European ISPs were home-user-oriented, and 40% were business-oriented.

Every single ISP, small or large, is expecting huge growth for 1998. Overall, the number of home subscribers is expected to show the largest growth. The investments in backbone infrastructure and access equipment are keeping pace with this growth in subscribers.

Local ISPs are sustaining a great variety of initiatives to consolidate their role. Some Internet service providers have launched their own Internet for Schools funding programme.

Internet access revenues are forecast to reach close to ECU 2.4 billion by the year 2000, from an estimated ECU 390 million at the end of 1996. This market, which includes individual access, value-added and wholesale services, will be driven by increased corporate spending on access and value-added services such as Web hosting and security.

	Downstream Data Range	Upstream Data Range	Platform
Dial-up modems (narrowband)	Up to 56 Kbps	Up to 56 Kbps	Normal phone lines
ISDN – BRI	56 Kbps to 128 Kbps	56 Kbps to 128 Kbps	Telecommunication-furnished equipment
ADSL (broadband)	1.5 Mbps to 9 Mbps	16 Kbps to 500 Kbps	Normal phone lines; in test phase
Cable modems (broadband)	500 Kbps to 30 Mbps	99.6 Kbps to 1 Mbps; also planning to use 28.8 Kbps (telecommunication return)	Cable TV networks; commercial deployment started
Satellite	400 Kbps	Modem required	Wireless path

Bandwidth

Multimedia applications such as real-time voice and video transmissions are straining the current resources. Efforts are under way by a variety of manufacturers to improve this situation, including expanding the Internet backbone. Further improvements in the quality of Internet telephony and enhanced multimedia capabilities require higher bandwidths than are commonly available today. The shift from narrow-band modems to ADSL or cable will be gradual. The table above identifies bandwidth ranges and availability.

One of the primary requirements for general acceptance of packet network usage is the ability to schedule or plan for specific session bandwidth through the resource reservation protocol (RSVP). This protocol allows bandwidth reservation in advance of a particular session. This includes multipoint sessions in which individuals connected on the Internet can interact with one another and collaborate on activities. Other key features of RSVP are scalability and adaptation to changing network conditions.

Internet access speed

In Europe, Internet users are mostly connected via a 28.8 Kbps modem. Demand for ISDN connections is quickly increasing, while access via 14.4 modem decreases. In Germany 45% of users access the Internet via ISDN (64 Kbps), while 26% in the UK, Switzerland and Norway had an Internet access speed of more than 64 Kbps.

So far, ISDN has had the biggest impact in Europe. The main driver behind this success is the fact that major national telecommunications operators decided early on to migrate their analogue telephone networks to digital ISDN networks. Furthermore, the European telecommunications operators and ISDN equipment vendors have been eager to achieve standardisation of ISDN features across Europe (EURO-ISDN) instead of sticking to proprietary services used nationally.

Germany has by far the largest number of ISDN BRI and ISDN PRI lines installed because Deutsche Telekom has been aggressive with ISDN pricing and promotion. After Germany, France has the second-largest installed base of ISDN lines, followed by the United Kingdom.

The following table illustrates Western European ISDN market growth by product segment.

Product Segment	1996-2000 CAGR (%)
ISDN connections	27
ISDN router shipments	45
ISDN BRI client-to-LAN B channels	51
RAS (Remote Access Server) concentrator B channels	64

The pattern of growth can be characterised as steady for ISDN connections, ISDN client-to-LAN RAS (Remote Access Server) B channels, and ISDN router markets. The market for RAS concentrator B channels is growing exponentially.

ADSL (Asymmetric Digital Subscriber Line) has been introduced to deliver interactive TV (ITV) and video-on-demand (VOD) to the home, but is becoming an increasingly interesting alternative to provide fast Internet access.

Wireless access to the Internet

As an increasing number of companies provide Internet access through their local area networks and corporate data systems, mobile employees would be able to access specific corporate applications through the Net. All that is required is local wireless access to the Internet. Mobile access does not necessarily mean wireless, as acceptable landline phone connections are now available in many locations such as airports and hotels.

Four criteria describe the ideal wireless communications network for Internet access:

- Low cost per kilobyte of data;
- High data throughput;
- Nationwide coverage;
- Low network latency.

No one network provides all the features required for ideal wireless Internet access. Circuit-switched access is possible, but errors can occur; although roaming theoretically allows access from anywhere in the cellular coverage area, the cost is prohibitive for most. Two-way paging can address the cost issue somewhat, but does not support interactive sessions because of the high latency, and coverage is also limited to date.

3. Improving European ICT Growth

Growth in the European ICT market is set to improve as a result of a unique combination of discontinuities in the economic environment and initiatives by government and concerned industries to make the Information Society happen in Europe as fast as possible.

These drivers combine in a unique set of interrelationships and positive influences on each other. They are related to:

- The adoption of a single currency, the Euro;
- The Year 2000 date change;
- IT platform consolidation towards more stabilised adoption according to application needs;
- The growing adoption of the Internet at business and household level;
- European Commission initiatives to implement the Information Society;
- Overall European businesses efforts to reduce the technology adoption gap with other worldwide regions.

3.1. Euro

Transition to Euro currency system by many European countries is due to be completed by 2002. In the transitional period, companies are expected to add the Euro as a unit of account, to run in parallel with existing currencies. From

1 January 1999, participating national currencies will be locked into a fixed conversion rate against the Euro. Governments will also give up control of monetary policy to a new body called the European System of Central Banks (ESCB). The definitive changeover, scheduled for January 1, 2002 through to July 1, 2002, will be when Euro banknotes and coins are issued and all national currencies effectively belong to the past.

The introduction of the Euro is expected to have a big impact on the way of doing business, and on the Information Technology infrastructure of European companies. However, relatively few European companies seem to have made significant progress to address the ICT impacts, with SMEs particularly unprepared.

This lack of urgency puts small and medium-sized enterprises at considerable risks. Many companies have underestimated the amount of time needed to prepare for the Euro conversion. And once even a budget and specific conversion plans are in place, the inevitable shortage of IT resources arising from Euro's coincidence with the preparation for the year 2000 is causing further delay. The costs of preparing for Euro are tiny compared to the potential losses arising from inadequate preparation. See also Part Two, *The Euro: Impact on Information Technology,* in this volume.

3.2. Year 2000

The Year 2000 problem is a maintenance project of massive proportions, for which there will be no obvious benefit except the continuation of the business. Because of the ubiquity and fixed deadline of this problem, projects cannot be delayed much longer. Many organisations with extensive computer applications have already begun to experience the ill effects of this date-conversion problem. For example, banks that forecast five years mortgage payoff amounts would find this impossible if their computer systems were unable to recognise years beyond 1999.

There are several approaches to addressing Year 2000 compliance. These include reengineering business processes, rewriting applications in modern languages, and installing packaged applications to replace in-house legacy systems. Renovating existing code is the most popular approach. Therefore, most tools acquired for Year 2000 projects will be in the areas of verification and program code/date conversion.

Because the Year 2000 problem is in many cases mainframe-centric, tools focus on that environment. Although many of the tools may themselves run on a desktop systems or in a client/server environment, they target mainframe-based applications.

Some portions of a Year 2000 project are best handled internally. These include setting overall priorities and providing expertise on the unique requirements of the business. This means that most companies are likely to retain control of the planning and assessment section of Year 2000 project activities. Companies need a major internal project management effort to cover all the related parts of a Year 2000 project and to coordinate the renovation projects with other aspects that are beyond the purview of outside vendors.

This is not to say that all the Year 2000 conversion work must be accomplished in-house; services companies can provide much needed expertise, tools, and resources. The demand for the Year 2000 solutions presents many opportunities for outsourcers. The greatest demand is for programming resources. External help is required because of the complex nature of the problem, the time involved to fix it, and the cost effectiveness of outsourcing. Outsourcers can leverage their economies of scale, technology strengths, and skill sets by offering Year 2000 solutions.

Outsourcers are working to provide better, faster, or more extensive services for the Year 2000 problem by increasing the number of consultants and programmers involved in providing Year 2000 solutions. However, even if Year 2000 solutions providers do hire additional programmers, the staffing shortage is not likely to be solved in the near future. As a result, a phenomenon of partnering has begun to emerge among Year 2000 vendors.

Despite a broad awareness of the Year 2000 problem, a significant proportion of the renovation has yet to be done. Although most firms have begun to address this issue, many of their projects are only in their pilot stages. This means that a lucrative opportunity for outsourcers still exists. By tapping their current customers for Year 2000 services, outsourcing firms could leverage their preexisting customer relationships. In addition, they could further utilise their technological skills and resources. Potentially, outsourcers could even charge inflated service prices and still win Year 2000 business.

Vendors have been quick to roll out and market products and services that address various aspects of the Year 2000 problem, but they have not been as forthright in providing customers with information about upgrade plans for their own legacy software offerings.

3.3. Consolidation among Platforms and Packages

1998 promises to be a year of major integration of multiple environments in IT architectures. Users will apply Internet technology to the servers on their network that will allow applications to tap into resources on many servers, rather than just one, as was common in the past.

Web browsers and Java virtual machines are becoming available on all graphically-based desktop operating environments. They will also be a standard part of network computers and network PCs. Thus, organisations that have adopted Web-based application architectures will be free to select the most cost-effective client regardless of its operating environment, its microprocessor, or its form factor.

The battle for ownership of the server environment is being fought furiously in the market, and is leading to a polarisation of leading positions at the different levels of application deployment:

- Unix and Windows NT environments appear to be the leading platforms for development, although the emerging world of Java development and the inclusion of the Java virtual machine in operating system packages will benefit all platforms.
- Clustering technology will be leveraged to be able to scale up system resources as more end-users access the systems and as corporate databases grow even larger. Used in another way, this technology can offer higher availability for a smaller number of users. Unix, NT, and, to a lesser extent, both OS/2 and InterNetWare application server systems will take part in this trend.
- At the same time, individual servers may be scaled up to include more processors through the use of symmetrical multiprocessing (SMP), massively parallel processing (MPP), and NUMA (Non-Uniform Memory Architecture).

Clustering software will allow many off-the-shelf server environments to be linked together, providing a single-system image, whereas before there were two, or four, or more.

New workplace segment	Features	Today's winner
Corporate Centralised	– IS department choses; – system or application supplier; – global store of data.	OS/390
Corporate Distributed	– IS department choses; – system or application supplier; – middle tier, data entered locally, used globally.	RISC Unix AS 400
Corporate Replicated	– IS department choses; – system or application supplier; – middle tier, data entered locally, used locally, data summary sent elsewhere.	Unix or Netware/NT
Independent Corporate	– local domain expert choses; – computer store or distributor; – stand alone, data entered locally, used locally.	NT Server
Independent Small to Medium Organisation	– VAR or ISV choses; – distributor; – stand alone, data entered locally, used locally.	Unix or NT

Most major Unix operating systems will make the transition from 32-bit addressing to full 64-bit addressing, making it possible to quickly search large databases with tens of gigabytes or more. At the same time, migration from 32-bit operating systems to 64-bit operating systems will become a focus for IT managers in many large corporations that maintain large databases on midrange Unix servers.

Currently, the enterprise systems scenario looks as shown in the table above.

There is a growing trend among large/medium enterprises to select different desktop environments for each type of worker (knowledge worker, and transactional worker) rather than standardising on one for everyone. Selecting two different platforms can increase costs in some areas. This increased level of costs can be minimised by an IS architecture that provides support for file sharing, electronic mail, and common workplace applications for both types of workers.

Knowledge workers often require the newest, most powerful, and, unfortunately, most complex application software. The availability of leading-edge personal productivity tools, development tools, and other packaged software products is usually the driving force behind the selection of a desktop environment.

It is clear that the Microsoft Windows 32 API is the interface being used for a significant number of the new applications and tools of interest to knowledge workers. Windows NT Workstation is likely to be used if security, robust multitasking, and support of complex, network-based applications are requirements. Window 95 and its successors, on the other hand, are likely to be used to support mobile computers, smaller hardware configurations, or where special-purpose hardware devices are key requirements.

Organisations whose knowledge workers primarily use custom or packaged applications are likely to continue to use these platforms unless there is a strong external reason to port these custom or packaged applications to an-

other platform. Each of these desktop environments has strengths that may be crucial to an organisation's success.

Transactional workers have different requirements than knowledge workers. These workers primarily use packaged or custom applications to improve their productivity doing basically non-computer-oriented tasks, such as entering orders or providing customer service. Transactional workers generally have little requirements for sophisticated data collection, analysis, or synthesis tools other than those provided by the packaged or custom business applications their organisations use. A stable, robust, and manageable environment is more important for these workers than one that is rapidly changing and highly adaptable.

Although any of the desktop operating environments can certainly be the platform for these applications, it would be wise for organisations to contemplate adopting Web technologies as they reconsider the platform for their custom or packaged transactional applications.

The final result is the integration and management of heterogeneous systems Unix, NT Netware, OS/2 on behalf of large/medium users.

3.4. Internet Applications

Access to the Internet for entertainment, communications and business needs is set to become rooted in every individual's every-day life. As outlined in section 2, this will be driving a strong increase in demand for applications, content and interfaces aimed to address the new tendency of moving traditional forms of entertainment and business interaction online.

3.5. EU beyond Telecommunications Liberalisation

Preparing for the post-liberalisation time frame, the European Commission is focusing on the faster development of the Information Society by achieving its three major requirements:

- A high level of information use by most people, in most organisations and workplaces;
- Common or compatible technology for a wide range of personal, social, educational and business activities;
- The ability to transmit and receive digital data rapidly.

The European Commission is committed to the introduction of new rules designed to stop Member States hampering the Information Society with a set of different laws across the Union.

European Commission Actions for the Information Society

Information Society projects

The European Commission has launched eight pilot projects on the Information Society and promoting employment and local development. Each project will develop local strategies and action plans and will be based on wide regional consensus on how to integrate the Information Society concept into employment and development policies at the local level. The projects will run for between 18 and 24 months, each receiving up to 250,000 ECU of co-financing.

The Communication on "The Information Society and Development – The Role of the European Union" reviews the potential opportunities for developing countries in the emerging Information Society and, in particular, those arising from the use of satellite communications and Internet applications in areas such as education, administration, health, transport, commerce and industry. The Communication calls for the establishment of pilot projects demonstrating the practical benefits of the Information Society.

Competitiveness

The European Union spotlight is now turning on the ICT industry itself because of the alarming delays being reported in some market segments.

The European Commission adopted a Communication on April 16, 1997 on the competitiveness of the European information and communication technologies industry. The Communication is split into two parts. The first makes an assessment of European ICT industries. They face intense global competition hampered by a number of disadvantages and difficulties. The second part deals with the need to improve the competitiveness of European ICT industries. A number of actions having an important impact on the competitiveness of ICT industries form part of initiatives already under way in the EU: those included in the action plan for the Information Society, and initiatives completing and harmonising the internal market, R&D programmes.

The Commission recognises that such policy initiatives must be complemented by specific actions, addressing particular problems of ICT industries and able to contribute to providing the conditions needed to compete successfully in the world market.

The proposals for action include:

- *Completing the abolition of trade tariffs on all IT products, by implementing the Information Technology Agreement (ITA) agreed in Singapore in December 1996;*
- *The removal of non-tariff barriers (by mutual recognition agreements);*
- *The creation of flexible frameworks for setting and developing industry-managed standards;*
- *SME start-up and development aid;*
- *Exploiting the potential of enlargement, by promoting industrial cooperation with Central and Eastern European countries and addressing the opportunities offered by these new growing markets;*
- *Encouraging industry to establish a skills certification scheme in order to improve industrial performance and employment opportunities;*
- *Encouraging benchmarking as a tool for identifying weaknesses and improving competitiveness.*

Education

The European Commission is favouring the introduction of multimedia in schools from 1998. The European foundation will aim to encourage the creation of business partnerships in the sectors of information technology and telecommunications, local and regional authorities and managers of educational systems. The "European Education Partnership" which will help in its creation currently comprises thirteen companies.

The Commission considers that public-private partnerships are essential to ensure the participation of educational establishments in the Information Society, to connect schools, ensure the technical maintenance of equipment, train instructors and develop multimedia contents. The foundation's mission will be to encourage the creation of new partnerships and the networking of associations. It will act as a think-tank on the development of technologies and educational practices and will serve as a reference and exchange point for good practices. It will play an active role in sponsoring educational projects based on the use of information networks.

Transparency

A "transparency" Directive has been proposed to force Member States to let their EU partners and the European Commission scrutinise their draft laws in advance to check whether they will hinder Union trade in Information Society services. The proposed directive will give the EU similar powers to vet draft laws on Information Society services as those it currently enjoys to scrutinise draft Member State rules covering goods, including those which affect Information Society products. Once it comes into force, draft national laws will be frozen for a three-month "standstill" period while other Member States and the Commission decide whether they are likely to have an adverse affect on the single market. A further one month standstill can then be imposed, to give the Member State concerned the chance to amend the law in question.

Legal protection of encrypted services

The Green Paper on the "Legal Protection of Encrypted Services in the Internal Market" was the subject of a wide-ranging process of consultation in 1996. The reactions to the Green Paper confirmed the need for a Community legal instrument the purpose of which should be to harmonise the legal protection of all those services whose remuneration depends on "conditional access" techniques such as encryption and electronic locks. Both the European Parliament and a clear majority of Member States share this view and have called upon the Commission to present a proposal for a Directive. The proposal for a Directive was announced in the Commission 1997 Work Program as well as in the Information Society "Rolling Action Plan".

The Directive aims to ensure that an equal level of protection is provided in each Member State. To this end, European countries will be required to ban the manufacture, sale, import from third countries, ownership for commercial or private ends, installation or commercial promotion of decoding mechanisms without the prior authorisation of the coding body or service supplier. Each country will be required to adopt effective, proportionate and dissuasive sanctions to punish violation and enable injured parties to seek compensation.

Electronic commerce

On 16 April 1997, the Commission adopted a Communication on "A European Initiative in Electronic Commerce". The aim is "to encourage the vigorous growth of electronic commerce in Europe", by implementing a "coherent framework of technological, regulatory and support actions, as a matter of urgency, by the year 2000".

Security

As service providers will need to be protected against the piracy of their services by illicit decoders, smart cards or other piracy devices, the Commission is set to propose a directive to establish an adequate level of protection for service providers across Europe.

Telecommunications liberalisation implementation

The European Commission adopted on 1 October 1997 a proposal for European Union legislation to achieve EU wide availability of so-called carrier pre-selection and number portability by 1 January 2000. Immediately upon the opening of the liberalised telecommunications market on 1 January 1998 and after commencement of operations by newly licensed operators, users should be able to choose service providers other than their local operator. This will be done by dialing a short prefix before every phone call. Two years later, as of 1 January 2000, consumers will have the option to pre-select such alternative service providers which means that their calls will be automatically routed to the provider of their choice without the need to dial extra digits. Users will also be able to retain their telephone number while switching the subscription of their telephone line to another operator.

The European Commission is urging Member States to put frameworks in place for handing out licences to operators in time for an expected roll-out of the EU standard universal telecommunications service (UMTS) by 2002. The EU telecommunications industry is close to deciding on the final shape of the UMTS technology, which is expected to take over from today's successful GSM digital telephone standard. The UMTS standard will build on GSM by linking with fixed telecommunications networks to provide users with the same level of service as they enjoy from the best fixed systems. Callers will be able to use the same numbers for mobile and fixed services and have on-the-road access to the Internet and other multimedia network.

The European Commission is also considering a change in community law which – if adopted by governments – could force telecommunications network operators to provide broadband services based on technologies such as ADSL (Asymmetric Digital Subscriber Line). Under the proposed ruling telephone operators will be obliged to ensure that telecommunications equipment approved for connection to the network will work.

Mobile and wireless communications technologies

The European Commission has proposed a strategy for the development of the next generation of mobile and wireless communications technologies. The Commission calls for urgent action by public authorities to guarantee an investment by industry in the development of new systems, offering mobile users wireless access to the Internet and other multimedia services. The pilot phase will not begin until 2002 but regulatory issues should be settled as soon as possible.

The Commission has proposed rapid action to clarify rules for issuing licenses and guaranteeing the availability of frequencies for UMTS, the principal system being envisaged by European industry. It also recommends a guarantee of pan-European "roaming" for the future services – one of the characteristics that has assured the success of present GSM systems – so that the user can benefit from a "wireless Information Society". The Commission is considering coming forward with a proposal to Parliament and the Council, before the end of the year, for a legislative decision on roaming, frequencies and standards.

Private telecommunications equipment

Within the context of telecommunications harmonisation among European countries, the proposal for a Directive on the approximation of the laws of the Member States concerning connected telecommunications equipment (and the mutual recognition of the conformity of equipment), represented a further step in the legislative framework necessary to support a genuinely competitive multi-vendor community market for connected telecommunications equipment.

The major elements of the new Directive are:

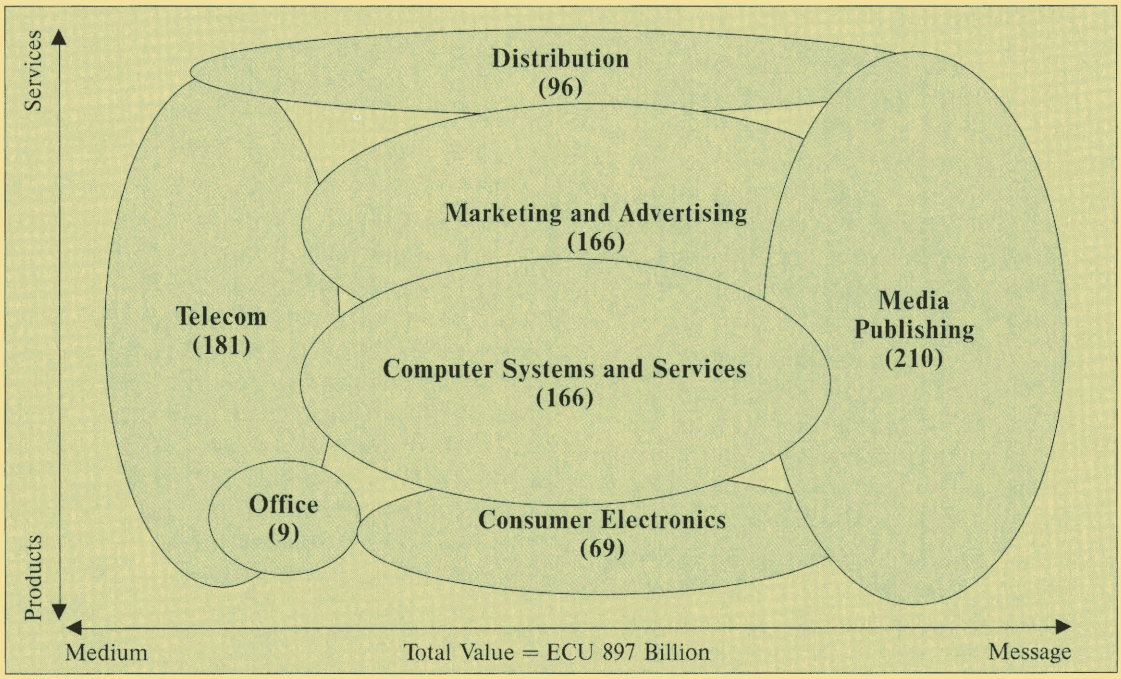
- *Enlargement of the scope of equipment covered by the inclusion of radio equipment;*
- *A set of new definitions making the Directive future-proof by taking into account the liberalisation of infrastructures and competition between operators;*
- *A development of the concept of telecommunications-specific essential requirements to take into account technological trends;*
- *A flexible decision-making process whereby future network infrastructures and systems can readily be covered;*
- *A light conformity assessment regime based upon the principle of manufacturer's declaration.*

Experience of the present legislation, and technological development, have demonstrated that a lighter interpretation of the concept of telecommunications essential requirements is appropriate and that more flexibility is needed in defining which essential requirements should apply to classes of equipment. This flexibility is necessary in order to respond to the specific needs of new network types, accommodate industry reaction to the current regime, be consistent with international trends and react to changing policy, market pressures and the increasing globalisation of telecommunications.

Cable

The European Commission is expected to outline its position on competition in the cable TV industry and ownership of cable TV networks by dominant phone companies. The target is to ensure that cable TV networks and basic telephone networks are not operated by the same company. However, in cases such as Germany, where Deutsche Telekom is the dominant phone company and controls cable televisions networks, there could be exceptional rules granted to take account of such market structures.

Figure 14
The European Information Business Arena. 1996, Billion ECU



However, the telecommunications sector in the European Union will not be fully liberalised in 1998. Some countries (Spain, Greece, Portugal, Ireland, and Luxembourg) were granted an additional period to implement a total liberalisation of telecommunications. The whole process of liberalisation will not be affected by the delay of these countries. The Commission has agreed to allow Luxembourg to wait until July 1, 1998, Spain until November 30, 1998, Portugal and Ireland until January 1, 2000, and Greece until 1 January 2001 to fully liberalise their telecommunications markets.

These delays were granted to allow these countries not only to adjust tariffs to bring them in line with costs, but also to modernise and digitalise the networks. In particular, in Greece the difficult geography and low per capita income affect the profitability potential of investments in the national networks.

The European Commission has provided a rigid timetable for each country, requiring it (among other measures) to notify legislative changes and licensing plans, to lift restrictions on alternative infrastructures for the provision of services already liberalised, to make public the conditions for authorising voice telephony and interconnection charges.

3.6. Reducing the Adoption Gap

In general, European businesses and governments have realised they cannot survive with chronic delay in technology adoption levels, which are driving faster economic growth in other regions. European users attitudes towards adopting ICT for core business processes and making ICT decisions part of overall business strategy decisions are improving, driven by a number of factors:

- Increasing competition within Europe and in the global economy challenges global players ability to deliver long-term value; this ability is increasingly dependent on the organisation's capabilities in dealing with information and goodwill assets.
- In view of the unification of European markets, large and small organisations in Europe have to eliminate process inefficiencies that national niche advantages and currency fluctuation effects used to allow.
- The adoption of the European single currency has a major impact on accountancy systems, and is putting increasing weight on the adoption of electronic cash systems.
- The faster movement towards putting more business processes, communication and entertainment content on the Internet allows unique advantages for the traditionally fragmented European culture and economy.

In this sense an Internet-based European economy would allow control of the traditional costly fragmentation and differentiation of national business, while exploiting the economic growth potential stemming from the diversity of European national cultures, preferences, languages, and markets. The traditional European disadvantages of national adaptation costs and smaller scale economies vis-à-vis other more homogeneous regions would finally be neutralised. If the management of interactive content and business processes is implemented effectively, the availability of multiple contents and demand for communications by a more differentiated population and economy will translate into higher potential for economic growth.

The Technological Evolution of ICT and Standards

This chapter has been provided by M. Bozzetti on behalf of SMAU in close co-operation with the EITO Task Force.

1. Evolution in ICT: A Global View

The aim of this chapter is to provide an overview and a basic description of the most significant technological factors affecting Information and Communication Technology (ICT) which are of decisive importance for the market now and which will continue to be so in the near future. As in our previous reports, we shall consider the following as the basic ICT technologies: microelectronics, computer hardware, software and telecommunications.

These technologies co-operate and interoperate by means of architectures, and their evolution plays a significant role in ICT, which both influences and is influenced by the developments taking place in the technologies themselves.

The technological trends indicated in the reports mainly concern the "industrial" status of the art, and not the most advanced R&D results at laboratory level; but even in this context, the reports cannot be exhaustive because of the limited space available and the fact that some of the information has already been presented in previous reports. On the basis of the experiences of the author and the EITO Task Force, only certain specific and significant items will be discussed, and it will also be assumed that the reader knows the previous reports and their contents.

The Internet phenomenon remains the main driving force for innovation in the whole ICT field, and has had a big impact on the megatrends considered over the last few years:

- The continuing miniaturisation of electronic components, with a parallel reduction in costs (and therefore price) and an increasingly greater level of reliability and ease of use;
- The continuous evolution of ICT products and systems towards becoming ubiquitous and powerful tools for both business and domestic use;
- The continuous improvement of human/machine interactions, with the goal of reaching a natural quality interface;
- The continuous migration from analogue to digital, from fixed to mobile, and from voice/text to multimedia equipment, regardless of distance or the physical location of the equipment itself.

This impact mainly concerns the following issues:

- IP (Internet Protocol) is becoming "the standard" for the whole ICT context;
- Applications are becoming web-enabling and browsers are going to become "the interface" for both interactive and hyper-multimedia;

- The increasing focus on "information" (i.e. the content) that facilitates and favours the convergence of the "media" and ICT markets and technologies (the media market is still not considered part of the ICT market by EITO, but some opinion leaders are moving in this direction);
- The effects on society and individuals, and all that these mean in terms in of consumer electronics and the media market;
- The growth of electronic commerce (an important step toward the digital economy and the Information Society) with much emphasis being based on security;
- Intranets and extranets are becoming key factors in the evolution of enterprise ICT architectures;
- The increasing use of VPN (Virtual Private Network) for supporting remote users and extranets;
- Functional integration and interoperability of lines-of-business, EUC (End-User Computing), ERP (Enterprise Resource Planning) and legacy applications via web-enabling solutions and browsers.

All technologies are contributing towards the evolution of ICT, but the "hottest" include very and ultra large system integration, wireless and fibre optic systems, very high speed communication systems, storage technologies, speech processing (in particular continuous speech processing recognition), image processing, display technologies, and battery technologies. Software technology is probably neither so engineered nor so advanced as hardware technology, but its evolution is continuous.

As detailed in our previous reports, standardisation continues to play a key role in ICT, and the merging of computers, telecommunications, consumer electronics and multimedia requires the constant introduction of new standards. In addition to the traditional international *de jure* bodies, such as ISO and ITU, the big pushers are now the Forums and Consortia that provide (and/or impose) *de facto* standards for the products for which they were set up, and these are becoming increasingly accepted as having *de jure* status. Consequently, the distinction between *de jure* and *de facto* standards is becoming less significant for users and, in any case, standards cannot (and must not) be seen as static influences or constraints on the introduction of innovations.

The International Organisation for Standardisation, (ISO) [http://www.iso.ch], the International Electrotechnical Commission, (IEC) and the International Telecommunication Union (ITU) [http://www.itu.ch], with its Consultative Committees CCITT and CCIR, are the worldwide *de jure* standardisation bodies operating in the interdisciplinary ICT sector. They have their counterparts in the European Standards Organisations: the Comité Européen de Normalisation (CEN), the Comité Européen de Normalisation Electrotechnique (CENELEC) and the European Telecommunications Standards Institute (ETSI) [http://www.etsi.fr].

The Internet Engineering Task Force (IETF) is the protocol engineering and development group for Internet, and provides both Internet-Drafts and Requests for Comments (RFC). RFCs are the official document series and are archived permanently: although not all RFCs are standards, the majority of them are the reference standards for Internet and, as public domain documents, are freely available online from various repositories. It is important to underline that the widespread diffusion of such standards has been facilitated by their free availability.

The IEEE, Institute of Electrical and Electronics Engineers, Standards Board [http:/ stdsbbs.ieee.org] is the engine for the standardisation of LANs with the 802 set of recommendations that are also included in the ISO standards as IS 8802 series.

Many of the most active Forums and Consortia are working in the same manner *(Table 1)*.

2. Microelectronics

There has been an expected evolution in transistor downsizing and growth in IC (Integrated Circuit) functionalities, particularly in terms of memory capacity and CPU processing speed, reduced costs and prices as the number of functions increases, and a higher level of integration.

First formulated in 1965, "Moore's Law" (i.e. the density of components per integrated circuit will double at regular intervals of around 18 months) is still as valid as ever, and used to project the future capabilities of semiconductors and successor technologies.

It is interesting to note that, due to the increasingly high costs of R&D and manufacturing, as well as the global competition that narrows market windows, the semiconductor industry has changed from the logic of vertical integration to a model of precompetitive research, technological specialisation and global alliances even between competitors.

A significant example in Europe is the new cooperative project, MEDEA (Microelectronics Development for European Applications), the goal of which is to develop chip sets for multimedia, communications and automotive applications based on 0.25 and 0.18 micron technologies.

As highlighted in last year's report, the transition from Very Large System Integration (VLSI) to Ultra Large System Integration (ULSI), with more than ten million transistors per chip, is approaching its technological limits and reducing the advantage of producers of silicon components.

The limit of optical lithography for the production of CMOS is about 0.12 microns, and the limit of the thickness of solid state "MOS" is about 0.005-0.01 microns. Intel [http:// www.intel.com] considers the thickness of 0.07 microns to be the technological limit, but the real problem is the cost of manufacturing such "thin" CPUs: as Intel points out, the cost of a factory in 1968 (when Intel was founded) was 10 million US dollars but is now about 1.5 billion.

The most advanced foundries currently make 0.25 micron circuits using deep-ultraviolet steppers with a wavelength of 245 nm. The next generation will probably have a wavelength of 193 nm, which will allow a thickness of 0.18-0.13 microns. Extreme ultraviolet systems, X-ray systems and optical systems are going to be developed by various laboratories in order to reach even smaller dimensions.

As we approach the limits of semiconductors, quantum mechanics begins to come into its own, which means that it will be necessary to develop "quantum" and "photon" components in order to be able to build multi-layer semiconductor crystals with a precision of about 1 nanometer.

Holographic techniques are being used for the optical archiving of information, thanks to their reachable high density (about 10 GB vs the current 100 KB per cm^2) and high speed (1 Gbps).

Another promising research area in the field of optical information storage is that of protein memories.

ADSL Forum	[http://www.adsl.com/adsl]
All-Optical Networking Consortium	[http://www.ll.mit.edu/aon]
ATM Forum	[http://www.atmforum.com]
Digital Audio Visual Council (DAVIC)	[http://www.davic.org]
Digital Video Broadcasting (DVB) Project	[http://www.dvb.org]
DVD Licenser Consortium	
European Board for EDI Standardisation (EBES)	[http://www.ebes.cenclcbel.be]
European Broadcasting Union (EBU)	[http://www.ebu.ch]
European Committee for Banking Standards (ECBS)	[http://www.ecbs.org]
European Computer Manufacturers Association (ECMA)	[http://www.ecma.org]
European Electronic Messaging Association (EEMA)	[http://www.eema.org]
European Workshop on Open Systems (EWOS)	[http://www.ewos.be]
European Committee for IT Testing and Certification (ECITC)	[http://www.ecitc.org]
European Association for the Co-ordination of Consumer Representation in Standardisation (ANEC)	
European Telecommunications and Professional Electronics Industry (ECTEL)	[http://www.ectel.org]
European Association of Manufacturers of Business Machines and Information Technology Industry (Eurobit)	[http://www.fvit-eurobit.de]
European Telecommunications Informatics Services (ETIS)	[http://www.etis.org]
Fast Ethernet Alliance	[http://www.gigabit-ethernet.org]
Frame Relay Forum	[http://www.frforum.com]
Giga Ethernet Alliance	[http://www.gigabit-ethernet.org]
High Level Strategy Group (HLSG) of European Union	[http://www.hlsg.org]
Information Infrastructure Standards Panel	[http://www.ansi.org/iisp]
International Color Consortium	[http://www.color.org]
Internet Engineering Task Force (IETF)	[http://www.ietf.cnri.reston.va.us]
IP Multicast Initiative (IPMI)	[http://www.ipmulticast.com]
Multimedia Communications Forum (MMCF)	[http://www.mmcf.org]
Network Management Forum (NMF)	[http://www.nmf.org]
Object Management Group (OMG)	[http://www.omg.org]
OLAP Council	[http://www.olapcouncil.org]
Open 56K	[http://www.open56k.org]
Open Group (ex X/Open)	[http://www.opengroup.org]
Standard Performance Evaluation Corporation (SPEC)	[http://www.specbench.org]
Telecommunications Information Networking Architecture Consortium (TINA-C)	[http://www.tinac.com]
Video Electronic Standards Association (VESA)	[http://www.vesa.org]
Virtual Socket Interface Alliance	[http://www.ip-net.org]
Voice Profile for Internet Mail Work Group (VPIM)	[http://www.ema.org/vpim]
W3 Consortium	[http://www.w3.org]

Table 1
Some Forums and Consortia Active or Involved in ICT Standardisation Activities

2.1. Microprocessors

The use of 32-bit microprocessors as CPUs for PCs is spreading, as is the use of 64-bit microprocessors (Alpha, Power PC, 860) for professional workstations and all top-class systems.

The difference between CISC systems (Complex Instruction Set Computing) and RISC (Reduced Instruction Set Computing) is becoming increasingly small as both architectures are trying to steal the best features of the other.

It needs to be remembered that CISC systems use a complex of instructions that often require different internal clock cycles, whereas RISC systems use a reduced set of simple instructions so that each instruction can be executed in one cycle (or less).

Table 2 summarises the CPU characteristics of the main builders.

The common technological trends include five metallic layers, speculative processing (branch prediction), a high number of registers and a separate cache memory bus. In terms of high-cost planning and manufacturing, the common approach is go for modular planning in order to reduce production cycles.

The market predominance of Intel Pentium is being challenged by its main competitors, AMD [http://www.amd.com] and Cyrix [http://www.cyrix.com]. Many builders have already announced that their new 0.25 micron processors have almost reached the production stage, and Intel has announced that this kind of CPU will be able to increase the capacity of the current Pentium from 5.5 million to more than 40 million transistors.

Intel has oriented the two main processors of the P6 family as follows: the Pentium Pro without MMX is mainly used for servers, whereas the new Pentium II (which has the same architecture but includes the MMX extension) is mainly used for clients and multimedia PCs.

AMD has licensed Intel's MMX design, but Cyrix wrote its own set of new instructions as part of its MediaGX processor, an unusual chip that incorporates multimedia functions in the CPU.

At present, the Digital 21264 Alpha model is at the top with 15.2 million transistors [http://www.digital.com].

2.1.1. The Benchmarking of CPU and ICT Systems

Constituted in 1988, the Standard Performance Evaluation Corporation (SPEC) is the body responsible for standardising benchmarking: it defines, accepts, maintains and publishes specifications for the measurement and control of modern system performances.

SPEC is made up of different working groups including:

- Open System Group for CPU, Web, SFS (System-level File System), SDM (System Development Multitasking);
- High-Performance Group for the benchmarking of multiprocessor systems, cluster and parallel systems, supercomputers;
- Graphic Performance Characterisation Group for the benchmarking of graphic systems, such as PLB, OPC, XPC, etc.

In August 1995, the CPU95 specifications replaced the old CPU92 specifications. CPU95 evaluates CPU memories and the generation of compiled code performances. It is divided into two test sets:

Table 2
Technical Characteristics of the Main New CPUs

Producer	Model	Target clock speed	SPEC Int 95[1]	SPEC FP 95[1]	Multi-media extension[2]	Technology
AMD/NexGen [www.amd.com]	K6-233-MMX	233 MHz	n.a.[3]	n.a.	MMX	CMOS/0.35-micron, 32 bit, 4 instructions per clock cycle
Cyrix [www.cyrix.com]	6X86MX-PR233 MediaGX	188 MHz 180 MHz	n.a. n.a.	n.a. n.a.	MMX MediaGX	CMOS/0.6-micron, 32 bit, 2 instructions per clock cycle
DEC [www.digital.com]	Alpha 21164A	500 MHz	15.4 (18)	21.1 (27)	MVI	CMOS/0.35-micron, 64 bit, 4 instructions per clock cycle
DEC	Alpha 21264	600 MHz	30+	50+	MVI	CMOS/0.35-micron, 64 bit, 6 instructions per clock cycle
HP [www.hp.com]	PA-8200	220 MHz	15.5	25	No	CMOS/0.5-micron, 64 bit, 4 instructions per clock cycle
HP	PA-8500	300+ MHz	n.a.	n.a.		CMOS/0.25-micron, 64 bit
Intel [www.intel.com]	Pentium Pro	200 MHz	8.58	6.48	No	BiCMOS/0.6-micron, 32 bit, Dual Independent Bus, 2 instructions per clock cycle
Intel	Pentium II (Klamath)	266 MHz	10	8	MMX	CMOS, 32 bit, Dual Independent Bus, 4 instructions per clock cycle
Intel-HP	Merced (P7)	300+ MHz	n.a.	n.a.	MMX	64 bit, announced, architecture IA64
MIPS/SGI [www.mips.com]	R10000	200 MHz	10.7	19	MDMX	CMOC/0.35-micron, 64 bit
Sun [www.sun.com]	Ultra Sparc-II Ultra Sparc-III	300 MHz 600 MHz	12.7	19.7	VIS VIS	CMOS/0.35-micron, 64 bit
PowerPC Consortium [www.mot.com]	740	266 MHz	11.5	6.9	No	CMOS/0.29-micron, 64 bit

[1] See paragraph 2.1.1
[2] See paragraph 2.1.3
[3] n.a.: not available

Table 3
The Eight CINT95 Test Programs

Number and name	Application
099.go	Artificial intelligence; plays the game of "Go"
124.m88ksim	Moto 88 K chip simulator; runs test program
126.gcc	New version of GCC; builds SPARC code
129.compress	Compresses and decompresses file in memory
130.li	LISP interpreter
132.jpeg	Graphic compression and decompression
134.perl	Manipulates strings (anagrams) and prime numbers in Perl
147.vortex	A database program

Source: SPEC

- CINT95: eight programs performing integer computations, all of them written in C *(Table 3)*;
- CFP95: ten programs with a Fortran 77-written floating-point to represent the most "CPU intensive" part for numerical and scientific applications *(Table 4)*.

CPUint95 and SPECfp95 tests are used to estimate processing speed, which is expressed as the ratio between the time spent to make a copy of the benchmark to the time expected by SPEC parameters. SPECint95 is the geometric mean of the eight CINT95 tests and SPECfp95 is the geometric mean of the ten CFP tests. Both of these specifications use "aggressive optimisation", by which is meant the tests are performed by the optimisation of all the options of the compilers and linkers needed to obtain the best performances, in comparison with the term "measures baseline".

2.1.2. Specific Microprocessors for PDA/Thin Clients

Thin clients are based on special high-performance and low-price processors.

The first chips on the market include Sun's Javachip [http://www.sun.com], Digital Semiconductor's StrongARM [http://www.europe.digital.com/info/semiconductor], NEC's VR4300 [http://www.nec.com] and the R4650 made by IDT (Integrated Device Technology) [http://www.idt.com].

All of these products have some elements in common: RISC, with a 100 MHz (or more) primary clock, 32 or 64 bit, some of which are specialised and called ASIC (Application Specific IC).

2.1.3. Microprocessors for Multimedia and MMX

A revision of existing CPU architectures was made necessary by the need to operate devices, multimedia applications and 3D graphics, particularly within x86 Intel. Intel has introduced MMX technology, which is capable of packing multiple pixels in one register and manipulating them using just one instruction.

Number and name	Application
101.tomcatv	A mesh-generation program
102.swim	Shallow water model with 513 x 513 grid
103.su2cor	Quantum physics; Monte Carlo simulation
104.hydro2d	Astrophysics; Hydrodynamic Navier Stokes equations
107.mgrid	Multi-grid solver in 3D potential field
110.applu	Parabolic/elliptic partial differential equations
125.turb3d	Simulates isotropic, homogeneous turbulence in a cube
141.apsi	Solves problems regarding temperature, wind, velocity, distribution of pollutants
145.fpppp	Quantum chemistry
146.wave5	Plasma physics; electromagnetic particle simulation

Table 4
The Ten CFP95 Test Programs

Source: SPEC

The programmer has eight new registers and 57 new instructions that allow him to manage video, sounds and multimedia animations. The MMX instructions support single-instruction multiple-data (SIMD) operations in order to able to perform the same operation on several data values at a time. MMX is not dependent on the operating system in use and makes it easier to update (as well as to preserve and maintain) existing programs. The improvements in performance are between 50% and 400%.

Intel would like to integrate MMX technology with all x86 architectures, as it did with the extension of the 32-bit CPU instruction ten years ago.

In the meantime, the main competitors of Intel have updated their own CPUs, often using software systems that are compatible with MMX technology (which can now be considered a standard): some typical examples are the K6 of AMD and M2 Cyrix, the evolution of 6x86 architecture.

2.1.4. ASICs, DSPs and Microcontrollers

Continuous innovations have led to the introduction of a large number of products for ASICs (Application Specific ICs), DSP (Digital Signal Processing) and microcontrollers for digital devices on the industrial equipment and consumer markets, particularly in the areas of TLC and multimedia image and sound management. The most significant of these include new generations of high-performance ASICs, single chip microcontrollers and powerful IGBTs (Insulated Gate Bipolar Transitors).

The need to squeeze as many functions as possible onto a single component has led to the development of a chip that includes a large DRAM: for example, there are now single chips that combine 16 Mb of memory with a 32-bit RISC, and occupy a space of no more than 2 by 2 mm.

The main innovations of all of these components include new packagings, increased integration, improved efficiencies and greater switching/reconfiguration capabilities. The most "intelligent" also make use of expert systems, fuzzy logic and neural networks.

2.2. Memories

Dual in-line memory module (DIMM) SDRAMs are replacing SIMM EDO-RAMs on mainboards, as memory manufacturers announce the next steps in the RAM evolution.

As an alternative to SDRAM, Intel is supporting RDRAM (Rambus DRAM), which has a speed of up to 600 MHz, while a consortium of computer vendors is working on an alternative memory architecture called SyncLink DRAM (SLDRAM).

RDRAM is already being used in place of VRAM in some graphics accelerator boards, but it is not expected to be used for the main memory of PCs until 1998 or 1999. Intel and Rambus are also working on a new version of RDRAM (called nDRAM) that will support data transfer speeds of up to 1,600 MHz.

The DDR (Dual Data Rate) RAM doubles its clock speed by transferring data on the up and down slope of a clock cycle. The synchronous static version (DDR-SSRAM) will be the choice for L2 cache RAM and is expected to run at clock speeds of up to 500 MHz.

In the non-volatile memory area, flash memories (see EITO 96) are very popular for storing BIOS in modern mainboards so that it can be easily updated if necessary. Flash memories are similar to EEPROMs (Electrically Erasable Programmable Read Only Memories), but EEPROMs are usually smaller and byte erasable/writable, whereas flash memories are usually bigger and block erasable/writable (blocks are groups of bytes, usually in multiples of 4 k, 16 k, etc.). The possibility of erasing and writing whole blocks at a time usually make flash memories faster than EEPROMs.

FRAMs (Ferroelectric RAMs) are now also commercially available: they are similar to flash memories insofar as they store data without power, but they allow faster reprogramming speeds, less power and a single 3-V power supply. Due to the fact that the reading is destructive, FRAM cells must be rewritten every time they are read.

3. Computer Technology and Hardware Products

These include systems and peripheral hardware technology. The difference between mainframe (large systems), medium and small systems is becoming increasingly less: CMOS technology is dominant for all CPUs, and large systems have CPUs that are very similar to those used for small systems. In accordance with the new classification of the EITO market analysis, we will therefore mainly refer to "client" and "server" systems.

The key innovation areas include increasing reliability and availability, a reduction in life times, a constant increase in the "down-sizing" of systems having the same capacity, and the growing availability of multimedia devices. The biggest impact comes from the Internet and Intranet phenomenon, which has really led systems evolution in "web" logic regardless of their dimension or functionality.

"Network-centric" and "web-centric" paradigms have led to an architectural transformation, and so now all multi-tasking, multiprocessing and multi-user systems have become "servers". This has meant the complete revision of "client-server" logic.

Newly emerging application-specific PCs include processor-based devices such as personal digital assistants (PDAs), thin clients and the so-called information appliances, which are very easy-to-use application-specific computers for the home market: a first example is a television set equipped with an Internet access.

3.1. Server Systems

The new classification groups "Large-scale", "Medium-scale" and "Small-scale" systems of the previous classification in a single category. As also discussed in section 6, servers are mainly characterised by the activities they support, in terms of platforms, configurations, multiprocessing, storage and computing power: and the market is proposing "ad hoc" transactional servers, database and datawarehouse servers, security servers, management servers, gateway servers, etc.

The "network-centric" paradigm has revitalised mainframes as servers for large Organisations and Corporates. Large and medium-scale servers are technologically based on architectural parallels of CMOS technology: MPP, SMP and NUMA logics and clustered configurations (see 3.3) that allow a high degree of scalability and availability.

Most of the systems allow the use of Unix, TCP/IP and HTTP protocols in addition to the classic legacy operating systems.

A special point of interest is the availability of specialised front-ends (hardware or software) that make it possible to access traditional TP monitor applications from common web browsers.

The server's low-end range includes low-end "mini", high-end workstations and LAN servers. They are very similar in typology and architectural logic to low-end workstations and high-end PCs. Unix is offered in the majority of these systems and is in competition with legacy NOS like Netware by Novell [http://www.novell.com], OS/2 by IBM [http://www.ibm.com] and NT by Microsoft [http://www.microsoft.com].

3.2. Client Systems

The kernel of this class is the personal computer, whose functional range can go from an X-Terminal up to a high-end multimedia workstation (WS), but it also includes "stand-alone" equipment of all types, from desktops to handset systems. It is important to note that practically all types of system can be connected to a network and interchange information with other systems.

The technological evolution of PCs is ongoing and is led by the evolution of CPUs and multimedia devices. The impact of Internet/Intranet has led to the emergence of "thin clients", as described in EITO 97.

PC configurations and functions are going to become specialised for the business and home markets. There are two main categories of clients: portables (such as laptops, notebooks and sub-notebooks) and desktops, which include tower systems.

The high-end range of clients are normally based on 64/128 bit CPUs, with high clock rates, 512 or more MByte RAMs and high capacity disks, and high resolution videos.

3.2.1. Thin Clients

The web-centric paradigm is reshaping the concept of client-server, and changing the role and structure of clients that have so far usually been PCs. A new workstation has now been developed with a powerful CPU but only a few devices. However, it is cheap and offers efficient connection to the web from which it can download the software module needed to operate.

Thin clients are a natural alternative to the "fat PC", which is more expensive to buy, manage and update. The cost of this kind of thin client varies from US$ 500 to US$ 1,000, depending on the drivers and facilities that are plugged in.

Normally based on RISC CPUs, they have various communication interfaces, data encryption, a browser with Java interpreter as a standard interface to the end-user, and various kinds of optional peripherals.

X-Terminal and X-Windows can be considered very thin clients. Typical in Unix environments, they do not use browser or Windows interfaces. In the new solutions, X-Terminals can emulate the Windows environment and Windows PCs can interface Unix environments (also see 5.1.2.).

3.2.2. PC97 and PC98 Specifications

As PC hardware and operating systems advance, one of the biggest challenges is to synchronizse these advances so that software can take full advantage of the hardware.

To ensure that PCs fully support new versions of "windows-oriented" operating systems, a program has been established by several OEM manufacturers and Microsoft with four objectives:

- To synchronise hardware and software advances;
- To increase the quality and ease-of-use of PCs;
- To reduce the total cost of ownership (TCO) of PCs;
- To encourage the incorporation of new technologies.

The "Designed for Microsoft Windows" guidelines are published in the "PC 97 Hardware Design Guide", and are frequently referred to as "PC 97 specifications". The "PC 98 System Design Guide, Version 1.0" is now available (http://www.microsoft.com/hwdev/download/desguid/pc98v1.zip).

PC97 contains several hundred guidelines for system design, bus implementation, and device design that range from microprocessor and memory guidelines to improved power management and Plug and Play functionality. Many are designed to advance the state-of-the-art of PCs, such as the Advanced Configuration and Power Interface (ACPI) guidelines.

PC97 requires several new technologies that improve the ease-of-use and functionality of PCs:

- Improved Plug and Play support through the use of new serial buses, such as the Universal Serial Bus (USB);
- ACPI/OnNow;
- Multiple adapter and monitor support.

Improved Plug and Play

The technical support costs associated with installing new system devices can be high in large enterprise networks. For example, adding a SCSI scanner to a system requires removing the PC cover, inserting an adapter, installing drivers for the device, connecting the scanner cable to the adapter, terminating the SCSI connection, and replacing the cover. To eliminate this overhead, PC97 requires OEMs to integrate the USB (see EITO 97) into their systems.

ACPI/OnNow

Power management has in the past been used on portable computers to reduce power consumption and increase battery life. PC97 advocates that all desktops and portable computers support power management at the operating system level. Microsoft is including software support for the power management of devices in its Windows 98 and Windows NT 5.0 operating systems. ACPI will permit the operating system to switch the computer to a low-power state during low-usage times. This feature also allows OnNow functionality: for example, the

system can be "awakened" instantly for external requests, such as incoming faxes, a user pressing a key, or a network-based systems management application request.

Multiple Adapter and Monitor Support

The ability to view multiple monitors simultaneously is increasingly important, particularly in financial and CAD applications. Furthermore, emerging mainstream productivity applications support this capability. Hardware and software support is required for two monitors to display different images simultaneously, with independent resolutions, colour depths, and refresh rates. PC97 requires hardware support for this capability. Software support is expected in the Windows 98 and Windows NT 5.0 operating systems.

Other PC97 Initiatives

Although ACPI, improved Plug and Play and multiple adapter/monitor support are important PC97 initiatives, there are a number of other significant requirements. PC97 specifies minimum audio/video quality and fan noise standards. It requires standard icon markings on connectors to prevent users connecting devices incorrectly. It also stresses the avoidance of blocked expansion slots.

3.2.3. Mainboards

With the advent of Pentium II CPUs, Intel switched to a proprietary physical interface called "Slot 1". The classical CPU package is replaced by a cartridge containing different chips, such as CPU, SRAM and discrete components. This new high-performance interface is mainly designed to optimise operations in multiprocessor systems, but it also has a second internal bus that makes it possible to access the cache much more quickly than when the older Socket 7 is used.

Intel's competitors still use Socket 7 and will push up its limit by moving to 100 MHz bus speed, with great difficulties for the chip set design. However, they are also working together on a Socket 7 successor. Meanwhile, Intel announced its Slot 2, a high performance version of Slot 1 that is oriented towards workstations and servers.

The result could be two competing PC architectures (Intel and non-Intel) which could lead to motherboard vendors having to create two versions of every product or choose sides.

3.2.4. I/O Bus

As the ISA bus is not yet supported in the PC98 specifications, PCI will be the only bus for all I/O operations except graphics, which will probably use the new Accelerated Graphics Port (AGP) bus defined by Intel.

AGP's 32-bit bus is very similar to PCI, but the fact that it is a "point-to-point" connection between the main memory and the graphics circuitry means that only one AGP slot needs to be present in a system. AGP-2x achieves 533 MBps by transferring data on both edges of a 66-MHz clock cycle. AGP-4x will deliver 1066 MBps by pushing the clock rate to 133 MHz.

3.2.5. Device Bay

Device Bay, which is receiving broad industrial acceptance, defines an industry specification for interchangeable peripheral devices, such as hard disk drives, modems, network adapters, CD drives, DVD drives and a variety of other electronic devices.

The technology is being developed in response to the customer desire to be able to upgrade and customise their PCs and peripherals more easily. With Device Bay, a customer can insert a peripheral such as a DVD drive directly into a PC without opening, rebooting or turning off the PC.

Device Bay would use the existing, complementary industry interfaces: the Universal Serial Bus (USB) and IEEE 1394 High Performance Serial Bus [EITO97] [http://www.device-bay.org].

3.3. Multiprocessing, Clustering, NUMA

Scalability from PC to mainframe is based on the possibility of making CMOS CPUs work "in parallel".

There are many innovations in this field including new architectures, high speed buses for interconnections, the use of special instructions for peripherals and memories, and operating system functionality.

The most widely used methods for multiprocessing are Massively Parallel Processing (MPP) and Symmetric Multi Processing (SMP). With MPP, every CPU has its own memory; in the case of SMP, the CPUs share memory by creating a "virtual machine" capable of processing applications without modifications.

Another way to achieve scalability (and fault tolerance) is "clustering", which makes a collection of loosely networked computers function as if they were a single computer. By functioning as a single unit, clusters give an application access to infinitely more CPUs than a single SMP machine. For example, if an application needs more CPU cycles than are available within a given machine, developers can simply connect a second SMP machine (called a node) to form a virtual machine with twice as many available CPU cycles.

In addition to creating scalability, clustering provides fault tolerance. If one of the machines within a cluster fails, the others can automatically take over its threads and processes, often without interrupting the user.

The term "cluster" refers to different solutions and architectures, that can be grouped as follows:

- A collection of single different and autonomous systems, that are coordinated by a system acting as a manager;
- A fail-over cluster consisting of two nodes (one primary and a back-up) for providing a typical back-up structure;
- A "coupled cluster", that is the real cluster architecture in which each unit closely cooperates with the others: this implies significant communication exchanges among nodes. Coupled clusters can share a common memory area or each node can work with its own memory space and communicate via messages. In the first case, the application does not need to be aware of the cluster structure, and considers the cluster as a single machine.

NUMA (Non Uniform Memory Access) architecture is used in some multiprocessor systems in order to overcome the limits of SMP architectures; very expensive solutions are normally needed to exceed 16 CPUs and the relationship between the number of processors and performance is not proportional.

At the hardware level, NUMA looks a little like a clustered system. A NUMA machine consists of nodes that are linked together via a fast interconnect, with each node containing a small number of processors, its own bus, and its own physical memory. However, there are significant differences from traditional clusters. First of all, NUMA introduces the concept of a "local memory" (a memory that physically resides on that node) and a "remote memory" (that physically resides on other nodes.) It is important to note, however, that the concept of local/remote memory exists only at the hardware level; from a programming perspective, it is all treated as

"local" memory. That is, if a NUMA system has three nodes, and each node contains 1 GB of physical memory, then the programmer sees one single, contiguous 3 GB address space.

3.4. Three Dimensional Graphics

3-D graphics is becoming increasingly widespread not only in workstations and PC environments, CAD-CAM design, virtual reality, animations and state-of-the-art games, but also for desktop applications such as graphic editors, spreadsheets, presentations, management tools, etc. The availability and low prices of software libraries and coprocessors for graphics, have promoted the spread of these programs. The main functions for managing a 3-D image include: rendering, tessellation, light/shadow and geometry.

In most of today's 3-D accelerators, the rendering function is handled inside the accelerator itself, and the geometry function (manipulating the mathematical models of the 3-D image) is done by the host CPU. Geometry processing generally requires floating-point computations, and so CPUs with a good FP performance are best for this task.

However, high-end 3-D accelerators have fast FP engines that handle geometry processing as well as rendering. These chips are currently primarily used in CAD applications, generally with the OpenGL API.

3.5. The Evolutions of Hard Disks and Their Drives

Last year's report described the new technologies for high capacity archiving at both the hardware (PRML, Partial-Response Maximum-Likelihood) and logical levels (RAID, Redundant Array of Inexpensive Disks, or HSM Hierarchical Storage Management).

This continuing evolution is currently allowing disk storage capacity to be increased by about 60% each year. To maintain this growth rate, the speed and storage capacity per area unit must be increased by moving the read and write head closer. The problem of avoiding a collision between the heads and the area has now been resolved by the aerodynamic design of the head, the use of specific lubricants, the implementation of tri-pad heads, and virtual contact techniques.

Speed is increased by increasing the speed of disk rotation: from 3,600 rpm (revolutions per minute) to today's 5,400 rpm for PCs and 7,200/10,000 rpm for servers.

Inductive heads have been replaced by magneto resistent (MR) heads that make it possible to manage smaller magnetic domains by improving the number of tpi and bpi: there are now 6,000 tpi and more than 100,000 bpi.

A further incentive for the development of high-capacity archiving systems comes from the network-centric paradigm, which concentrates and centralizes storage on special high-capacity memorisation systems, thus allowing the information to be shared by several connected clients. This logic is known as Nas (Network attached storage), which was first used in LAN environments as an evolution of traditional file servers, and is now growing thanks to the Internet/Intranet phenomenon.

3.6. CD-ROM and Digital Video Disk Evolution

The evolution in the field of CD-ROMs is the introduction of speeds up to 24X. Digital Video Disks (DVDs) are a development of CD-audio and ROM, laser disks and videotapes. The current standard promoted by the DVD Licenser Consortium is the combination of two different proposals: MMCD, MultiMedia Compact Disc, and SD, Super Density.

DVD comprises two main types of product: DVD Video, which are TV peripherals, and DVD-ROM, which are PC peripherals. A DVD-Audio is scheduled as a peripheral of a stereo system (even if this function is already a characteristic of the two previous classes). The physical size of the disk is 12 cm (like CD-ROMs) or 8 cm, and they can be single or double-sided.

The video format is MPEG-2, and the reference format sound is LPCM (Linear Pulse Code Modulation). Dolby Digital can be used as well as MPEG-2.

3.7. Printers

The most important printer innovations concern the colour treatment, particularly for desktop printers. Printers mainly use the CMYK (Cyan-Magenta-Yellow-Black) colour scheme, and the colour tone on printed paper depends on this combination. Like RGB, this scheme depends on the hardware implementation.

To get around these problems, the ICC (International Colour Consortium) has defined a standard that is independent of hardware platforms and reduces calibration problems (principally the transformation between RGB and CMYK schemes).

The ICC's "Colour Management Framework" standardises the formats of all kinds of input, output and profiles, or rather the characteristics of the hardware devices. The logic is to insert the transformation of colour spaces inside operating system, as the graphic interfaces (GDI, Graphical Device Interface, and QuickDraw) already do. The selected space of "device-independent" colours is LAB (defined by the CIE, International Lighting Commission); L represents brightness on a scale of 0 to 100, whereas A and B represent the difference of a colour in comparison with white.

3.8. Video Monitors

The most important technological news is the implementation of monitors having LCDs (Liquid Crystal Displays) that are larger and equipped with TFTs (Thin-Film Transistors), particularly useful for PC desktops.

The new LCD size is 16.1″ (up till now the size was 12.1″) for SXGA 1280 x 1024 pixel, but the price is still too high for widespread diffusion of these products.

Wall monitors (from a minimum size of 20″ to 42″ and more) are called Plasma Display Panels (PDP), and are used for TV (digital and high resolution). The few problems concerning SVGA and SXGA are being solved.

The innovations in both high-end and low-end CRTs involve prices and performances. At the high-end there are better technologies for colour monitors, particularly for "shadow-mask" management. New standards have been issued by the Video Electronic Standard Association (VESA), for example, increased vertical frequency for better resolution (from 75 to 85 Hz) and the consequent offer of 1600 x 1200 monitors, although the most widely used are 1280 x 1024.

The best improvements concern interfaces, particularly the USB. One innovative trend is the introduction of On Screen Display (OSD), which allows improvements in both costs and performances.

4. Telecommunications

With increasing globalisation, the continuing explosion in mobile services, the ever-closer integration of voice, data and video, and the widespread penetration of the Internet, the global telecommunications marketplace has become one of the fastest-growing and fastest-changing markets in the world.

All of the key TLC technological evolutions described in previous EITO reports were completed during 1997 or at the beginning of 1998 and, also thanks to growing liberalisation and deregulation, have had (and still have) a great impact on the market and TLC services.

The main factors still driving this technological evolution are:

- The dominance and spread of the WWW (World Wide Web) and Internet/Intranet protocol stacks;
- The growing use of mobile systems, and their increasingly greater integration with fixed systems;
- The increased speed and capacity of WAN (Wide Area Networks), LANs (Local Area Networks) and local accesses (last mile).

The Internet/Intranet phenomenon is the leading driver, and TCP/IP logics and addressing schemes will also become the reference standards for other telecom technologies. In order to solve the multimedia problems, high-speed network and system management techniques have been proposed and implemented, together with new protocols and services. As already pointed out in the last EITO report, Internet/IP logics and addressing schemes are unifying and standardising TLC architectures and services for both public and private networks.

4.1. Public and Private TLC Evolution Scenarios

The impact of the Internet parallels all of the developments in telephony and other traditional means of telecommunications: Internet technology largely relies on the intelligence existing in user terminals, whereas traditional telecommunications make use of the intelligence residing within the network. The strengths of traditional telecommunications are their high level of security, reliability and quality of service. The integration of these with increased computer power and software capability will lead not only to an unprecedented opportunity in terms of offering versatile multimedia and information services, but also to innovations in the way in which these services are created and provided.

Deregulation (re-regulation) and liberalisation processes are already (or will soon become) a reality in Western countries: examples include the EU efforts with ONP (Open Network Provision, [http://europa.eu.int]), the 1996 US Telecommunications Deployment Act, and the 1996 World Trade Organisation (WTO) Information Technology Agreement (EITO 97). These processes not only affect regulatory aspects, but are (or should be) also influenced by technical issues, such as interconnection problems between different carrier networks. Together with the technical and marketing trends mentioned above, all of these need to be borne in mind when considering possible future scenarios.

The increasing competition between the different carriers that has been facilitated by this process of liberalisation-reregulation has led to attempts to squeeze as much as possible out of the present TLC infrastructure in terms of performances, and this in turn has led to the introduction of protocol, services and equipment innovations.

As a common orientation, the new generation LANs are based on frame technologies (such as Ethernet), with hybrid switches and routers. The new generation of public wide-area nets will also be hybrids primarily based on cell-based ATM (Asynchronous Transfer Mode).

The evolution of these two cornerstone networking technologies is changing protocol stacks and routing logic. Routing was, and still is, mainly based on destination host numbers,

but in the future it will also be based on different logics/parameters such as source hosts, source users, destination universal resource locators (URLs), specific business policies, etc. The new routing protocols and algorithms include Open Shortest Path First (OSPF), Exterior Gateway Protocol (EGP), Border Gateway Protocol (BGP), and multicast routing (see also section 4.8.).

The main carriers (particularly those which are incumbent) are being forced to adopt "open" scenarios in order to satisfy the need to open the nets to other (third) parties for sharing very high level multimedia functionalities. These needs also imply the solution of a number of technical problems, such as intelligent networks, broadband, integration, management and security.

Telecommunications Information Networking Architecture (TINA) and the related Consortium TINA-C activities have recently become widely accepted by the key players in the public network arena, from Telecommunications Operators (TOs) to Telecommunications and Computer Manufacturers and Software Houses.

It is important to underline that one of the success factors of TINA (section 6.3.) is the need to reduce the risk of very large-scale investments and exploit the convenience of sharing a number of activities - particularly R&D - in partnership. It is also worth noting that the competitive focus is moving from technical innovation to the globalisation and completeness of the services offered.

4.2. Media Innovations

At media level, the main factor of innovation is represented by increased speed. At present, this is at gigabit level, but this is likely to reach tera and then petabit optical fibre trunk levels over the next few years.

Other innovations are being made in terms of cabling system management, with the use of fire-proof materials in order to improve safety.

All of the media are involved in these innovations, but the area that is most involved is customer access for which a number of wireless and other technical solutions are now available, with the latter using twisted-pair, coaxial or fibre cables.

A cabling connection from the Central Office (CO) to customer premises *(Figure 1)* may be all in fibre (FTTH - Fibre to the Home) or copper (typically xSDL - see section 4.6.), or make use of a hybrid mix of different cables, such as FTTx or HFC (Hybrid Fibre-Coax).

The main twisted-pair technological innovations include:

- UTP (Unshielded Twisted Pair) Category 5: Four pairs operating at a maximum of 100 MHz with an attenuation of 22 db for Token ring, Ethernet, Fast and GigaEthernet, and ATM connections at 155 Mbps. This has been approved by the ISO and by the USA TIA;
- UTP Category 5 enhanced: like the above, but operating at a maximum of 200 MHz with improved performances - the term "enhanced" means that crosstalk levels are kept to a minimum thanks to special manufacturing techniques (this category still has to be standardised, which may cause some problems as one TIA committee is considering a 300-MHz minimum);
- Category 6 - SFTP, Shielded Foil Twisted Pair: Four pairs operating at a maximum of 600 MHz for Token ring, Ethernet, Fast and GigaEthernet, with ATM connections at 155 Mbps; the average price is three times that of UTP Category 5. ISO, TIA and Cenelec are working on its standardisation.

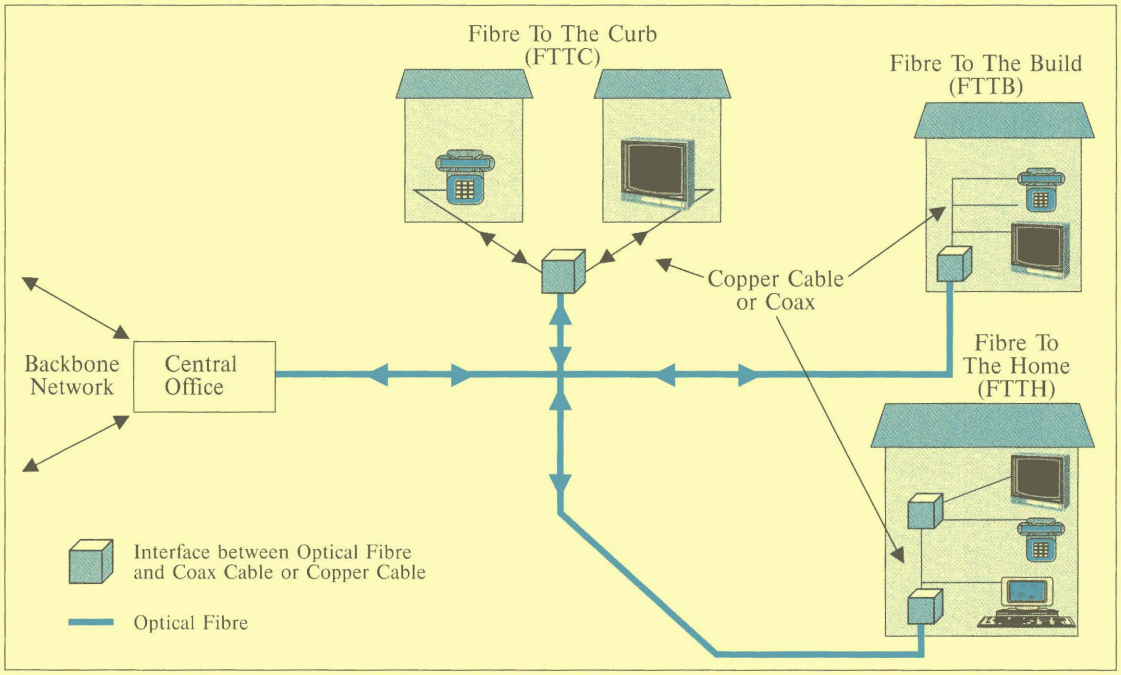


Figure 1
Cabling Connection Alternatives

The main fibre optics improvements include:

- The ongoing widespread deployment and parallel improvement in WDM technology (explained in section 4.4.1.);
- Continuing improvements in analogue signaling techniques, which now make it possible to send three bits per pulse and thus effectively triple the theoretical capacity of a fibre to about 150 Tbit/s (the current norm is just one bit per pulse);
- Improvements in optical amplification by means of a small tract of fibre drugged with erbium (rare earths) and a laser diode chip. Fibre-carried signals degrade over distance and need to be amplified every 100 kilometers. A traditional amplifier converts optical into electrical signals, amplifies then and then reconverts the electric to reinforced optical signals. However, this mechanism interrupts the continuity of signal propagation. An erbium amplifier avoids this interruption, and therefore also avoids the major limitations of the number of channels that can be signaled through a fibre and the speed at which this can be done. It is important to underline the fact that the increasingly wider use of optical fibres is also changing cabling system logic. The fibre can be directly connected to the end-user PC or workstation, and the LAN and cabling connection equipment can be distributed floor by floor or centralised in a single wiring closet.

4.3. The Switching Evolution

A new generation of "high speed" network units is in the offing that will provide multi-gigabit and terabit routers and ATM switches for both private and public networks.

The main objectives for the switching systems include increasing Tbit/s capacity and establishing greater flexibility, configurability and scalability. The main tools for reaching these goals include the widespread use of object oriented technology and a few chips for all of the possible solutions, as well as the use of photonics (see EITO 96 and 97). ATM is the reference technique for public networks: ITU-T and the ATM Forum are working on the development of protocols and services particularly related to signalling. Object technology is widely used to describe all network resources, and their management is based on the concept of transactions involving these objects.

Despite the fact that optical switching has long been considered the key step for the next switching generation, it still remains a subject of R&D. Very few and only limited applications can be found on the products/systems market, mainly because of the lack of efficient integrated components.

The ETSI Core INAP (Intelligent Network Application Protocol) standard has been derived from the CCITT Q.1218 and it is followed by all of the major manufacturers of Service Switching Point (SSP) and Service Control Point (SCP) nodes for Intelligent Network (IN) environments.

The most innovative systems use the available components and WDM also for switchboards, ATM multiplexers, etc.

The need to integrate different connection networks and current ATM technologies has led to hybrid solutions and gateways, such as the Time-Cell-Time architecture, ATM-TDM, and the evolution of CSS No. 7 with the aim of supporting ATM communications.

Network management is one of the most innovative areas for product/system development. The main applications concern network availability and reliability, with the automatic management of redundant paths without any service interruption, dynamic reconfiguration, etc. Accounting and multimedia network management are still at a less advanced stage.

Control of network intelligence is becoming an increasingly important strategic issue in responding to the growing demand for flexible, advanced and customised services.

For the main carriers, mastering networking services has already become a must and has required the introduction of a "second generation" Intelligent Network, characterised by a Service Creation Environment (SCE), standard protocols to ensure interoperability between switching and IN units (a number of solutions are still proprietary and "capability set" oriented, i.e. specific for a particular [set of] service[s]), and Service nodes that will act as servers for highly interactive and multimedia services. Unix, HTTP-TCP/IP and CORBA are the reference platforms for these "new nodes".

4.3.1. Router, Switch, Hub

Previous EITO reports have outlined the rapid evolution of routers and switches, and their diffusion not only in LANs but also in WANs, thanks to the widespread adoption of IP and Virtual LAN (VLAN). This evolution in functionalities and performances is due the fact that the new network-centred and Web-based architectures no longer follow the old 80/20 rule (i.e. 80% of local traffic and 20% routed) and that the growing complexity of the networks, particularly corporate nets, requires new tools for managing them. A LAN switch is the device that allows the creation of a VLAN, which is a "hybrid" between a bridge and a router that looks at the first packet to find the right outgoing port. All of the following packets are "switched" to layer 2 and bound for the same address.

The main innovations concern the internal architecture of the node, greater scalability, compatibility with other switches, protocols and nets (IPX, SNA, ATM, Frame Relay, X.25, FDDI, Ethernet, Token Ring, Fast Ethernet, Gigabit Ethernet), the use of high-performance ASIC dedicated to specific processes, very high speeds per port (up to OC-12 at 622 Mbps), new routing methods such as Routing Information Protocol (RIP), Netware Link State Protocol (NLSP), Open Shortest Path First (OSPF), Border Gateway Protocol (BGP), advanced management functions and RMON Remote Monitoring, and finally multicasting.

Segmented, shared and switching hubs, and port, layer 3 and multilayer switches, are the evolving products that are helping to build up and manage the new, increasingly complex and traffic-intensive networks. It is worth noting that some nodes operate on proprietary routing updates, and are therefore incompatible with the units of other manufacturers.

All of these "super" network units can be classified on the basis of the following operational logics:

- Multigigabit routers, which handle up to 20-30 million pps (packets per second), and use ASIC for routing processes and switching matrices instead of traditional bus backplanes.
- Layer 3 high-performance switching, which also handles routing functions in hardware: in comparison with the previous type, this uses more "traditional" internal architectures, does not provide all of the functions normally provided by an actual router, and is therefore better suited to LANs than corporate backbones.
- Peer-to-peer multilayer switches, which map layer 3 (IP) addresses to layer 2 destination addresses. They provide routing functions (normally via a dedicated processor) that identify a virtual path through the net on which all of the packets to that destination are switched at layer 2 in order to avoid the delays and bottlenecks of layer 3 processing. The products provide different routing schemas, some of which are based on topological information and others also on traffic types and flows; this logic often limits their use to proprietary architectures, with all of the products that support the same routing updates and protocols. IETF is also working on Multi Protocol Label Swapping (MPLS) in order to define a standard that offers the best of topology and flow-based logics.
- Server-based units which, when required to deliver a packet to a destination, ask for the destination MAC address and the VLAN to the nearest "routing server" by means of the IETF's Next Hop Routing Protocol (NHRP). If the server identifies the destination, it returns the address and the sender can switch all of the traffic directly to the destination. If the server does not know the destination address, it passes the request on to the next routing server or to a router. The draft standards IEEE 802.1Q and 802.1p are also complementary to NHRP for virtual-bridged LANs, traffic class services and multicasting.
- IP address learning: a device, similar to a routing server, which informs the end stations how to send packets to another subnet by means of an Internet Control Message Protocol (ICMP).

One of the latest innovations is the "multilayer switch", which best combines the low-cost, low latency and high-speed characteristics of a switch with the high level functions of a router - particularly flow control, dynamic re-routing, and traffic distribution under congestion. The top products currently available on the market can reach 600,000 pps, with a shortest latency of about 70 microseconds.

4.4. High-speed WANs

Frame Relay (FR) and Asynchronous Transfer Mode (ATM) are the key technologies, but the dominance of the Internet has modified their roles and evolution trends (see also EITO 95, EITO 96 and EITO 97).

ATM is becoming dominant as a public WAN service (particularly for the main voice carriers) and as a multimedia backbone for huge WANs. It is based on ISDN addresses and the building of end-to-end ATM networks but, given the dominance of IP addresses and LANs based mainly on Ethernet, Fast Ethernet and, in the near future, on Gigabit Ethernet, it is very expensive, and requires the addition of a lot of hardware and software to the computers at each end.

FR networks are also growing at an increasing rate, and for the same reasons. FR is based on IP addresses and is now gaining some of the advanced features previously considered to be exclusive to ATM: high speeds, such as T1/E1 (1,5-2 Mbps) and T3/E3 (44.736/34.368 Mbps), although ATM speeds are continuing to increase even further; guaranteed bandwidths using the Committed Information Rate (CIR), flow control management, Quality of Service (QoS) levels; the fragmentation of the FR into smaller frames; and, finally, voice services.

The developments of ATM mainly concern:

- Integration with IP;
- Multicasting (section 4.6.);
- Circuit Emulation Service (CES) for emulating T1/E1 and T3/E3 circuits over ATM;
- LAN Emulation (LANE) for interconnecting LANs, servers and clients via ATM backbones, by means of suitable mechanisms and protocols defined as standard by RFC 1483 and ATM Forum, which emulate the connection-less environment typical of LANs into the ATM connection-oriented environment;
- Multiprotocol over ATM (MPOA) for scalable internetworking and integration with existing Ethernet, Token Ring and TCP/IP infrastructures, using LANE, an evolution of the Next Hop Resolution Protocol (NHRP), a multicast address resolution server (Mars), and Integrated Private Network to Node Interface (IPNNI) that provides topology distribution mechanisms and supports Class Of Service (COS) sensitive routing at call set-up;
- Resource reSerVation Protocol (RSVP), see section 4.9.4.

The Internet is going to enter a "second generation" with a mix of "supersonic" giga and tera-bit switches and routers using ATM, Sonet, high-speed satellites (section 4.10.2.) and high-speed access schemes. All of this environment is and will continue to be based on IP, with the ongoing transfer IPv4 to the "new" IPv6, as described in EITO 97. Voice is also very important and will be increasingly carried over IP (see section 4.7.).

4.4.1. Wavelength Division Multiplexing (WDM)

WDM is the optical version of Frequency Division Multiplexing (FDM) for long-haul nets with optical fibres that allow 1 Tbps (i.e. 1000 Gbps). This technology refers to the transmission of light pulses centred in each partition of the frequency spectrum, just as FDM transmits similarly centred electrical impulses.

Based on a frequency division multiplexing logic, it has not only been tested at laboratory level, but also implemented in the real world by some carriers, thanks to its cost-effectiveness.

WDM uses 1550 nm optical fibres that allow minimum attenuation and the use of erbium-doped broadband amplifiers. The current commercial standard is 8 or 16 channels per fibre, a density referred to as Dense WDM (DWDM), but some laboratory tests indicate that this could be increased to some thousands of channels per fibre.

Unlike TDM (Time Division Multiplexing), WDM provides separate channels for each service. It transfers multiple signals at different wavelengths through the same fibre, whereas TDM shares the common bandwidth of the link and uses different time slots for each service. With WDM, each service can run separately at the fastest available speed.

The main carriers are working on WDM deployment, with some projects already in an advanced implementation phase. With a link of more than 27,000 km passing under the Atlantic, the Mediterranean, the Red Sea, and the Indian and Pacific Oceans, Fibre-optic Link Around the Globe (FLAG) connects Britain to Japan by means of the world's largest undersea fibre network, while Africa ONE is a WDM Sonet ring around Africa.

4.5. High-speed LANs

The previous EITO edition reported year by year the growing speed of LANs and the consequent evolution of techniques and protocols.

The evolution of high-speed customer access technologies (section 4.6.), and in particular of xDSL, is influencing both the high-speed LAN's technologies and diffusion, and also the standardisation activities.

The emerging solution is Ethernet with the Fast Ethernet, the IEEE 100Base-T for 100 Mbps LAN, and the Giga Ethernet for 1000 Mbps LAN, with the standardisation process in progress by IEEE 802.3, both supported by the Fast Ethernet Alliance and the Giga Ethernet Alliance respectively.

Ethernet technology is ubiquitous and has the largest installed percentage of all installed network connections and network equipment, in comparison with all the other LAN technologies, from Token Ring to FDDI and ATM. The Fast Ethernet standard established Ethernet as a scalable technology and the current development of Gigabit Ethernet extends the scalability of Ethernet even further. Gigabit Ethernet is an extension to the highly successful 10 Mbps and 100 Mbps IEEE 802.3 Ethernet standards. It maintains full compatibility with the installed base of Ethernet nodes. In fact Gigabit Ethernet follows the same form, fit and function as its 10 Mbps and 100 Mbps Ethernet precursors. All three Ethernet speeds use the same IEEE 802.3 frame format, full-duplex operation and flow control methods. *Table 5* shows a comparison between the distance restrictions for current Ethernet topologies and Gigabit Ethernet.

Table 5
Ethernet Topologies and Gigabit Ethernet

	Ethernet 10 BaseT	Fast Ethernet 100 BaseT	Gigabit Ethernet Goals 1000 Base X
Data Rate	10 Mbps	100 Mbps	1000 Base X (1 gigabit per second)
Cat 5 UTP	100 m (min)	100 m	100 m
STP/Coax	500 m	100 m	25 m
Multimode Fibre	2 km	412 m (hd)** 2 km (fd)*	500 m
Single-mode Fibre	25 km	20 km	3 km

* IEEE spec full duplex, **IEEE spec half duplex
Source: Gigabit Ethernet Alliance

Gigabit Ethernet communicates in full-duplex mode; when operating in half-duplex mode, it adopts the same fundamental CSMA/CD access method to resolve contention. The Gigabit Ethernet CSMA/CD method has been enhanced in order to maintain a 200-meter collision diameter at gigabit speeds, avoiding completion of transmission of minimum-sized Ethernet packets before the transmitting station senses a collision. The enhancement is based on the extension of the minimum CSMA/CD carrier time and of the Ethernet slot time from their present value of 64 bytes to 512 bytes.

Figure 2 illustrates the functional elements of Gigabit Ethernet.

Gigabit Ethernet utilises the same management standards as the previous Ethernet, including SNMP, Simple Network Management Protocol, and RMON, Remote MONitoring, thanks to the same standard frames. And therefore also the objects of the SNMP MIB (management information base) structures and their agents can be utilised to provide network management at gigabit speeds.

Several Giga Ethernet products are already on the market, although the standardisation process is still in progress by the 802.3z Gigabit Ethernet task force within the IEEE 802.3 working group. The IEEE is also actively investigating technology that would support link distances of at least 100 meters over Category 5 unshielded twisted pair (UTP) wiring. In addition, the task force has decided to include a specification for an optional Gigabit Media Independent Interface (GMII) in the scope of their work.

Gigabit Ethernet provides high-speed connectivity, but does not by itself support a full set of services such as Quality of Service (QoS), automatic redundant fail-over or higher-level routing services. These can be added via other open standards such as RSVP for bandwidth reservation and by the new emerging 802.1Q and/or 802.1p, for providing VLAN (Virtual LAN, see EITO 97) and explicit priority information.

4.6. High-speed Customer Access

The rapid increase in the speed and capabilities of WANs and backbone nets requires a parallel increase in the speed and capacity of local access by end-users.

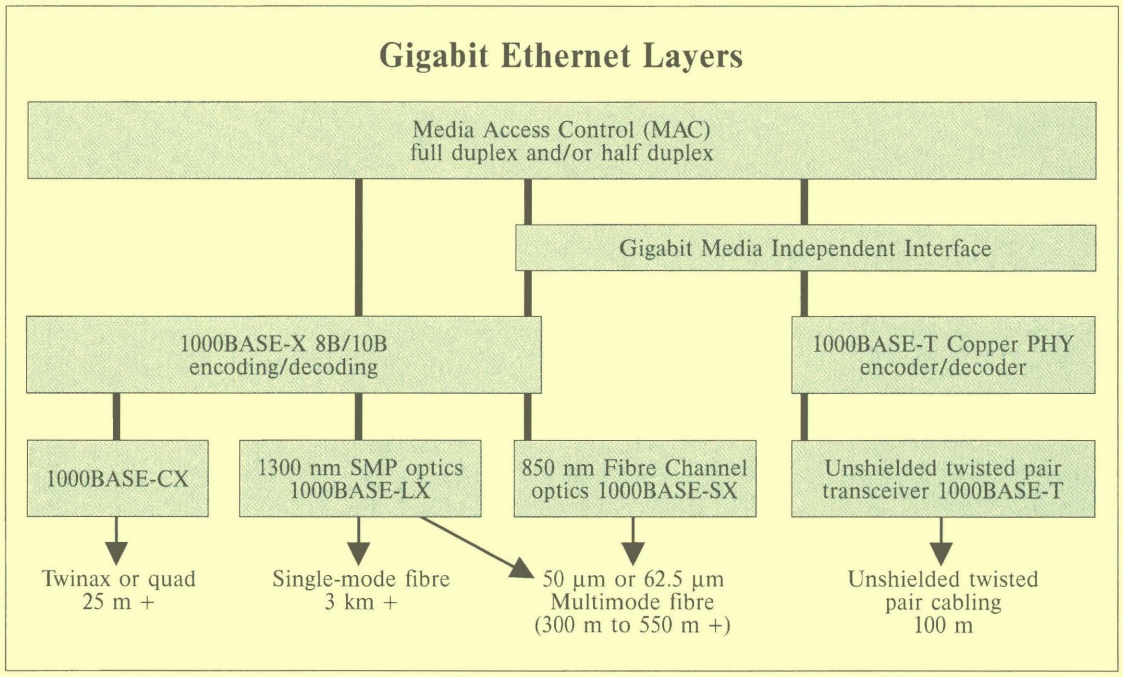


Figure 2
The Functional Elements of Gigabit Ethernet

Source: Gigabit Ethernet Alliance

Customer access has so far been provided via modem by the traditional POTS (Plain Old Telephone Service), which allows speeds in the range of 2.4-28.4 Kbps (for higher speeds, see section 4.6.3.). In order to support interactive multimedia, local access has to provide faster facilities that are also cheaper than the use of dedicated T1/E1 or ISDN lines. The emerging technologies include xDSLs, which try to squeeze the best possible performance from the existing telephone infrastructures, and broadband modems that use CATV cabling.

According to a number of forecasts, these techniques are unlikely to be widely available in a short time. However, it is probable that satellite-based services might help to close the access speed gap, at least as far as applications suitable for satellite communications are concerned.

4.6.1. Digital Subscriber Loops (xDSL)

xDSL is a set of large-scale bandwidth-rich broadband technologies based on traditional, twisted-pair copper wire standard phone cable.

Table 6 compares these new access technologies, which provide different maximum speeds for upstream and downstream transmissions.

The "basic" DSL carries both a 4 kHz analog signal for audio (the traditional POTS) and a digital signal for data. DSLs run from a telephone company's central office (CO) into a customer's building, where they are connected to one or more telephones, fax machines, or modems.

Table 6
xDSL Comparisons

DSL Technique	Distance	Upstream Transmission Rate	Downstream Transmission Rate
IDSL, ISDN Digital Subscriber Line	12,000-18,000 feet	128 Kbps	128 Kbps
HDSL, High Data rate Digital Subscriber Line	up to 12,000 feet	- 768 Kbps - 1.544 Mbps with 2 twisted-pair lines - 2.048 Mbps with 3 twisted-pair lines	- 768 Kbps - 1.544 Mbps with 2 twisted-pair lines - 2.048 Mbps with 3 twisted-pair lines
SDSL, Single line Digital Subscriber Line	up to 10,000 feet		- 1.544 Mbps with 1 line - 2.048 Mbps with 1 line
ADSL, Asymmetric Digital Subscriber Line	downstream is affected by distance: from 9,000 up to 18,000 feet for decreasing speed	from 16 to 640 Kbps	from 1.5 to 9 Mbps
RADSL, Rate-Adaptive Digital Subscriber Line	12,000-18,000 feet	from 128 Kbps to 1 Mbps	from 600 Kbps to 7 Mbps
VDSL, Very high data rate Digital Subscriber Line	from 1,000 up to 4,500 feet for decreasing speed	from 1.5 to 2.3 Mbps	from 13 to 52 Mbps

ADSLs can deliver voice, TV images and online interactive data along two pairs of UTP lines. They have three channels: a traditional analogue telephone channel, a unidirectional data channel of 1.5-6 Mbps, and a bidirectional data channel of 16 Kbps. With about 2 Mbps, it is possible to transfer compressed TV images of VHS quality; with 16 Kbps, it is possible to "interact" with a central host. At the CO, a modem modulates and encodes all of the signals into an ADSL signal. The modem combines the 4-kHz POTS signal with the DSL signal before sending it over the existing phone wiring. Downstream, a splitter separates the POTS signal from the digital signal. Upstream (from the end-user to the CO), the modem modulates and encodes the upstream digital signal and combines it with the 4-kHz POTS signal; at the CO, the POTS signal is again separated from the ADSL digital, and the upstream signal is demodulated, decoded and sent to the other end.

ADSLs use MPEG2 for compression, and transmission is based on multicarrier modulations with discrete multi-tone (DMT) and Quadrature Amplitude Modulation (QAM).

DMT has been adopted by ANSI (ANSI T1.413) as a standard method for ADSL modulation.

Several hardware manufacturers use Carrierless Amplitude and Phase (CAP) modulation with V.32 and V.34 modems.

Symmetric Digital Subscriber Lines (SDSLs) provide upstream and downstream signals of equal size and might be used for bidirectional applications, such as videoconferencing and real-time editing of program codes and documents.

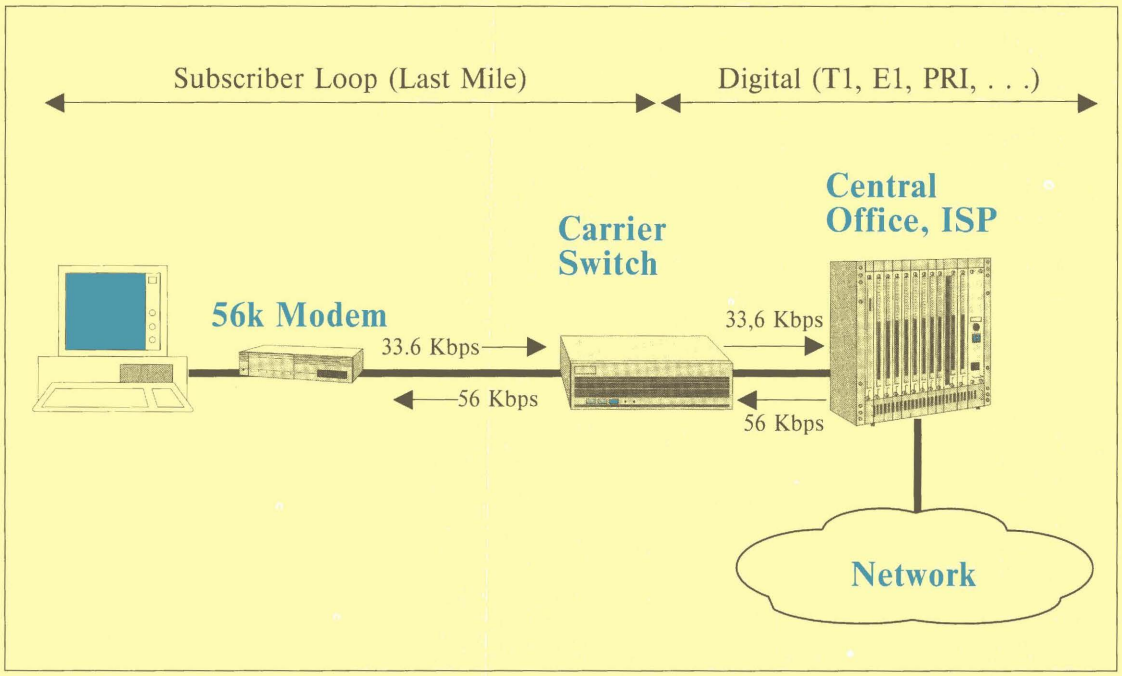


Figure 3
Example of a 56 Kbps Modem Connection

4.6.2. Cable Modems

Cable modems provide secure, high-performance, asymmetric connectivity. They use the existing TV cabling and are capable of data rates that are nearly 1000 times faster than traditional telephone modems. A typical broadband modem features a 30 Mbps downstream data rate and a 2.56 Mbps upstream rate. However, as most cable is unidirectional (designed to carry a video signal from a cable company to a subscriber's residence), a large percentage of installed cable provides only downstream transfer. Cable transmission requires an inverted tree topology: a large trunk carries the signal from the cable company, and then is divided into branches (i.e., cables) and sub-branches until reaching the subscribers' homes. All of the users on a branch share the cable's bandwidth. If the cable can deliver 6 Mbps of data, a solitary user on a branch enjoys more capacity than he or she can use, but when 50-100 or more users are on the same branch, the 6-Mbps downstream signal is divided among the number of people vying for bandwidth, and the speed at which data can be delivered is similar to that provided by an analog modem. Additional channels might have to be added, and additional cable laid, in order to deliver high bandwidth.

4.6.3. 56 Kbps Modem

The demand for faster communication is finding a response in traditional modems for switched lines. The latest models have a speed of as much as 56 Kbps, which is particular useful for connecting portable PCs to the Internet. Such speeds represent almost an extreme limit for switched lines, and can only be reached for downstream transmissions (from the Net to the PC); the maximum in the opposite direction is 33.6 Kbps. Furthermore, the connection requires a digital line at least up to the final switch *(Figure 3)* before the subscriber's loop

towards the address of the end-user, because it is this condition that reduces the number of analogue/digital conversions to only two (the modem on the one hand and the last switch of the carrier on the other), thus increasing the overall quality of the connection. The difference in the speeds that can be reached in the two directions is due to the fact that an analogue/digital conversion gets more from the signal than a digital/analogue conversion.

Fifty-six Kbps modems require high quality lines with a very good signal/noise ratio.

From a technical point of view, manufacturers have adopted two different approaches: X2 developed by US Robotics [http://www.usr.com], and K56flex developed by Lucent (the company deriving from the famous AT&T laboratories) and Rockwell Semiconductor System Inc. [http://www.lucwnt.com]. A Consortium of a large number of manufacturers (Open 56K) has been set up and has presented K56flex to the ITU [http://www.itu.ch] for standardisation.

4.7. Computer Telephony and Internet

The evolution of advanced telephony is strictly related to PCs, and more generally related to computers and the Internet thanks to voice digitalisation.

The use of Computer Telephone Integration (CTI), see EITO 96, is being extended and now enriches various applications and services. Interactive Voice Response (IVR), fax on demand, and voice over Internet/FR and in the WWW will lead to the redesign of the the logic, cost and prices of integrated applications as well as "traditional" voice services, particularly in the case of long-distance calls. Taken together, these innovations represent a further step towards the real deployment of multimedia and ICT by providing integrated applications, such as information access, transaction processing, real-time voice communication, and intelligent call management. Some market standards are emerging, and providing the basis for development tools that complement the more widely used Visual Basic, C++ and Java, and make it easier to develop new services and applications.

The key standards include TAPI (Telephone API), TSAPI (Telephone Service API), HVML (Hyper Voice Markup Language) and VPIM (Voice Profile for Internet Mail).

CTI applications go from the simplest automation of handling a telephone call (i.e. answering the call, greeting and responding to the caller with speech synthesis) up to complex functions and operations such as speech recognition, voice mailing, text-to-speech conversion, etc.

Application Programmer Interfaces (APIs) are one of the key elements for developing CTI applications, the most widely used being TAPI (developed by Intel and Microsoft), which allows Windows applications to access voice services, and TSAPI (developed by AT&T and Novell), which allows both PC-to-telephone equipment and PABX-to-Netware server connections. ECMA defined the CSTA (Computer-Supported Telephony Application) recommendation, which is a protocol for connecting a switch to a computer.

Voice transfer over IP addressing schema is another big issue, which has the aim of drastically reducing the cost of an intercontinental voice call via Internet to that of a local call.

Unlike ISDN and ATM, the Internet and Frame Relay were not originally designed for voice communications or voice/data integration, but an increasing number of products now offer such features for both. Over the Internet, it is necessary to guarantee a real-time, constant-rate and uninterrupted audio connection. The

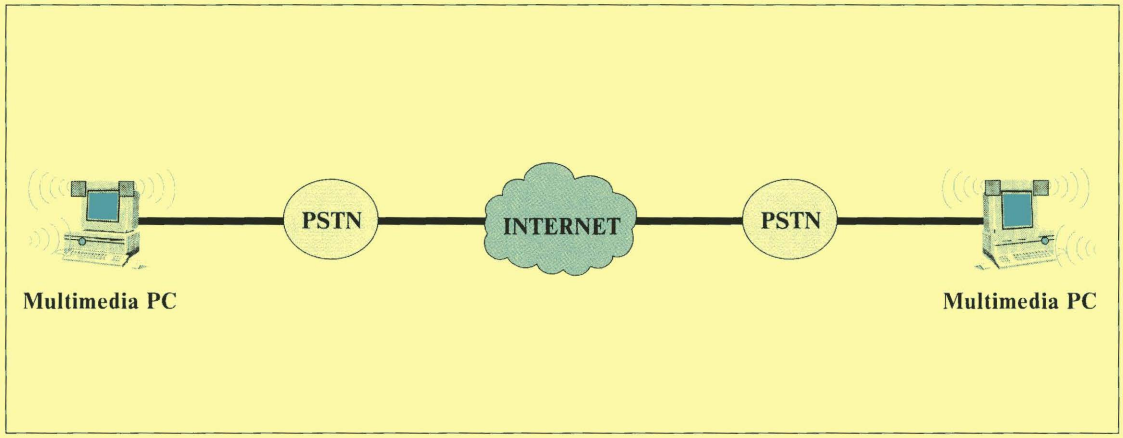


Figure 4
Computer-to-Computer Internet Telephony

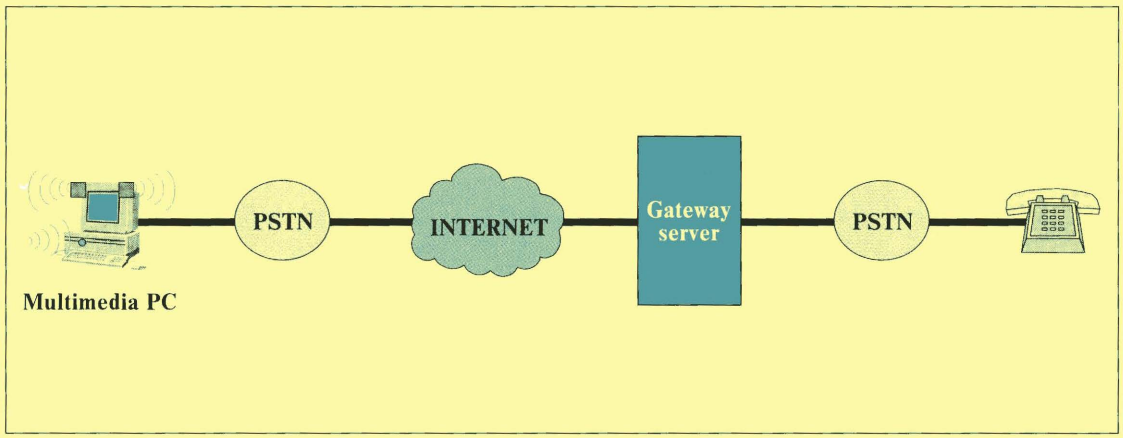


Figure 5
Computer-to-Telephone Internet Telephony

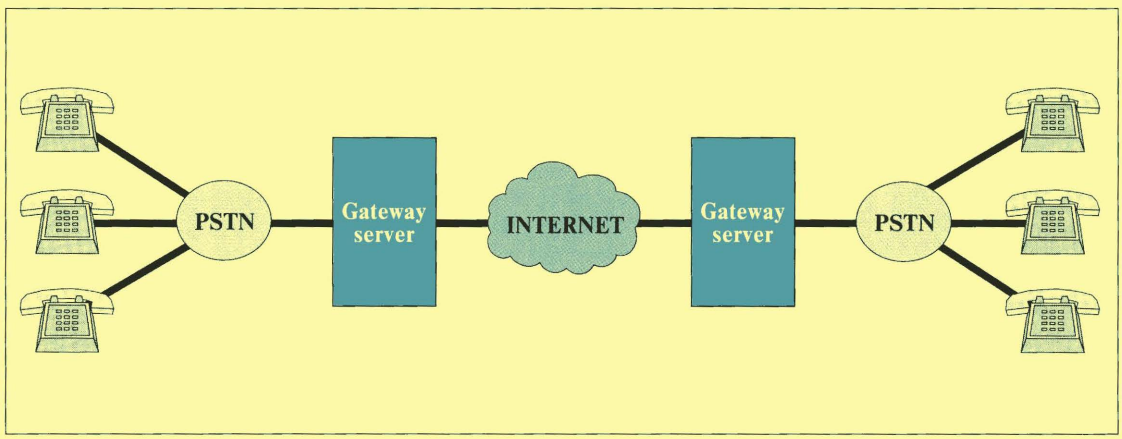


Figure 6
Telephone-to-Telephone Internet Telephony

present TCP/IP protocols cannot guarantee these characteristics and the solutions offered on the market have introduced proprietary protocols capable of streaming audio transmissions. The voice is digitally coded and transported to the interlocutors via the TCP/IP addressing schema.

There are three different ways of carrying voice over the Internet:

a) Computer-to-computer Internet Telephony: multimedia personal computers with suitable software and hardware (microphone) exchange voice streams with the remote interlocutor *(Figure 4)*;

b) Computer-to-telephone Internet Telephony: the remote interlocutor uses a normal telephone set connected via PSTN, Public Switching Telephone Network, to a gateway server *(Figure 5)*;

c) Telephone-to-telephone Internet Telephony: PSTN users use special Internet gateway servers to transport voice traffic for long distance or international calls *(Figure 6)*.

Various solutions have been adopted for TCP/IP transport. One approach is based on the datagram connectionless User Datagram Protocol (UDP), which can provide a continuous stream due to the absence of overhead but requires higher level proprietary protocols for error recovery. A second approach is based on the TCP connection-oriented protocol, which provides end-to-end flow control and avoids possible network congestion but without the transmission interruptions that may affect UDP.

Further areas of innovation strictly associated with the Internet concern the integration of voice services with WWW pages and e-mail.

Hyper Voice Markup Language (HVML) makes it possible to extend Hyper Text Markup Language (HTML) by including a voice response in order to specify how a WWW page should sound to users calling via telephone. Through HVML, the Web site understands that an Internet voice access is being made (and therefore Intranet), and can answer as an Internet IVR by voice or fax.

The integration and common management of e-mail with voice-mail and faxes is being pursued by means of unified messaging systems, such as VPIM.

The VPIM v.2 protocol, defined by the VPIM Work Group [htttp://www.ema.org/vpimdir], makes it possible to interchange voice and fax messages between different systems connected via Internet/Intranet over suitable profiles of ESMTP/MIME (8 bit SMTP extension/Multipurpose Internet Mail Extension). VPIM provides the mapping specification between the voice and non-voice systems, and also establishes a directory service.

Another growing area of computer telephony applications relates to intelligent call management, which includes outbound predictive dialers, incoming call routing via ANI/DNIS (Automatic Number Identification/Dialed Number Identification Service), international callback systems, call scheduling, etc.

Other standards for voice integration and management into the Internet/Intranet include the ITU T.120 protocols for data and audiographic conferencing, MMUSIC (Multiparty Multimedia Session Control), H.323 and H.3xx for videoconferencing (for a list of these standards see [http://rpcp.mit.edu/~itel/standards.htm]).

4.8. IP Multicast

Killer applications, such as software and information distribution, televideoconferencing and webcasting require messages to be sent once to multiple users, without duplicating the same information for each receiver. Network applications work or message duplication (i.e. in a unicast logic), or broadcasting a single information stream to every station in the network, involve heavy traffic loads, waste bandwidth and have a cost that is proportionate to the number of receivers.

In order to avoid these problems, IP Multicasting logic based on new Internet protocol standards is likely to become widely accepted.

Multicasting is a receiver-based concept. The receivers join a particular multicast session group and traffic is delivered to all group members via the network infrastructure. Only one copy of a multicast message passes over any link in the network, and copies of the message are made only where paths diverge at a router. A multicasting enabled router has to forward the multicast stream only to those networks which have multicast receivers; the networks with no declared receivers do not receive any information streams.

Multicasting has already been pioneered on the Internet using MBONE (Multicast backBONE) for multicasting audio and video from IETF meetings.

IP Multicast is an extension of the standard IP network-level protocol, defined in RFC 1112, Host Extensions for IP Multicasting.

Multicasting requires the multicast-enabling of the host computer's operating systems, the TCP/IP stack, the adaptors and their drivers, the network units (switches, routers, bridges). The application also has to be aware of the multicasting, and therefore has to be specially written or rewritten. IETF has already delivered some standards and is working on others. Key manufacturers such as AT&T, IBM, Intel, Microsoft, HP, Netscape, Sun, 3Com, etc. have created the IP Multicasting Initiative (IPMI) in order to support the standardisation process and deliver compliant multicasting products.

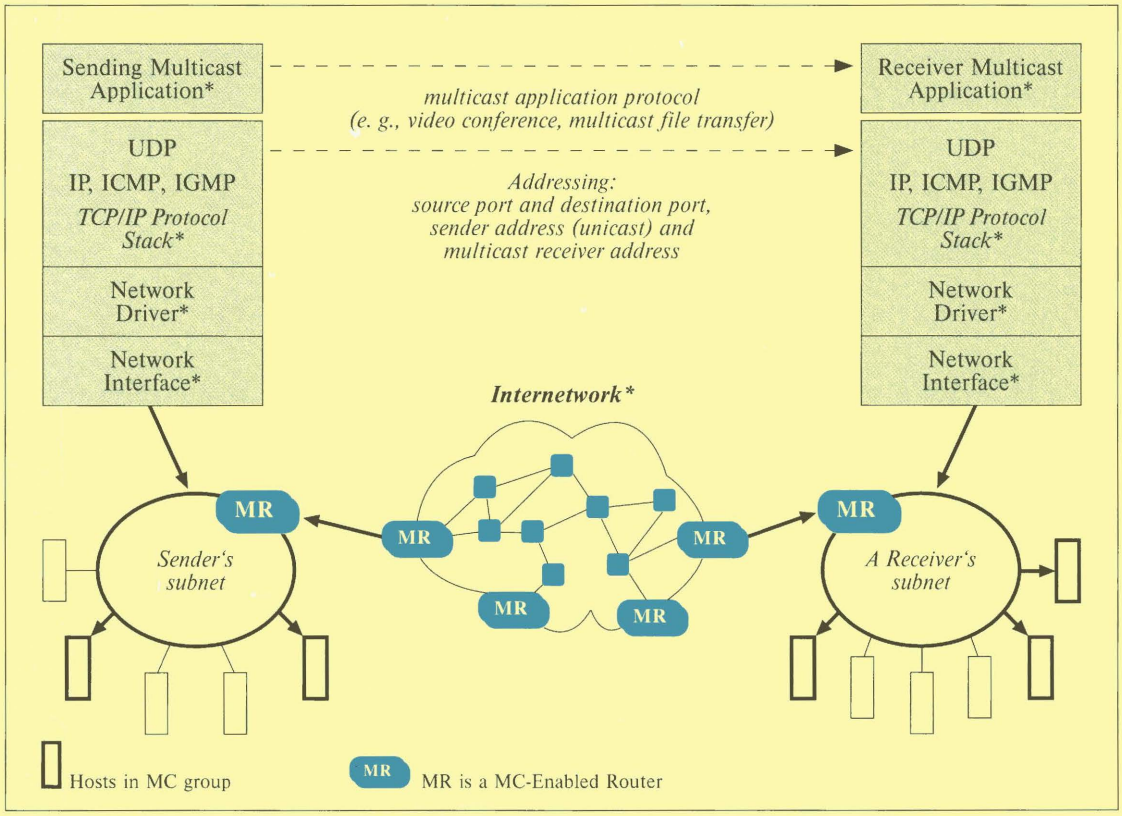
A number of network devices and the majority of Operating Systems currently on the market are already capable of dealing with multicasting. The main problems concern applications and the use of the connectionless User Datagram Protocol (UDP), which cannot guarantee reliable delivery.

Figure 7 shows the main components that must be multicast-enabled. The direction of traffic shown is for multicast datagrams. The traffic needed to communicate host group membership and routing information is not shown.

IP Multicast uses Class D Internet Protocol addresses (those with 1110 as their high-order four bits) in order to specify multicast host groups.

To send an IP Multicast datagram, the sender specifies a destination address representing a host group. IP Multicast datagrams are sent using the same "Send IP" operation used for unicast datagrams. In order to receive datagrams, a user's host application requests membership of the multicast host group. This membership request is communicated to the LAN router and, if necessary, to intermediate routers between the sender and the receiver. The receiving host's network interface card starts filtering for the LAN-specific hardware (data-link layer) address associated with the new multicast group address. WAN routers deliver the requested incoming multicast datagrams to the LAN router, which maps the host group address to its associated hardware address and builds the message

Figure 7
IP Multicasting



Components must be multicast-enabled

Source: IPMI

(e.g. an Ethernet frame) using this address. The receiving host's network interface card and network driver listen for these addresses and pass the multicast messages to the TCP/IP protocol stack, which makes them available as input to the user's application.

An IP host group address is dynamically bound to a set of local network interfaces on a set of IP networks. An IP host group address is not bound to a set of IP unicast addresses. Multicast routers do not need to know the list of member hosts for each group – only the groups that have one member on the subnetwork.

The key element in the TCP/IP stack for IP multicasting is the Internet Group Management Protocol (IGMP – called RFC 1112 by IETF). This protocol allows an end-user workstation to ask the server managing the multicast group list for permission to join an IP multicasting group. IGMP also exchanges/distributes multicast group information among neighbouring routers.

IGMP is used by multicast routers to learn of the existence of host group members on their directly attached subnets by sending IGMP queries and having IP hosts report their host group memberships.

IGMP has only two kinds of packets: Host Membership Query and Host Membership Report. To determine whether any hosts on a local subnet belong to a multicast group, one multicast router per subnet periodically sends a hard-

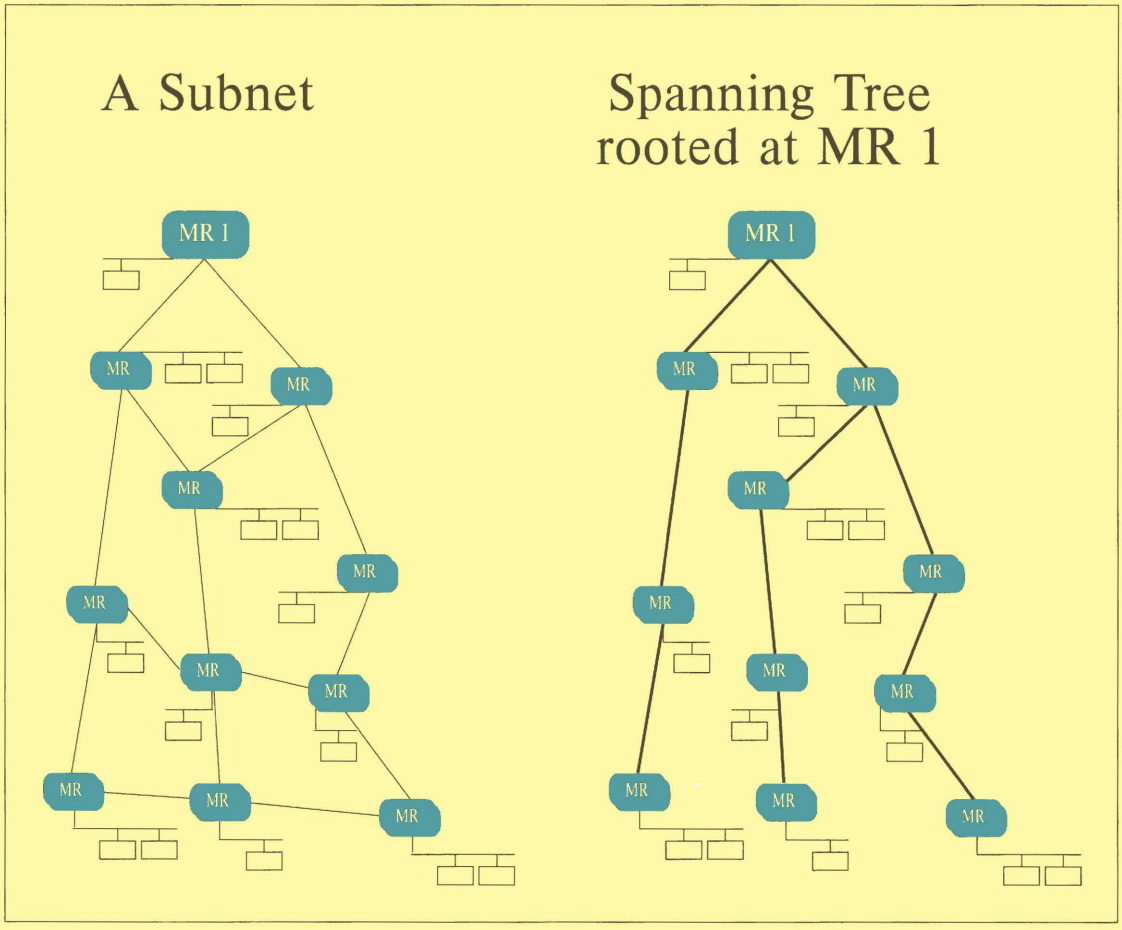


Figure 8
The Spanning Tree

Source: IPMI

ware (data-link layer) multicast IGMP Host Membership Query to all IP end nodes on its LAN, asking them to report back on the host group memberships of their processes. This query is sent to the all-hosts group (network address 224.0.0.1). Each host sends back one IGMP Host Membership Report message per host group, which is also sent to the group address so that all group members see it.

IGMP updates are used by multicast routing protocols to communicate host group memberships to neighbouring routers.

New techniques have been developed to address the problem of efficiently routing multicast traffic. Since the number of receivers for a multicast session may be quite large, the source should not need to know all of the relevant addresses; it is the network routers that must somehow be capable of translating multicast into host addresses. The basic principle involved in multicast routing is that routers interact with each other to exchange information about neighbouring routers. To avoid the duplication of effort, a single router is selected (via IGMP) as the Designated Router for each physical network.

On a routed network, the multicast information is transmitted by a source server to a destination group via a "spanning tree" that connects all of the members of an IP Multicast group, and which can follow the "dense" or the "sparse" mode.

A spanning tree has just enough connectivity to ensure that there is only one path between every pair of routers, and is loop-free. If each router knows which of its lines belong to the spanning tree, it can copy an incoming multicast datagram onto all of its outgoing branches by generating only the minimum number of copies required.

The dense mode refers to multicast groups whose members are densely distributed throughout the net: the related routing protocols rely on periodic flooding of the network with multicast traffic in order to set up and maintain the spanning tree. These protocols include:

- Distance-Vector Multicast Routing Protocol (DVMRP), which is described in RFC 1075 and requires RIP, Routing Information Protocol;
- Multicast OSPF (MOSPF), described in RFC 1584 and requires OSPF, Open Shortest Path First;
- Protocol Independent Multicast - Dense Mode (PIM-DM) is a protocol that is independent of the routing mechanism, and capable of running on either RIP or OSPF. The standardisation process is carried out by the IDMR (InterDomain Multicasting Routing) Working Group.

The sparse mode refers to multicast groups whose members are sparsely distributed throughout the net or when the network has limited bandwidth. IETF considers the following protocols:

- PIM-SM, Sparse Mode: a focal router called "rendezvous point", which concentrates all of the traffic over the same tree;
- CBT, Core Based Tree: the logic is analogous to the PIM, but the focal router is called "the core".

At network level, IP Multicast can also be optimised on a LAN using multicast filtering switches. These select the ports connected to the end nodes participating in the multicast group (in the case of broad transfers, the switch normally sends packets to all ports). Otherwise, the multicast traffic is sent to all of the segments on the local subnet. An IP Multicast aware switch can automatically set up multicast filters so the multicast traffic is directed only to the participating end nodes.

Figure 9 shows the use of a multicast filtering switch.

PIM, MOSPF, DVMRP do not control interdomain multicast routing, nor do they limit the propagation of routing information. Furthermore, multicasting does not have an equivalent of the Border Gateway Protocol (BGP) that provides interdomain routing capabilities for IP.

As mentioned at the beginning, multicasting also requires high level protocols that are already, or will be, standardised by IEFT. These include the Real-Time Transport Protocol (RTP), which provides end-to-end network transport functions suitable for applications transmitting real-time data, such as audio, video or simulation data, over multicast or unicast network services; the ReSerVation Protocol (RSVP), which enhances the current Internet architecture with support requests for a specific quality of service (QoS) from the network for particular data streams or flows; the Real-Time Streaming Protocol (RTSP), which is an application-level protocol designed to control the delivery of data with real-time properties in order

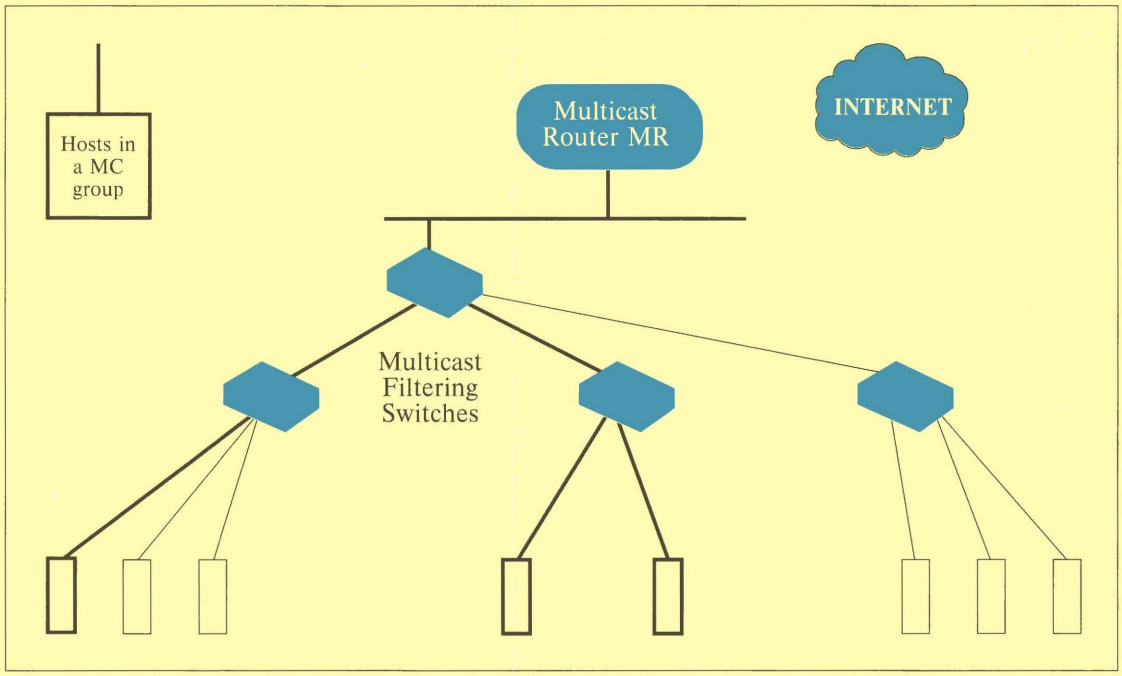


Figure 9
The Use of a Multicast Filtering Switch

Source: IPMI

to enable the controlled, on-demand delivery of real-time data, such as audio and video data. Reliable multicast protocols are being developed to overcome the limitations of unreliable multicast datagram delivery and expand the uses of IP Multicast.

4.9. New Application Protocols

4.9.1. Real-time Transport Protocol (RTP)

RTP (version 2) is a real-time transport protocol that provides end-to-end delivery services to support applications transmitting real-time data, such as interactive audio and video data, over unicast and multicast network services. RTP is defined in IETF RFC 1889, together with a profile for carrying audio and video over RTP in RFC 1890. Both are IETF Proposed Standards. RTP is used on the MBONE by vat, the video/audio tool. Commercial implementations of RTP and RTP-using applications are currently available for a number of platforms.

RTP services include payload-type identification, sequence numbering and time stamping. Delivery is monitored by means of a closely integrated control protocol called RTCP (see next section).

RTP does not provide any mechanisms to ensure timely delivery or quality-of-service guarantees. It does not guarantee delivery or prevent out-of-order delivery, nor does it assume that the underlying network is reliable.

4.9.2. Real-time Control Protocol (RTCP)

RTCP is the control protocol that works in conjunction with RTP. RTCP control packets are periodically transmitted by each participant in an RTP session to all other participants. Feedback of information to the application can be used to control performance and for diagnostic purposes.

RTCP has the following main functions:

- It provides information to the application regarding the quality of data distribution and distribution faults. Each RTCP packet contains sender and/or receiver reports and statistics, which include the number of packets sent, the number of packets lost, interarrival jitter, etc.
- It identifies the RTP source by means of a transport-level identifier called the canonical name (CNAME), which keeps track of the participants in an RTP session. Receivers use the CNAME to associate multiple data streams from a given participant in a set of related RTP sessions (e.g., to synchronise audio and video).
- It controls RTCP traffic, which is limited to a maximum of 5% of the overall session traffic. This limit is enforced by adjusting the rate at which RTCP packets are transmitted as a function of the number of participants. Since each participant sends control packets to everyone else, each can keep track of the total number of participants and use this number to calculate the rate at which to send RTCP packets.
- It conveys minimal session control information to all session participants. This function might be useful in loosely-controlled sessions that can be informally entered and left by the participants: for example, RTCP might carry a personal name in order to identify a participant on the user's display.

4.9.3. Real-Time Streaming Protocol (RTSP)

The application-level Real Time Streaming Protocol (RTSP) is intended to be a robust protocol for streaming multimedia in one-to-many applications over unicast and multicast, and supporting interoperability between clients and servers from different vendors. Its draft specification is in the very early stages of submission to the IETF. Products using RTSP are already available (even though RTSP is likely to undergo significant changes as it goes through the IETF process).

"Streaming" breaks data into many packets of the appropriate size for the bandwidth available between client and server.

Its purpose is to control multiple data delivery sessions, and provide a means for choosing delivery channels such as UDP, TCP, IP Multicast, or RTP-based delivery mechanisms. RTSP is being designed to work on top of RTP in order to control and deliver real-time content. RTSP can also be used with RSVP to set up and manage reserved-bandwidth streaming sessions.

4.9.4. Resource Reservation Protocol (RSVP)

This is a resource reservation setup protocol designed for an integrated services internetwork. An application invokes RSVP in order to request a specific end-to-end QoS for a data stream. RSVP is intended to set up guaranteed QoS resource reservations in an efficient manner in order to support unicast and multicast routing protocols and scale well for large multicast delivery groups. It is currently being defined by the IETF.

A host receiver uses RSVP to request a specific QoS from the network for a particular data stream from a particular data source. An elementary RSVP reservation request consists of a specification for the desired end-to-end QoS (e.g. peak/average bandwidth and delay bounds), and a definition of the set of data packets to receive the QoS. RSVP is useful for environments in which QoS reservations can be supported by reallocating rather than adding resources. All of the hosts, routers and other network infrastructure elements between the receiver and sender must be capable of supporting RSVP, and each of them reserves system resources such as bandwidth, CPU and memory buffers in order to satisfy the QoS request.

RSVP operates on top of IP (either IPv4 or IPv6). Although it occupies the place of a transport protocol in the protocol stack, it provides session layer services (it does not transport any data). RSVP is an Internet control protocol (like IGMP or ICMP), not a routing protocol.

4.10. Mobile and Satellite Systems

These technologies are used at the levels of both customer-access LANs and long-haul nets. The main innovations concern increasing bandwidths (and therefore speed) and the support of multimedia information. Their key characteristic is that they are "wire-less". The most significant examples include:

- The evolution from GSM to UMTS in cellular telephony;
- The use of extremely high frequencies (EHF) in the range of 30-300 GHz;
- The availability of global mobile voice and datacom services by means of pocket-sized and hand-held devices;
- The introduction of broadband satellite systems.

4.10.1. UMTS

GSM has been one of the few worldwide successes, and is the dominant European technology and standard.

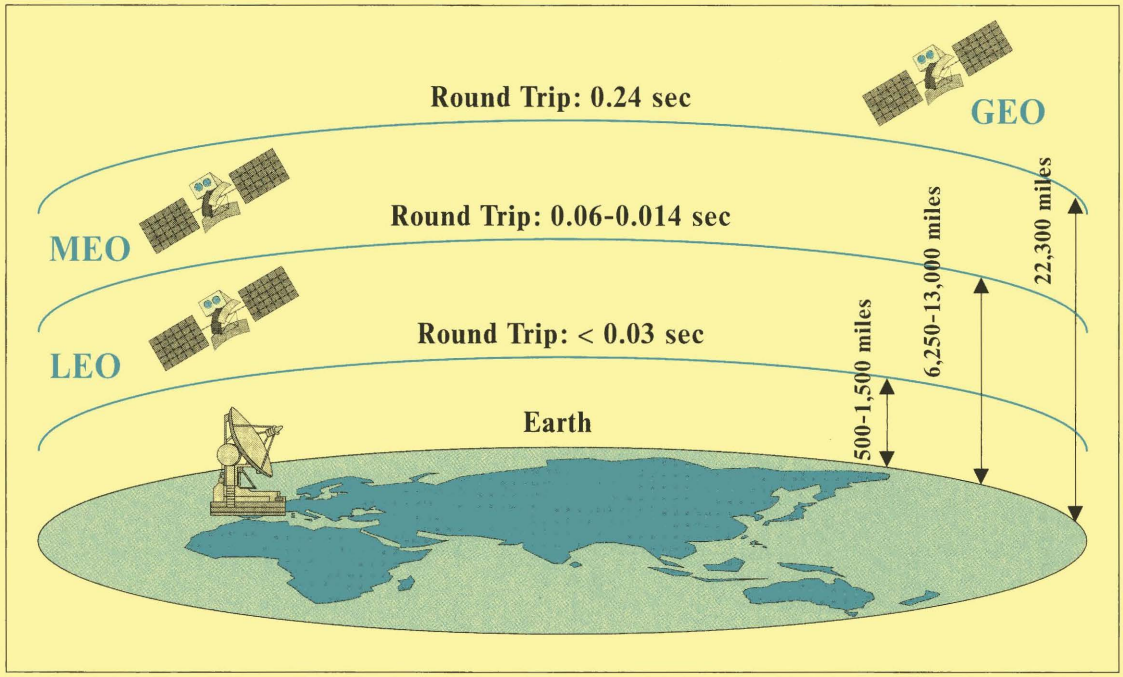
The Universal Mobile Telecommunications System (UMTS) represents a new generation of mobile communications technology for a world in which "personal services will be based on a combination of fixed and wireless/mobile services to form a seamless end-to-end service for the user".

The deployment of UMTS will begin to offer services that have (or could have) been provided by traditional fixed networks, including wideband services of up to 2 Mb/s. The European Project RACE Mobile is studying a Mobile Broadband System operating in the 60 GHz bands for mobile service applications in the approximate range of 2-100 Mb/s.

UMTS will also function as a stand-alone network implementation.

UMTS is a third-generation mobile technology that supports on-demand transmission capacities of up to 2 Mb/s in a large variety of radio environments, compatible with B-ISDN and consistent with the ITU's FPLMTS (Future Public Land Mobile Telecommunication Systems) recommendations, also named IMT-2000 [http://www.itu.int./imt/]. Together with its international counterpart FPLMTS, UMTS extends the vision of personal mobility to the universal mobile telecommunications dimension, including an integrated satellite component.

Figure 10
The Key Orbits of Satellite Systems



The 2 Mb/s services that UMTS can support (in what environments and for what applications) are currently under study. The radio interface is an area in which substantial European RACE Mobile research into the relative merits of CDMA (Code Division Multiple Access) and TDMA (Time Division Multiple Access) is ongoing. Other techniques, such as OFDMA (Orthogonal Frequency Division Multiple Access), multi-carrier and hybrid solutions, may also be appropriate to UMTS.

The parallel process of UMTS design and second-generation enhancement will call for careful market management and compatibility between UMTS and second-generation service standards in order to ensure a smooth, customer-sensitive transition at the appropriate time. Multi-mode transceiver technology may be used to provide multi-standard terminal equipment, particularly between UMTS, DCS1800 and DECT, Digital European Cordless Telecommunications (see EITO 96).

4.10.2. Broadband Satellite Systems

The present satellite communications limit their bandwidth to the low and mid-range, for example by providing up to 1.5 Mbps in a point-to-point connection via Very Small Aperture Terminals (VSATs). A new class of broadband satellite communications is going to be introduced (particularly for multinational corporations and sparsely populated areas) in order to make very high-speed, low-latency, round-trip, high-security transmissions.

The main issue is to be able to operate in the range of several Mbps, using beams and digital signal technology, an increasing re-use of frequencies and a dish size that is reduced from metres to centimetres. *Figure 10* shows the key orbits and their latency, and *Table 7* shows the main systems planned for the near future. The first in the arena will all be Geosynchronous Earth Orbit (GEO) satellites, which will be

Name	Cyberstar	Spaceway	Astrolink	Skybridge	Celestri	Teledesic
Company	Loral	GM-Hughes	Lockheed	Alcatel, Loral	Motorola	Craig McCaw, Boeing, Bill Gates
Planned Availability	1998	2000	Late 2000	2001	2002	2002
Orbit	GEO	GEO	GEO	LEO	GEO and LEO	LEO
Spectrum used	Ku and Ka	Ka	Ka	Ku	Ka and 40-50 GHz	Ka
Max speed	30 Mbps	6 Mbps	9.6 Mbps	2 Mbps upstream; up to 60 Mbps downstream	155 Mbps	64 Mbps
Number of satellites	n.a.	8 initially	9	64	63 LEOs 9 GEOs	288
Antenna size (inches)	16	26	33-47	n.a.	24	10

Table 7
The Main Broadband Satellite Systems

n.a.: not available

followed by Low Earth Orbit (LEO) and hybrid solutions involving constellations of LEO (Teledesic plans hundreds of these) and GEO satellites.

The table also shows the widespread use of the very high frequency Ka- and Ku-bands.

The existing GEO satellites normally use the L-band, which is in the range of 1.530-2.700 GHz.

The Ku-band is already mostly allocated: it supports 11.7-12.7 GHz down-link, and 14-17.8 GHz up-link.

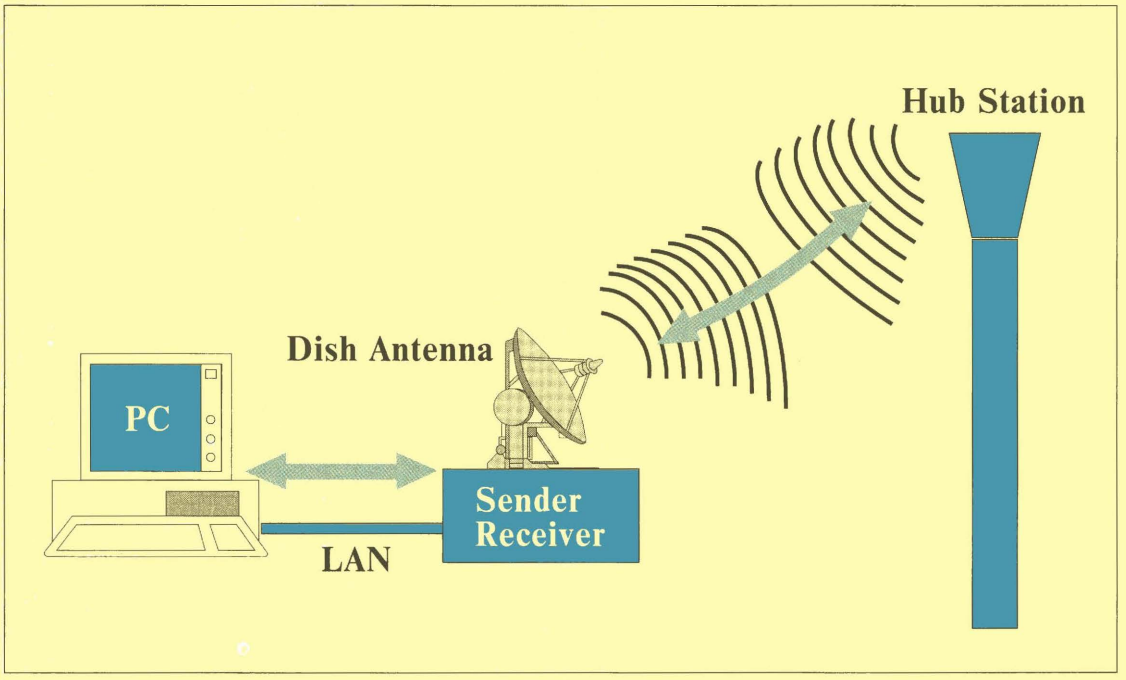
The Ka-band, which supports 18-31 GHz is mostly available.

In 1997, the USA FCC granted orbital locations and Ka-band licenses to 13 companies.

4.10.3. LMDS

The Local Multi-point Distribution Service (LMDS) is an asymmetric wireless access based on a dish antenna that acts as both a receiver and sender in association with a hub station (see *Figure 11*). LMDS will use a 1 GHz chunk spectrum at very high frequency (around 28 GHz). USA FCC (Federal Communication Commission) has allocated 1300 MHz (by comparison, broadcast TV uses 6 MHz of bandwidth, cellular phones use 25 MHz and broadband radios 30 MHz). This extremely high frequency limits the transmission signal to a radius of about 25 square miles, and therefore signals from antennas placed 10 or more miles apart can use identical frequencies without the risk of crosstalk or other interference problems.

Figure 11
LMDS, Local Multipoint Distribution Service



LMDS splits the 1 GHz band into 850 MHz for downstream and 150 MHz for upstream communications. The two paths are shared by all of the users on a hub, with separate channels of 20-40 MHz wide. The final end-user throughput is in the range of 10 Mbps both up- and downstream.

Where available, LMDS might represent an alternative solution for high-speed customer access.

5. Software Technologies

In the present Web and multimedia-oriented context, software technologies are becoming increasingly pervasive throughout the ICT world. The extraordinary rapidity of the rate of innovation not only involves background aspects common to all ICT fields, such as objects, middleware and operating systems, "visual" and RAD (Rapid Application Development) systems, protocols, storage and database systems, and global system management, but also a wide range of applications and human interfaces that can be considered field-specific.

The coming of the year 2000 and the introduction of the Euro are two of the main factors compelling an urgent review of existing applications.

The problems concerning the arrival of the year 2000 have created a significant product and services market sector based on the use of "reverse-engineering" and other tools designed to automate changes in dating systems that use only two digits to identify the year.

5.1. System Software and Utilities

Some of the most significant news includes the consolidation of the open-system concept (in the sense established by the Open Group, see also EITO 97), the integration of Internet/Intranet logics in basic software, the evolution of software development tools, and the increasing scalability of different hardware platforms from PCs to multiprocessing systems.

It is worth pointing out that the marketed products have become increasingly integrated, and now include an operating system, collections of utilities and management tools in the same box. The Microsoft NT Server and Windows 95 operating systems are examples of this trend.

The main differences between consumer- and professionally-oriented operating systems are becoming less due to increased connectivity and interoperability.

5.1.1. Operating System (OS) Evolution

There has been a considerable reduction in the number of different operating systems as a result of the widespread acceptance of standards such as Posix, and the increasing spread of client-server and Web-centric architectures (see also section 6.).

Modern operating systems are based on the use of microkernel, multi-thread and object technologies, and can support parallel CPU architectures (mainly of the RISC type) using different levels of scalability. They can supply different protocol stacks (typically TCP/IP and IBM SNA, System Network Architecture), and support different types of database. The main project goals are to respond to security and performance concerns, principally in transactional environments.

A large area of innovation has been opened up by the use of Internet/Intranet and Java, together with the microkernel approach, the use of object technology and a high degree of portability and scalability.

- The reference points within the PC area are Windows 95/NT and Macintosh.
- Unix is the reference point within the workstation and departmental systems area (Unix is often sold under different names depending on the different providers, but only IBM OS/400 can compete as a legacy system).
- Within the mainframe area, the mainly IBM-consolidated legacy operating systems persist, but they have become increasingly open and thus offer great Unix compatibility.

Unix world

The Internet/Intranet phenomenon reinforces the role of Unix, particularly as a Web-server. As anticipated in last year's report, Unix95 is now the brand name of "The Open Group" trademark for a group of similar OS with a common reference point: System V (i.e. the basis of X/Open standards) and the single Unix specification based on Unix95 and API, as described in Spec.1170, which is now supported by operating systems such as MVS, OS/400, VMS and GCOS (the name comes from the fact that the specification includes a total of exactly 1170 interfaces, commands and header files).

The "Open Group" has the aim of creating a true Unix standard that is scalable for PCs, Workstations and Servers.

Microsoft NT will support these specifications by means of a specific addendum: the main PC operating systems still fail to comply with these Unix standards, but they will soon.

The main technical characteristics of Unix95 include:

- XPG4 specifications for both the v.2 and "Unix" versions;
- ISO C Library support and Multibyte Support Extension;
- Stream functions, shared memory calls and 1170 APIs.

Unix products support all of the main data base management systems (DBMSes) on the market, and provide compatibility with Windows environments via Object Linking and Embedding (OLE), advanced graphic interfaces, improved security and increasingly friendly system management.

Network Operating System (NOS) and PCs

Despite growing Microsoft dominance with both the Windows and NT environments, which have a technical influence over all of the other operating systems, innovations continue to emerge. Moreover, Internet/Intranet is pushing to create "light operating systems" (particularly for "thin clients") and better integration/conversion of NOS in Web servers.

Light operating systems for thin clients are usually based on open system logic. Their main characteristics are that they have multitasking capability, are multi-thread, offer multimedia support, provide 32 and 64 bit CPU management, and make it possible to manage a large number of peripherals.

They always include TCP/IP stack protocols, a browser, a script interpreter and components such as Javascript, Vbscript, Java applets and ActiveX. Some of them derive from Windows, others from Unix, and still others have been based on browser functionality. All of the best producers have their own "light" operating systems.

The main practical aspects of other operating systems have already been listed: innovations are based on the increasing scalability that is reducing the differences between small, medium and large systems, and are leading to easier management and greater interconnectivity, reliability and security.

New announcements usually refer to multiprocessing, clustering management, high speed communication support and distributed resources management, such as objects, directories, and file systems.

Java Virtual Machine and JavaOS

An interesting novelty for systems to be connected to the Internet is the Java Virtual Machine (JVM). JVM is an abstraction of a "computer machine" elaborating Java language on both software and hardware platforms (cross-platform delivery) *(Figure 12)*.

JVM does not emulate a specific computer, but has its own instructions set and can define and use different memory areas. It is not interpreted; it can be implemented by executing its compiled instructions like a common program on a real CPU, it can reside in microcode, or it can even coincide with a real machine, as in the Sun Javachip.

JVM knows nothing about Java language, but only about a particular file ("class" file) containing JVM instructions, the "bytecode", and other information and auxiliary tables. JVM imposes strict limits and formats in the code contained in this file, for security reasons. Although JVM was created for Java language, it can get a "class" file derived from other languages: for this reason many manufacturers are creating JVMs that can support other languages within their hardware and software platform areas.

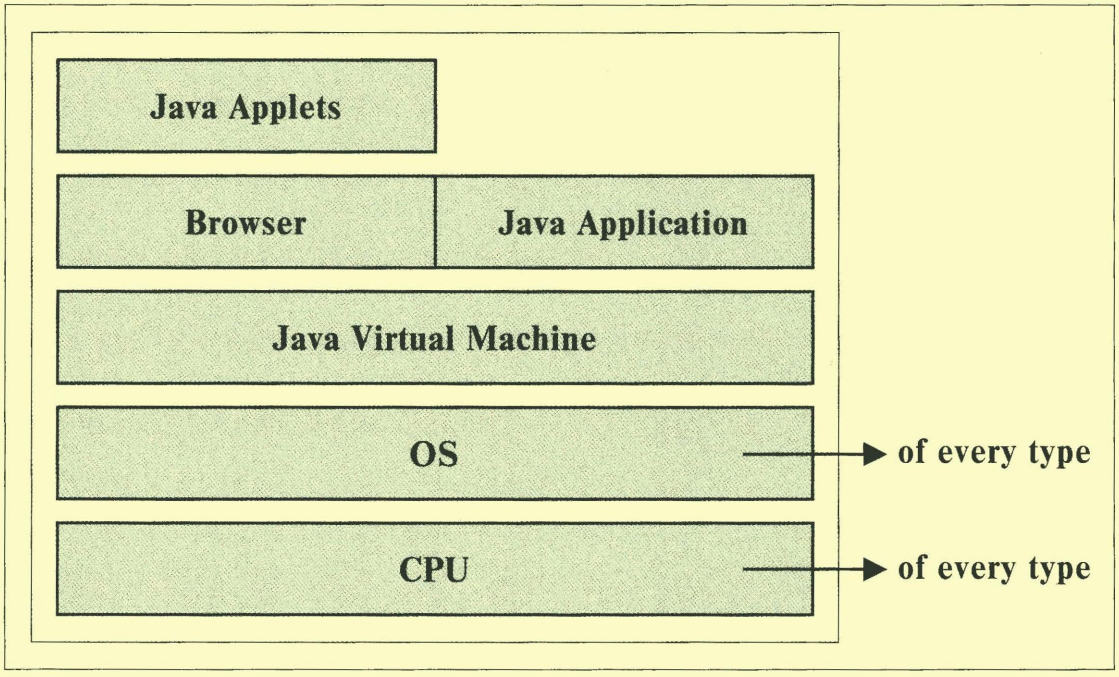


Figure 12
Structure of a Java Virtual Machine (JVM)

A JVM consists of a "bytecode" interpreter, a "class loader" linking and connecting local and remote classes, a bytecode verifier (which assures the correctness of the imported codes), run-time libraries including system, net and files accesses, and other basic functions.

The JavaOS has been designed specifically to support Java and Java applets without having to provide backward compatibility with other legacy applications.

The JavaOS uses a layered architecture *(Figure 13)*, whereby each layer can be independently updated. The JavaOS layered architecture is divided into platform-specific and platform-independent codes. The former, which is compiled to the native code, consists of the kernel and the JVM. The platform-independent portion of JavaOS - written in Java - contains the windowing and graphics systems, device drivers and the network classes.

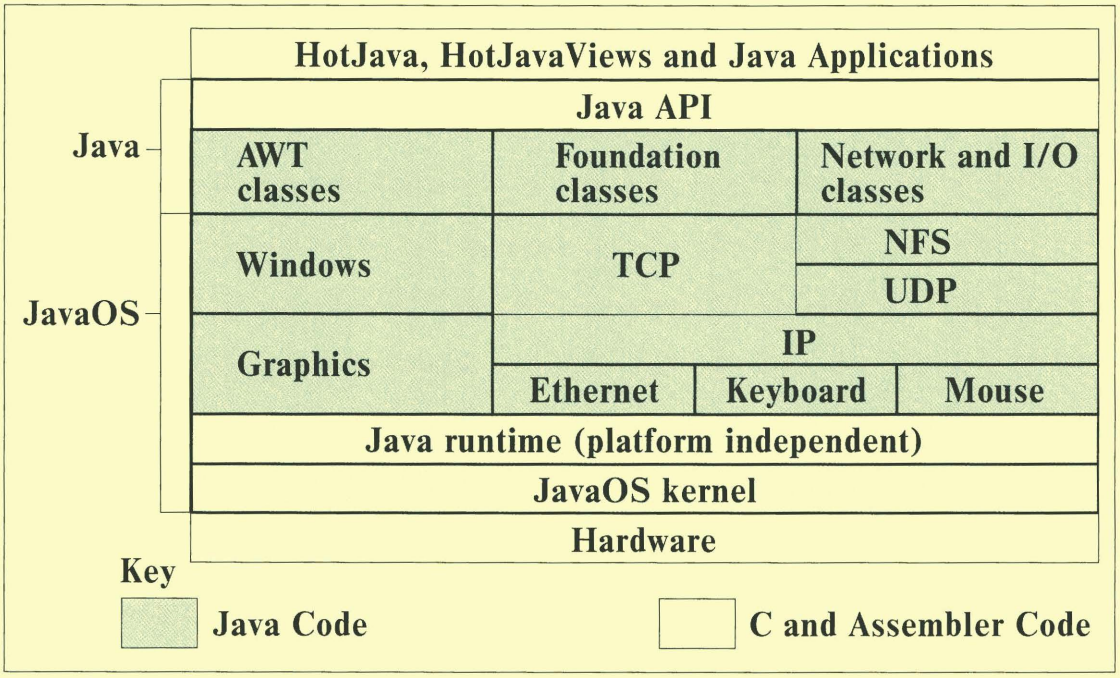
5.1.2. Interoperability between the Unix and Windows Worlds

As Windows and Unix are the most common environments, many solutions are being created to allow the "viewing" of different environments, for example SAMBA, WinFrame by Citrix, Insigna NTRingue, NCD WinCenter and Tektronix WinDD.

SAMBA is a whole set of software modules, freely available from the Internet, which make it possible to implement an SMB server (Server Message Block) on a Unix system. SMB is the high-level protocol that supplies file sharing services and printers, user authentication and IPC (InterProcess Communication) *(Figure 14)*.

Once it has been installed and configured, every Windows for Workgroup, Windows NT, Windows95, OS/2 and DOS system can access to system Unix resources as if it were its terminal.

Figure 13
Structure of a JavaOS



gure 14
MB System Logical
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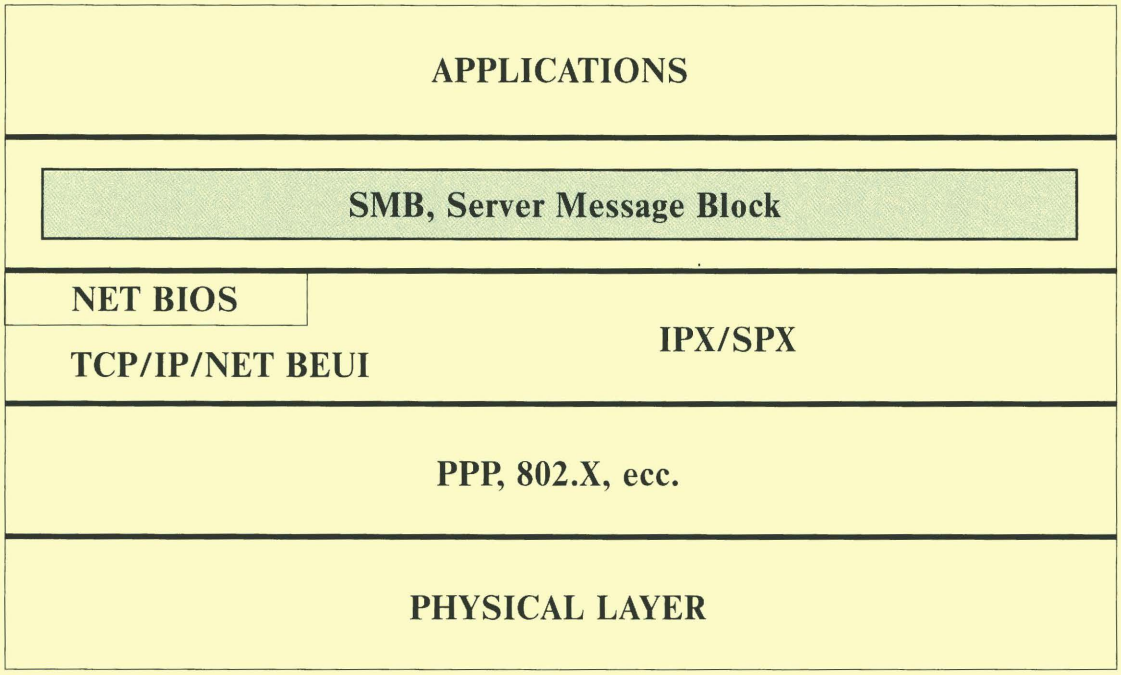

The SMB protocol is not a legacy protocol, but is included in X/Open standards. Nevertheless some vendors have developed some legacy versions in order to improve its performance, for example CIFS (Common Internet File System). SMB alone currently has at least ten dialects.

On the other hand, users of clients such as X-Terminal, ICA (Intelligent Console Architecture), which are typical Unix environments, can use Windows applications operating on multi-user NT servers.

Citrix with Winframe (and its licenses, such as Insigna, NCD, Tektronix) increases NT server functionality, allowing multi-user operations. ICA is a Citrix owner protocol that distributes graphic processing capabilities to clients. ICA intercepts calls to Windows GDI (Graphical Device Interface) and it directs them toward the client.

5.1.3. From RPC to OTM: the Evolution in Middleware

As the name suggests, the generic term middleware refers to a wide area of software falling between the hardware platform and the software application. Middleware has to offer a consistant interface for programming by hiding the specific characteristics of the hardware, the communications protocol stack, the operating system and, in some cases, also the different programming languages. Together with the operating system (although some people also categorise operating systems as middleware), it is the operating kernel of all ICT equipment and therefore an important area of innovation, particularly because it is an essential element for distributed computing. Well known examples of "traditional" middleware are the transaction processing monitors, such as IBM's famous CICS for mainframe and Digital's Application Control Management System (ACMS) for non-mainframe systems. Object technology is a key driver of the latest innovations, particularly for program-to-program communications, such as Object Request Brokers (ORB), and the "next generation" Object Transaction Monitors (OTM).

Different mechanisms for program-to-program communications have been used, including:

- Remote Procedure Call (RPC), which works like a program's subroutine call; the Distributed Computing Environment (DCE) model (described and discussed in EITO 93) specifies a standard DCE RPC, but also other "RPC-like" mechanisms are implemented and used in several products, from TP monitors to ERP (Enterprise Resource Planning) packages;
- A message-based mechanism providing one-way transfer operations, which is mainly used for electronic mail and message exchange systems; the new generation of these mechanisms include the Message Oriented Monitor (MOM), which provides high-speed, highly reliable and guaranteed delivery even in the case of failures;
- A message queuing mechanism based on a storage-and-forward logic in which the queue is a storage of messages in process; it provides asynchronous transfer and delivery can be deferred;
- OBR is an evolution of RPC that is based on object technology: like RPC, OBR uses a call-and-return mechanism and improves such functions by means of activating object components, handling parameters and performing directory lookups. Several ORB-like mechanisms have been implemented; Common Object Request Broker Architecture (CORBA - see also EITO 95) is the standard specification of the Object Management Group (OMG).

OTM is the new boundary of the evolution in middleware, which combines and integrates the features of TP monitors with those of message queuing and ORBs. Its development is still in an initial phase and OTM will be a new application platform, where the middleware itself is less visible to the applications.

5.1.4. Management Systems

Due to the growing complexity and heterogeneity of modern ICT environments, which consist of various TLC services, and WANs, LANs, and the Webs (several servers all tied together in n-tier logic), the role of system management systems is also being extended. This means that they will become more critical and more integrated.

The main trend differentiates two product lines:

- The first includes management systems specific for proprietary architectures and networks, such as for LANs and routers, and also the management systems for public networks.
- The second includes "global" management systems that cover and integrate the management of both networks and IT systems, and will be used by large corporates.

The Simple Network Management Protocol (SNMP) is the reference point of the main products on the market. Some of these products can also manage other protocol stacks. The NMS (Network Management System by OSI architecture) remains a functional reference point for all environments, but has not been found effective; for example, Posix.0 (see EITO 97) has taken into consideration OSF DME (Distributed Management Environment) by DCE architecture (see EITO 95).

Internet technologies are once again significant in this area and security management is playing a growing role, together with the use of centralised and/or distributed Directory Services in accordance with X.500, DNS and LDAP standards.

Most of the important products on the market are based on these standards and have spread their "control" over different network and computing platforms. They are also capable of managing new high-speed protocols.

Lightweight Directory Access Protocol (LDAP)

LDAP was developed by the University of Michigan in order to facilitate access to X.500. It is a modification of the DAP (Directory Access Protocol) portion of the X.500 directory service. There is no database behind LDAP. It is simply a protocol for accessing X.500 databases.

There are four major differences between X.500 DAP and LDAP:

- LDAP runs over TCP/IP, and so it eliminates the top layers of the OSI stack.
- LDAP simplifies the X.500 model, leaving out some of the less popular features.
- LDAP uses less complex encoding methods than X.500: many things are stored as simple strings of characters, rather than in binary code.
- LDAP chases down referrals, which means that, if the LDAP server does not know the answer to a query, it will go to another server for the information rather than send a message telling the user to go to that other server.

These characteristics make the system run more efficiently, require less computer power, and make LDAP easier to implement than X.500. It is easier for the user, more available and more reliable.

Web-Based Enterprise Management (WBEM)

Growing interest in Intranet has led the main manufacturers to create a Consortium called WBEM with the purpose of consolidating and unifying the data provided by existing management technologies. WBEM does not attempt to replace existing management standards, such as SNMP, DMI or CMIP (Common Management Information Protocol [see EITO 95]), or to preclude proprietary or platform-specific frameworks such as NDS, but complements these initiatives by providing an integration point through which data from all such sources can be accessed. This makes all management applications independent of specific APIs (Application Programme Interface) or standards used to implement each managed entity, allowing the correlation of data and events from multiple sources on a local or enterprise basis.

First intervention areas include:

- HMMS, HyperMedia Management Schema, a model for data presentation;
- HMMP, HyperMedia Management Protocol, a management protocol that uses HTTP;
- HMOM, HyperMedia Object Manager, based on OLE;
- VDOLive, Video on Internet Protocols.

5.2. Application Development Tools

The Internet/Intranet and software components based on object technology are the main drivers of the evolution in this area, which requires rapid developments (RAD, Rapid Application Development) to respond to business and users' needs.

Application lifetimes are now greatly reduced and the market is continuously offering innovations ranging from networks to databases, and so multimedia on PCs and Internet information have accustomed users to completely new interfaces. The spread of the ERP (Enterprise Resource Planning) package, and the need for the coexistence of legacy systems with new applications and environments, are a further reason for improving software development tools.

As a consequence, many new development environments have entered the market; their common bases consist of the choice of an object environment, the possibility of re-using modules, independence from hardware platforms, the scalability and portability of modules, "visual programming", and particularly compatibility with the most widely-used browsers.

The main difference lies in the degree of adhesion to CORBA logic or COM/DCOM, or the support of both, the complex of languages used, and the ability to support one or more database.

It is interesting to see that the "battle" between the most important producers on the market is taking place at two different levels: independence from operating systems is most favoured, but using only one language (Java, for example). On the other hand, operating systems are limited (Microsoft, for example) and this promotes the integration of modules written in different languages and different development environments, such as C, C++, Visual Basic, Visual Java, etc.

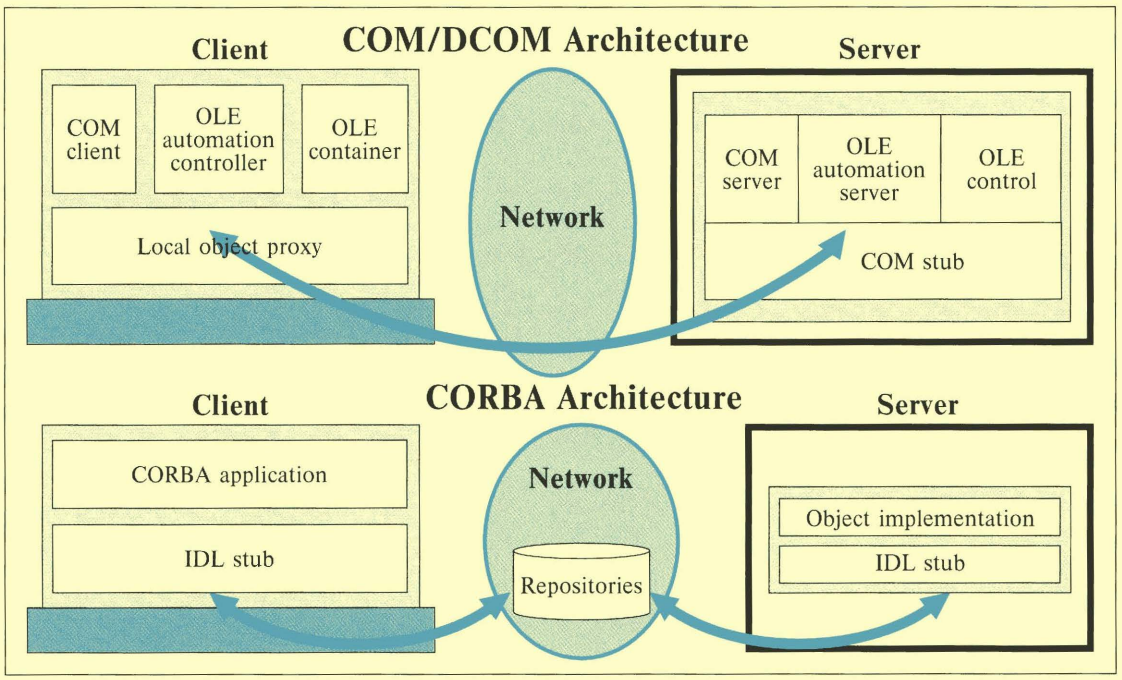

Figure 15
COM/DCOM and CORBA Architectures

5.2.1. Object Technology and "Componentware"

Object Management Group (OMG) Standards

Object technology has changed the way of designing and developing programs, working methods and the required skills.

The evolution of languages and development environments, as well as the evolution of Internet/Intranet, have led to two architectural models of object technology being introduced onto the market: COM/DCOM by Microsoft and CORBA by OMG.

CORBA (Common Object Request Broker Architecture) has been proposed as a standard, and has also been adopted by Hot Java (by Sun) and by SOM/DSOM (System Object Model/ Distributed SOM by IBM) [http://www.ibm.com].

Figure 15 illustrates the different architectural logic of the two environments.

In comparison with recent years, the great difference is that many software houses are now producing software that is more compatible with CORBA and COM/DCOM.

COM/DCOM used to be Windows environments in the client area, and CORBA to Unix environments in the server area. But now COM/DCOM has also been included in Open Group standards. Both standards are available on many different platforms and environments for clients and server, from Open VMS to MVS mainframe, and from Windows to Unix (Solaris, HP-UX, Digital Unix, etc.).

The IIOP (Internet Interoperable ORB protocol), now released as a specification by OMG, is taking on an increasing role. As its name suggests, IIOP makes it possible to interact between different ORBs working on different engines. It is now used over a safe transport service such as SSL (Secure Sockets Layer) for LDAP. Netscape has recently taken the decision to include IIOP in its next browser, and this will be a significant factor for its diffusion.

Internet Explorer Browser by Microsoft offers a similar functionality by including a DCOM "stub". As Microsoft did for COM/DCOM, some other operating systems now have a CORBA native implementation. Their availability in different programming languages is growing, and many languages can support objects from one another.

The need to interoperate with the emerging CORBA and COM/DCOM worlds (particularly with their re-usability) has led to the introduction of many innovations on the market. A large number of libraries and objects based on different architectures are now available, including Internet Foundation Class by Netscape, Java Beans by Sun, ActiveX by Microsoft, Java Remote Method Invocation, and Live Connect.

OMG has issued a new standard called the COM/CORBA Interworking Specification, which defines the different possible ways of allowing CORBA and COM/DCOM to interoperate.

Two levels of interoperability have been considered:

a) OLE Automation with CORBA: OLEs supply an easy way of manipulating objects by script, but have limits concerning performances and data types.

b) COM with CORBA: COM supplies a more complete tool that offers better performances than OLEs, but needs more competence in programming (practically from a script language to a real and complete language such as C++).

Two different logics can be used for management purposes:

- One-way interoperability called "mapping": for example, CORBA objects can be available for OLE, but OLE's objects are not available for CORBA.
- Two-way inter-operability called "interworking". This solution has been implemented by various providers using two different methods. The first, particularly used by Sun, HP, Digital, requests object converters for OLE, COM and CORBA, and allows every class and object to be connected, seen and used by the other environment in use. The second is based on CORBA logic and IDL (Interface Definition Language) to use OLE or COM objects, or to develop new objects through the normal IDL procedure that is well known by programmers (who do not need to know OLE and/or COM logic and semantics).

Unified Modelling Language (UML)

Object Oriented Programming (OOP) should use object-based analysis and conceptual model definition: in this environment, after the birth and limited diffusion of Object Oriented Analysis (OOA) tools, the UML is now being standardised.

UML is a new language for object modelling that has been adopted by the leading software houses from Microsoft to Oracle, and from Texas Instruments to HP. It represents the standardisation of various pre-existing methods, such as Booch-93, OMT and OOSE.

UML is not a legacy language and, as it was submitted for official OMG approval in 1997, should become the reference standard for the specification, realisation, documentation and visualisation of object oriented systems.

5.2.2. Languages

Scripting Languages

The most important news concerns the spread of scripting languages in addition to Java: Javascript and Perl are two very interesting and widespread examples.

Java is an object oriented language that improves C++ while preserving its main logical and syntactic characteristics. Java eliminates the direct management of system memory (one of the major problems of C and C++) by introducing a new model of memory allocation that avoids the need to allocate/deallocate specific memory areas. The pointers are also eliminated, and so there is no possibility of virus infection.

Except for the primary data, everything within Java is an object. Java supplies classes, methods, variables and sub-classes, but with multiple "inheritance". It does not use statements such as struct, union or typedef, and even the arrays and strings are objects.

Multithreading is managed by means of object classes and is integrated at language and run-time level. As Java is mainly considered a language for distributed applications, the security area is dominant. Many of its language limitations, such as the absence of pointers and the restrictions to object access are due to security issues. JVM controls bytecode, and it is possible to define a security policy that has different levels for system, file and network access.

A scripting language is a programming language used to manipulate, personalise and automate the functions of an existing system. It is then possible to put these functions under the direct control of a software program. The existing system supplies the host environment that completes and integrates the language capabilities. Scripting code is usually enclosed in HTML pages.

Javascript, initially developed by Netscape, has recently been standardised by the ECMA (European Computer Manufacturers Association) as ECMA-262 (with the name ECMA-Script), and has now been submitted for ISO/IEC JTC 1 approval.

ECMAScript is an object environment in which a program is a cluster of intercommunicating objects. It is based on Javascript and it uses Java syntax.

ECMAScript was initially designed as a "Web scripting language" supplying browser tools for Web management, and for carrying out data processing on a server in a Web-based client-server architecture.

The browser provides client processing environments, such as windows, menus, pop-ups, dialog boxes, cookies, input/output, etc. It also offers functions that make it possible to associate scripting code with particular events, such as the loading/unloading of pages and images, in order to allow effective error management, etc.

The Web server environment supplies functions for file and application processing and sharing.

The Perl (Practical Extraction and Report Language) scripting language, developed by GNU and MIT for Unix and then ported to Windows NT, standardizes the various typical languages interpreted by Unix and the best characteristics of C, AWK, SED and SH. As its name suggests, Perl is optimized for text file scans, information searches and report generation. Perl syntax is similar to that of C, but it has no logical limits in terms of data dimensions. It can accept a whole file as a string.

Unicode Standard

The traditional standards for 8-bit character encoding (such as the well-known ASCII) can encode a maximum of 256 characters, which are not sufficient to cover all of the EU characters. ISO has therefore defined the 16-bit Unicode standard (ISO 10646) to consider all of the characters in the world's most widely used languages, including Chinese, Japanese and Korean. Unicode is being increasingly used by the major software providers.

Unicode is based on the logic of locating a specific memory area, its content and its graphic representation, and not the final user interface. Unicode is used both in operating systems and languages such as Java, as default "data type".

5.2.3. Database World

Databases are playing an increasing role within the modern information systems area. The innovations here have taken two main directions. One is technological, such as the use of object technology in relational databases (RDBMS Relational Data Base Management System), Web interfaces and in the use of new search engines. The other involves the construction of new structures for information management, such as multidimensional DBs and "data warehouses", or for specific functions, such as OLAP (On Line Analytical Processing), the MOLAP evolution (Multi-dimension OLAP) and ROLAP (Relational OLAP).

A Data Warehouse is a "historical archive" relating to a company's global business. It can collect, correlate and integrate the information concerning different company processes that comes from applications and their databases.

It must be chronological, non-volatile, easily accessible, and decisional support oriented. Its main characteristic is the association of data with the business, rather than applications. The data are collected from all of the company's systems or external databases, and then undergo a process of integration, rationalisation, consolidation and memorisation in a database. A Data Warehouse designed for a specific department or company function is called a Data Mart.

The database is generally relational, and its structure, together with its loading rules and data semantics, is stored in a Metadata database.

A Data Warehouse serves as a decision support for management by transforming data into information using tools such as:

- Multidimensional databases: the data are considered in different dimensions (for example time, place, people etc.), thus facilitating quick and easy exploration;
- EIS (Executive Information System): a tool that visualises information in a highly legible way and allows easy surfing;
- Data Mining: tools for correlation searching. For example, in a sales area, these can find combinations of customers' preferred products.

A Data Warehouse can essentially be constructed using a top-down or bottom-up approach. The first method starts from a global analysis of the company information system to identify the information to insert into the warehouse. The second builds the warehouse as an integration of previously defined departmental Data Marts.

The first method has been preferred initially because it can create a data warehouse with more integrated information. The second, however, has faster development times.

In terms of standardisation, only one query language has found a real and large diffusion among producers: SQL (Structured Query Language).

The first version (SQL1) dates back to 1989 and is used for interactive queries as an extension of programming languages. From a logical point of view, it is equivalent to complete relational algebra, but it still has some lacunae: the type of data is limited, there is no orthogonality, it ignores referential integrity, it does not understand "meta-queries", and it does not consider "embedded-procedures".

The subsequent version (SQL2, introduced in 1992) is the currently mature reference standard, which includes integrity limitations, "outer" operators, and limitation and rules support. Only the first level of conformity, called entry SQL, is accepted by the major producers.

ISO and ANSI are now working on new SQL3 specifications, which will also introduce OO extensions with an Object Rationale that states that the data model remains relational, but the data types are only defined by external objects and the access methods are attached to the data type. The reference product is Illustra by Informix.

OLE DB

OLE DB is a method of gaining access to data through a COM-independent standard interface to specify where and how the data are memorized. The data come from RDBMs, a file, a document, a worksheet or a mail message. With OLE technology, a database becomes a component known as a "data provider", and every component capable of providing its function through an OLE DB interface becomes an "OLE DB data provider". OLE DB uses ODBC (Open Data Base Connection) connectivity with an OLE DB provider.

5.2.4. Search Engines for the World Wide Web

The enormous availability of Internet information without any classification or general control makes it difficult to find the information needed by means of typical "pull" browser logic, which is why a large number of search engines have been created. They are associated with a databank containing addresses, a URL (Uniform Resource Locator) and some information about the page. The search is based on keywords written by the user. The words must find a correspondence with those in the database and must summarise the contents of the page. The result of the search is a list of pages that respond to the entered criteria, but it may not be exhaustive.

The effectiveness of a search module depends on many factors, including the indexing mode, the size of the databank, the up-dating mode and the frequency. Databanks are updated by automatic programs, called crawlers or spiders. They periodically examine all of the Internet-connected sites in order to verify the existence of new pages. The search mode of these engines may involve the introduction of keywords or strings, or combinations of keywords using boolean operators.

6. Architectures, New Services and Applications

The client-server and the Internet/Intranet are converging on the same logic and architecture in a rapid evolutionary process, discussed in depth in EITO 97. This convergence, together with the parallel evolution of the telecommunications systems and services, is reshaping both the architectures of the ICT infrastructures, and the architectures and the logics of applications, both as development methods and as final solutions for the end-user.

The concept of "integration" covers different contexts, including the transmission of different types of information, the multimedia services, CTI and finally the integrated applications that are allowing a simple interoperability among ERP (Enterprise Resource Planning), EUC (End-User Computing), DSS (Decision Support Systems), Groupware etc.

It is essential that ICT systems offer a real "added value" to the core business and the end-user. Innovation is driven more and more by business needs, and not only by the technological trends. ICT should coordinate changes in business with innovations in system technology, and the "return on investment" in ICT must be quantified and evaluated in a systematic manner (thinking, for example, of the Total Cost of Ownership [TCO]). The dynamism and turbulence of the ICT context demand progressive risk-education and flexible planning of delivery and deployment of the actual innovations. A lot of technical myths fly across the ICT world like shooting stars, so that enterprise ICT architectures have to (or try to) manage with a combination of the best new and previous-generation systems, applications and logics. The Internet/Intranet paradigm is therefore gradually being inserted into the earlier client-server and mainframe-centred environments. In fact, the latest architectures balance (or try to balance) the user-centric paradigm with the network-centric and ultimately with the web-centric paradigms. The attention and importance given to security is ever increasing, with an increasing adoption of asymmetric cryptography systems that allow strong authentification, digital signature and notarisation (see also EITO 97).

The growing network speeds and bandwidth together with the availability of different client and server platforms are leading to architectures based on two or three tiers. They are characterised by the server, in terms of platforms, configurations, multiprocessing, storage and computing power, depending on the supported activities: transactional servers, database and data-warehouse servers, security servers, management servers, gateway servers, etc.

To achieve the above goals, these architectures must be able to guarantee functional interoperability and integration between new applications and ERPs and the legacy systems, and also their very rapid deployment, drastically reducing development times. The "time" factor is increasingly critical also because of the Year 2000 and the Euro adoption.

From the end-user point of view, a key innovation is the change from GUI (Graphical User Interface) to NUI (Network User Interface). The new browsers are going to be the ultimate common standard end-user multimedia interactive interface. In addition, they reduce or eliminate the need to maintain application shells on the client PC.

The Web-centric approach is also helping to focus on aspects of "content": the real strategic asset is in fact the information itself, not the tools for managing it. And the discipline of Knowledging Management (KM) is gaining in

importance, thanks also to easier and more friendly integrated access via a browser to different applications, such as ERPs, groupware, workflow, document management and EUC. Here again, the role of "web-enabling", i.e. the possibility of accessing an application via a browser, is significant to allow the survival and coexistence of new applications with the "old" ones, in particular the legacy systems.

The Web-centric and interactive multimedia architectures imply high bandwidth, and this is accelerating the migration to high speed LANs and WANs.

Besides what has already been described in the previous sections, in the following there are described relevant innovations at the multimedia architectural level.

6.1. Push Technology

The traditional logic for surfing on the Internet is based on the request/reply model, also known as the pull technology. Information consumers ask a server to send back the information of interest. The user has to know where the information is stored, generally in form of site name or URL address, and has also to check the server periodically to get new or modified information. If the user does not know where the information is, a search has to be conducted among several sites, often by means of search engines and/or of personal agents, that filter the retrieved information. But this process requires experience and capability, it is time consuming and does not always end with the right expected information.

In several applications the need is to deliver the most up-to-date information to the end-user, independently of their knowledge and capability. In this context a promising new technology is emerging, the push technology. Applications bring the information of interest directly to mass consumers rather than their having to fetch it themselves. It is very attractive because it allows users to get information as soon as it becomes available and therefore typical applications include news release, press distribution, software distribution, collaborative working groups, etc.

The push technology is based on a broadcasting logic. The first implementations are based on unicast or narrowcast logic, but the new ones will utilise IP multicasting (see section 4.8.).

For the standardisation process, both Netscape and Microsoft have proposed their solutions to the WWW Consortium. Microsoft proposes its own Cdf (Channel definition format), already employed in the Explorer 4.0. Netscape proposes Cpfo (Channel profile file object), employed in Costellation, the Internet/Intranet suite of which Navigator 4.0 is one of the components.

Both proposals detail how to collect and deliver information. They allow the use of applets, cookies and plug-ins to customise the information for each specific user.

6.2. Multimedia Global Standards

Multimedia interactivity is a great area of innovation and standardisation. Several aspects have been already introduced in the section on telecommunications. In the following paragraphs the main standardisation efforts for multimedia architectures (in the sense of global standards) will be described. As described in previous EITO editions, some standards have been issued and are already largely used, but they are related to specific media types, such as JPEG, MPEG, etc.

For real multimedia operations, there is the need to define higher level standards, referring to the contemporaneous mixed use of different media, and how they can be correlated, synchronised and presented. Among other proposals, such as PREMO (Presentation Environments for Multimedia Objects) [ftp://ftp.gmd.edu/documents/iso/premo/], HyperODA (Hyper Office Document Architecture), OMF (Open Media Framework) [http://www.omfi.org], the most comprehensive standards include HyTime, MHEG and Davic.

6.2.1. HyTime

HyTime is the acronym for **Hy**permedia **Time** based Structuring Language defined by ISO for the definition of hypermedia documents via SGML. HyTime allows building up documents based on objects, linking them and relating them into the space and the time. HyTime provides only "static" multimedia documents, as it does not support dynamic behaviours.

6.2.2. MHEG

The Multimedia and Hypermedia information coding Expert Group [MHEG] operates in the ISO context for the definition of an object oriented multi-hypermedia model. MHEG considers the information as a set of multimedia and hypermedia objects, each of them able to deal with texts, images, voice and video using the present standards such as JPEG and MPEG. Four object types are considered:

- Input objects: examples are buttons, windows menu, etc.;
- Output objects: examples are viewers of text and image;
- Interactive objects: these are objects constituted by input and output objects;
- Hyperobjects: these are interactive objects with their components linked in different possible manners.

In contrast to HyTime, MHEG provides mechanisms for dynamic interactions among objects, and the dynamic presentation of their contents, independently of the supporting platforms. MHEG is in fact designed to interchange multi and hypermedia information and to allow their use by means of a suitable MHEG engine.

6.2.3. DAVIC

The Digital Audio-Visual Council, DAVIC, is a non-profit Association, established in August 1994, that includes more than 200 companies worldwide and representing all sectors of the audio-visual industries: content, service and manufacturing companies as well as government agencies and research organisations. The main goal of DAVIC is to define standard technical specification for operational integration of systems working in different domains.

Table 8

	Modulation	Bandwidth	Bit-rate
Downstream	QAM 16/24/256	54-1000 MHz	a) 27.8-55.6 Mbps per channel at 8 MHz b) 221.2-42.4 Mbps per channel at 6 MHz
Downstream without band signalling	QPSK	70-130 MHz	a) 1.5 Mbps per channel at 1 MHz b) 3.033 Mbps per channel at 2 MHz
Upstream	QPSK	200 kHz (per channel)	a) 1.5 Mbps per channel at 1 MHz b) 3.033 Mbps per channel at 2 MHz

In the current phase of work DAVIC is concentrating on digital audio-visual applications and services of broadcast and interactive type, considering all the information chain components: the content provider system, the service provider systems and the service user system. These three entities are connected by two delivery systems, the first connecting the content provider to the service provider and the second the service provider to the service user.

DAVIC specifications contain the reference model of the DAVIC system and its subsystems. DAVIC specifications also define reference points, i.e. points of particular interest in the system. These points have a normative value if they are accessible. Therefore a digital audio-visual subsystem conforms to DAVIC specifications if its accessible reference points do.

DAVIC specifications define the technical "tools" whose use allows the provision of "functionalities" required by the DAVIC system and the applications that make use of it. Tools are usually associated with grades that determine the level of performance of a given tool, e.g. mono-stereo-multichannel audio, TV-HDTV, bandwidth of a return channel etc.

The current DAVIC 1.0 version of specifications defines a first set of tools enabling the deployment of systems that support initial applications such as TV distribution, near video-on-demand, video-on-demand and some basic forms of teleshopping. Each future version will specify different grades of previously defined tools or more tools in addition to previously specified tools.

The key characteristics of v.1.2 include:

a) At the physical layer (see *Table 8*);

b) The access protocol MAC is constituted by a mix technique based on Slotted ALOHA and TDMA with dynamic band management.

c) MPEG-2 and ATM cells are used for the frame transport.

DAVIC strictly operates with IEEE 802.14 Working Group that is defining standards for the bi-directional transmission over HFC systems (section 4.2.).

Several international projects have already employed the DAVIC specifications, in particular the DAM Project (DAVIC Accompanying Measures) within ACTS projects (founded by EEC DG XIII) for testing interoperability of DAVIC-based systems and the EURESCOM JUPITER Project.

6.3. TINA

TINA, the Telecommunications Information Networking Architecture is a software architecture for the provision of multimedia telecommunication and information services, defined and validated by 45 leading network operators, telecommunications and computing companies worldwide in the TINA-C Consortium.

The first TINA Workshop was held in 1990. This was the first occasion in the telecom community to assess the common need for improving the way services are designed and the common opportunity for tomorrow's services. It was also discovered that similar studies on a software architecture were being conducted in many parts of the world. These led to the creation of the consortium for cooperatively defining a common architecture.

After more than seven years of existence, TINA is now the open software architecture for the TLC Industries with a standard set of specifications for building and managing services on a global scale. TINA-C interacts with standards bodies and industry consortia, including ATMForum, DAVIC, ITU-T, NMF (Network Management Forum) and OMG (Object Management Group) in order to achieve harmony of mutual specifications and avoid duplication of work.

TINA is intended to be applied to all parts of telecommunications and information systems, from terminals (personal computers, etc.) to transport servers (switching systems, routers, etc.), and from service servers (VoD, web, etc.) to management servers (authentication, billing, etc.).

In order to insure interoperability, portability and reusability of software components and independence from specific technologies, and to share the burden of creating and managing a complex system among different business stakeholders, such as consumers, service providers, and connectivity providers, TINA has been designed on the basis of the following architectural principles:

- TINA integrates all the control and management functions into a unified, logical software architecture.
- TINA logically separates the high-level applications and the physical infrastructure from the need to communicate directly with each other. This isolates the more stable Control and Management aspects from the very dynamic technology thrust and commercial service needs, thereby creating an enduring software Architecture.
- TINA is supported by a single Distributed Processing Environment (DPE), i.e. the control and management functions can be flexibly placed in the network.
- TINA defines the roles of each player in the industry in order to allow each player to enter the marketplace and flexibly expand its business.

Software components are decoupled from each other so that a change in one component due to a change in underlying technology (standards, languages, programs, materials, networks, etc.) would not affect other components. And the object oriented analysis captures the complexity of a system from different angles and breaks it down into a set of models (Reference Points).

The models considered by TINA are:

- The Business Model, that describes the different parties involved in service provision and their relationship to each other: the consumer, retailer, broker, third party service provider, content provider, and connectivity provider;
- The Information Model, that describes information-bearing entities, their relations to each other, and the constraints and rules governing their behaviour. These are described using the OMT (Object Modelling Technique) modelling techniques;
- The Computational Model, that describes computational objects and their relations: TINA defines the Object Definition Language (ODL), as an extension of OMG's IDL, in order to help define these computational objects.

According to the separation principles, TINA is divided into the following (sub-)architectures:

- Computing Architecture defines modelling concepts and the DPE. The DPE is the environment that supports realisation of applications: it resides in heterogeneous pieces of equipment, and, by hiding their distribution, makes them function as a single system for applications. The DPE services and facilities can be distributed over multiple nodes connected by the Kernel Transport Network (kTN). Both DPE nodes and kTNs are logical entities and can be implemented in a variety of ways. The TINA DPE is based on OMG's CORBA with adaptation for telecommunications requirements.
- Service Architecture defines a set of principles for providing services. It uses a notion of session to offer a coherent view of the various events and relationships taking place during the provision of services. TINA defines different types of session, corresponding to different types of activities. The access session corresponds to the establishment of the terms and conditions of the session (e.g., authentication, selection of service profile). The service session corresponds to the provision of the service itself and insures overall coherence of control and management. The communication session provides an abstract view of the actual transport network connections.
- Network Architecture describes a generic, technology-independent model for setting up connections and managing telecommunication networks. It refers to ITU-T and other standards bodies, and is made up of: the Communication Session layer, that provides service-independent interfaces for managing end-to-end communication, the Connectivity Session layer, that provides technology-independent interfaces for interconnecting network-level termination points, and the Layer Network that deals with the setup and management of connection within a specific network technology.

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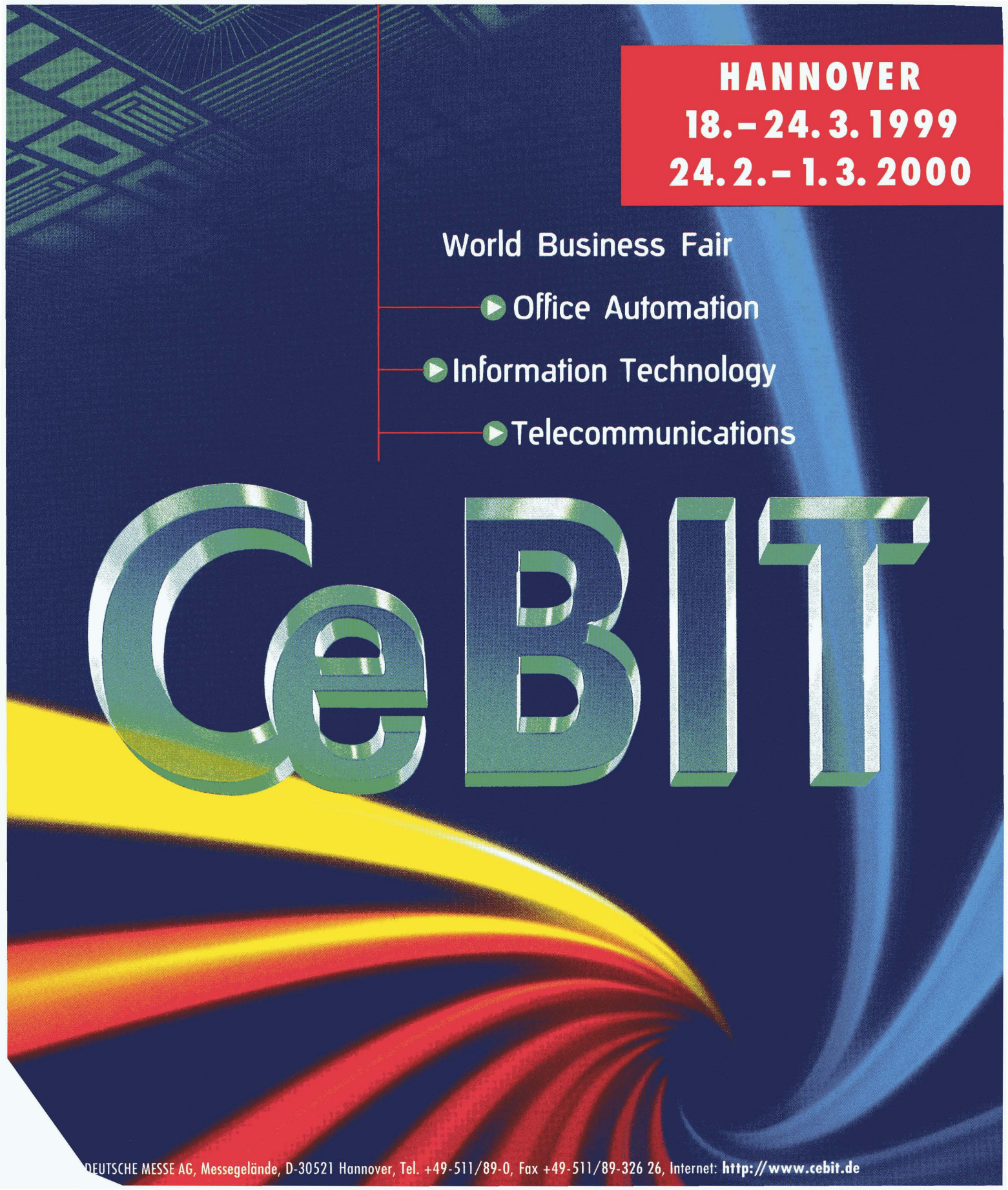
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Part Two

ICT for European Homes: Devices, Services and Applications

This chapter has been provided by IDC in close co-operation with the EITO Task Force.

Introduction

Globally, the home consumer market is blossoming for ICT products, services and applications.

The advent of a networked marketplace and progress towards the creation of a true Information Society provide the impetus for homes and consumers to start "getting connected".

Home users demand for home communication devices is growing in many regions, as is the use of the Internet. By 2000 about 38 million home users will access the Internet in Europe and 50 million in the United States. Already one out of every two PC households use their PC at least once a day. Making communications devices a focal point of daily routine will be important for many other segments of the ICT industry.

Interactive, digital entertainment and information are strong candidates to drive this trend. With digital signals and advancements in compression technology, new opportunities exist to broadcast higher-resolution television signals concurrently with new interactive services. New content may be based on the Internet, interactive TV, interactive CD-ROMs, and video games. This is a truly new kind of content as it goes beyond one-dimensional media like print and two-dimensional media like motion pictures or TV by incorporating interactive multimedia communication in the entertainment or information experience. Web software and its ability to capture the preferences of critical masses of consumers, is the cornerstone in the virtual consumer marketplace.

On the supply side, the key to achieving higher penetration is to push home ICT products and services prices lower while making them more compelling and easy to use. On the price front, suppliers of home communication access devices will be unable to reduce prices to the magical entry prices (such as the ECU 400-500 for PCs) and remain profitable. Major changes in chip design, motherboard design and video technology will help to lower the cost of chip technology, thus allowing vendors to lower the overall cost of home communication devices.

On the remote-access front the television, satellite and cable sectors find themselves at the heart of the digital revolution. Cable offers a choice of several television programmes. With the advent of digital transmission, the capacity for sending out television programmes is increased several times. Diversification and competition between different digital, wireless and cable methods of transmitting pay-television is therefore a new challenge. At the same time, the digital revolution is abolishing the technical barriers between audio-visual transmission, the telephone and computing. This means that the cable and the satellite will gradually be transformed from distributors of television channels into distributors of a whole range of interactive services: telephone, high-speed data transmission, Intranet/Internet, and television. Fresh opportunities are therefore opening up, although in some cases, substantial scale of investment and risks are involved.

1. ICT Applications in the Home Market

In this study the home market is defined as the set of ICT devices, applications and services used by consumer households (as opposed to businesses) for communication, commerce, entertainment, education, work at home, and other purposes.

Based on the economics and predominant technology of the ICT segments involved, this account concentrates on three main areas:

- Home devices;
- Applications;
- Access.

1.1. Devices

New devices and communications differ from the old ones because they are digital (not analogue), and dynamic (not static). Audio, video, and text combine in a digital multimedia state. Consumers access this combination independently of their "receiver" or delivery channel type (phone, cable TV, satellite).

Electronics appliances and telecommunications terminal equipment are increasingly digital, computerised and Internet access enabled. Device overlap makes the undergoing battle for the next home digital platform standard among the most challenging in the ICT, electronics and entertainment industry.

Four major types of industries (*consumer/home electronics, communication devices, computing devices and peripherals)* are teaming up to introduce their technology and products for the next-generation digital new media hardware platform. Convergence is increasingly popular, as the four different players are teaming up to introduce joint PC/TV or digital handsets, "converged" product combinations: DTV, NetTV, direct broadcast satellite (DBS), digital video disc (DVD), and other products.

In particular PCs and computing peripherals face tremendous functional, value, and operational challenges in becoming the next mass-media standard. The PC industry needs to push through wide availability and usage of interactive content to justify the emergence of a true PC/TV market demand. Consequently, the PC industry has proposed its own version of the DTV broadcast standard. A more data-intensive approach would sacrifice higher-resolution television broadcast quality for the ability to transmit interactive services.

Alongside the PC model, consumer, communications and computing devices enabling access to the Internet will soon enter the consumer market. For example Network Computers are designed to be inexpensive to purchase and maintain as well as easy to use (often with push functionality). They are designed to access the Internet and to perform a specific set of functions. This simplified model is often held up against the PC, which is portrayed as expensive, complex, and beyond the needs of many average consumers and businesses. Their presence in the market will start to become relevant after 1999.

Home Device Overlap

Consumer/Home Electronics

TVs, VCRs and laser discs, camcorders, game consoles, audio equipment, word processors, radios, CD players, DVD players, answering machines, calculators, set-top boxes, learning computers, tape recorders, DSS dishes

Computing Devices

Home PCs: *As a subset of the PC marketplace, a home PC is a desktop or portable PC purchased primarily for household consumption.*

Smart Handhelds: *PDAs, high-end organisers, PC companions, personal companions, smart phones, pen tablets, pen notepads, and keypad handhelds*

Communication Devices

Telephones, cell phones, smart phones, pagers, short-wave radios, Minitel

Peripherals

Printers, scanners, docking stations, digital cameras, copiers, faxes, multi-function peripherals

Appliances Control Devices

Climate control, home security

PC/TVs

Devices similar to a PC in terms of architecture, but designed and marketed by PC vendors primarily for home living room entertainment usage, including broadcast television input and output capabilities.

Network Computers

NetTVs: *Television-centric analog and digital set-top boxes designed for interactive services, such as Internet access, and marketed primarily for household entertainment consumption. Unlike PCs, NetTVs do not feature PC architecture and rely on a television set as their primary display. Game consoles are excluded.*

Internet screenphones: *High-end telephones with LCD screens and keyboards offering Internet access.*

Internet game consoles: *Internet access integrated into standalone game consoles or add-on kits that provide Internet access.*

Internet smart handhelds: *PDAs, high-end organisers, PC companions, personal companions, smart phones, pen tablets, pen notepads, and keypad handhelds with Internet access.*

Other: *Devices not included in the other categories that offer Internet access. They include LCD projectors and personal word processors.*

1.2. Applications

Games and entertainment products is the leading segment within the consumer software market, accounting for almost a half of the market. This segment is strongly influenced by the availability of US titles, and localisation issues are of less importance.

The education and edutainment segment accounts for almost one third of total revenues. Demand is strong for quality children's multimedia reference and education products. This segment is strongly driven by availability of local content.

The remaining share is attributed to the home productivity segment.

The key aspect of applications in the new digital age is that they will enable *interactivity.* New digital interactive content will have profound effects on applications related to:

- *Information:* Through search tools, phone books and maps in digital format, enabling users to select precise data according to the parameters they set;
- *Entertainment:* Through online games allowing users to play with people across the country or across the world. New e-mail packages offer multiple interfaces that cater to children or adults and offer the ability for users to attach video and/or voice;
- *Communication:* Through live chat rooms and 3D capabilities in cyberspace, allowing users to interact in virtual communities. Virtual communities provide "smart" advertisement space, displaying advertising for products related to the topics of conversations;

- *Education:* Through Web sites providing animated graphics and colourful click-through pages. The enthusiasm children show for them leads education Web sites to be considered as the key services which can trigger the use of PCs. Supporting education in the home is the number-one reason home users purchase PCs. Another relevant reason to buy a PC for first-time buyers is to access online services;
- *Commerce:* Home pages are undergoing major feature enhancements as companies move from pure marketing to a full interactive or transaction phase in the deployment of Internet technology. Home shopping and home banking enhanced content and services. A reinforced organisation structure to support electronic transaction and delivery will make electronic commerce as a proposition more compelling in 1998.

True interactivity enables the individual consumer to:

- Join new communities or access consumer content that a group has created;
- Add, edit or alter new contents to the programme or discussion;
- Decide what they want to receive and how they will receive it, instead of leaving this decision to the publisher;
- Combine the advertising media and the transaction, whereas old media advertising stimulated future purchasing behaviour.

Home automation

Householders of the future could return home to find the oven preheated, the video set and the washing machine going thanks to home automation modem systems. Remote control devices control household appliances from anywhere in the house via the mains wiring system. With the modem plugged into a phone socket, appliances can also be operated from a fixed or mobile phone.

Existing main networks provide a good basis for introducing higher levels of automation in the home, although fibre optics and other systems are being considered to provide the infrastructure for more automation. Recent developments in semiconductor technology have also resulted in more robust microcontrollers which can interface directly with the mains due to their high-EMI immunity.

1.3. Access Technologies

Availability of sufficient remote bandwidth to the home is becoming critically important as the millions of new home users use powerful applications via the Internet. Digitally converted images and voices can be sent by a wide range of methods, and, thanks to signal compression, with lower bandwidth barriers. This means a breaking down of the current barriers between telecommunications, cable television, and wireless operators, with multiple technologies competing in offering remote-access infrastructure.

PSTN

With the advantage of a pervasive two-way network, telecommunications operators are in a position to compete with cable and wireless access operators. Their initiatives focus around increasing the capacity and quality of their networks.

The current state of 14.4 Kbps or 28.8 Kbps analogue modem access is insufficient to support higher-bandwidth applications, such as downloading large graphics files, images, voice, and other multimedia applications.

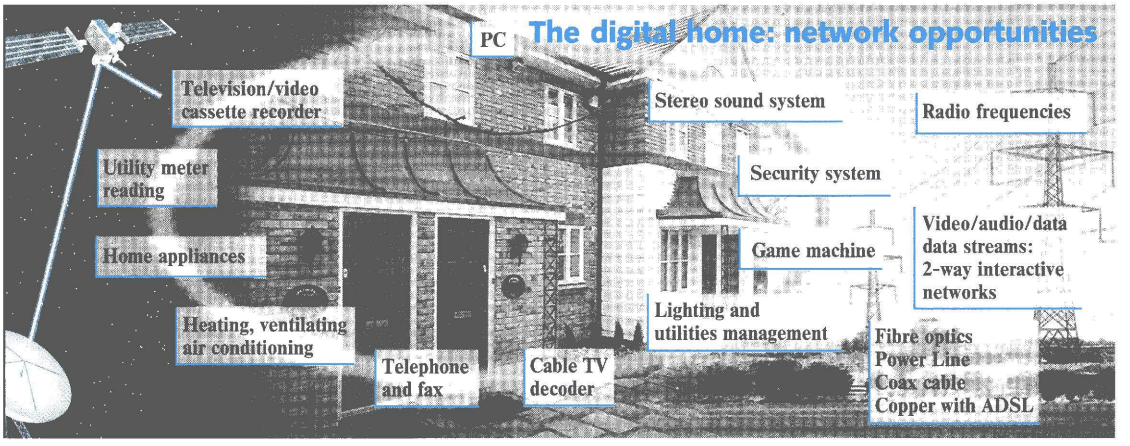


Figure 1
The Digital Home: Network Opportunities

Source: The Financial Times

The 28.8/33.6 Kbps *analogue modem* is the most popular connectivity standard for the remote home user, because of its easy access (almost any phone line), ease of use (widely supported by software), and low cost. The vast majority of modems in ISPs (Internet Services Providers) networks and in the home need to be upgraded to support increasing demand for remote access bandwidth during the time frame of 1998 to 2000.

ISDN is the second most popular home remote access option. Internet connectivity and remote access are the key applications driving this growth, which is accelerated by European telecommunication service suppliers promotion. Some phone companies offer attractive pricing, low-priced ISDN terminal adapters and easier plug-and-play service provisioning to accelerate the migration of regular analogue phone service over to ISDN for remote access to the Internet across Europe. In the German market, for example, a basic ISDN card can be purchased at a similar price to a modem.

Three new high-bandwidth technologies, *Digital Subscriber Lines (DSL), cable modems, and wireless technologies* have entered the trial and early adoption stages. These technologies promise significantly higher (640 Kbps to 8 Mbps) bandwidth to remote/home users.

Cable

Cable television wiring plants have the ability to deliver large amounts of bandwidth (1 to 27 MB) to the home user. The ability to offer high-speed Internet or corporate access is an attractive option to cable companies with their stable base of paid subscribers. Technological innovations open up for cable operators the possibility of diversifying their sources of income (from television subscriptions).

To offer both television and telephone services, cable operators are transforming their existing one-way transmission networks to two-way. Data transmission, especially in connection with the Internet, involves costly techniques and fewer adaptation problems. The technology requires the cable company to install sophisticated equipment at the head-end (to route incoming and outgoing data), provide a connection to the Internet, and install a cable modem box at the customer site (home). Cable modems enabling PCs to be linked to data-transmission networks have development potential, at least until such time as the telecommunications operators are in a position to offer equivalent transmission speeds at similar cost. In the case of mainly fibre-optic networks, transmission speeds are up to 1,000 times faster than with traditional modems.

Wireless

Wireless technologies have the potential to offer higher bandwidth without the need for massive cable or equipment infrastructure upgrades. Currently, the most promising wireless technology for the home is satellite technology. Digital broadcasting is radically altering the economics of access and infrastructure technologies, as Digital Broadcast Satellite (DBS) providers represent another channel that can deliver content to the home platform.

The DBS industry has taken off rapidly in the last few years, and presents itself as a formidable competitor to the traditional cable industry. The DBS providers offer digital-quality pictures and are not technically limited to traditional television programming. With digital compression technology, they can offer a greater number of channels and they can theoretically deliver content and interactive services (broadcast, Internet, data, and multimedia) to both PCs and TVs.

In addition, the increased channel capacity of DBS allows for moderate narrowcasting of niche/thematic channels and near video-on-demand pay-per-view broadcasts. Interactive TV diversification is developing along three major types: "pay-per-view" involving exceptional programmes billed separately, "near video-on-demand" (NVOD) with waveband groupings each offering a single film starting at staggered times, and "video-on-demand" (VOD), enabling request for a particular film to start at the exact time of choice. The final stage of this evolution would be a "customised" television service, in which each viewer would receive a "channel" consisting of their chosen programmes, drawn from the whole range of those available. Although more satellites might be required, highly targeted interactive advertising, home shopping, home banking, e-mail, Internet access, and games are all possibilities with DBS technology.

From a regulatory perspective, the EU is closely following initiatives to set a digital television standard. Cautious optimism after failed Interactive TV trials invites digital television to focus simply on delivering higher-definition broadcast signal, while prospects for mass-market interactive entertainment are mixed.

Access by electricity

Utilities are trialing new technology to take advanced telecommunications and Internet services to the home via the electricity mains through the local electricity network. The new technology prevents the electrical current from distorting Internet signals and other computer data transmitted over the mains. It will enable electricity companies to offer their customers Internet access at speeds 30 times greater than today's high-speed modems attached to telephone lines, and open the way to mass-marketing of the Internet at prices which most families will be able to afford.

At present the system relies on a special feed from the household electricity meter, but the developers are confident that within a few years personal computer owners will just have to plug them into the nearest household electricity point to link up to the Internet.

The Internet information is lifted from a small box linked to the electricity meter. It is then carried round the house along co-axial cables similar to those used to link televisions to aerial sockets. The cable is linked to the computer using a PC card. The service is on a six-month marketing trial until mid-1998.

At present the system has to use conventional telecommunications networks to link the electricity sub-stations to the Internet. But the technology is expected to be suitable for telephone calls as a result of development which is still in progress.

Emerging Access Technology

Digital subscriber lines (DSLs) *are a technology designed to use existing copper phone line connections to the home to run high-speed digital remote access services. A number of DSL technologies exist, including HDSL, SDSL, and ADSL. All of these technologies represent different methods to provide higher bandwidth over copper lines.*

Direct Broadcast Satellite (DBS) *is an audio and video distribution mechanism that uses satellite technology to transmit multichannel video programming to its subscribers. A special satellite receiver, access hardware, and PC card can enable Internet downloads of 400 Kbps via satellite. Upstream requests, however, must travel via a modem (at 28.8 Kbps). The current cost is higher than an ISDN terminal adaptor.*

2. Profile of European Households

The offer profile determined by technology evolution and major access infrastructure promotion works with differing intensity and speed across European countries, depending on characteristics of demand. These characteristics are analysed in the following paragraphs, first from a purely demographic perspective, then from the point of view of attitudes.

2.1. Demographics

As of end 1996, there were some 150 million households in Western Europe, for a total of 384 million population. The average household size in Europe is 2.6 members. Due to a higher presence of single member households in Germany and the UK, the average size in these countries is lower than average. Compared with other worldwide regions European households have the same average size as in the US, and are smaller than in Japan (which counts an average of 2.9 members per household).

Some 43.8% of European population is concentrated in the 15-44 age range, which is the most likely to include a higher proportion of PC users and, eventually, of Web surfers. This proportion is lower than in the US (45.4%) and higher than in Japan (42.2%). Among the major countries with a higher share of 15-44 year olds are Spain (46.2%) and Italy (44.0%).

Among the top countries in 1995, Germany and the UK had higher newspaper circulation and higher share of population living in urban areas while Spain had the highest share of pupils learning English, after Germany. Germany and the UK also have the highest share of income to the top 20% of households.

Comparing Europe to USA and Japan, the advantage of a better age profile is offset by an average lower income profile. The majority of European households show average disposable incomes lower than that one recorded for US or Japanese households, with ECU 15,215 and ECU 20,518 respectively in 1996. Among the major European countries Germany has the highest average household income, ECU 14,677 in 1996. The gap with US households is expected to widen in 1997 and 1998 as annual growth of average household income across all the major European countries is estimated to be lower than in the USA (and slightly higher than in Japan). Better news come from households' savings ratio, as a potential source of future ICT application investment. All of the top European countries' households record savings ratios in the region of 11.6% or higher in 1996, against an average of 5.0% in the USA and 11.9% in Japan. The same gap is expected to be recorded in 1997 and 1998.

Table 1
Population and Households by Size (Thousands)

	Population	Number of households	Average members per household
France	58,270	22,385	2.6
Germany	82,140	37,264	2.2
Italy	57,250	20,010	2.9
Spain	39,220	11,909	3.3
UK	58,780	23,192	2.5
W. Europe	**384,450**	**150,459**	**2.6**
US	265,557	100,080	2.6
Japan	125,864	44,010	2.9

Source: EITO Task Force

2.2. Spending Patterns

Level and growth prospects for spending and penetration rates of electronic equipment and related services depend on the quantity and quality of the products and programmes on offer, the cost of the basic subscription, the average "age" of the networks and the urban population age and average income, as a proportion of the total. Taking these factors together (numerical evidence is provided in the tables and figures of this chapter) points to Germany and the UK as the most favoured countries in terms of availability of more income and cultural attitudes towards communications and entertainment technology.

Table 2
Age Profile of Population – % by Age, 1995

	< 15	15-24	25-34	35-44	45-54	55-64	65-74	> 75	Total
France	19.6	13.9	14.9	14.8	11.8	9.9	8.9	6.1	100.0
Germany[1]	16.4	11.8	17.3	14.4	12.9	12.0	8.9	6.3	100.0
Italy[1]	15.3	14.7	15.9	13.4	12.8	11.8	9.6	6.5	100.0
Spain	16.8	16.3	16.4	13.5	11.4	10.6	8.9	6.0	100.0
UK	19.5	12.8	16.0	13.5	12.6	9.9	8.8	6.9	100.0
Western Europe	**17.7**	**13.7**	**16.0**	**14.0**	**12.5**	**10.8**	**8.9**	**6.4**	**100.0**
US	22.0	13.7	15.6	16.2	11.8	8.0	7.1	5.6	100.0
Japan[1]	16.3	15.1	13.3	13.9	15.2	12.1	8.6	5.5	100.0

[1] 1994

Source: UN, OECD 1997, Council of Europe Press.

Table 3
Education and Social Indicators, 1995

	France	Germany	Italy	Spain	UK
% of pupils learning English	85	95	62	92	100
Expected years of schooling for child aged 3-5[1]	14.6	14.6	n.a.	14.7	14.9
Compulsory no. of years of education	10	12	8	10	11
Book sales by value (million ECU)	2,661	7,844	1,769	2,356	2,874
Newspaper circulation per 1,000 population	205	323	106	104	383
% of population living in urban areas	73	86	n.a.	76	89

[1] Data refer to child aged 2-5 for France and Spain; Data refer to child aged 3-4 for the UK

Source: The Economist

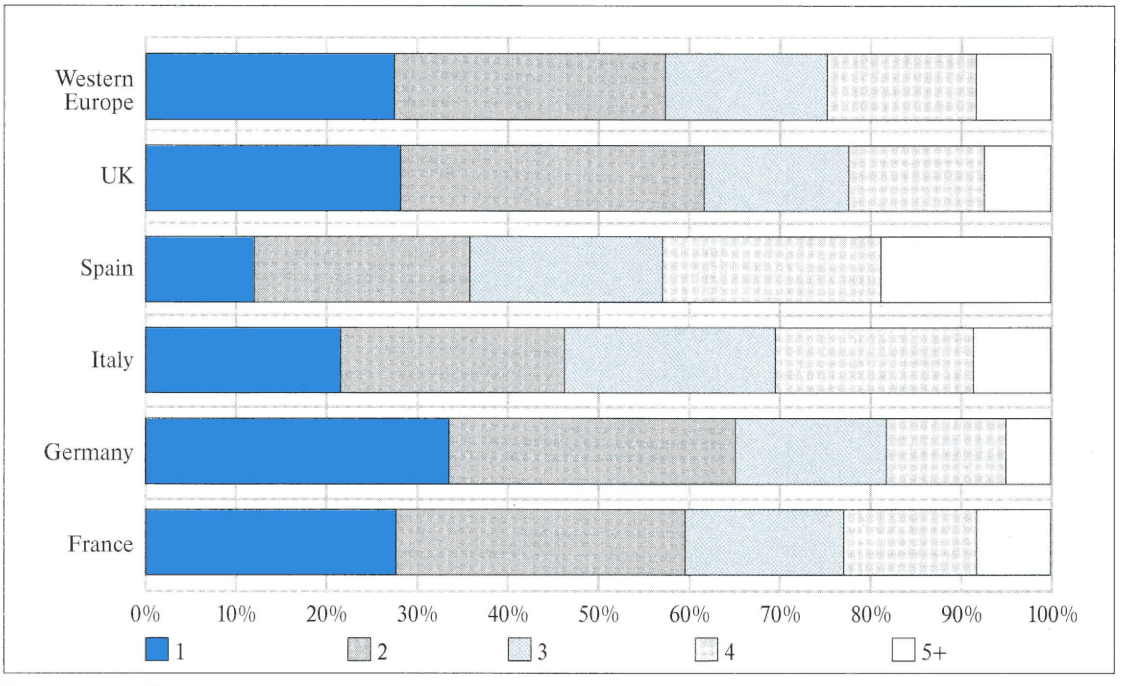


Figure 2 a
Distribution of Households by Household Size Class, 1996

Source: Eurostat, 1996, National Statistics

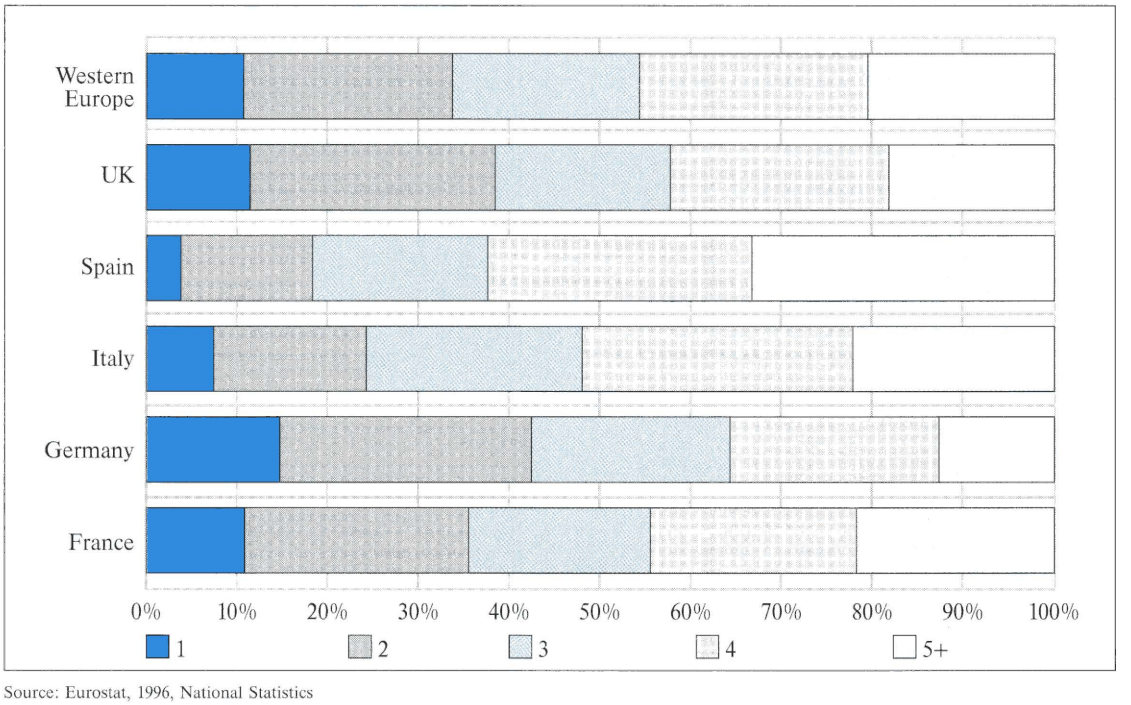
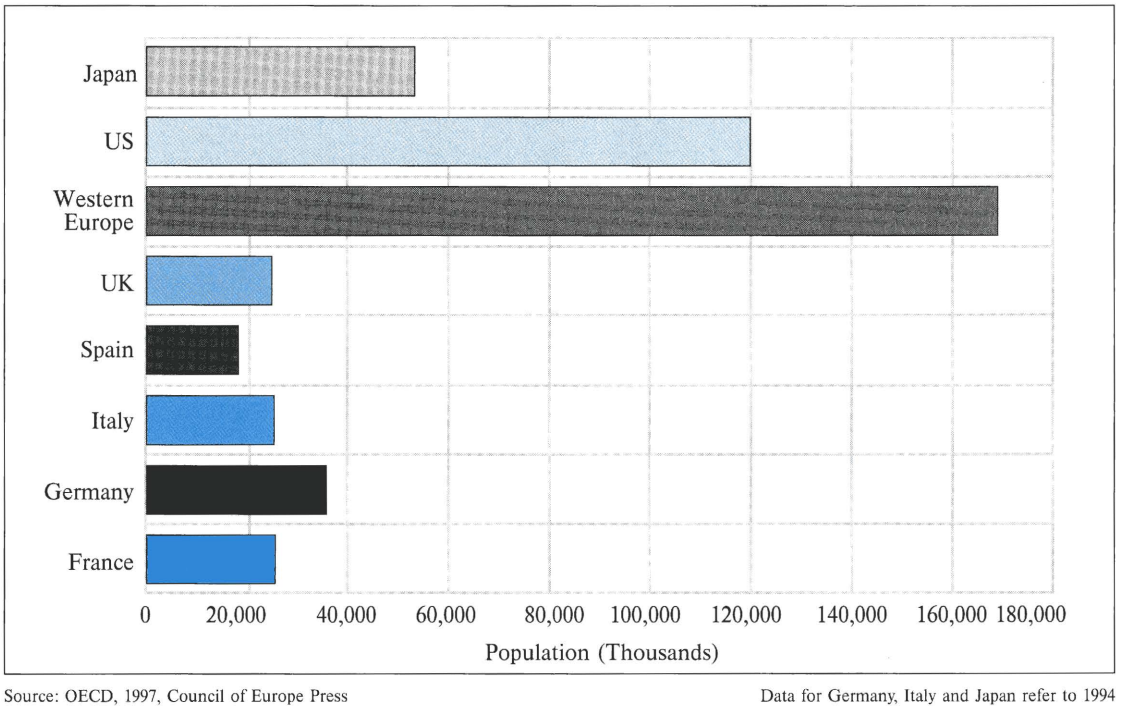


Figure 2 b
Distribution of Population by Size of Household, 1996

Source: Eurostat, 1996, National Statistics

Figure 3
15-44 Year-old Population by Country and Region, 1995



Source: OECD, 1997, Council of Europe Press

Data for Germany, Italy and Japan refer to 1994

Table 4
Households Disposable Income, per Capita, ECU

	1994	1995	1996	1997
France	12,027	12,557	12,795	13,179
Germany*	13,715	14,209	14,677	15,059
Italy	10,149	10,839	11,197	11,544
Spain	6,512	6,707	6,909	7,116
UK	9,307	9,819	10,467	11,043
Japan	19,936	20,195	20,518	20,970
US	13,761	14,518	15,215	16,113

* Data refer to Western Germany

Source: OECD, October 1996

A close analysis of expenditure on electronic equipment across the top 5 countries shows that, relative to TV spending, spending on PCs is more concentrated in the UK and much less present in Italy.

Household spending profile of various electronic products for the entire entertainment base shows that VCRs and Hi-fi systems have the highest penetration rate of the total base. Spending for video cameras is more concentrated in France, while spending for video recorders is more concentrated in the UK.

On the other hand, the *videogame owners* although exhibiting the characteristics of highly interactive consumers, are both the least wealthy and the least educated group. They also tend to be the youngest group and have more children.

	France	Germany	Italy[1]	Spain	UK[2]
Share of top 20% of households	42	45	43	40	27.8[3]
Share of bottom 40% of households	17	18	18	19	n.a.
Share of bottom 20% of households	6	7	7	7	4.6

Source: World Bank International Economics Department, 1996

Table 5
Households Income, % of Income, 1996

1 = Source: Bank of Italy
2 = 1988; data refer to population
3 = Share of top 10% households

Spending on entertainment services across countries is related to the different infrastructure provided.

Some of the least interactive consumer subgroups are the basic cable subscribers and those who are aware of Digital Satellite System.

Satellite dish for TV reception subscribers and videogame owners also fall into the highly interactive consumer category. The Satellite TV subscribers tend to be more highly educated and have higher income levels than many of the other subgroups.

	1995	1996	1997	1998
France	14.5	12.8	13.0	12.7
Germany	11.6	11.6	11.5	11.6
Italy	14.8	13.4	13.5	14.2
Spain	12.5	12.7	12.4	12.1
UK	11.0	11.6	10.9	10.6
Japan	13.1	11.9	11.5	11.5
US	4.8	5.0	5.2	5.7

Source: OECD, June 1997

Table 6
Households Savings Ratio, as % of Disposable Income

	France	Germany	Italy	Spain	UK	W. Europe
Food	15.0	11.4	17.0	17.4	11.3	14.9
Drink and tobacco	3.1	4.0	2.7	2.8	9.0	4.5
Clothing and footwear	6.1	7.0	9.8	8.6	5.7	7.4
Gross rent, fuel and power	20.0	18.8	15.9	12.5	19.4	17.8
Furniture and household equipment	7.7	8.3	9.5	6.5	6.5	7.9
Medical care	9.8	15.1	7.1	4.3	1.6	8.7
Transport and communication	16.1	16.3	11.7	15.5	16.8	15.2
Education, books, newspapers	2.1	n.a.	2.3	2.4	2.7	n.a.
Other entertainment, recreational-cultural services	2.1	n.a.	2.7	1.7	3.2	n.a.
Other	18.0	19.1	21.3	28.3	23.8	23.6

Source: Eurostat 1995

Table 7
Households' Consumption by Item, as % of Total Consumption at Current Prices, 1995

Table 8
Consumer Purchases of Electronic Equipment and Entertainment Services, 1996

Thousands of Units	France	Germany	Italy	Spain	UK	W. Europe
TV sets	3,860	5,658	3,346	1,185	3,773	22,001
Video recorders	2,075	3,202	1,249	458	2,423	12,128
Video cameras/camcorders	355	630	303	75	281	2,213
Home PC	729	1,461	363	144	1,090	5,098
% Breakdown						
TV sets	17.5	25.7	15.2	5.4	17.1	100.0
Video recorders	17.1	26.4	10.3	3.8	20.0	100.0
Video cameras/camcorders	16.0	28.5	13.7	3.4	12.7	100.0
Home PC	14.3	28.7	7.1	2.8	21.4	100.0

Source: Euromonitor, 1997 and estimates

Table 9
Consumer Expenditure on Electronic Equipment and Entertainment Services, 1996

Million ECU	France	Germany	Italy	Spain	UK	W. Europe
TV sets	1,177	2,935	1,287	299	1,707	10,387
Cable services	724	2,476	32	146	513	n.a.
Satellite services	670	940	234	349	1,135	n.a.
Video recorders	525	1,312	448	114	904	4,550
Video cameras/camcorders	397	544	178	33	256	1,979
Home PC	948	1,961	503	199	1,678	7,342
Fax	212	490	130	n.a.	243	n.a.
Console	425	363	240	n.a.	490	n.a.
% Breakdown						
TV	11.3	28.3	12.4	2.9	16.4	100.0
Video recorders	11.5	28.8	9.8	2.5	19.9	100.0
Video cameras/camcorders	20.1	27.5	9.0	1.7	12.9	100.0
Home PC	12.9	26.7	6.9	2.7	22.9	100.0

Source: Euromonitor, 1997 and estimates

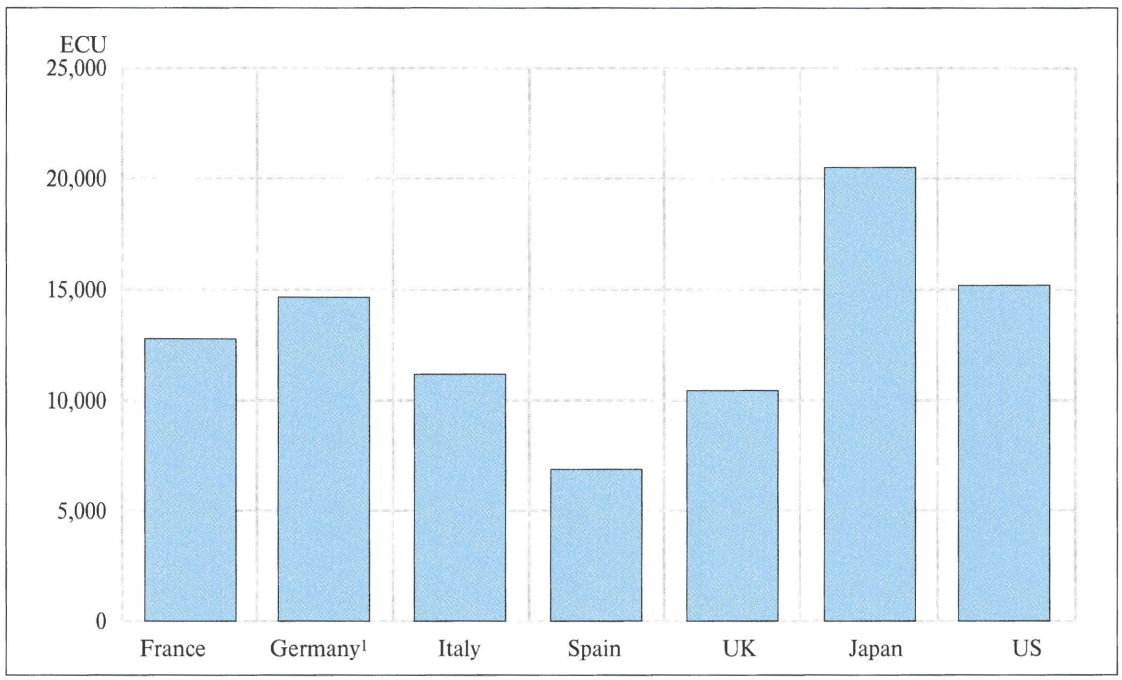


Figure 4
Households Disposable Income per Capita, 1996

[1] Data refer to Western Germany

Source: OECD, October 1996

In particular the importance of *cable networks* differs widely. Spain and Italy have little or no cable, while others, like Germany or Benelux are almost entirely cabled.

3. Devices and Services in and for the Home

Different income and population characteristics as well as different culture and habits result in differing adoption of ICT across European households. Current usage and penetration of the most important segments of devices, applications and services for the home are described in the following paragraphs.

3.1. Ownership Penetration of ICT Devices and Services

Electronic devices

Ownership of PCs is higher among households in the UK (23%) and Germany (21%) than in the other major countries. However, the penetration rate remains low compared to the US (37%).

Ownership of electronic communications products is variable across Europe. In terms of share of households owning the technology, France stands out for its higher share of families owning cordless phones (35%) and telephone answering machines (38%) closely followed by

Germany. Italy is distinguished by higher share of households (19%) owning a car/mobile/cellular phone (closely followed by the UK with 15%), and of electronic organisers (19% followed by France with 12%). A higher proportion of households in Germany and Italy also own typewriters and photocopying machines.

In Sweden, 28% of PC-owning households have a modem, followed by Germany with almost 17%. Approximately 10% of the PC owners in Europe acquired their modem with their PC, 6% acquired it later and 11% intend to purchase a modem within the next 12 months.

Across the five major European countries the most widely available modem speed was the 28.8 Kbps modem, used by 51% in Italy to 19% in Germany. Although all countries were marketing ISDN, the usage of this technology was minimal, for example 3% in Germany. However, a high percentage of respondents were unaware of their modem speed.

PCs versus TVs

With the advent of the Internet and the World Wide Web, the convergence of broadcast television with interactive computing has started accelerating. Companies have pursued more decisively the aim to bring interactivity to passive television viewing (e.g. WebTV and ViewCall).

Europeans have been spending more money on watching television every year, as pay TV penetration widens and the home video market continues to grow. On the other hand computer usage is rising within households, most likely resulting in fewer television viewing hours.

TV broadcasters home pages reportedly logged more millions of hits, suggesting the powerful synergies of Webcasting. Online users within their household visit Web sites they have seen advertised on TV or in magazines.

Evidence suggests that television has already entered the "new interactive" age:

- Up to 10% of total time spent watching TV is spent watching recorded videocassettes.
- A recent survey in the UK suggested that up to a third of children's time spent in front of the TV set involves non-broadcast TV; mainly video games or pre-recorded videos.
- The impact of pay TV is increasing, as the two leading providers in Europe are two of the world's most successful TV companies.

Many households have embraced the idea that television sets may have broader technology capabilities in the future. In contrast, they expect a little less from PCs and even less from telephones. When asked about the delivery of information and entertainment to the home in the future, 84% agreed strongly or somewhat that delivery would come via an advanced version of a television set, 81% felt it would be via an advanced version of the PC, and 71% said via an advanced version of the telephone.

Cable

Three major indicators influence the economics of the cable industry: the household "passed" as a measure of infrastructure development, the penetration rate as an indicator of potential profitability, and the amount spent per subscriber.

The *number of households "passed"* by the cable as a proportion of total households is higher in Germany (75%) and the UK (44%) compared to the other top countries. The share of households with cable services available is 87% in the US and 45% in Japan. Overall this share is related to:

	France	Germany	Italy	UK	US	Japan
Cable services available	41	75	5	44	87	45
Subscribe to cable TV	12	50	0	9	65	17
Average monthly cable TV bill (ECU)	24	11	n.a.	20	26	24
Access to satellite dish	8	29	4	18	8	33

Table 10
Penetration of TV-related Services, % of Households, 1997

- The influence (positive or otherwise) that can be exerted by the government and the regulatory authorities in a given country;
- The "age" of the network;
- The existence or non-existence of pay-television channels using the hertzian-terrestrial network prior to the development of the cable;
- Urban density, as the construction of a cable network is much easier in countries where urban density is high.

Despite increasing availability of cable services, subscriptions are still at a rather low levels compared to the much higher penetration in the US (65%). High price and/or poor value continue to be the areas of highest discontent among cable viewers. The Japanese penetration rate is 10%.

Satellite

Satellite dishes tie for the lowest penetration rate of the total base. The share of households subscribing to satellite TV is higher in Germany (29%) and the UK (18%), compared to the US (8%) but lower than in Japan (33%).

Alongside the penetration rate itself, *the amount spent per subscriber* on entertainment services depends mainly on GDP per head, on the relationship between the quality of traditional television (at virtually zero cost) and the satellite, as compared with that provided on the cable and, finally, on the average age of the networks. Other essential factors are the cultural characteristics of individual countries and the types of leisure activity normally practised.

Table 11
Penetration of Electronic Communications and Productivity Products, % of Households, 1997

	France	Germany	Italy	UK	US	Japan
Cordless phone	35	31	24	22	60	62
Car/mobile/cellular phone[1]	8	10	19	15	21	22
Pager/beeper	4	3	1	3	28	19
Telephone answering	38	37	19	33	67	67
Fax machine	8	11	5	7	12	27
Electronic organiser	12	8	19	10	23	22
Typewriter	32	57	51	35	n.a.	48
Photocopying machine	4	5	5	2	8	14

1 = Per 100 inhabitants, 1997

Table 12
Penetration of Electronic Entertainment Products, % of Households, 1997

	France	Germany	Italy	Spain	UK	US	Japan
Colour TV	91	95	93	95	93	n.a.	99
Satellite dish for TV	8	29	4	n.a.	18	8	33
VCR/VCP	70	68	66	65	79	87	91
Camcorder/video camera	20	20	17	n.a.	17	28	40
Hi-Fi stereo system	74	77	56	60	79	52	71
CD-Compact disc player	64	69	34	n.a.	54	60	80
Video game console for TV	26	10	12	35	18	38	46
Laser disk player	22	3	5	n.a.	4	n.a.	20

Table 13
Penetration of PCs, % of Households, 1997

	France	Germany	Italy	Spain	UK	Western Europe	US	Japan
% of HHs owning PCs	19	21	13	11	23	19	37	26
% of PC-owning HHs w/desktop PCs	93	91	82	n.a.	86	n.a.	83	84
% of PC-owning HHs w/portable PCs	10	6	9	n.a.	22	n.a.	12	29
% of PC-owning HHs w/MMPCs	32	37	29	n.a.	28	n.a.	53	46
Average no. PCs per HH	1.1	1.2	1.1	1.1	1.2	1.1	1.3	1.4

3.2. European Household ICT Usage Patterns

3.2.1. PC Usage

The profile of the typical home PC purchaser in Western Europe is affected by many social and economical aspects. Typical home PC purchasers in Europe are in the higher income and educational level bands, even more so than in the US. The typical budget range for a home PC is between ECU 1,000 and ECU 1,800 which puts a significant proportion of models outside their price range.

Different growth trends in the home PC market are a product of different realities regarding new demand and replacement cycles, channel and marketing campaign initiatives, pricing structures and effects, and public/private-championed home PC purchase promotions. When deciding which make and model to buy, the home PC buyer is typically looking for the best technology at a price point, the main source of advice being colleagues and computer specific publications.

In addition price comparison with the US market suggests European consumers get considerably less value for money when buying latest PC technology. The price of desirable multimedia home PC models is pushed outside the reach of household budgets of the vast majority of the population due to:

- Higher costs of doing business in Europe for vendors and resellers including increased staff, distribution, localisation costs;
- Higher consumer taxes in Europe than in the US;
- Higher costs of software and communications;
- Less disposable income, on average, than in the US;
- Greater home user uncertainties about the economy and fear of unemployment.

The majority of home PCs are purchased by office workers with comparatively high incomes who pay more attention in their purchase decision to the advice of colleagues and computer publications than to mass media advertising. Work at home drives the usage of 72% of current home PC users in Western Europe, heightened by the need to work longer hours and complemented by more flexible working practices and improved communications.

Frequency of usage is higher in the UK and Germany compared to the other top countries, while primary usage by children and teenagers seems to be higher in Italy and France.

Word processing and spreadsheets are the main applications used by households on PCs across all countries. Games/entertainment and education follow in order of frequency. In contrast the share of US households using education applications is twice as high as the average of the top European countries.

Table 14
Microprocessors and Modems Used by PC-Owners, % of Households, 1996

	France	Germany	Italy	UK	US	Japan
RAM						
More than 16 MB	7	17	7	6	9	17
16 MB	8	12	6	6	14	27
9-15 MB	6	1	1	2	0	6
8 MB	16	23	14	16	25	23
5-7 MB	7	1	3	3	0	1
4 MB	9	10	12	7	10	4
Less than 4 MB	4	6	4	12	7	11
Don't know	43	30	53	48	36	11
Processor						
Pentium Pro	1	21	1	4		1
Pentium	18	26	12	13	19	28
486	25	16	20	17	22	22
386	5	3	10	6	9	3
286/lower	1	1	1	3	4	9
Apple/Mac	4	0	1	3	3	8
PowerPC	1	0	1	2	3	9
Don't know	45	33	54	52	39.8	20
Modems						
Fax modem	16	19	13	n.a.	54[1]	38
Data modem	16	15	9	n.a.	n.a.	30
Voice modem	4	8	4	n.a.	n.a.	14
Average expenditure on software in last 12 months (ECU)	180	201	150	n.a.	359	419
Number of software programmes purchased in the last 12 months	5.4	4.5	3.5	5.0	5.1	4.2

[1] Includes all modems

	France	Germany	Italy	UK	US	Japan
HHs with printers (% of PC owners)	77	88	71	78	89	82
Type of printer owned						
Colour dot matrix printers	2	3	3	11	n.a.	11
Monochrome dot matrix printers	16	25	26	24	n.a.	25
Colour inkjet printers	23	28	11	19	n.a.	47
Monochrome inkjet	38	35	14	17	n.a.	14
Colour laser printers	8	1	1	3	n.a.	1
Monochrome laser printers	12	9	7	15	n.a.	10

Table 15
Penetration of Printers among PC-owning Households, % of Households, 1997

	France	Germany	Italy	UK	US	Japan
CD-ROM	18	49	16	23	27	42
Sound card	19	27	14	13	22	18
TV reception board	6	6	5	5	n.a.	20
Colour monitor	66	79	67	51	75	67
Mouse	87	92	82	72	n.a.	80
Scanner	23	30	21	18	24	35
Videogame controller/joystick	41	32	38	36	37	18
Fax modem	28	30	24	22	63[1]	48
Data modem	24	21	16	20	[1]	40
Voice modem	9	12	9	8	[1]	18
Additional memory	31	45	23	30	n.a.	53

Table 16
Penetration of Peripherals among PC-owning Households, % of Households, 1997

[1] For the US, fax modem includes all modems.

3.2.2. Internet Usage

Online subscriptions and Internet access have increased steadily in the last year, even though the usefulness and entertainment value of the online environment is still very much under construction.

The use of Internet and online services in homes was surveyed by IDC/Links in 5,034 households in Europe (UK, Germany, France, Italy and Sweden). Most of the home respondents (as in the business segment) are connected to the Internet through local ISPs (Internet Service Providers) or other Internet access devices rather than through online services.

Demographically, the online household group encompasses the greatest number of work-at-home households and includes those households with the highest incomes and the most education. It is likely that these households are the most technologically aware, since they are also the households with the highest daily log-in rate and the ones whose online sessions are the most active. Average characteristics of the online household in Europe are outlined below.

Characteristics of the Online Household

- *Average age lower than the consumer market as a whole, but rising;*
- *Higher education levels;*
- *10% to 20% higher average income;*
- *Increasing number of users per household with both parents and children as active users;*
- *Higher presence of work-at-homes;*
- *Strong demand for multimedia PCs, videogames, interactive information;*
- *Already subscribers to entertainment services (basic and premium cable TV, pay per view, and videocassette rentals);*
- *Early adopters of new information and entertainment services such as PC-based videogames and online activities;*
- *Own fax machines at three times the rate of the average household rate;*
- *Own cellular phones at three times the average household;*
- *Twice as frequent presence of second or more phone lines than the average household (mainly for Internet access);*
- *Higher subscription rates for all call management services (call waiting, voice mail, three-way conference calling, speed dialling, and call forwarding);*
- *Higher usage rates in calling patterns, with total monthly phone bill up to 50% higher than the average household;*
- *Higher subscription rates for cellular phone and paging services than the average;*
- *Keener interest in higher-speed modems and services, such as cable modems and ISDN lines.*

3.2.3. The Work-at-home Household

The changing nature of the workforce and of the work environment (often enhanced by the changing nature of technology), and the changing role of the virtual office in companies of all types, continue to drive ICT demand growth in the work-at-home household. For more analysis of the work-at-home phenomenon and teleworking please refer to *Part Two, Telework: Status, Development and Issues.*

	France	Germany	Italy	UK
Average yearly household income (ECU)	48,310	63,169	42,076	56,586
Average weekly hours on the Internet	6.9	5.8	7.4	8.8
Average monthly spending (ECU) on Internet	51	45	24	55
Users on the Internet in 18-49 age class	91.3%	85.9%	95.7%	91.7%
ISDN Internet access	16.3%	44.8%	7.2%	14.7%
Up to 28.8 modem	49.2%	37.9%	59.4%	47.0%
64/Kb/SEC	17.4%	11.0%	21.7%	26.5%
Number of questionnaire respondents[1]	995	987	996	998

Note: Results are based on IDC's self-selecting European Web-based Internet User Survey, conducted in 1997.
The Survey had a response of 3,976 completed questionnaires.
The questionnaire was placed on a Web server in Germany and was offered in four different languages, German, English, French, and Italian.

Table 17
Internet User Profiles
Western Europe, 1997

[1] Number of respondents may vary by type of question.

3.3. Applications and Services

According to a self-selecting survey carried out in 1997, European users on the Internet are mostly in the 18-49 age class and spend on average from 6 to 9 hours per week on the Internet (see *Table 17*). Online households perceive *information access* as the number one application for the Internet, with stronger focus on educational information, followed by weather, general news, and entertainment information. The "need for online access" is soon to become a significant factor for acquiring another Internet access device (such as a PC) for the household, in order to support the educational activities of children. *Online gaming, home banking activities,* e-mail and software downloading are also commonly used Internet applications. Consumer *home shopping* behaviour is still very cautious. *Internet telephony* and *TV-Internet services* are emerging to offer online households alternative channels of online communication to access their preferred information, financial, education or entertainment applications.

3.3.1. Online Information Access

Internet content providers operating in Europe offer a network of globally-branded properties, speciality programming, and aggregated content distributed primarily on the Web-serving business professionals and consumers. They have recently increased the attraction of interactive content by enhancing localisation for European users. Initiatives include a number of important content relationships in the key areas of news, weather, sports, entertainment, and financial information. The user response to "localised" web navigation has been positive, with up to 50% quarterly growth of page views per day. This means also a growing audience reach delivered to local and international advertisers.

3.3.2. Online Gaming

Many of the leading online gaming sites are experiencing far faster growth in their subscriber base than the online services experienced in their early stages of development. Such demand growth is being met increasingly with an exponential jump in the supply curve. The popularity of online, networked-based gaming increased

as thousands of free network-based games appeared over the Internet - creating for the first time a massive rush for online gaming tournaments. New online gaming services have appeared. Publishers and developers are quickly rushing to establish new titles with online gameplay.

Judging from the widespread success of only a handful of recent announcements, online gaming has become the hottest topic within the electronic gaming industry - hotter than DVD, 64-bit, or even 3D. Thanks to the Internet, the rejuvenated console market and the continued positive performance of PCs, the electronic gaming market continues to grow. As a result, the competitive landscape has blossomed with growing numbers of starts, and growing interest by large, established IT and publishing companies.

3.3.3. Home Banking

Home banking has started to emerge, and is set to record increasing acceptance.

Providers of home banking services have a prospective audience that is comfortable with the basics of using an online interactive service and is familiar with both ATMs and touch-tone telephone banking services. As a result, despite cautiousness and the doubts continuing to emerge concerning security and real payback time of homebanking channel investments, financial institutions show renewed interest in home banking. A sustained push into home banking has taken place by major financial institutions in a series of alliances forged with technology companies, credit card providers, electronic transaction processors and consumer online services. As a result some 80 banks offer online transaction services through their home page, as of the end of 1997 in Europe. The driving forces behind their move are:

- A real need to lower costs over time;
- Increased competitive pressure to maintain and gain customers;
- The opportunity to use technology to secure a competitive advantage in the marketplace.

Unlike earlier attempts at online home banking, which lacked the user tools and a critical mass audience to support its growth, current market conditions are favourable for its full development. The prime market is 30-45-year-olds, with salaries more than ECU 39,000, who use a PC at home and are online literate. Estimates of 1997 market size range at around 1 million, with anticipated growth to 35 million by 2001.

3.3.4. Home Shopping

In spite of the immaturity of the Internet as a shopping venue, there is already a significant base of support for home shopping via the Internet among those households that currently surf the Web. Germany currently dominates the online market, with mail order companies having a strong hold for clothes and household electronics sold online. The ability to quickly aggregate multiple sources of products and price information is a quite unique advantage of home shopping.

However the Internet is making more impact in terms of how retailers communicate with their customers more than replacing traditional shopping completely. For the present basic e-mail orders will continue to be the most likely uses for home shopping.

Smart cards would be the favourite way to pay for electronic commerce, as consumers would gradually lose their fears about giving credit card details on the Internet and gain

confidence in the security measures to encrypt financial information. Products which require information collection and comparison, like travel products, would be the most favoured.

Growth in electronic shopping will be driven by:

- The improved quantity and variety of shops available online;
- The value that they offer;
- Better home delivery services made available by retailers;
- Availability of new forms of digital cash payments;
- New measures to improve security of payments encouraging shoppers to use Internet online facilities.

3.3.5. Online Education

The school is seen as the flagship for online education in Europe. Schools at the leading edge of information technology are making the vision of providing education to the whole community a reality. The "connected learning community" is a way of describing a network of schools and colleges which are electronically linked. These networks may also include links with the home and other resources such as libraries, universities and the Internet. Such projects are starting to become widespread in Europe, especially in the UK. The content of learning online services is usually developed by teams of educationalists, parents and children, and is continually refined and enriched with considerable user interactive feedback. Teachers become knowledge facilitators and mentors, able to guide pupils through the breadth of material now available.

3.3.6. Internet Telephony

Internet telephony is currently a speciality market. Based on recent technological advancements and standard activities, it has significant potential to rapidly become mainstream. Response by telecommunications service providers, cable, and computer companies and the evolution of telecommunications deregulation are likely to affect this market. Although growth will be driven primarily by business users, consumers also play an important role in the development of Internet telephony.

The primary consumers uses of Internet telephony are for long distance calls, Internet chat groups, and some modest business experimentation in intranet applications. On a more exploratory basis, consumer market segment applications include the following:

- *Interactive entertainment games* enhanced with real-time dialogue occurring between a computer and one or more players; this enhancement would be possible on commercial services and the Internet.
- *Real-time customer service* giving the consumer the added advantage of discussion with a live operator or with a voice messaging system to check prices, product features, and other pertinent information before purchase. Service applications and real-time problem solving present similar types of opportunities.
- *Education and distance learning* enabled by real-time, multicast interaction between teacher and students, enhancing learning techniques from the currently more widespread text and e-mail-based solutions.

Potential future applications include interactive electronic commerce, intra-enterprise connectivity, and collaborative computing.

Table 18
Primary PC Users and Frequency of PC Use, % of PC-owning Households, 1997

	France	Germany	Italy	UK	US	Japan
Primary PC user						
Child under 6 year	0	0	1	1	1	2
Child 6-12 year	4	4	5	6	5	2
Teenager: 13-18	14	9	15	11	8	3
Child 19+ not attending college	6	6	18	3	4	4
Child 19+ attending college	14	6	12	10	4	8
Male head of HH	42	57	39	47	42	63
Female head of HH	18	16	8	19	34	5
Other adult in the HH	2	2	2	3	2	13
Frequency of use						
At least once a day	44	50	53	46	65	54
2-3 times per week	34	38	27	36	26	23
Once a week	11	7	10	8	5	14
Once or twice a month	5	2	5	4	3	5
Less than once a month	5	2	3	4	n.a.	3
Use of modem for electronic communication[1]						
At least once a day	16	19	34	32	n.a.	21
2-3 times per week	31	31	17	44	n.a.	18
Once a week	6	29	12	15	n.a.	20
Once or twice a month	11	8	14	1	n.a.	11
Less than once a month	13	10	0	8	n.a.	16

[1] = Data refer to PCs connected.

Three critical factors for success are apparent:

- Ease of connectivity for anyone connected to the Internet to dial another party direct;
- An open set of standards independent of the Internet telephony software in use;
- Availability of value-added features and options.

3.3.7. Internet TV Services

Europe's first personalised TV-Internet service was launched in the UK in mid-1997. Cable TV companies aim to attract thousands of additional customers following the introduction of new TV-Internet services.

	France	Germany	Italy	UK	US	Japan
Games/entertainment	68	63	70	58	77	74
Children's education	39	29	42	35	68	14
Adult's education	31	42	44	33	-	12
Word processing/report writing	84	91	70	81	86	87
Electronic spreadsheet	65	64	36	52	51	69
Database management	68	51	57	56	60	53
Graphs/charts	63	63	47	48	54	61
Making/receiving phone calls	8	7	5	12	n.a.	15
Viewing TV programmes	2	3	n.a.	4	n.a.	6
Income tax filing	33	30	17	17	15	7
Home budgeting	47	9	26	33	44	19
Desktop publishing	25	31	36	38	43	7
Stock and portfolio analysis	21	6	4	9	15	4
Electronic calendar	19	23	33	21	39	6
Musical applications	20	26	30	19	23	19
Cataloguing photographs	8	7	10	7	9	7
Office/business-related tasks	50	41	57	50	63	54

Table 19
Current Use of PCs among PC-owning Households, % of Households, 1997

These new services allow anyone to access and explore the Internet, as well as to send and receive electronic mail messages, via their existing domestic TV seats linked to a simple-to-use set-top box and a standard telephone line.

TV-Internet services offer cable TV operators unique commercial and joint marketing opportunities for first and second telephone line sales, call minutes and other franchise services from both new and existing customers. Most important, cable TV could offer co-branded local information, personalised content, through to tailored launch and relationship marketing programmes, and digital home shopping, competing with digital TV operators.

4. Technological Development and Market Drivers

4.1. Technology

4.1.1. High Bandwidth Technologies

In the short term, limited availability of such high-speed alternatives as DSL and cable modems make ISDN a preferable choice to 56 Kbps modem technology for most users seeking access speeds faster than those available using dial-up modems.

In the longer term competition among means of online information distribution will mount as other digital services (e.g., digital cable, wireless digital services) are rolled out. As the consumer electronics industry moves increasingly toward more digital products, such as DVD, wide-screen TV and digital TV, Digital Broadcast Satellite services and cable are expected to find successful market positions, although some markets will remain dominated by one or the other as a result of regulatory or historical factors. In spite of the attention which terrestrial digital TV has been receiving, the fundamental weaknesses of its position (limited capacity, a late starter) continue to outweigh its potential strengths (universal access, local coverage).

New interactive and data broadcast services will include: selecting Web content, multimedia magazines, current information including real-time tickers of financial information, news, weather and sports, data-enhanced TV programming (e.g., viewing a recipe while watching a cooking show or receiving sports statistics while watching a game), electronic software distribution and sales, games and children's programming. Interactive services could be a value-added proposition that helps DBS surpass cable.

The major influences on the short and medium term developments in high bandwidth technologies are outlined below:

DSL

Drivers: *Increasing availability of DSL services.*

Inhibitors: *Lack of standards; high development costs; expected high monthly prices.*

Cable

Drivers: *Penetration of TV cable services; technical/regulatory advantage for the ability to deliver a local broadcast signal.*

Inhibitors: *Low technology attitudes among basic cable subscribers homes; high cost of upgrade to hybrid fibre/coax technology (to provide for two-way transmission); high rates for high-speed Internet access; difficulties in supporting low-tech users; difficulties in raising the capital; competition from direct broadcast satellites.*

DBS

Drivers: *Incorporation of off-air antennas offering hybrid products to eliminate cable local transmission advantage; lower-cost infrastructure than that of cable; lower subscriber charges; digital platform for new media services; expanded bandwidth for provision of richer content; multimedia, interactive data, and digital video programming can complement the Internet and online services without replacing them or the ISP.*

Inhibitors: *Uncertain level of demand for DBS services; entry of other digital media, including digital cable, MMDS, and DVD; two-way interactivity solutions and challenges; dependence on effectiveness of the security and signal encryption features of the DBS systems; changes in government regulation or actions leading to adverse consequences; overall economic conditions.*

4.1.2. End-user Devices

Today's home information and entertainment appliances are dominated by an analogue, passive, TV-centric model. NetTV boxes bring marginal interactivity but still rely on passive television as the central source of entertainment.

With the advent of satellite broadcast, DVD, and digital television, the change from analogue to digital content will require a change in sets. There are many examples suggesting the mass market will not continue to follow a passive model but may be moving increasingly to an *interactive form of entertainment and access to information.* Years of good growth, as the European population replaces today's installed base of 140

million analogue TV sets with digital ones, are awaited with the same eagerness by television and computer suppliers.

With future digital, interactive home entertainment, the possibility has begun to exist that the television might not continue as the dominant home entertainment/information platform, although the view from the households suggests that the TV retains its role of excellence as the preferred home device to receive and send information.

Aside from its functional role, the PC industry's interest in defining the next-generation home entertainment platform is therefore quite strong in both the multimedia PC and PC/TV segments. Meanwhile digital TV is developing around digital broadcasting. If broadcasters begin to transmit interactive services concurrent with new digital television signals, the distinction between passive and interactive entertainment could become increasingly less clear, creating a larger demand for an intelligent data-processing device as part of the next home platform. Under optimistic assumptions regarding the behaviour of operators and regulators, increasing household penetration levels, and acceptance of annual fees on television services, revenues from digital television services in Europe are estimated to reach ECU 788 million in 1997 and ECU 7.6 billion by 2000.

Debate is intensifying around network computers (or non-PC Internet access devices) and their ability to broaden dramatically the base of IT users. At present network computers are still at the concept stage. The race for user interfaces, system software, and applications standards will cause the network computer market to remain fragmented in the short term. Suppliers will implement new features through incremental steps.

Culture and infrastructure differences will drive different and evolving household attitudes towards ICT devices and the delivery of information.

The major influences on the short and medium term developments in end-user devices incorporating increasingly interactive features are outlined below:

Personal Computers

Drivers: *Lower price points; volume purchase credits; no-interest finance schemes; new product designs, addressing the saving of space; helping consumers to legitimately overcome the VAT barrier; marketing and communication campaigns; introduction of the MMX technology in early 1997; new upgrade cycle with Pentium II performance improvements in excess of 233 MHz; leverage on 3D chips and joystick bundles for PCs designed primarily for gaming; raising performance bar of the PC platform to almost equal that of consoles; wider availability of feature-rich and less-expensive education as well as PC games/entertainment software making home multimedia PCs a viable education/gaming platform; rapidly increasing frequency of usage and willingness to use the traditional and new PC technology in a wider range of applications; once purchased, increasing role of the personal computer in family activities and in driving the adoption of more than one PC.*

Inhibitors: *High price compared to game or communication home devices, low penetration (PCs have yet to breach 20% household penetration in Europe compared to 90% or higher household penetration levels of other consumer devices such as televisions, VCRs, and telephones).*

PC/TV

Drivers: *Better positioning than TV as a powerful data-processing client able to receive and transmit digital signals with large amounts of interactive content; larger VGA; TV friendly user interface; better video-output quality; other drivers acting for personal computers.*

Inhibitors: *Mixed results of the interactive television trials; mixed interest and unclear demand for new interactive services; unclear new business commitments by broadcasters having to invest in new infrastructure and capabilities; insufficient installed base for critical-mass, mass media content; lack of infrastructure supporting the delivery of interactive content; little market need for a PC-type device as part of the consumer home entertainment platform; need to provide significant business incentives for a wide interactive content subeconomy to develop; disadvantage versus task-specific televisions, VCRs, or telephones optimised in terms of functionality, ease of use, and cost; price too high to compete effectively as a mass-market consumer device; mounting competition from new consumer electronics products; need to shift business model closer to electronics industry's to address wide customer base, longer product life cycles, and lower price points.*

Digital TV

Drivers: *Falling receiver equipment prices; increasingly competitive offer of cable companies that go digital; offering of more choice and premium programming (such as live sports and first-run films); offering of intelligence, such as electronic programme guides, or programme search engines.*

Inhibitors: *Resistance among European TV users to the idea of paying around ECU 390 a year for television services; obstacles to the development of a digital TV set-top box receiver market (after user resistance to pay, just as analogue pay TV channels are paid today); negative attitude towards accelerating technology obsolescence (due to changes in encryption or digital broadcast technology) as TV sets are seen as expensive devices intended to last for years; programmers, broadcasters, and regulators approach risks stalling the market's development in a particular country or region.*

Videogame consoles

Drivers: *Rapid acceptance of higher-priced next-generation videogame consoles; videogame console software growth pulled by the growing installed base of 32-/64-bit consoles; significant console upgrade potential from the falling installed base of 16-bit consoles; lower price: even with performance parity with home multimedia PCs; ease of use; higher household penetration rates, require the lengthening of product cycles.*

Inhibitors: *Dedicated function, increasingly price competitive alternative PC or interactive TV platforms among households with higher technology attitudes.*

Network computers *(i.e. Internet smart phones, handhelds, companions, Internet terminals)*

Drivers: *Lower cost of the device and of managing and operating it; portability; design enhancements including integrated communications, technology developments.*

Inhibitors: *Small displays, high cost to connect, lack of applications, lack of content, bandwidth.*

Home printers

Drivers: *Upgrade of current base of dot matrix printers to inkjet technology; aggressive pricing policies, adoption by additional segments of households; growth of the home PC market inducing printer purchase.*

Inhibitors: *Competition from multifunction peripherals.*

4.1.3. Peripherals

Multi-function peripherals

Multi-function peripherals are not very widespread among European households. However, as home users distribute documents in hard copy for a majority of cases, and electronic distribution is still in its infancy among European households, multi-function peripherals (MFPs) purchases are set to increase strongly. Work-at-home and home business households are the most keen on an MFP purchase in the near future. The most perceived benefits of multi-function peripherals are space savings, convenience, lower costs than those for the sum of parts, access from the desktop, and simple work process.

The biggest concern of home users relative to multi-function peripherals is that when one function is down, all are. Moreover, costs are not low enough to enhance a MFPs boom at least in the short term.

The preferred combination of functions is print/scan/fax/copy, followed by print/fax, print/scan, print/scan/copy, print/copy, and print/fax/copy. Consistently, the print function is the most popular, followed by copy, fax, and scan functions.

Printers and fax machines are the most vulnerable to MFP purchases. This is likely a reflection of users' need to update older printing technology with new technology. The tendency to replace fax machine(s) with an MFP is especially strong among home business.

Home scanners

The opportunity for scanners in the consumer market is widening. The trend toward multimedia applications will continue to rise because of:

- More affordable and improved scanning and printing technology;
- Fine-tuned imaging software;
- Increasing interest among consumers to use the PC for digital imaging applications such as desktop publishing, photograph cataloguing, or exchanging photos over the Internet;
- Recently launched home scanners designed with similar quality, ease-of-use and scanning capabilities to the office versions;
- Next-generation colour correction technology built into the software to automatically detect and brighten dark areas in an image without altering the quality of other areas in the image;
- New bundled software packages allowing photo-based projects editing, optical character recognition, file and retrieve documents, ability to use photos online via e-mail and personal Web pages, ability to become detached for handheld scanning.

Digital camera

The digital camera joins the Internet and multimedia applications as another stimulus to the home PC industry, as it develops beyond the early adopter stage. The declining price of PCs will be combined with the increasing functionality of digital photography equipment, such as the ability to apply pictures to Web-based applications and other forms of electronic communication, and digital photography, adding a deeper element of creativity to desktop publishing applications.

This combination will yield a parity, at which potential PC buyers who have an interest in digital photography will be coaxed into investing in a PC because of the availability of quality digital imaging equipment.

Printer vendors are also making the adoption of digital cameras attractive to users, having recently introduced inkjet printers designed for photographic output and at inexpensive prices.

Factors internal to the digital camera industry will also influence mass adoption as decreasing cost feature-rich mobile cameras populate the market:

- Its return on investment, as the cost of film is eliminated;
- More functions on one chip: control, memory, compression, microprocessing, CCD sensor, LCD control, audio, video out, on-screen display control;
- Use of advanced chip sets, increasing functionality at lower costs;
- Form-factor enhancements, and LCD monitors allowing users to view and delete the shots;
- The removal of high sensor costs;
- Economies of scale leading to lower development costs and, therefore, lower prices.

Among the breadth of digital camera products that will arise from the combination of different imaging performance, camera features, and customer usage, digital *imaging assistants,* have just begun to emerge. Products will come from two convergent technology directions: on the one hand, cameras that have basic image acquisition with added capability of running software applications and, on the other hand, PDAs that have the added capability of capturing images.

4.2. Applications Evolution

4.2.1. Electronic Commerce

European consumers started to buy products and services over the Internet in 1997. Yet Web purchasing activity by consumers is still relatively small in Europe, although Web users are more active in Scandinavia, the UK and the Netherlands. As more consumers start to buy goods and services over the Internet and the number and variety of commercial Web sites increases, average expenditure levels are due to increase gradually.

Electronic commerce is expected to grow at differing rates in Europe, as there are considerable country differences across the region. The strong online culture in countries such as Germany and France, combined with the widespread adoption of the Internet in regions such as Scandinavia, is generating more interest in the consumer Internet commerce marketplace. Growth will not be a standard progression from information provision on Web sites to full electronic commerce, as significant developments are required for full potential deployment. In order to make electronic commerce widely accessible, acceptable progress is required for business practice, ease of use, payment and service, security and reliability, more bandwidth, as well as better integration with existing IT environments.

The business-to-business electronic commerce market is set to predominate in the short term. EDI and media companies are more likely to adopt electronic commerce in these early stages in Europe, to connect widely dispersed trading partners, as a channel for selling advertising and content, and for broadcasting multimedia services such as TV and radio. In the longer term, the addition of Intranet-based call centers into customer service and sales infrastructures will help to widen the Internet commerce circle.

It is likely to be a minimum of four to five years before wide scale migration to Web commerce for business to consumer is seen. Nevertheless the business-to-consumer market holds significant potential.

Internet malls appear to be an easy entry point to electronic commerce and will enable companies of all sizes, trade associations and industry bodies to test out electronic commerce. Gaining expertise in online transaction software is one of the major challenges for European operators.

Electronic Commerce Development Drivers and Inhibitors: the Supply Side Perspective

Drivers

From a technology perspective, the rate of Internet commerce growth is linked with:

- *The speed with which companies adopt IP in the LAN and wide area network, and create external Web sites and Intranets;*
- *Security and systems integration;*
- *Interoperability between differing systems;*
- *Availability of middleware, and of software packages geared to online transaction processing and Internet commerce.*

The following products and technologies help the Internet become better equipped to support commercial transactions and appeal to wider segments of users:

Internet commerce servers: *These software platforms will be a key customer focus and are being prepared for rollout in Europe.*

Hosted intranet and Internet commerce services and sites, *which are already being introduced by ISPs and other network providers.*

Web site analysis and management: *The products that support tasks such as content management and demographic analysis are critical for optimising and measuring the return on investment from commerce sites.*

Content and software "push" technologies: *These will allow automated delivery/broadcast of information without the user needing to search for it, thereby helping to create a broader community of Web users.*

Internet application servers: *The "Web-ifying" of major business applications, opening them up to users through a Web browser interface, is starting to take place. Internal applications (that is intranets) will make up most of the applications initially.*

Java-based development tools: *The availability of real programming tools that facilitate and accelerate Java-based application building is increasing.*

IP Technology: *The increasing implementation of IP networks, the integration of IP technology within operating systems combined with the development of advanced intranet applications (rather than just information publishing) help to make the technology accepted by a broader market base.*

Inhibitors

PC and modem penetration: *around 18% of households with active PCs (with sufficient memory) have a modem, with this proportion varying considerably across Europe.*

Security issues: *European consumers are very wary of using what is perceived to be an insecure medium for payments, particularly the transmission of credit card details. Going "offline" to make the payment detracts from the overall convenience of an Internet-based transaction.*

Compensation: *Consumers expect to be rewarded for overcoming their initial barriers to Web purchasing, whether by better prices or increased services. For merchants this means introducing new service levels and/or pricing. Various companies offer security as a third-party service to merchants, including the back-office support for the transaction.*

Low risk-profile: *As they gain experience, many companies have kept their commerce offerings as a low-cost sales channel for targeting niche markets or for reducing excess inventory, such as airline tickets. The market now requires more retailers to offer a complete range of products on the Internet, at competitive prices, and also to take advantage of Internet marketing and selling capabilities such as interactivity, dynamic displays, multimedia content and customisation of formats.*

Fear of damaging the brand: *Fear of negative publicity about a commercial Web site and its brand in general, for example for security breaches or system failures, is holding back some European developments, especially in the finance sector.*

Low propensity to re-branding: *Online sales are based on strong consumer branding strategies at three levels: content (the branded products), context (the look and feel of the site), and the delivery network infrastructure (to fulfil the order). To enhance consumer confidence, Web sites need to offer the same facilities and resources that consumers expect from the retail outlets and stores.*

Internet congestion: *For most users ISP connection is a major problem, and delays throughout the Internet backbone are set to continue for several years in Europe.*

Billing systems: *The Internet commerce market is looking for a cost-per-transaction billing system which most carriers as yet seem reluctant to contemplate, preferring the continuation of the cost-per-minute charging associated with voice traffic.*

4.2.2. Online Gaming and Education

Attempts of bringing the commodity/pricing relationship, that is prevalent in traditional consumer goods to the software industry have led to price decreases of up to 40% in 1997, coupled with product line extensions.

While under the current market conditions there are too many titles for the given population available to use them, overall consumer software market growth remains restricted by a number of factors:

- The limited growth in PC penetration in homes;
- Localisation issues for software;
- Massive consolidations of software suppliers;
- Withdrawal of venture capital funds;
- Pricing pressure, as attempts to spur added purchasing point vendors towards reducing pricing;
- Higher demand for product differentiation.

For many viewers of the consumer software market and its vendors, the Internet offers the first true shift in several years. Over time the Internet and its expansion of awareness (not necessarily PC units) will have an impact on home computing:

- The addition of URLs to virtually every television commercial, print ad, and billboard is changing the way people expect to absorb information and ultimately content.
- The level of ubiquitousness and ease-of-use will dictate how quickly this mechanism (online) usurps existing ones.
- The awareness is currently being built among consumers, to be followed by the installation of the necessary equipment. (It remains to be seen what final form that equipment will take.)

For software vendors, this emerging period will present challenges and the ability to respond to software opportunities.

Online electronic gaming

The number of online gaming households is expected to increase at least by a ratio of 10 to 1 between now and year 2000, for the following reasons:

- Continuing market appetite for electronic games;
- Addictive and serial nature of multiplayer gameplay;
- Continuing growth in online interactive activity;
- Growth in PC households;
- Growth in other interactive devices;
- Very innovative new gaming applications.

Although online gaming represents a minority of the electronic gaming industry, its anticipated growth brings moderate revenue and profit opportunities for the following reasons:

- Growth in free online gaming will suppress full revenue potential in the near and medium terms.
- Households will learn to pay for online content (just as they currently pay for entertainment content vis-à-vis cable and DBS).
- The lack of significant critical mass will minimise advertising revenue streams.

Virtual TV gaming

The low-key beginning to the latest innovation in television technology is a virtual reality game show described as the first live broadcast from a shared virtual world and a significant moment in the convergence of television and the Internet. The world's first virtual reality television programme was broadcast at the end of 1997, hooking around 150 people from all over Britain into an interactive game and letting them play together centrally via the Internet from their homes.

The players are represented on screen by human-shaped figures. Special CD discs are allocated to each of the players and the virtual world in which the game is played created on their computer screens. The net will be used simply to transfer information about the players' positions to a central computer that will blend the information in as the show progresses. The game show is the first small step towards turning the fiction into reality.

At this stage the programme does little more than put the web onto television. The ultimate objective would be to allow, through virtual reality TV, people with similar television and theatre interests to watch them communally even though they are in different parts of the world. The potential for VRTV at a communication level is enormous. It could be used to create new kinds of communities and societies, while local organisations such as councils or other ruling bodies could create their own shared TV spaces via the net, even from different countries.

Online education

Enabling factors to the development of online learning include:

- Access to education resources in the home, where students and parents have time for research not available in school. On the net, students can perform a keyword search across all encyclopedia, dictionary, thesaurus, newspaper and photo resources;
- Widespreading availability of user friendly, customised product searching tools to help the above described process, such as links to other home and education sites, links to a wide variety of other information of interest to parents, teachers, and pupils, services of "Expert online";
- Availability of cost-effective hardware to allow relatively low costs for home users. To support some projects, in the UK the industry has funded the in-school equipment.

Critics of the new online culture claim there is a lack of interrelationship and potential anti-social effects in online education. This view is opposed by the perception of online education as a tool to supplement traditional learning techniques, rather than supplant them.

4.3. Economic Policy and Regulatory Decisions

Governments need to develop a new legal environment, to take into account global Internet home usage of all types. Key issues which need addressing in order to reach these goals are as follows:

- Taxes and other duties;
- Licensing requirements;
- Control over standards development;
- Restrictions on the type of information transmitted.

Territorial understanding of "residence" and "source" of income is the major challenge. In mid-1997 the EU issued a declaration on Internet use, including content, tariffing and taxation. The EU's view is that the Internet will not be a duty-free zone but taxes should be non-discriminatory. On the contrary the US government argues that the Internet should be a tariff-free zone, as tariff administration is difficult due to the lack of clear geographical boundaries. The US Federal Communications Commission (FCC) is recommending that any taxes on Internet sales should be simple and transparent, be consistent with principles of international taxation and neither hinder nor distort commerce.

Few European countries have yet issued specific Internet commerce policies, although plans are under way in some countries to deliver proposals for government action and an assessment of the issues. A new multimedia law has come into effect in Germany. The law states that contracts over the Internet are equal under law to those signed on paper, and recognises the digital signature as legally binding.

Joint initiatives have been set up by the European Union and the US government for Internet commerce solutions. Organisations are springing up to promote Internet commerce in Europe by providing support to government developments, providing training and support, and co-ordinating research. Internet codes of conduct are emerging for countries such as France, Germany and the UK.

A related issue is the need for an Internet Uniform Code of Conduct to develop a legal framework, clarify rules, ensure consumer confidence and reduce transaction costs. A frame-

work is also required to define intellectual property for:

- Copyright;
- Database;
- Patents and trademarks;
- Domain names.

Internet security aspects

The European Union is seeking to ensure that Member States legally recognise each other's digital signatures, which rely on the participation of certification authorities. The nature of the certification authority itself has yet to be defined, though, mainly because of the lack of agreement between the Member States. Outstanding security issues also relate to the encryption systems considered secure for commercial transactions. The OECD envisages that governments, rather than individual businesses, should be left to oversee encryption and certification policies.

Encryption systems (with public keys supplied by the trusted third party) with attached digital signatures are widely considered secure. The current situation is that both France and the UK back the holding of encryption keys by trusted third parties, so that governments can quickly recover the keys, whereas the Nordic countries are against it.

5. Challenges for the Market Players

The consumer market is prompting the interest of consolidated and new breeds of ICT players.

Vendors cannot ignore the next wave of digital interactive household communication that will bring new home communication devices, applications and services to mass market adoption. They need to be able to adapt soon to the evolving new media markets industry model.

5.1. Telecommunications

In many countries network statistics show call growth to Internet access providers doubling year on year, promising good opportunities for access network operators who charge by the minute. The combination of increased competition and the unexpected acceptance of the Internet is leading telephone companies to review their business models.

Internet access provision is the short-term priority, preferred to aggressive broadband deployment. Over the long term, there is still a chance that cyberspace could reach a plateau, undershooting the long term network investment made to accommodate it.

At present, European operators worry about switch congestion because of the long holding times. New solutions involve a range of network elements designed to take the load of both the telephone company voice switch and the Internet access provider, helping access network operators "build value" at their position in the chain.

Current growth rates may see Internet calls representing more than half of all call traffic early in the next century. Although most households are unlikely to launch into cyberspace in the near future, those that do will make the difference. Telephone companies that charge by the minute for local calls may be eagerly anticipating an explosion in dial-up access to the Internet, but the strains on switch capacity make this opportunity a double-edged sword. The key measure is holding time. Internet calls are usually held for between 20 and 30 minutes, compared to the voice call average of three minutes. If 15 households in 100 – a feasible Web penetration figure for 2002 – make as many Internet calls as they make voice calls, it will double the residential local-call-minutes total.

5.2. Cable Services

De-regulation and the digital revolution are widening the development potential of the cable sector, which is well suited to combining video, telephone and high-speed interactive data transmission. They are, however, also producing higher costs and increased competition.

Cable TV basic service revenue, although still growing, has started to suffer because of four major factors:

- Constraints imposed by *household income and personal availability,* putting a ceiling to growth of individual countries' propensities to pay for new types of service;
- The *saturation of the time available for viewing:* and consequent unwillingness of households to pay more for programmes that they will physically be incapable of watching;
- A *decrease in the attraction of premium channels* (they account for less than 20% of sales), hit by the rapid increase in the number of specialist channels (as part of the basic offer);
- The *increasing threat of digital satellite broadcasting* via the defection of cable subscribers to satellite transmission.

Cable operators are counteracting these trends via:

- Vigorous attempts to offer at least the same service as the digital satellite, through the modernisation of the cable network. This will mean that up to 500-600 digital wavebands will be available in the next few years through costly adaptation of existing networks (of the order of ECU 550 per household upgraded);
- Creating new sources of revenue such as advertising, cable telephony, and high-speed data transmission, important elements in the economics of the cable industry.

Advertising revenue, driven by the steep increase in the audience for the cable channels and the greater opportunity to reach a target audience via the specialist channels.

Cable telephony, this service has taken the lead in some countries, especially in the United Kingdom where telephone revenue accounts for 55% of cable operators' total sales. The quality of the service and the inter-connection costs are crucial factors in the use of the cable for telephone services.

High-speed data transmission is highly promising in that cable modems provide faster (and hence more convenient) access to online services, than the traditional modems using telephone lines. High-speed data transmission could account up to 10% of cable operators' income by the year 2002.

The cable operators are striving to maximise the penetration rate and the spending per subscriber, but their strategy also consists of seeking out possible synergy and attaining critical mass:

- *Vertical integration* is sought between the programming function and that of the distribution of audio-visual services, in order to economise on the cost of programmes or to have exclusive rights to programmes. This enables them to differentiate themselves from the programmes available from satellite services and to spread the risks to a certain extent.
- The offer of an *increasingly wide choice* to subscribers is aimed to face the explosion of audio-visual supply possibilities. This leads to increasingly high programme charges, because high-quality programmes, the key factor in pay-television, are tending to be in increasingly short supply. The risk is that the rise in programme charges will hit price-sensitive subscribers' propensity for pay-television.

- Vertical-in tegration strategy tends to be replaced by the attempt to provide a *comprehensive "one-stop shopping" service* encompassing television, telephone and online services to the same subscriber. The search for synergy in the telephone and online services fields takes advantage of the diversification possibilities opened up by digital technology. This search is normally based on alliances or outright take-overs, in view of the high entry costs, and is already clearly visible in the UK.
- Another aim is to *attain critical mass* of several hundred thousand subscribers, given that this is an essentially capital-intensive industry. The merger of separate networks allows a reduction of the number of head-ends (the centres where the various programmes are received, usually by satellite, before being sent out over the cable) and of the costly signal-distribution nodes, to take advantage of quantity rebates on programming costs, and to reduce administrative, marketing and advertising costs.

5.3. PC/TV versus Digital TV

PC/TV futures

PC/TV suppliers need to overcome significant barriers to the nascent PC/TV market that could materially impact its development:

- Lack of infrastructure supporting the delivery of interactive content;
- Little market need for a PC-type device as part of the consumer home entertainment platform exists;
- Need to provide significant business incentives for a wide interactive content subeconomy to develop;
- Marginal value proposition disadvantage versus task-specific televisions, VCRs, or telephones optimised in terms of functionality, ease of use, and cost;
- Need to address current pricing structures to compete effectively as a mass-market consumer device;
- Need to set proposition at significantly greater value to ward off the mounting competition - addressed to discretionary spending - from new consumer electronics products, such as digital televisions, NetTV boxes, DVD players, new videogame consoles, and AC-3 stereo receivers.

Satellite digital TV

The digital revolution advantage of satellite is opening the door to new forms of television, as well as to other services.

The major advantages of satellite include:

- Break out from national frontiers possible, bringing such new features as over 100 channels, and a wide range of pay-per-view choice;
- Digital-quality picture and sound;
- A greater range of wavebands to wider areas, with less network infrastructure cost;
- Opportunity for existing subscribers to trade up to digital services and retain existing analogue services at no extra cost;
- Set-top box specifications include a 28.8 kbit/s modem and the ability for the satellite box to be upgraded to receive digital terrestrial and digital satellite transmissions;
- Card slots are included in the set-top box - one for news services conditional access system and a second for the Mondex payment system.

The main interactive service categories offered by interactive broadcasting services in Europe are: shopping; banking; holidays and travel; games; learning online; entertainment and leisure; and sports.

Working groups have been formed with a number of large retailers, travel agencies, publishers to develop content for interactive services, such as the holiday service (ability to place bookings online), car buying, sports events, on-line gaming, and home banking.

Interactive advertising will allow viewers to receive additional information on particular products by a pressing a button on the remote. Interactive advertising will be signalled by the presence of an on-screen icon.

In the long term, however, as more digital players enter the market, the digital business model will evolve and become more like traditional cable:

- Digital delivery will become more of a commodity product.
- Future competition among hardware manufacturers will lead to lower equipment prices.
- DBS players will move towards giving the equipment away and charging for programming and other value-added, interactive services.

5.4. Internet Service Providers (ISPs)

In almost every European country, the growing general interest in the Internet phenomenon resulted in exploding numbers of subscriptions by residential users and work-at-home households with Internet service providers.

As a result of exponential Internet home usage growth, even large Internet service providers in the most developed European Internet markets (e.g., Germany, the United Kingdom, the Netherlands, and Nordic countries) are struggling to keep up with the constant flow of new subscribers.

The European Internet access market is a highly competitive environment that, in most countries, is dominated by a few large national ISPs, joined by many smaller, national and regional ISPs, each with relatively few subscribers. The result is a fierce battle for subscribers, with many ISPs eager to claim the leading position. Yet the contours of large national and international ISPs are becoming clear, as early indicators of a maturing Internet access market that will eventually consist of fewer but bigger players. In addition, Europe's telecommunications services providers are rushing to secure their part of the Internet business, either by setting up their own Internet divisions or by acquiring existing ISPs.

According to their data communications equipment expenditure in 1996, almost 80% of European ISPs can be categorised as small to medium-sized businesses.

Considerable differences in network topology and spending on data communications equipment can be noted between ISPs that are focusing on home users and those targeting business users. Home-user-oriented ISPs, on average, spend more on remote access server (RAS) equipment; the main part of business-oriented ISPs' budget is spent on routers. Overall they expect ISDN to be the dominant Internet access method by the year 2000, among home users. However, from a market point of view it is not clear this is going to happen.

European ISPs, small or large, are recording strong growth in the number of subscribers for 1997, with the number of home subscribers showing the fastest pace. Investments in backbone infrastructure and access equipment are keeping pace with this growth in subscribers. In the course of 1997, European ISPs were estimated to triple the bandwidth of their connection to the Internet, on average. Also the number of ISDN access ports was showing a very high growth rate.

Internet Service Provider (ISP): *A company that sells Internet access to others. Web site hosting, Web site design, and LAN interconnects are additional services these ISPs might offer to their customers. ISPs can focus on selling to businesses or home users, and some access providers sell to other smaller access providers. In this category online service providers operating proprietary networks with Internet gateways are also included, as Internet access is the dominant reason to subscribe to ISPs.*

Top-level providers: *An Internet service provider that has its own direct connection to the Internet. (This can be a proprietary connection or line, but it often means a connection to Internet Exchange points through international carriers). Other, smaller ISPs connect to the Internet via a top-level ISP.*

Backbone/wholesale subscribers: *Backbone subscribers are themselves selling Internet access to others (individuals and/or businesses) and pay a top-level provider to get a connection to the Internet. Most operators can be characterised as pure ISPs whose core business is the provision of Internet access to their customers.*

5.5. Internet Telephony Players

Internet telephony is currently a speciality market.

A growing number of companies are selling software programmes that enable a computer to transmit voice conversations, or building Internet telephony functions into their products. These include:

- Vendors of collaborative computing and desktop connectivity such as videoconferencing software;
- Developers of digital speech processing such as Internet phone telephony gateway server;
- Internet service providers who have developed their own software technology that allows anyone to dial through the Internet and place outbound calls at cheaper than international calling rates;
- Leading Internet technology companies initiating standards for vendor interoperability, and planning to introduce Internet telephony features on their existing Internet client and server software portfolios, as soon as Internet telephony technology achieves better multimedia standards resolutions as well as better quality and reliability for electronic commerce applications.

The new entrants and the large Internet companies are likely to have a major impact on the near-term and long-term direction of the Internet telephony market, while several products are expected to be either discontinued or absorbed through acquisition into other companies.

5.6. Software and Services for Electronic Commerce

The number of commercial Web sites worldwide is expected to grow from 45,000 in 1996 to 100,000 by 2000. Web sites are viewed as a potentially powerful new sales medium. It requires new electronic branding and ability to translate the company's core values into the look and feel of the Web site. The model of the emerging European Electronic Commerce is one of shared risk, as in the short term there will be little return on investment for many players.

New Web-based start-ups and niche operators are trying to gain experience of Internet commerce, and to be well positioned when the market begins to take off. Web developers and Web software suppliers are keen to exploit the potential attraction that the Web development and hosting outsourcing route offers to corporates launching their products and services on the Web.

The cornerstone of all the storefronts in the virtual marketplace, for commercial or consumer use, is Web site development. Its success is measured through the ability to evolve corporate sites from basic home pages into well planned and fully interactive environments. Design abilities can contribute to developing the right combination of faster pages, stronger content and brighter graphics. Despite the intangible nature of success as it relates to the Web, the most important principles that should be observed are to identify exactly the audience the Web page is trying to attract, and avoid slow pages.

Web site software is an extremely important opportunity with a market revenue already exceeding ECU 800 million worldwide in 1997. Web site software areas that offer opportunity are commerce servers, groupware, and Web analysis tools. Web analysis tools help customers measure the return on investment from their Web sites. They track where Web surfers are going on a Web site, where surfers are not going, what surfers like, and what they do not like. Through the use of these tools, merchants in the virtual marketplace can fine tune their storefronts and maximise their business.

Of the many segments affected by the development of electronic commerce, home banking stands out for the key role it will have in finance services delivery strategies. The section below outlines home banking's short term development.

Home banking

The provision of financial services is changing, and it will probably not be very long before branch-based banking is one among many channels used by banks to reach their customers. The recent growth of telephone banking services is already posing a threat to the traditional network of branches. Now the market is changing further as new players, such as large street retailers, move into a sector which was previously the sole preserve of the financial institutions.

Major competitive challenges emerge in the home banking segment. There continue to be various approaches to the delivery of home banking services. They cluster around the following groups:

- Technology companies;
- Bank Web-based banking;
- Bank proprietary systems;
- Banker consortia;
- New entrants from other sectors.

Banks have stepped also up their efforts to compete in home banking. More than 80 European banks now have a presence on the World Wide Web, with more than simple electronic brochures. They offer various types of PC-based online banking through private networks, consumer online services or the Internet. Although banks have traditionally enjoyed almost complete consumer confidence when it comes to depositing money, major financial institutions are now concerned that the widespread brand recognition and use of personal financial software could tip the balance in favour of PC-based banking. For this reason, alliances and partnerships between banks and personal financial software suppliers are an important part of the current market strategy in home banking.

Major players in the personal financial software arena are developing a home banking strategy driven by working partnerships with financial institutions. The strategies mostly center on offering a complete solution to include software, systems, and processing, bringing large numbers of qualified customers to financial institutions, securing a high-volume/low-cost market position over time.

5.7. Online Entertainment Services

Online entertainment service providers have started to launch operations across Europe. Subscribers to online entertainment services can download popular games to play on their PC at home, or play online against other users in new, multi-player games developed especially for the Internet.

The services initially offer a modest selection of traditional games, while the company concentrates on establishing partnerships with games companies and Internet service providers, which can offer online entertainment services as part of their package of services. Meanwhile the portfolio is expanded through signing licensing deals with major games companies. The following step is to get backing from investors and advertising, to expand the offer, adding localised language services for new additional European countries. Attempts to attract families to the service include offering of selection of educational software titles, and online magazines.

Online entertainment services ambitions are not limited to the Internet. As the majority of homes in Europe still do not have PCs, their strategy is also to enter many homes through broadband services such as cable and digital TV. Moreover the bandwidth limitations of the Internet restrict the type of games that can conveniently be played online or downloaded using conventional modem links, while with broadband, much more exciting content can be delivered.

Positioning themselves for the arrival of broadband services, online entertainment service suppliers are signing a number of deals with cable services, which can provide access to games that can currently only be distributed on CD-ROM. The advantage of these deals for the consumer is that some cable companies may provide online entertainment services as part of their standard package of TV channels, at no extra cost for using the service.

Online entertainment service companies are also working on interactive TV programming, although they recognise digital TV will not have enough of an impact to make these new programmes widely available before two years. While digital television will offer 200 channels, online entertainment companies emphasis will be on developing content. They expect this effort to pay off as there is not enough content even to fill 100 of these new channels.

6. Perspectives to 2001

Table 20
Estimated Internet and Online Users, 1995-2001, Thousands

	1995	1996	1997	1998	1999	2000	2001
Business Users	6,466	9,226	12,530	13,247	13,904	15,161	16,279
Home Users	5,860	8,663	11,398	18,231	27,007	37,820	50,394
Western Europe[1]	12,326	17,889	23,928	31,478	40,911	52,981	66,673

1 Incl. Turkey

6.1. Increasing Bandwidth

Availability

The overall number of home users accessing the Internet will grow from around 11.4 million in 1997 to more than 50 million by 2001. Compression and efficient bandwidth use will allow for a much larger pool of Internet users.

The amount of bandwidth available to these users will increase but proportionately to how much users will be willing to pay. Users unwilling to pay relatively high access fees will continue to access the Internet primarily by analogue modem or ISDN (if competitively priced). Improved compression technology is also likely to help throughput. High-end users (those in dense, high-income neighbourhoods) and users sponsored by their corporations will have access to higher-speed remote access options, including DSL, cable, and ISDN.

The evolution of remote bandwidth has the potential to affect the type of Internet access device users will install and the viability of high-bandwidth Internet applications. Limited bandwidth could severely affect acceptance of Internet access devices requiring high bandwidth to the home, such as:

- Network computers, which must download software code to perform basic applications;
- Web TV, that will be directly affected by the percentage of users with cable modem access;
- Interactive games;
- Internet applications, such real-time videoconferencing, real-time voice, and high-resolution graphics.

Internet application providers need to consider that approximately four fifths of home users will still have less than 64 Kb of bandwidth available. There will also be increasing commitment to a second phone line for Internet access. Only some 10% of users will be paying to have high bandwidth available.

6.2. Home Devices

This section examines the direction home devices will follow with respect to the increased adoption of Internet access devices by households.

Demand for true, interactive information, communication and entertainment is confirmed by the following aspects:

- Increasing computer usage by households over time at the expense of passive television viewing;
- Demand for new forms of entertainment content by a new wave of customers;
- Demographic changes resulting in demand for new interactive services, among young families, middle-class families, work-at-home, children and teenagers;
- Home communication devices' recent rise in household consumption.

The battle for the home device is likely to concentrate around three major options: network computers, PC/TVs, and digital TVs.

Network computers

Accelerated investment in the network computing market is resulting in a growing array of product designs, building-block technologies, big-name market entrants, services, and content. In the long term, NCs that are projected to win the greatest market success will build on already-existing devices and usage metaphors.

The forecast for NCs is growing now, but will accelerate after 1999. Nevertheless, the NC market is showing only modest momentum as communications, computing, and consumer electronics industries are looking to provide low-cost, easy-to-use devices that tap into the growing capabilities of the Internet.

Where, when, and at what rate NCs do (or do not) take off in the market - and how well PC and software suppliers anticipate and position their offerings - could largely dictate who the next leaders will be in microprocessors, end-user devices (including PCs), and software.

The largest category of network computers in the home by 2001 is forecast to be smart handhelds. After starting slowly, the *Internet smart handheld* market is expected to undergo a big leap in volume from 1999 to 2001 due to the emergence of the smart-phone category, as well as a majority of handheld companion-class devices using Internet access. By 2001, this category will represent the largest in value.

NetTVs and game consoles will lag far behind because of much lower average device prices. In the near term, the market will be led by sub-ECU 400 set-top products like WebTV.

In the longer-term, NetTV will benefit from an Internet access availability via a number of devices, including traditional cable boxes, TV, and direct satellite broadcast products.

The market for *Internet-enabled game consoles* will start to accelerate by the end of the decade: by 2001, the game console is projected to be the second-largest category of network computers. The following factors are driving this growth:

- By 1999 or 2000, the Internet connection is expected to be a built-in feature on next-generation products.
- *Online gaming* will be on the increase along with the availability of more compelling Internet content.
- The game console industry's focus will be away from standalone to connected gaming environments.

The market for *screenphones using the Internet* is forecast to accelerate growth from 1999 and onwards, thanks to the declining cost of the devices, combined with broad distribution by telecommunications, content, and service providers.

With a plethora of other network computing devices dominating the market in the short and medium terms, there is likely to be only limited opportunity to add Internet access to other devices. In the longer-term a variety of inexpensive Internet terminals will come to market from a number of distribution channels. These devices will focus on communications such as e-mail and conducting transactions.

PC/TV

Even under the best-case scenarios in which broadcasters elect to transmit interactive services and a supporting content subeconomy develops, PC/TVs will still suffer from significant price levels that historically have prevented mass consumer adoption. Demand for interactive entertainment will be better addressed by lower-cost, task-specific NetTV boxes that are more attractive to non-traditional PC buyers.

Through the end of the century DTV will begin to roll out and the interactive content industry will begin to develop widely. Concurrent with the growth in digital television and new interactive services, NetTV boxes will begin riding the growth of interactive demand.

Instead of continuing the traditional PC value proposition, which has not fared well in the consumer entertainment segment, PC/TV vendors could de-emphasise the PC/TV's resemblance to general-purpose PCs and target a more optimised product design. Future PC/TVs could be designed to excel at particular functions, such as interactive content playback and transmission, rather than perform well in a variety of functions, to be more price-attractive as a specialised interactive console device.

6.3. Competition Evolution

As the home market grows, individual component markets will develop and players can capitalise on them. Evolution of competition includes the following trends:

- Companies that have already developed new media products or tools will find increasing opportunities as the market begins to develop.
- Companies that are not pure-play new media producers or online content producers may choose to develop new products in this market, but they may be better off finding a way to partner with new media producers in a way that complements their business.
- Bundled software with pre-selected Internet links also marks a unique partnership.
- Targeting the end-user demand for education and entertainment through pre-loaded links that eliminate complicated and time-consuming downloads appears to be a wide-open opportunity.
- Database vendors would be looking to Internet service providers, online service providers, and even some direct content providers as markets for search tools.
- End-users need robust search tools to access and manipulate the rich content that new media offer.
- Peripherals vendors will see increasing demand for digital cameras and digital sound equipment.
- These products will provide home users with more than just a keyboard as their means of interaction with the digital community.
- These products will prove important not only to PC gamers but also to an increasing portion of the online population.

6.4. Towards the Interactive Society

The rise of the networked household movement is largely tied to the fact that more than two out of every three European households do not have a PC. By comparison, such appliances as the television, VCR, and telephone are nearly universal.

Many forecasts now promise a brighter future for the interactive society.

The European Commission has studied the changing patterns of ICT consumption to develop effective guidelines in its "Green Paper on the Convergence of Telecommunications, Media and Information Technology Sectors, and the Implications for Regulation towards an Information Society Approach", released in December 1997.

According to the Commission, the take-off of new interactive services cannot be simply supply-driven but must take account of demand and, in particular, of the consumer viewpoint. This is reflected in consumption trends which are beginning to show the first signs of a convergence in the home:

- In 1998 for the first time more personal computers will be sold in the world than television sets, although PCs are sold to both businesses and homes.

Table 21
Total Cable TV Subscribers, 1996-2001, Thousands

	1996	1997	1998	1999	2000	2001	CAGR 1996-2001
France	2,280	2,590	2,890	3,170	3,420	3,650	9.9
Germany	17,700	18,500	19,200	19,900	20,500	21,100	3.6
Italy	20	70	300	410	540	690	103.0
Spain	1,890	1,960	2,030	2,090	2,150	2,210	3.2
UK	1,700	2,000	2,300	2,600	2,900	3,200	13.5
Western Europe[1]	**42,733**	**44,925**	**47,004**	**49,003**	**50,827**	**52,631**	**4.3**
Eastern Europe	10,629	11,704	12,439	13,120	13,744	14,324	6.1
Total Europe	**53,362**	**56,629**	**59,443**	**62,123**	**64,571**	**66,955**	**4.6**
USA	64,000	64,640	64,963	65,288	65,614	65,680	0.5
Japan	3,220	4,290	5,910	8,000	10,200	12,290	30.7
Rest of World	74,330	85,119	97,013	108,613	119,741	130,592	11.9
World	**194,912**	**210,678**	**227,329**	**244,024**	**260,126**	**275,517**	**7.2**

[1] Incl. Turkey

Source: EITO Task Force

Table 22
Total Mobile Telephone Subscribers, 1996-2001, Thousands

	1996	1997	1998	1999	2000	2001	CAGR 1996-2001
France	2,501	4,400	6,800	9,500	12,500	15,400	43.8
Germany	5,504	8,000	11,000	14,800	19,000	22,900	33.0
Italy	6,418	11,000	14,800	18,100	21,000	23,500	29.6
Spain	2,996	4,800	6,500	8,100	9,600	11,000	29.7
UK	6,810	8,700	10,900	13,300	15,900	18,600	22.3
Western Europe[1]	**36,001**	**53,632**	**72,115**	**91,332**	**110,878**	**129,463**	**29.2**
Eastern Europe	1,509	3,600	6,258	9,223	12,369	15,649	59.6
Total Europe	**37,510**	**57,232**	**78,373**	**100,555**	**123,247**	**145,112**	**31.1**
USA	44,093	55,000	68,500	84,000	100,000	115,000	21.1
Japan	18,167	28,000	36,000	42,000	46,000	50,000	22.4
Rest of World	36,905	57,295	83,330	113,369	146,249	181,001	37.4
World	**136,675**	**197,527**	**266,203**	**339,924**	**415,496**	**491,113**	**29.2**

[1] Incl. Turkey

Source: EITO Task Force

Table 23
Households with PC, 1996-2001, Thousands

	1996	1997	1998	1999	2000	2001	CAGR 1996-2001
France	3,561	4,330	5,297	6,375	7,551	8,759	19.7
Germany	6,792	7,793	8,761	9,870	10,813	11,772	11.6
Italy	2,397	2,622	2,915	3,266	3,631	3,992	10.7
Spain	1,331	1,342	1,387	1,482	1,615	1,752	5.6
UK	4,707	5,356	5,968	6,604	7,244	7,892	10.9
Western Europe	**25,336**	**29,071**	**33,018**	**37,312**	**41,455**	**45,473**	**12.4**

Source: EITO/IDC Internet Commerce Market Model, 1997

Table 24
Households with PC or NC, 1996-2001, Thousands

	1996	1997	1998	1999	2000	2001	CAGR 1996-2001
France	3,921	4,788	5,894	7,174	8,720	10,862	22.6
Germany	8,038	9,294	10,564	12,199	14,162	17,048	16.2
Italy	2,449	2,691	3,012	3,421	3,919	4,625	13.6
Spain	1,360	1,379	1,436	1,559	1,766	2,034	8.4
UK	5,943	6,815	7,673	8,685	10,097	12,140	15.4
Western Europe	**29,541**	**34,134**	**39,144**	**45,127**	**52,576**	**62,900**	**16.3**

Source: EITO/IDC Internet Commerce Market Model, 1997

Table 25
Households with Internet Access, 1996-2001, Thousands

	1996	1997	1998	1999	2000	2001	CAGR 1996-2001
France	144	393	781	1,237	1,828	3,590	90.2
Germany	892	1,561	2,596	4,223	6,191	9,230	59.6
Italy	140	265	447	685	949	1,619	63.1
Spain	84	160	243	358	522	721	53.9
UK	682	1,142	1,823	2,839	4,316	6,447	56.7
Western Europe	**2,838**	**5,177**	**8,516**	**13,252**	**19,253**	**29,280**	**59.5**

Source: EITO/IDC Internet Commerce Market Model, 1997

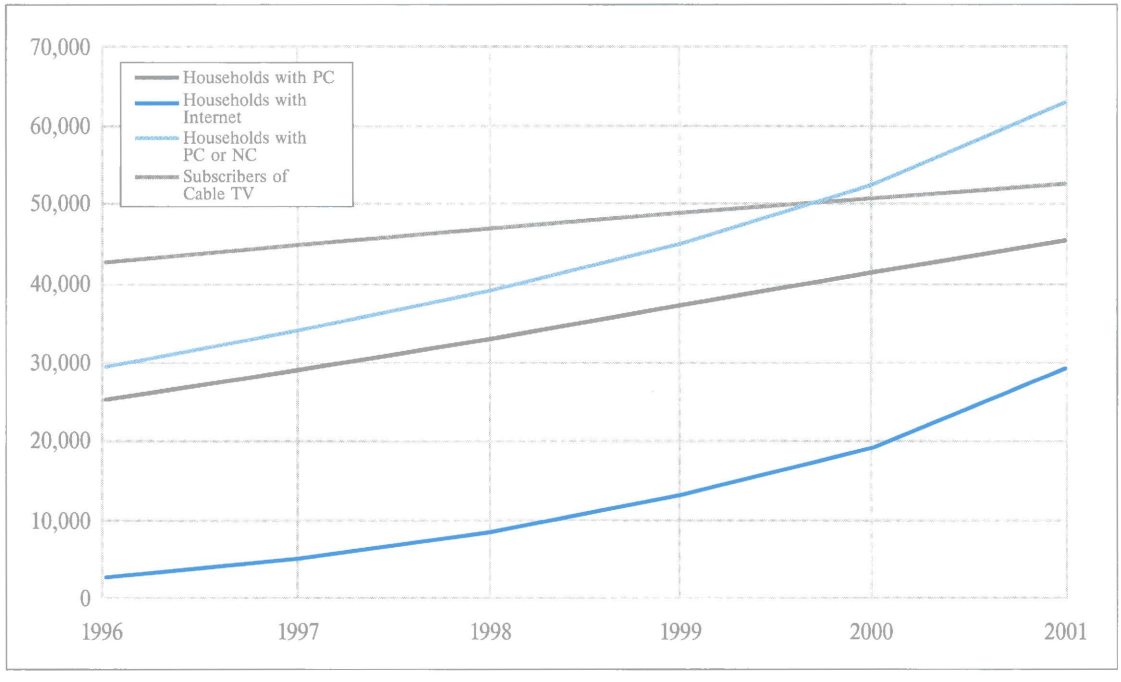


Figure 5
Households with ICT Devices and Services, 1996-2001, Thousands

Source: EITO/IDC Internet Commerce Market Model, 1997

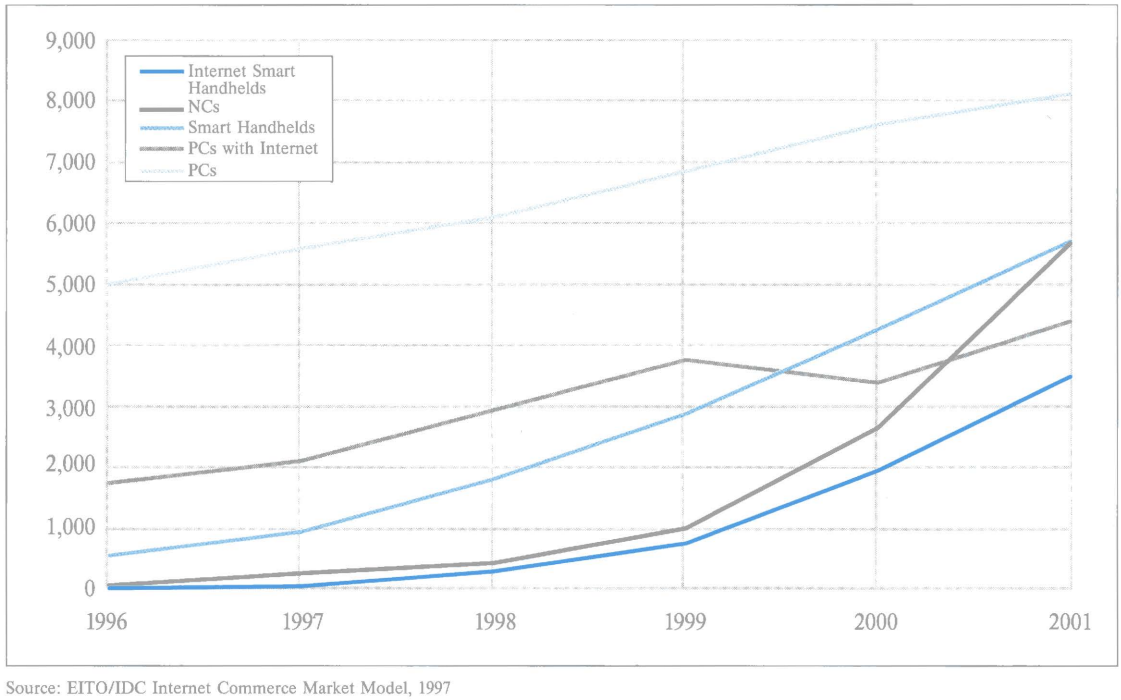


Figure 6
Unit Shipments of Devices for Households, 1996-2001, Thousands

Source: EITO/IDC Internet Commerce Market Model, 1997

Figure 7
European Home Internet Commerce Revenue, 1995-2001

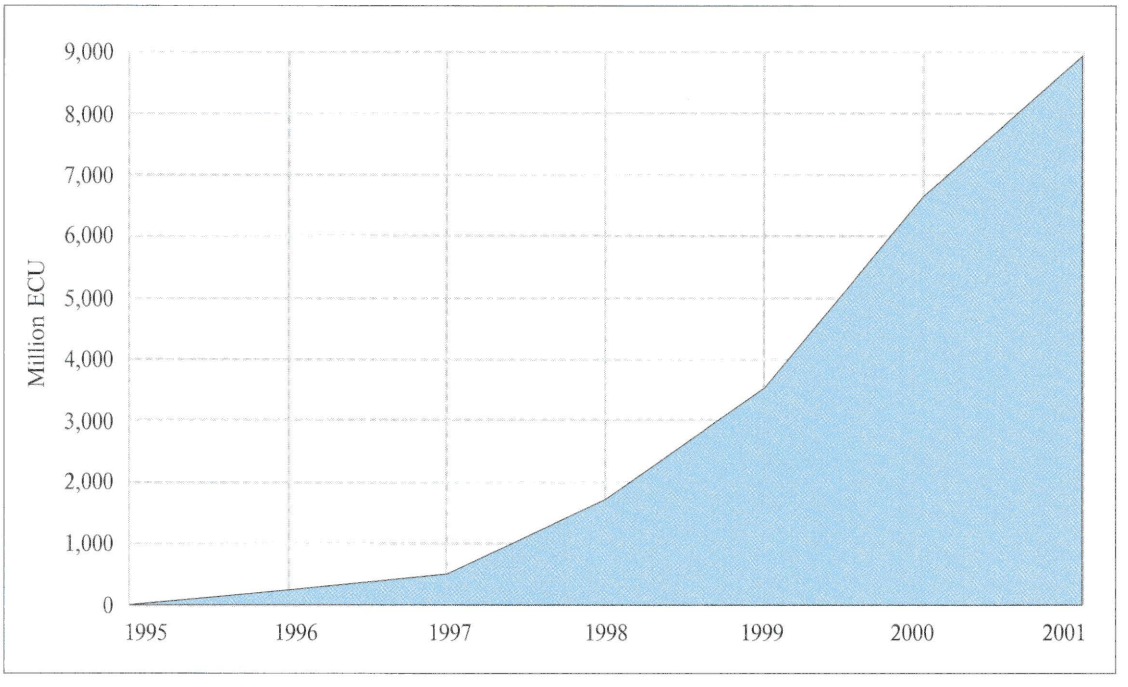
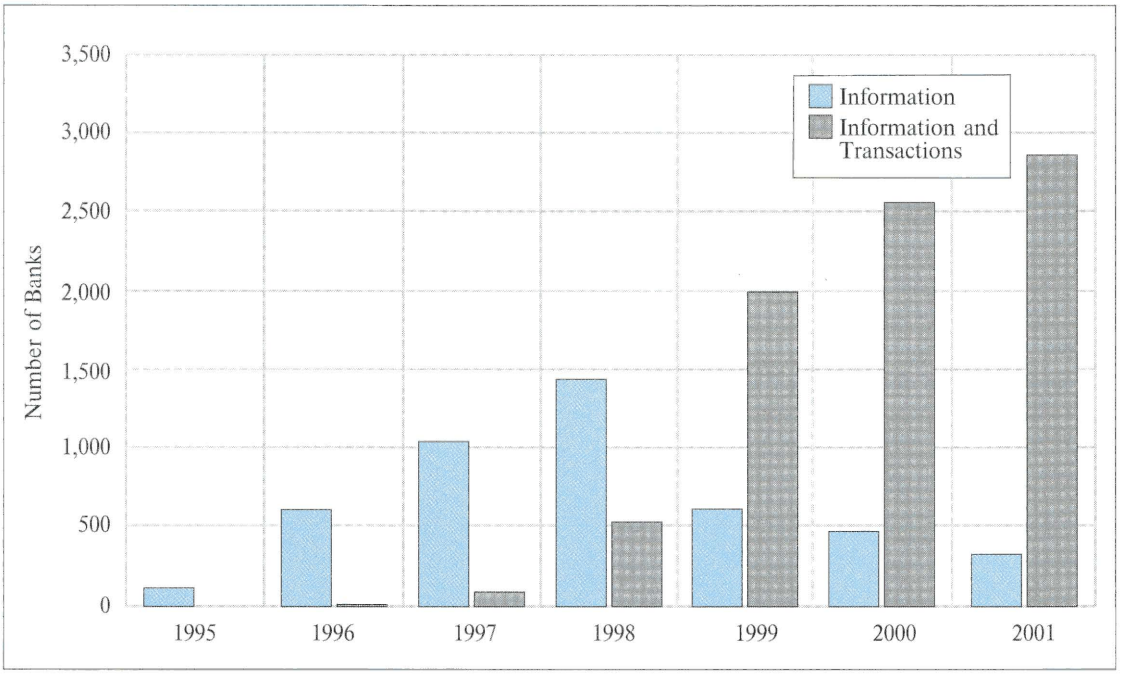


Figure 8
Number of Internet Banking Sites in Europe, 1995-2001



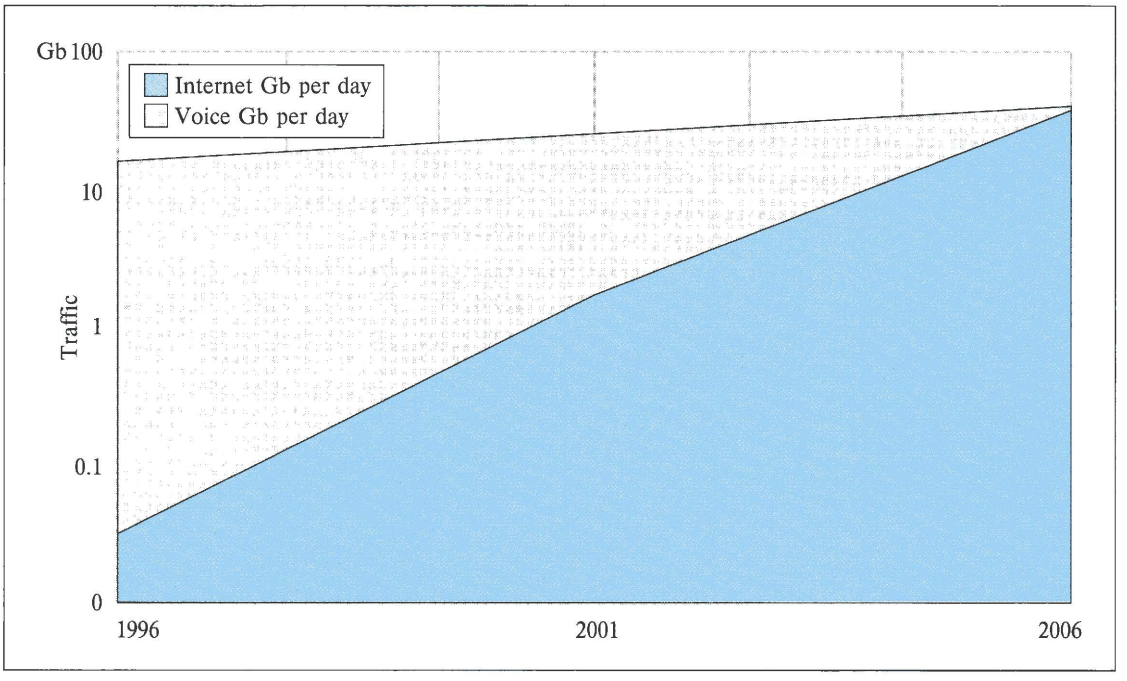


Figure 9
Bandwidth Demand Scenario, 1996, 2001 and 2006

Note: Data presented along a semilogarithmic scale.

- In 1995 US people spent less than half of all screen-viewing time in front of computers; according to recent measurements, Web users already consume 59% less television than average viewers and it is estimated that the TV set's share of screen time will be half that of the personal computer in 2005. On the other hand, audience figures for 1995/96 show that the average daily viewing time in Europe increased by 4 minutes, compared to a decrease of 2 minutes in the US.
- Research into activities displaced by increased personal computer usage shows that watching television loses out rather than reading books and magazines, or playing console video games.
- In terms of available leisure time and expenditure, the youth segments are already opting for interactivity. Video games alone represent nearly 20% of under 16 year olds' total media consumption in some markets.

Supply side trends outlined in the previous paragraphs have to interact more strongly with demand-pull factors, before interactive ICT devices, applications and services for European homes become a mass market reality. This trend can be accelerated by the following aspects:

1) Interactivity synergy

- More free time, because work will be more focused, and electronically enabled with easier access to resources;
- Faster, more precise and more targeted information gathering;
- More effective education;
- More effective electronic forums;
- Wider range of more specific contacts;
- More targeted communications.

2) Fragmentation synergy

- Demand for interactive content is magnified in Europe compared to other worldwide regions due to the multiplicity of languages and cultures.
- Localisation acts and countervails globalisation in the development of services aimed at addressing the habits and culture of European households. These needs have to be addressed by suppliers with a blend of global competitiveness and local uniqueness;
- Cost economies in a virtual dimension can reach competitive levels compared to other geographic regions, as the multiplicity of contents and communications will reach great efficiencies in a fully interconnected work. What was very costly to manage because of fragmentation in a non-connected world, becomes more effective to manage in a virtual world.

The impact of technology-push and demand-pull factors on the dynamics of households demand for interactive access to education, entertainment, communication, shopping, and other applications, generates the following trends in the Western European electronic commerce market:

- The number of home Internet users will be higher than the number of business Internet users (after taking out the effects of double-counting for users accessing the Internet both at home and at work) starting from 1998. There will be more than 50 million home Internet users by 2001, compared to 11.4 million in 1997 (CAGR of 45%). Home Internet users are likely to be found among subscribers of cable services, mobile telecommunication services, and households with a personal computer.
- The number of cable TV subscribers in Western Europe will grow from 44.9 million in 1997 to almost 52.6 million in 2001, an average annual growth of 4%.
- The number of mobile phone subscribers will increase by an average annual growth of almost 25% from 53.6 million in 1997 to 129.5 million in 2001.
- There were some 29.1 million households with a personal computer in Europe in 1997. They will increase to 45.5 million by 2001, an average annual growth of almost 12%.
- The growth of households with either a personal computer or a network computer device (NetTVs, Internet screenphones; Internet game consoles, Internet smart handhelds such as PDAs, high-end organisers, or smart phones) will reach 16.5% through 2001, when there will be some 62.9 million NC or PC households (compared to 34.1 million in 1997), or some 41.5% of Western European households (compared to 22.5% in 1997).
- Households with Internet access will grow from 5.2 million or 3.4% of all Western European households, to 29.3 million or 19.3% of households (average annual growth of 54.2% in the 1997-2001 period).

If the synergy related to increased use of interactive communications and content is combined with more favourable economic prospects a more optimistic view can be justified. The CAGR of Internet connected families in Europe can be upgraded to 75%, as more families will perceive the Internet as an indispensable tool in their daily life. Internet traffic will equal voice traffic in less than eight years.

The growing number of households accessing the Internet reflects a growing trend in unit shipments of Internet access devices. With an average annual increase of 205% in the next four years, unit shipments of *Internet smart handheld devices* will grow from 40,000 in 1997 (or some 4% of unit shipments in Western Europe) to 1.9 million in 2001 (or some 46% of all unit shipments). Unit shipments of network computers in Western Europe are set to grow from 249,000 in 1997 to 5.7 million in 2001, for an average annual growth of 118%. Western European unit shipments of home PCs with Internet access will grow from 2.1 million in 1997 (or some 37% of all home PCs shipped) to 4.4 million in 2001 (or 54% of all home PCs sold), an average annual growth of 20.3%.

As a consequence of more home users accessing the Internet, more time spent by them surfing Web pages, and more goods, services and content available for sale, the value of electronic commerce transactions carried out by households on the Internet is set to increase. In 1997 some ECU 0.5 billions worth of transactions was performed on the Internet. This amount is expected to grow by an average annual rate of 105% to ECU 8.9 billions in 2001.

Growth in electronic commerce will also be favoured by the exploding number of banks moving from pure marketing home pages towards offering financial transaction services over the Internet. This number is due to increase from almost 100 banks in 1997 across Europe to some 2,900 in 2001 (out of some 8,000 institutions currently operating in Western Europe).

As a consequence of the increasing number of users and increasing time spent surfing the Internet, Internet traffic will grow from mere noise in the overall communications world to a more significant trend. In a longer perspective it will grow by three orders of magnitude to equal traditional telecommunicatons traffic by year 2006.

The resulting outlook for tomorrow's interactive society is distinguished by strong optimism, especially on the point of improving communication.

The communication process will be more adaptable to individuals' interests and needs. Unwanted information will be eliminated and replaced with wanted and targeted messages, whether information or entertainment. Users will in some instances pay for this - either by paying a fee or by revealing personal information to the provider.

In the future interactive society, individuals can expect continued frenzied demands on their time, wealth, and commitments. But they will have greater control over what they want to do, when, with whom, and what they are willing to pay. The opportunity for suppliers would be to gain from an early entry into this new market, because if they set the technology rules for creating content for the virtual community, they also ensure themselves market share when they create content and virtual relationships.

The Euro: Impact on Information Technology

This chapter has been provided by GartnerConsulting in close co-operation with the EITO Task Force.

1. Euro Scenario

1.1. Introduction

Economic and Monetary Union (EMU) is a major economic and political project for the European Union. One of the key components will be the creation of a single currency known as the "Euro". The introduction of the Euro will have a profound impact on the way enterprises operate. It will be the most important change in Europe's economic landscape in the next few years. The changeover to the Euro also has a number of practical consequences for the day-to-day operations of enterprises, e.g. information systems will need to be prepared for the use of the Euro.

The Euro will have wide-ranging and significant effects on the operations of business enterprises throughout Europe. From major strategic opportunities and threats arising from changing markets and products, to the detailed operational aspects of adapting information and IT systems to the Euro, it is imperative that businesses plan their changes accurately and punctually. Companies must ask questions such as:

- What exactly does this company need to do?
- Who will be responsible for each phase of the process?
- When will the process happen and how long will it take?

In this chapter, the various steps, alternatives and potential approaches are described, starting with the typology of different companies and the related opportunities and threats.

The chapter works on the assumption that the introduction of the Euro proceeds as planned. It does not consider the likely members and non-members.

1.2. What is the Euro: Timing and Potential Scenarios

The transition to the single currency will take place in three phases, for which definite dates have been set *(Figure 1)*.

1.2.1. Phase A: Euro Launch

The leaders of the 15 EU member states will meet at a special summit planned for May 1998 to decide which countries should join the first group adopting the Euro (starting from 1 January 1999) fulfilling the necessary conditions[1]; the European Central Bank will also be set in place. The conditions for conducting the single monetary and exchange-rate policy will be decided. Preparations in the participating countries will be stepped up throughout this phase, particularly in administrations and in banks and financial institutions.

[1] To become a member of EMU, each EU country must satisfy the "convergence criteria" set out in the Maastricht Treaty, showing that their economies have sustainably converged on certain economic targets. These targets relate to: inflation, interest rates, general government debt, general government deficit and exchange rate stability. Other factors will be taken into account and will have a great impact on the IT projects and the timing and speed of the changeover, for example some national financial agreements (such as the payment systems in Euro in 1999, the stock exchange quotation in Euro in 1999 etc.), the Public Administration approach (issuing and convergence of national debit in Euro in 1999, acceptance of payments and declarations in Euro in 1999) and, finally, the possibility to adopt the legal account in Euro in 1999.

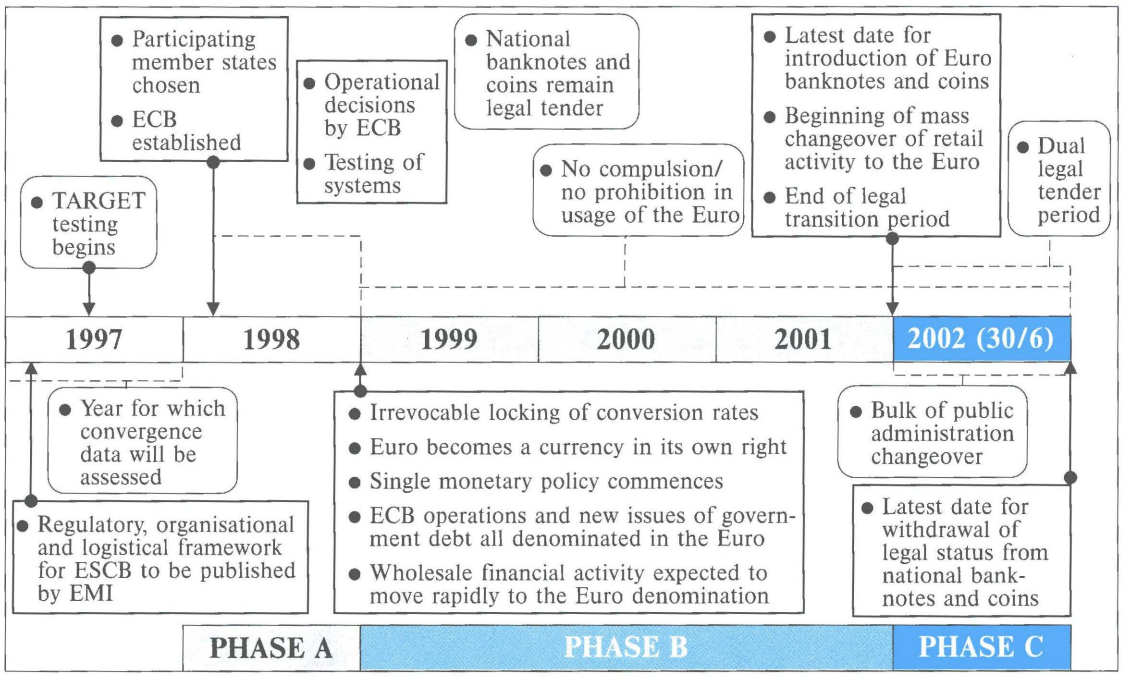


Figure 1
Timeline of Phases A-C.
1997 to 2002

1.2.2. Phase B: Effective Start of the Euro

This phase will begin on 1 January 1999, when the rates of conversion between the Euro and the participating national currencies will be irrevocably fixed and the Euro will become a currency in its own right. The currencies of the participating Member States will be replaced by the Euro, which will be denominated both in its own unit (1 Euro), in sub-units (100 cents) and in national currency units. This phase will end on 31 December 2001.

Companies most heavily involved in international and European trade are most likely to opt for early conversion of all or part of their operations (as will be seen in the next few sections, according to the research). Administrations will also continue to prepare actively for their own changeover, where it has not already been executed.

One of the key issues of this phase is represented by the "no compulsion" and "no prohibition" principles for use of the Euro unit, as laid down in the reference scenario decided by the European Council of Madrid. These principles have to be respected by both economic agents and Member States themselves. As a result, enterprises may be faced with the following situations: a) it may not be possible to file tax returns for income taxes, value added taxes and customs and duties, in Euro, from the start of phase B; and b) other transactions with government bodies and agencies, such as payments of registration fees or sales and purchases, may only be possible in the national currency unit during phase B. The important conclusion is that business and public enterprises will have to deal with amounts denominated in Euro and national currency units during the transitional period. Few, if any, enterprises will be able to avoid using the Euro before the end of the

transitional period (in the following sections it will be shown that this is also true for SMEs – Small and Medium Enterprises that can be pushed to adopt the Euro early by their main customers or providers).

Hence, even if the final changes are scheduled by 1 January 2002, the majority of companies will be concerned by the Euro from January 1999, as any company from this date could choose to make payments in Euro (including taxes and wages). It will also be possible to open bank accounts in Euro. This is a key decision for companies; the choice must be based on strategic, business, organisational issues.

To summarise, during phase B:

- Double quotation of currency is possible.
- Member States can allow markets to operate and price in Euro.
- With regard to financial information and accounting:
  - Accounting in Euro must be authorised by Member States, which can authorise but not enforce the choice of Euro.
  - According to EEC directive 90/604, Member States can publish their accounting information in Euro.

1.2.3. Phase C: Definitive Changeover to the Euro

After 31 December 2001, amounts which are still expressed in national currency units of the participating Member States on 31 December 2001 will be deemed to be expressed in Euro units, converted at the official rates. Not later than 1 January 2002, and over a short period (which will be determined by each Member State but will not exceed six months), the new Euro banknotes and coins will be put into circulation to replace the old national currency units.

This phase should last no longer than is strictly necessary, in order to minimise any complications for users which could be caused by national currency units remaining in circulation for an extended period alongside the single currency (this is a key point which is still under discussion). The operation will end by 1 July 2002 at the latest, when Euro banknotes and coins will be the only legal tender in participating Member States.

2. The Impact of the Euro on Companies

The most important economic benefits of the Euro are as follows:

- Transactions costs of exchanging different currencies will be eliminated (these costs, which include commission charges and the bid to offer spread, account for around 0.4% of European Union GDP).
- Short-term (day-to-day) intra-EU exchange rate volatility will be eliminated, thus eliminating the difficulties caused by trade and investment from this source.
- By eliminating exchange rate uncertainty, the Monetary Union should lower the risk premium built into interest rates.
- The Monetary Union should promote and maintain price stability.

Enterprises must evaluate how the Euro and the changeover to it is likely to affect them. Preparations must be very careful and timely, so that each company can make the transition smoothly and be ready to deal with the challenges and new opportunities. There are many implications for a company, both business/organisational and technological *(Table 1)*.

- *Information Technology* (to be analysed in the following sections of this chapter). Among the issues confronting this function are choice of changeover dates, choice of strategy for changeover (e.g. parallel systems, replacement systems, etc.) and resource implications, in terms of equipment, software development, staff training, interface with supplier and customer systems.
- *Accounting.* Similar issues will arise for the accounting function: choice of changeover times; interface with suppliers and customers; treasury management issues; banking services requirements; implications for training; budget planning; cash handling operations; and preparation for the new notes and coins.
- *Legal aspects.* EU level regulations will cover issues such as continuity of contracts, rounding rules, etc., that each company should implement in order to review existing contracts and to plan new ones.
- *Purchasing strategies.* These will also be affected by the Euro, either because they are part of a new market strategy for the enterprise or because the Euro would create opportunities for savings.
- *Marketing.* Rethinking of company strategy in light of the Euro and the necessary changeover may identify new opportunities and challenges but, even with no changes in market strategy, some issues would need be faced, such as pricing policy, price lists and catalogues and a display of prices.
- *Production management.* According to the Euro opportunities and challenges in exporting, some issues could be faced, such as product modifications, new products development or changes in the production processes.
- *Training.* Staff will need to be able to implement the company strategy for the changeover and to carry out the operational changes needed to achieve it. Issues include: drawing up the main lines of the training programme; a detailed training requirements specification; and planning for the outsourcing of additional training resources, if required.
- *Personnel administration.* This function will play a key role in ensuring that the changeover goes smoothly, especially with regard to the following issues: planning and implementing staff changes; communicating company policy on the changeover to all staff (including the changeover of salaries and benefits to the new currency); receiving feedback on any special requirements.

Table 1
Main Implications for a Company Evaluated from the Key Issues

Are there any significant differences between large companies and SMEs?

Even though the key issues in evaluating the Euro changeover are often not very different for large and small companies, some differences have to be noted:

- Small and medium-sized enterprises are the suppliers, sub-contractors, affiliates or customers of large companies and are therefore stronger depending on the choices of partners.
- A large company is likely to have specific departments for each function; in a small company, many functions may be carried out by one person, with potentially large time and work problems. There are two ways to make the workload easier:
  - Collecting information - many business organisations and other bodies will be looking at the issues of the changeover, and they can be consulted on these issues.
  - Outsourcing of services - if a company does not have adequate resources, it can plan to use the services of other companies and professionals to do the work.

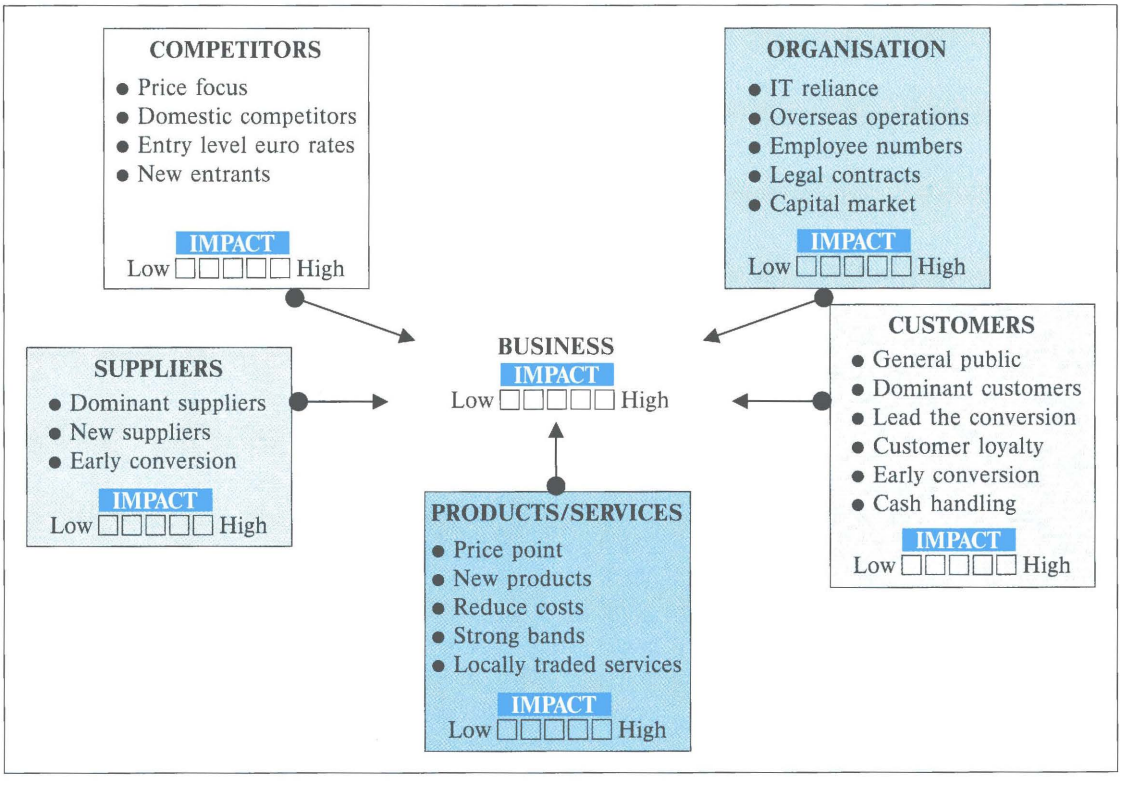


Figure 2
The Key Areas to Evaluate the Business Impact of the Euro on a Company

2.1. Company Impact

Each company is called on to evaluate its own market positioning and the related Euro impact. The evaluation is very important, in order to decide what to do and when, in order to prepare the company for the changeover of Euro; IT plays a key role in the changeover.

Many European organisations have given a check list of issues that they must evaluate. There are five key areas for consideration *(Figure 2)*:

- Customers;
- Products/services;
- Competitors;
- Suppliers;
- Organisation.

Expanded are sample characteristics of businesses that make them more or less open to direct impact. The listed examples are indicative, and it is important to stress that the Euro will present at least as many new opportunities as threats to a company's business - for many European companies, this presents an opportunity to review business positioning, strategic focus and direction.

Customers

The Euro may significantly affect a company's customer base and how it conducts business with them, both during and after the changeover process. Issues include: managing customer relationships; discussing relevant issues before the changeover; defining pricing strategies; and managing supporting technology. The Euro changeover may also give rise to opportunities in overseas markets, once the foreign currency barriers are removed.

High impact characteristics:

- *General public.* The Euro is a complex issue and the process of communicating the effect on the customer relationships, and training staff to deal with the issues, is likely to be particularly challenging for enterprises which sell primarily to the general public. Issues will include pricing, invoicing, explaining the transition process, converting balances to Euro and helping to minimise disruption to customer relations.
- *Dominant customers.* For enterprises with a small number of major customers, there is a particular risk that these customers will be in a position to dictate the timing of changeover to Euro pricing and transaction processing. The changeover may consequently be brought forward or delayed and these companies should bear in mind that larger companies are likely to convert earlier (as will be seen, this is the preference of most of the large groups we analysed). Given that each of the customers has a choice of dates, within the three-year period from 1 January 1999, the most difficult issue to deal with may be the variety of customer conversion dates and a potential extended period of dual currency operations.
- *Opportunity for market leadership.* The Euro could be a significant opportunity to gain a competitive advantage, if the company is one of the first to publicly address the related issues and discuss them in a knowledgeable way with its key customers. Many key European banks are doing this.
- *Focus on domestic markets.* For enterprises which do not export to other EU countries, opportunities may arise to compete in these markets once the foreign currency barrier is removed.
- *Customers who shop around.* Some customers may be more inclined to buy from other competitors once exchange risks and transaction costs are eliminated, and the prices being offered in different countries become more comparable (as in the telecoms market, described above). The transparency of prices for products sold across Europe will increase greatly, with customers querying Euro-based price differentials that cannot be explained purely by transportation costs.
- *Cash handling.* Enterprises dealing in large volumes of cash will have particular conversion difficulties during the dual currency period. Customers will be free to pay cash in either Euro or national currency for a period of up to six months. These dual currency issues may well be mitigated by increasing the use of electronic payment methods, such as debit cards, smart cards and Internet-based banking.

Products/services

The Euro may affect the design and positioning of the company's products/services. The monetary issues may open new product opportunities arising from closer economic union as well as the changeover process itself.

High impact characteristics

- *Important price points.* If the key products rely on particular price points (e.g., under £ 10, under £ 100, under FF 100), then when the Euro becomes the accepted medium of exchange, the price points are likely to shift. This may need a re-evaluation of the target pricing for the products and even result in a need to reposition/redesign such products.
- *Specific Euro-related product/service opportunities.* Some companies could evaluate the new product and services opportunities from the Euro process. Industries expected to benefit include: financial companies; information and communications technology providers, for systems issues; printers and designers, for redesign of packaging/brochures; and professional service providers, such as accountants and solicitors.
- *Foreign exchange transaction costs.* The relative impact on the company margins, has to be analysed carefully.
- *Efficiency of production process.* The deepening of the single market associated with the Euro is expected to favour enterprises whose production processes and costs compare favourably with their international competitors. Less efficient producers are expected to come under increased pressure.

Competitors

As a major step in the process of deepening the single European market, the most significant economic impact is expected to be an increase in competition across European borders.

- *Price-focused competitors.* For enterprises which compete primarily on price, the opportunities and risks presented by the Euro are clearly high, as all prices will be in Euro and direct comparison will be far easier than at present.
- *Entry level exchange rate.* The entry level exchange rate for the local currency against the Euro is obviously important to enterprises' competitive positions.
- *Threat of new entrants.* Enterprises whose competitors, both domestic and foreign, currently see intra-European foreign exchange risk and transaction costs as major barriers to cross-border trade within Europe are likely to review their plans for European market penetration post-Euro.

Suppliers

The source and cost of supplies of goods and services may also be affected by the Euro, particularly by the timing of the changeover to the Euro by the major suppliers. New purchasing opportunities will arise with alternative European sources, but a company may have its conversion timetable influenced by the behaviour of important suppliers as of important clients.

- *Supplier opportunities.* The Euro may present an opportunity to find new suppliers in other EU countries and to buy directly from producers in Euro-participating countries.
- *Supplier readiness.* Companies must ensure that critical elements of their supply channel are properly prepared.

Organisational factors

Organisational issues may also affect the impact of the Euro on the business.

- *Reliance on IT for key business processes.* The systems conversion costs may be significant and must be included in future IT strategies and budgets.
- *Overseas operations.* Organisations with overseas business units will have more complex changeover issues to deal with, although their administrative operations should benefit from the Euro.
- *Employee communication.* The process of communicating the implications of the Euro to employees is obviously more challenging in larger organisations, as is the provision of training to help staff recognise and deal with Euro-related issues.
- *Multi currency and long-term contracts.* Legal agreements most affected are likely to be in multi-currency areas, where contract terms extend beyond the conversion dates. Where simply substituting a Euro amount for a domestic currency amount (or other participating country currency) is not a comprehensive solution, difficulties may arise. In particular, complex legal agreements drafted without any consideration of the Euro process will need to be reviewed. Also of concern is the impact of the Euro on contracts drawn up under the jurisdiction of non-EU countries (e.g. US contracts).
- *Finance and capital market transactions.* Significant benefits from the Euro are expected for enterprises which will be in a position to access Europe-wide capital markets. This is primarily due to new opportunities to obtain funding outside domestic banking arrangements, and the expectation that the Euro will significantly increase competition between European banks. In addition, the rationalisation of European stock exchanges is also expected and the Euro may be an opportunity to re-negotiate entire banking relationships.

The Euro can be both an opportunity and a threat. *Table 2* indicates that the Euro's arrival is mainly perceived as an opportunity.

Mainly an opportunity - 75%	**Mainly a threat - 25%**
Disappearance of foreign exchange risks in European transactions (sales and purchases)	Relevant conversion costs with no benefits in terms of sales/savings
Simplification of finance and administrative processes (mainly treasury processes)	Relevant changes in operations
Streamlining of relationships with banks (number of supplier banks will be reduced)	Loss of revenues from foreign currency transactions
Benefits in terms of image when adopting the Euro	Downward pressure on prices
Increased price competitivity because of market transparency	Impossibility to justify different pricing policies in different countries
Opportunity to increase sales in Europe	Cultural problems in adopting the Euro
Opportunity to introduce Euro-based products	Risks of failure or bad management in the Euro project

Table 2
What is your Evaluation of the Euro Impact on your Company Business?

According to the companies analysed, the main Euro benefits are in terms of monetary savings and financial/administrative process rationalisation, rather then new business opportunities. Some industry differences can be underlined:

- Multinational and export companies will benefit from the simplification of financial processes (in many cases, the finance department will be reorganised).
- Large groups will benefit from the simplification of inter-company transactions.
- Utilities, retail and other companies focused on the domestic market will suffer relevant changeover costs, mainly in terms of changed management and pricing activities, with few benefits. This is particularly true for companies which have a large number of customers and a relevant activity in invoicing and receiving payments.
- For banks and financial companies, the Euro is both a business opportunity (new market/products during the transition period and after the Euro completion) and a threat (loss of revenues from foreign currency transactions and a review of relationships with banks by corporate clients).
- A number of SMEs are sceptical about the Euro but there are different approaches:
  - Most are focused on domestic markets and do not believe they will be able to benefit from the Euro, in terms of increased competition and export opportunities; some SMEs with export activities believe that the Euro will mainly benefit multinationals, in terms of financial and administrative savings, but will not have a relevant impact on their business.
  - Some SMEs consider the Euro to be a competitive tool, especially for some specific targets (corporate customers, business travellers, etc.).

2.2. The Impact of the Euro on IT Systems

The impact of the Euro on IT will be substantial. The scope of technical changes will depend on both business type and geographic location, but the following may be included:

- Output and input representations of currency data will change. Screen and report layouts must be modified to reflect the changes (e.g., new currency names and field widths). Paper forms read by optical character recognition devices must be redesigned.
- Database schema definitions may need to be modified to change currency field lengths and, perhaps, add currency indicators and decimal points.
- Programme logic changes may be required for decimalisation, new rounding rules, changed declaration sizes for internal calculations and new validation. Specialised financial systems may also be affected by technical issues still under discussion (e.g. the possible harmonisation of interest calculation periods).
- Historical financial data must be converted to Euro, or new business rules must be implemented to perform "on the fly" conversion or combination of pre- and post-Euro values.
- New business processes must be supported by new applications. Examples might include the extension of a single-currency retail system to support dual-currency trading and price printing during the changeover period.
- IT system changes will require corresponding support, documentation and training that may extend beyond staff to customers and even end-users. For example, some organisations will need to establish customer help lines to answer queries about invoices or statements.

- Organisations must update or replace currency handling hardware, such as automated teller machines (ATMs), point of sale (POS) terminals, credit card charging terminals and coin-operated machinery.
- External interfaces, such as electronic data interchange with trading partners, must be re-negotiated. Interfaces with government (e.g. to satisfy legal requirements related to financial reporting) must be modified.
- It is likely that the EC will define a new single-character symbol for the Euro. If adopted, this would require changes to keyboards, fonts, character-generator read-only memory (ROMs) and printing hardware (e.g. daisy wheels).

In order to define the minimum effort required to deal the Euro changeover, it must be noted that only systems used to process financial information in one of the participating national currencies can be affected by the Euro changeover. This means that many information systems - those dealing with non-financial information - will not be affected by the Euro at all, unless for business strategies.

Examples of systems affected by the introduction of the Euro include:

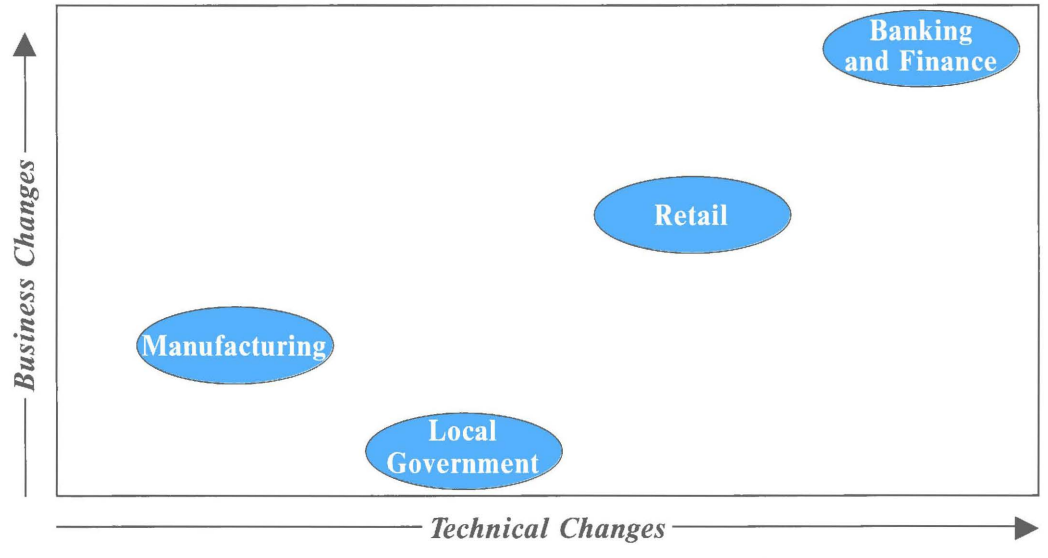
- Accounting software (general ledger);
- Electronic payment systems;
- Invoicing and billing systems;
- Payroll systems;
- Accounts receivable and accounts payable sub-ledgers (the information systems that record transactions in detail; usually linked to the general ledger, which records only part of the details or a summary of the details of a financial information system);
- Inventory sub-ledgers, which record the value of the inventory;
- Fixed asset sub-ledgers, which keep track of the fixed assets and their value, and calculate the depreciation charge for the period;
- Work-in-progress systems;
- Financial planning and budgeting software;
- Enterprise resource planning (ERP) systems.

The above list of financial information systems is certainly not meant to be exhaustive. Many specific categories of information systems that will also be affected by the Euro are easily overlooked, for example:

- Enterprises often have more financial information systems to process financial information than they themselves realise. This is especially true for large enterprises that have standardised on a certain software package. Many branches of such large enterprises use additional software packages that the parent company is not aware of.
- Some financial information systems are not used by the accounting department, for instance software for making cost calculations or databases, as used by the marketing department. It is easy to overlook these applications if the Euro changeover is initiated from the accounting department.

Finally, it should be noted that the Euro project, in many companies, could also involve other applications and functions, according to new business strategies.

Figure 3
Implications of the Euro Support



The Euro support requires applications to be changed for technical changes (new currency formats and calculation rules) and business changes according to new threats and opportunities. The scope and the ratio of technical-to-business changes varies by industry sectors (as illustrated), company typology and geography.

2.3. Which Companies are Affected?

The Euro leads applications to be changed in two ways: first for technical reasons to support new currency formats and calculation rules. The second type of change occurs as the business responds to the new challenges and opportunities. The urgency of Euro projects, their scope and the ratio of technical-to-business changes will vary by geography and industry sectors (see *Figure 3*).

Financial organisations in countries likely to adopt the Euro early are affected the most, as they may need to complete major system changes before 1999. Many such organisations have already started Euro projects, on the assumption that it will proceed, because they cannot afford to wait until the time table becomes clear. At the other end of the spectrum, organisations outside the financial sector, and located in countries unlikely to adopt the Euro, may not need to consider the issue for several years.

Banking and finance are most affected by the Euro for a number of reasons:

- *Highest business impact.* The following opportunities noted by companies interviewed will impact on banking systems:
  - Relevant streamlining of relationships with banks;
  - A reduction in exchange risks;
  - Simplification of accounting in foreign currencies;
  - Increased competition among banks, which will in turn improve terms and conditions for business customers;
  - The lowered inflation and interest rates;
  - A reduction in the number of banking partners, etc.

It is interesting to note that savings from the Euro will far exceed the changeover cost for most companies, excluding the retail and financial sectors.

- *Highest impact on information systems.* Nearly all the systems need financial information.
- *Banks must be ready by January 1999* (at least for a part of the changeover). This brings a higher risk of not being ready in time, a shorter time frame and potential overlap with the year 2000 project.
- *They could gain more competitive advantages* by offering Euro products and services during the transition period.

The retail industry will play a key role in the Euro changeover, strongly influencing the private sector. In addition to helping the consumer, it will play a major role in withdrawing the old currency from circulation and introducing the new currency. Hence, the key issues for this sectors are represented by:

- The dual pricing and pricing policy;
- The payments (e.g. check-out counters, POS devices);
- The management of high volume of cash (more problems in the changeover period).
- Furthermore, dealing with a large number of customers is a complex issue in itself:
  - Process of communicating the effect on the customer relationships;
  - Training the staff to deal with the issues;
  - Monitoring the requirements and attitude of SMEs and private customers, and thereby deciding the speed of changeover, is complex.

Public administration will be affected, too: the necessary IT changes cover every single application in a country's public administration - vertically from a national level down to municipalities, and horizontally into parafiscal systems, such as autonomous public social security systems.

Individual national transition plans can differ considerably. For example, at least six Member Countries foresee a concurrent option between the Euro (as scriptural money) and national currency units, from 1 January 1999, for all enterprises' payments and communications for, e.g. tax declarations, fiscal and social security systems, and ensuing IT applications. But other countries will attempt to initiate most of the public administrations changeover on 1 January 2002. However, even from that date onwards, national currency denominations will have to be used in government for some time - in some countries for several years (e.g. tax declarations for fiscal years up to 2001, legal archiving requirements etc.).

All the other companies are affected because of the need for changes in financial applications, relationships with other European countries (export business, multinational, travel and tourism) or because of issues of invoicing processes and pricing policy, such as utilities, which are likely to be affected by the Euro in the second phase.

2.3.1. What about SMEs?

Many small firms, of up to 10 employees, are less critically IT-dependent than firms with up to 500 employees that would be able to buy low cost standard products off the shelf, supported by local service suppliers. These products and services were not widely available until 1997, but the general feeling is that the market would generate them in plenty of time, given the improvements apparent in terms of political certainty and an increasing flow of information.

The medium-sized companies, with between 500 and 5000 employees, had the most need to start preparations early; they had individually designed or adapted programmes, and resources for adapting them were limited and becoming more expensive. They also suffered more severe constraints regarding IT budgets and availability of analysts capable of contributing to reviews and revisions of their essential business processes. These medium-sized companies could be under time pressures as suppliers to major companies; a number of them have declared that they will operate exclusively in Euro from the start of the transition period (1 January 1999). Some of these major companies are expected to encourage their medium-sized suppliers to invoice in Euro.

2.4. The Costs and Risks of Supporting the Euro

2.4.1. The Costs

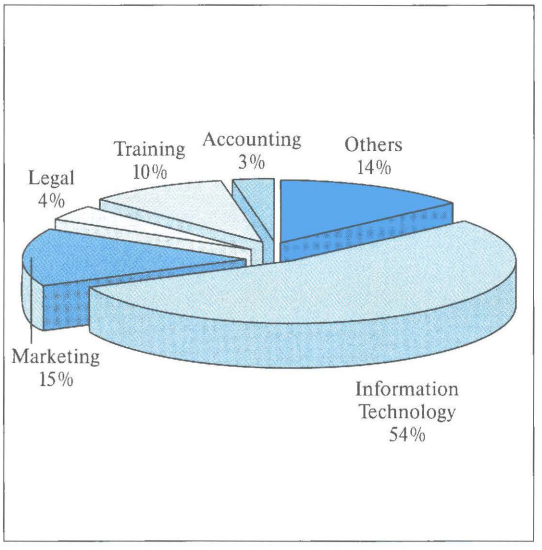
The Euro support will involve several cost elements:

- *Direct costs of programme development and testing.* The effort required for invasive changes to an individual programme will be approximately equal to that required to achieve year 2000 compliance. Estimating factors similar to those used in year 2000 projects (e.g. ECU 1.4 to ECU 1.9 per executable line of code) are appropriate for programmes requiring invasive modifications. In the case of financial applications, the cost of the Euro conformance will be higher because of additional new development work required to support new business rules. Countries with a decimalised currency (i.e. one that uses a decimal point), such as the United Kingdom, will find the Euro adoption significantly cheaper than those countries that do not use a decimal point, such as Italy and Spain. The cost of decimalisation alone can be comparable to year 2000 conformance for financial systems.
- *Package costs:* Significant updating, reconfiguring or replacement of packages may be required.
- *Data conversion costs:* There is a direct cost of conversion, as well as risk incurred, for some organisations which will have to reorganise databases in the limited number of weekends remaining before January 1999.
- *Project management costs:* The Euro support can be very complex (more complex than year 2000) and, for most organisations, will involve multiple, related, complex and large projects.
- *Impact assessment cost:* Determining the impact of the Euro is a significant project in its own right.
- *Operational costs:* Converted systems may require more disk space or processor cycles.
- *Hidden and indirect IT costs:* Many IT applications dealing with financial data are not under central control. Large organisations may have thousands of PCs, and many personal and workgroup PC applications manipulate and store financial data using macros, personal databases and simple programming tools. The cost of finding and "Euro-enabling" these applications and databases will be substantial, and will probably also be hidden from conventional IT budgets.
- *Hardware costs:* Changes to hardware, such as keyboards, ROMs and cash-handling machinery involve significant manual effort and relatively long lead times.

Other elements that have to be taken into account are:

- *Overlap with year 2000 conformance efforts.* This will involve companies (many multinational, large, corporate banks and financial companies) which have decided to adopt the Euro from January 1999.
- *The cost of uncertainty.* Plans must be continually revised to track the changing political climate and the varying adoption plans of business partners. Relatively minor political changes, such as revising the changeover period (now defined as a maximum of six months), could imply large IT cost changes.

Costs will vary by industry - a key driver being the amount of business change implied by the Euro. A number of estimates have been published, mostly by financial institutions which are particularly aware of the issues: Figures ranging from 13 million ECU to more than 130 million ECU for individual European banks have been quoted - such costs typically include software, hardware and training elements. Some financial organisations claim that the Euro support may cost the IT organisation up to five times as much as year 2000 conformance; however, such estimates may be misleading, as they are worst case figures that include decimalisation, hidden year 2000 work and the costs of supporting significant new business functionality. EuroCommerce, a retail industry lobbying organisation, has estimated that the total cost - including costs such as hardware, software and training - to the European retail industry ranges from 27 billion ECU to 42 billion ECU, depending on legislative requirements. Individual, large European retail and industrial organisations, such as vehicle manufacturers and store chains, have already published cost estimates exceeding 50 million ECU. The move to the Euro will come with a substantial price tag, not least for converting IT systems which handle cash. The Association of Payments and Clearing Systems (APACS) predicts that the total bill to UK companies will be almost 800 million ECU, 50 percent of which will be used for changing IT systems. APACS also contends that the process of converting to a single currency will take three years - and potentially longer, if dual currencies need to be supported.



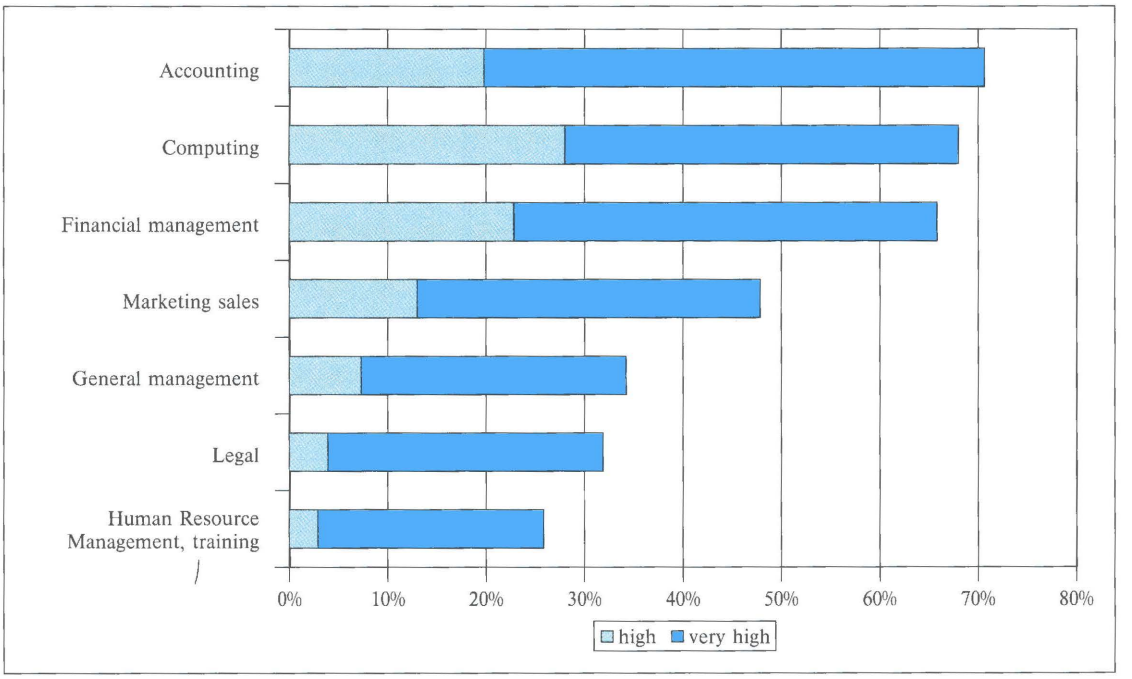
Source: The European Banking Federation

Figure 4
The Banking Costs Breakdown

Available estimates in general consider the costs of changing all existing systems, assuming that these will stay and be converted to handle the Euro. Application suppliers may be able to offer less expensive solutions, either through generalised conversion packages or by incorporating changes in revised versions of their software and providing standard tools for the transition phase.

The European Banking Federation's estimate *(Figure 4)* and some companies' evaluations, as

Figure 5
How Companies Consider the Cost of the Transition to Single Currency



Source: CEGOS for the Association for the Monetary Union of Europe (AMUE)

shown in a CEGOS survey *(Figure 5)*, can be looked at in order to understand the breakdown of costs.

A significant issue is represented by the fact that, even by 1997, IT directors still had little understanding of the potential impact of the Euro, in terms of budgeting for conversion projects; this is revealing in the lack of illumination it provides. IT end user organisations clearly have nascent views on what the Euro will cost their businesses and what it may or may not mean to them, but more than 50 percent of managers and directors (see *Figure 6*) had no idea at all of the cost of this type of projects.

2.4.2. The Risks

The Euro poses many business challenges that ultimately will impact the IT community. According to the uncertain scenario a key issue for companies is the potential delay in starting the project that could imply a number of risks - these can be listed as follows:

- Failing to be ready in January 1999;
- Further compression in the already short time-frame for the project;
- Greater resources problems (resources already committed to other companies that made an earlier start);
- Rather than being an opportunity it becomes a survival project;
- By completing this project late losing competitive advantages to those companies that completed earlier and are now implementing new applications.

The business and IT impact may change substantially during the next few years, as the Euro process evolves and technical details are clarified. Modifications to the changeover

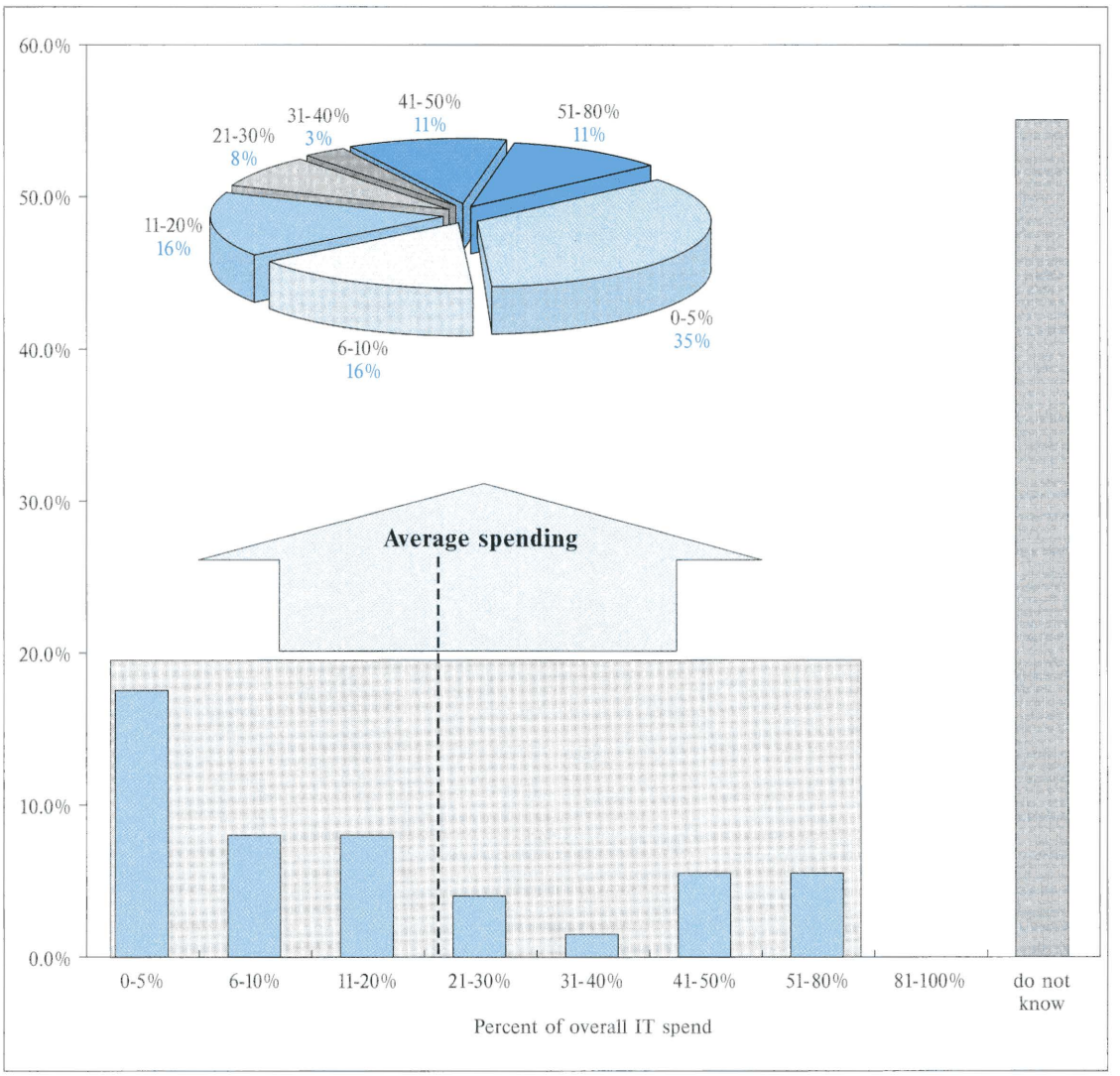


Figure 6
Euro Project Spend as a Percentage of Overall IT Spend, Europe 1997

Table 3
Companies' Approach by Industry

Company category	Companies' approach by industry
Banking and Finance	Most banks will be ready in order to guarantee the Euro operativity (in some countries such as Germany and Italy most banks signed an agreement with the Banking Association). Many banks are developing Euro products and services in order to gain competitive advantages during the transition period
Insurance	A high proportion of companies are working in order to guarantee some or all services Euro-compliant
Manufacturing and Retail	Wide variation depending on the geographical positioning, size, and business
Services	Approach is strongly affected by the activity/market, most companies planned to be ready by 2002 (i.e. most utilities are likely to manage only the dual pricing; most tour operators and hotel chains are already developing Euro services)
Public Administration	Depending on country, about 40% of EU Public Administration have already decided to accept payments and declaration in Euro

process from local-currency notes and coins to Euro notes and coins are particularly likely to have a substantial impact. The precise timing for the introduction of Euro notes and coins has generated considerable debate. European retail organisations in 1997 petitioned to move the proposed date from January to another month, so that to avoid conflicts with year-end sales, and also suggested that dual pricing should be optional, because of the large IT and labour costs required for such "throw away" system changes. Monitoring and management of the changing technical and business environment will be vital to successful adoption of the Euro.

Developers must be realistic - not optimistic. The cost and complexity of overlapping Euro and year 2000 projects, combined with a European shortage of skilled resources, will result in many organisations failing to complete either project on time. Business and IT groups must work together to plan for the worst case before it occurs - prioritisation is vital. As with the year 2000, the most important systems must be addressed first. A typical order might be:

1. Customer-facing, mission-critical systems;
2. Internal, mission-critical systems;
3. Internal, operational systems;
4. Peripheral systems.

3. Company IT Opportunities and Threats: Typical Approach

3.1. Euro When? Some Considerations about the Company Approach

Each company is formally free to decide the timing of the Euro changeover between January 1999 and January 2002. As already noted, examples of early changeover plans are banks that have to guarantee the conversion into Euro of wholesale payment systems and settlement/delivery systems as from 1 January 1999 (in some countries, such as Germany and Italy, banks have signed an agreement proposed by the National Banking Associations, in order to guarantee some key products and services Euro-compliant from January 1999).

Company category	Companies' approach by country participation
Domestic-country probably IN	Wide variation depending on industry, size and business, but the majority of larger companies is already facing the Euro issues
Domestic-country probably OUT or late	Wide variation depending on industry, size, and business, but most companies are still waiting
Multinational	A vast majority decided to operate in Euro by 1/99. Some different approaches: all or part of activities, which activities, which countries

Table 4
Companies' Approach by Country Participation

Company category	Companies' approach by size
Large	Approaches vary depending on the industry, geographical coverage and business, but many very large firms have started preparing for the Euro early and would make a successful changeover
SMEs	Only 10-15% of SMEs have taken action to prepare for EMU. Smallest (up to 10 employees) are less critically IT dependent. Medium-sized companies (500-5000 employees) specially needed to start preparation early and have more severe constraints: IT budget, resources availability, pressure as suppliers to major companies that are expected to encourage them to invoice in Euro

Table 5
Companies' Approach by Size

Company category	Companies' approach by characteristics of customers and suppliers
Companies targeting large corporate customers	Companies with dominant large corporate customers especially needed to start preparation early. Not enough did so, leading to potentially significant difficulties
Companies targeting private and SME customers	Most companies are still waiting, some of them decided just for a dual pricing policy. Banks and retailers will play a key role in building up the successful introduction of the Euro that will largely depend on its acceptance by the consumer
Companies depending on suppliers in other European countries	Many companies decided just to focus on purchasing application Euro-compliant in a first phase

Table 6
Companies' Approach by Characteristics of Customers and Suppliers

The company approach is dependent on some internal or external issues/characteristics, as described in *Tables 3-6.*

Many companies have decided to be Euro-compliant by January 1999, but only a small number of them plan to adopt the Euro for all their activities by 1 January 1999. Most companies, in fact, plan to start in Euro only with the activities which, in their opinion, will most benefit from the use of the Euro. These are,

Table 7
Companies' Evaluation of Euro Impact on their IT Systems

Mainly an opportunity (52%)	Mainly a threat (48%)
When it is an occasion to replace the old in-house-built systems with software packages	When systems have recently been updated and the Euro will only be an additional cost
When companies start with the project in advance, so that the time schedule is not so tight and so the Euro can be faced as an opportunity to completely re-design existing systems	When the Euro will delay other IT projects that are considered key for the business development
When it presents the opportunity to check systems and re-design them to according to new platforms and technology	The Euro project (also because of the millennium problem) is likely to cause an increased cost of programmers and IT resources
When it presents the opportunity to bring systems into line with new business processes	For companies where only marginal changes of systems are necessary and planned
	For companies that have not identified any business advantages from the Euro changeover

according to the cases: financial transactions; accounting; reporting; purchasing; inter-company transactions (for groups); and transactions with large corporate customers. Some companies will use the Euro from 1 January 1999 for the sales of some kind of products or for exports, while using the national currency for the other products or for sales on the domestic market. In this type of situation, the Euro is often considered as a tool to promote corporate image or to increase sales in Europe. Some retail and utilities companies will only have dual pricing in Euro and national currency from 1 January 1999, and believe that payments in Euro will be low during the changeover.

3.2. Is the Euro an Opportunity to Review the Information System according to New Business Processes?

Expenditure on IT systems to cope with the introduction of the Euro can represent an investment opportunity. The strategic business analysis provoked by the need to adapt systems would give firms the potential of longer term advantage. Furthermore, it would allow for rationalisation of IT systems, thus generating cost savings.

An example of this is that some firms (especially manufacturing companies and medium-small firms) would be able to replace their existing systems, often individually designed when packages were unavailable, with new, cheaper to maintain and better-performing standard packages.

Overall, it could be regarded as an opportunity for organisations to take advantage of the rapidly developing information society, and of more modern approaches to doing business, as exemplified by electronic commerce.

On balance half of the analysed companies viewed the Euro project as mainly an opportunity to review systems and an half viewed the project as mainly a cost *(Table 7)*.

Most companies evaluate the Euro (mainly opportunity versus cost for IT) according to systems age and relevance of changes to be made.

3.3. The Impact on Spending Priorities: Can the Euro Stop Other Projects?

The Euro project will require considerable investments that could reduce the companies' capabilities to invest in other projects. One in five organisations estimated that more than 40 percent of their total IT budgets will be spent on Euro projects *(Figure 6)*. Recent evidence on the market suggests that this could be underestimated because of extent of external resources constraints. Furthermore if we consider that many companies have to face the Euro problem in conjunction with the year 2000 issue, it is clear that they will not be able to invest much in other areas. This is especially a problem for banks; about 65 percent of them declared that they will have to stop or delay many other projects - for example, new electronic delivery systems.

According to our research, in the larger companies, most investment in the Euro will be focused:

- Through 1996-1999 on banking and financial companies;
- Through 1998-2000 on retail, services and manufacturing.

3.4. IT Project Resources

The Euro is not only the package vendor's problem, as will be seen in the following section; companies will mainly need professional services: for fixing existing systems; project management; technological and business/organisational consulting; software packages customisation and integration; testing and solution roll-out; application inventory; and changes in planning, etc.

We are concerned here therefore with high value services requiring a high level of skills and experiences.

The overlap of year 2000 and Euro-compliance projects is a big deal for European IT industry users, but a gold mine for service vendors. There is already insufficient worldwide service capacity to satisfy the likely demand for year 2000 outsourcing and contract programming. As we approach 2000, the laws of supply and demand will cause outsourcing prices to rise and availability to fall. Superimposing an equivalent project (in terms of European effort and expenditure) on the year 2000 requirement exacerbates the situation, as illustrated in *Figure 7* and *Table 8*.

In countries where the Euro begins before 2000, the computer service industry is likely to have only 20 percent of the required outsourcing capacity from 1998 through 2001. Organisations still contemplating outsourcing either year 2000 or Euro projects before 1999 will face difficult negotiations with service providers and should complete contracts as soon as possible. Organisations that have waited until 1998 to obtain programming or package installation services may be unable to find a suitable provider.

Outsourcing urgent year 2000 or Euro projects is not without risks, particularly if the organisation has not previously dealt with outsourcers.

There are many challenges to be faced:

- An abiding principle of IT is that adding staff to a project that is already late is very unlikely to speed it up. Outsourcing in any form must be planned well in advance.
- Organisations typically underestimate the cultural and management challenges when dealing with offshore development and a vendor with whom they do not already have an established relationship. The first offshore project may overrun - this may not be an acceptable risk for time-critical Euro or year 2000 projects.

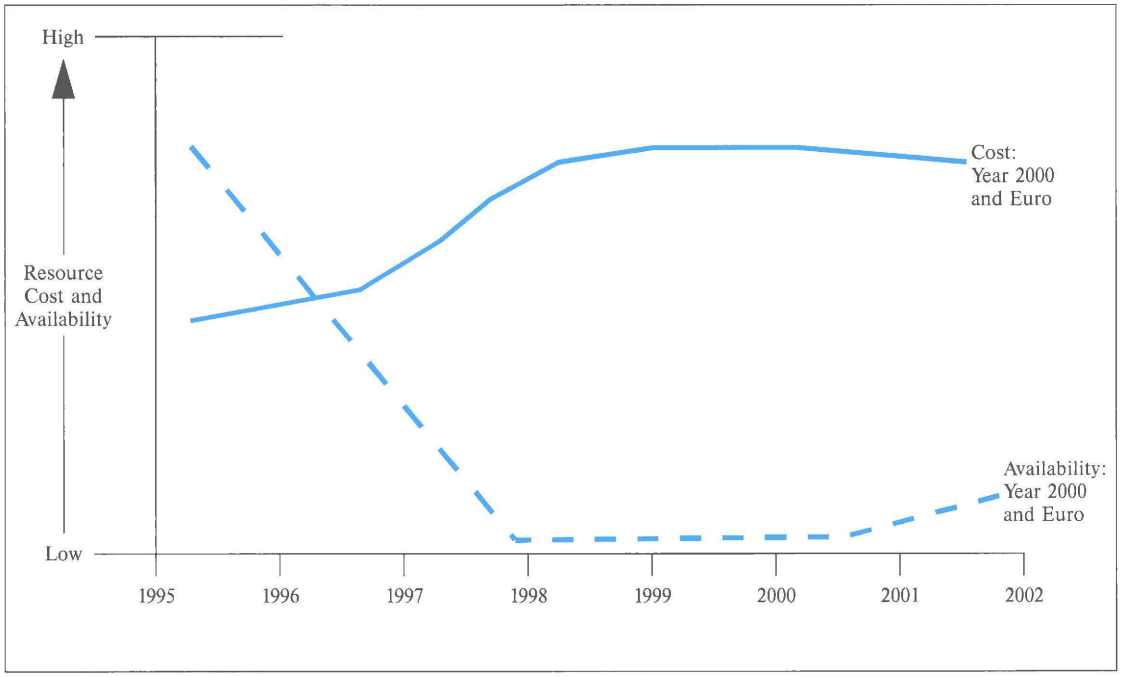


Figure 7
European Resources Cost and Resources Availability Trends

Yes, resources will be a critical issue (60%)	No, resources will not be a critical issue (40%)
Scarcity of resources in the last phases of Euro projects	Internal resources are enough for the Euro project
External resources costs will rise	IT vendors will cover the requirements of large companies, and resources availability will be an issue for SMEs
Other IT projects will be delayed	The real issue is scheduling and co-ordinating resources

Table 8
Do Companies believe that the Euro Project Resources will be a Critical Issue for their Organisation?

4. Euro Project Planning and Management in Business

4.1. Project Approach: Steps

Our first evaluation of the companies' approach to the project related to the Euro changeover asks when did they start to plan the Euro strategy *(Figure 8)*.

If we consider that this sample mainly addresses the larger companies which started in advance with the Euro strategy, it is quite clear that many European companies (including SMEs) still have to start with Euro project management.

Modifying IT systems to support a single European currency may be complex and expensive. Organisations have to first assess when they may require full or partial Euro support according to a typical action list *(Table 9)*.

It is interesting to evaluate the state of play of projects as of September 1997 across the limited number of detailed cases studies *(Figure 9)*, in order to understand the typical steps in European companies, if this not statistically valid. Most large companies, as shown in the previous sections, are already facing the Euro project.

The first step is to establish the Euro Task Force where all affected departments (Finance, IT, Sales and Marketing, Accounting, etc.) are represented. In many companies, the Task Force is organised by working groups with specialised tasks:

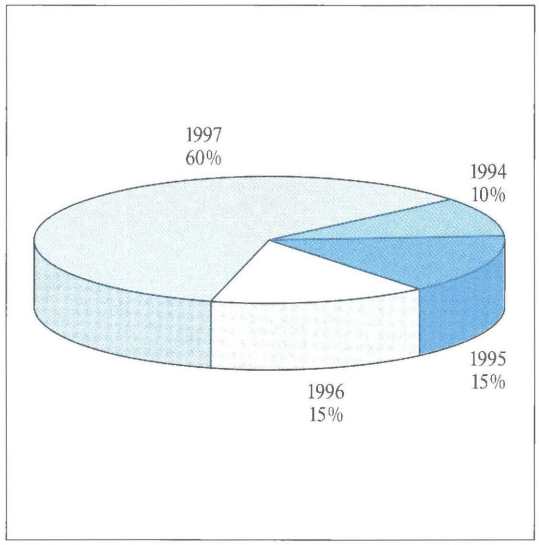


Figure 8
When did the Companies Interviewed Start to Plan the Euro Strategy?

Euro check list
Form an Euro project group.
Ensure that the Euro project has appropriate high-level sponsorship.
Gather information about the attitude of clients, competitors and suppliers, examine the value chain surrounding the organisation. Review key partners' progress to ensure that their timetables and technical approaches are both viable and compatible.
Evaluate the potential Euro impact on company business, organisation and IT systems.
Consider a range of solutions appropriate to each characteristics and prioritise development to minimise overall risk.
Decide on the Euro strategy (i.e. when the company would like to start operating in Euro and choosing activities; plan an education and awareness programme, on Euro issues, relationships with customers - when appropriate - and for internal IT users.
Make an inventory of applications affected by the Euro. Where possible exploit experience and deliverables, such as the system inventory from year 2000 projects.
Verify internal resources available for the Euro project and plan training activities if required.
Verify vendor availability for the Euro project and review contracts with outsourcers and pack vendors, to establish who is responsible for the Euro support, what will be delivered, when it will be available and what it will cost to obtain and install.
Decide on the budget for the Euro project/activities.
Prepare an action plan for the Euro.
Start to change management activities (communication plan, training, etc.).

Table 9
Typical Action List in the Euro Project

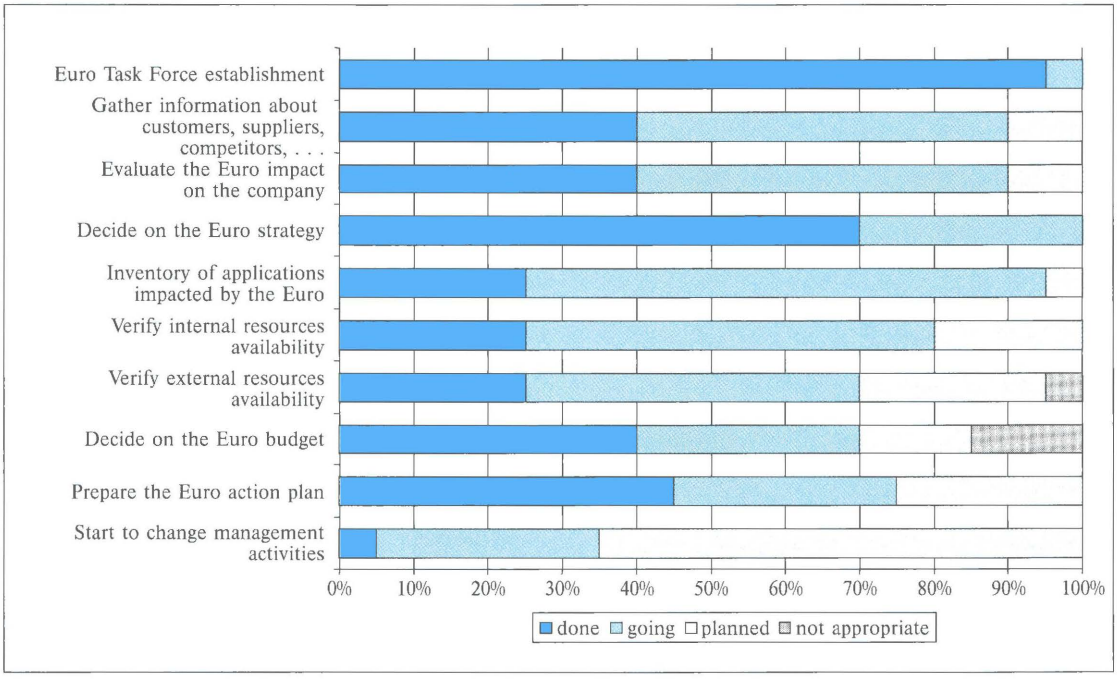


Figure 9
The Project Steps Advancement in European Companies Analysed. 1997

- *Example in banking:* macroeconomic monetary policy, business analysis, financial markets (stocks and bonds, inter-banking, exchange rates, etc.), IT impact (payment systems, procedures and archives, payment cards, processes and IT issues), systems and organisation (stationery, accounting, personnel, contracts), legal issues, institutional aspects, etc.;
- *Example in retail:* payments and cash handling, labelling, purchasing, accounting and fiscal declarations, pricing, logistics, relationship with banks, changes in management and training.

In smaller firms the Euro Task Force is often assembled by the head of Finance in co-operation with the CEO, and it rarely has formal structure or procedures.

The second step is represented by the decision about the Euro strategy that, in this sample, has been implemented in 70 percent of cases. In the other 30 percent, it was under discussion and decided by the end of 1997. Most SMEs waited longer to make more definite plans, based on such issues as whether the country would be a member in the first group.

The next step is represented by an action plan; about 45 percent of companies have already completed at least some part of this action plan; another 35 percent are working on it. According to these results, it is clear that the Euro takes a good deal of work for planning and analysis activities and that there is a delay in the implementing activities.

The business impact analyses and the necessary collation of information from the market are managed in parallel to other actions and under the same action plan. The activities more closely related to the IT Euro aspects were not so well advanced: inventory of applications affected by the Euro and resources availability had been completed in only 25 percent of the companies.

The phase of defining the budget is very critical for different reasons: a) often the companies defined only a partial action plan; b) only a small number had already verified the costs and availability of providers and external products and services and, furthermore, had not yet selected products; c) the costs of services are likely to increase in the next few years, according to the increasing demand; d) in conglomerates there is a need to collect the requirements and plans of many companies.

Change management activities have already been implemented in a few cases but are mainly planned for 1998 (60 percent of cases).

Only a few banks and a few large manufacturing companies declared that they had already completed all the above-mentioned activities, including the change management activities. Banks, large manufacturing companies and some service companies (mainly those related to the financial sector, such as financial information providers) are the most prepared for the Euro changeover, while insurance companies seem to be less prepared. To sum up smaller firms are the least prepared and, considering the industries, utilities and retail companies are later than banking and manufacturing.

4.2. Project Approach: Fix Existing Systems or Re-make?

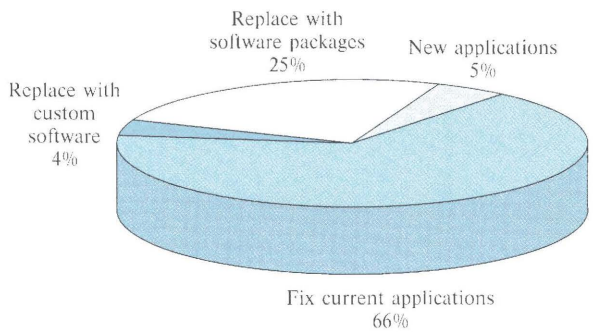
There is no single strategy to make a system Euro-compliant - organisations must consider a spectrum of solutions ranging from "quick fix" tactical changes to strategic solutions (e.g. package adoption). Each system that carries out any form of financial processing must be reviewed. The strategy will be modified by the urgency of the Euro support. Organisations requiring such support sooner may be forced to carry out tactical changes; those with more time may have the opportunity to add greater business value or integrate Euro changes with other enhancements.

As mentioned above, the Euro support needs a comprehensive system inventory; once it has been taken, conventional legacy code assessment principles may prove useful in reviewing systems. Applications can be categorised in terms of business value and technical quality; applications with low value and low quality are retirement candidates, while applications with high value and high quality are enhancement candidates - other systems may be enhanced or replaced as appropriate.

Hence, the Euro project may trigger more radical solutions, such as the replacement of in-house applications with packages, or the replacement of coin-handling machinery with alternatives that are more easily modified. For example some telecommunication providers are actively considering the replacement of all coin-operated phones with card phones. In the short-term, the Euro will boost the European package market, as organisations discover applications that are cheaper to replace than convert.

It is important to emphasise that every option could cause opportunities and threats. For example, it is a common misconception that the replacement of applications with software packages will be a cure-all solution, but organisations have to consider that the installation of Enterprise Resources Planning - ERP packages (which we found was the implemented solution in some interviewed manufacturing companies) can take nine to 18 months, and that multi-site, multinational package installations may take

Figure 10
Company Approach to Application Changes in the Euro Project



A spectrum of solutions can be evaluated in order to make a system Euro-compliant:

- Fix current applications (usually applications with high value and quality are candidates for enhancement).
- Applications with low quality are usually candidates for retirement (often package adoption).
- Some new applications can be developed relative to new products and services related to Euro business opportunities.

Table 10
Main Reasons for Company Approach to Application Changes in the Euro Project

Main reasons for "fix current applications":	**Main reasons for "replace with standard/customised packages":**	**Main reasons for "replace with custom software" and "develop new applications":**
Strong integration of systems, impossible to replace a part of them	Cost savings	Take advantage of the opportunity to renew old systems
Internal IT resources know systems very well	Time savings	Capitalise on internal IT skills
Better control of the project	Leverage on software vendor's skills	
Independence of external providers	Adoption of packages implies process innovation	
Established fit with business needs	Replacement of in-house and custom solutions (more often than when packages are already adopted)	
Too late to doing anything else		

even longer. Furthermore, major package installations and upgrades are primarily a service cost; the availability of suitable staff and service providers will diminish sharply through 1998.

About 30 percent of the larger companies will buy software standard packages, about 15 percent will adopt some custom development and about eight percent will develop some new applications.

Some difference according to industry may be noted:

- Fixing current applications is more common in banking, services and retail.
- Replacing applications with standard packages is more common in manufacturing.
- There will be no relevant difference in custom developments, of which there are few in any company.
- The development of new applications is decidedly higher in banking, and quite high in retail and service companies (specifically related with financial services), and is absent in manufacturing industries.

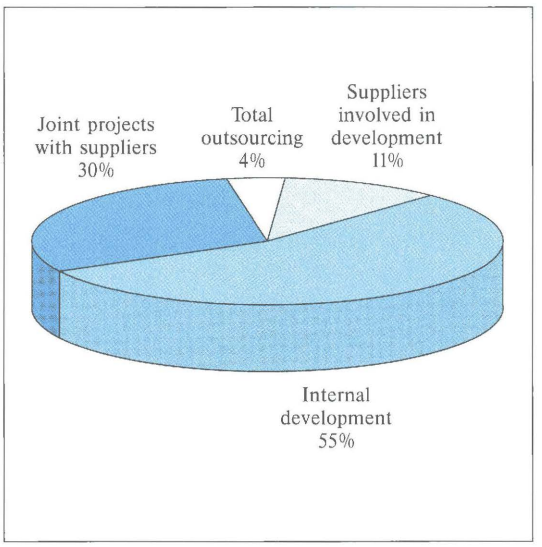


Figure 11
Company Approach to Development in the Euro Project

Main reasons for "internal development" (often related to the applications fixing):	Main reasons for "joint projects with suppliers":	Main reasons for "global outsourcing":
Strong integration of systems	Prevents IT resource shortage, reduces risks	Right approach for systems which are not relevant for the company core business
Internal IT resources know systems very well	Keep project management internal and capitalise on supplier skills and IT resources	Preferred by smaller firms
Better control over project execution	Several partners need to be involved on an Euro project (SW houses, consulting companies, HW vendors) and the provider is called on to be a system integrator	

Table 11
Main Reasons for the Company Approach to Development in the Euro Project

4.3. Project approach: Make or Buy

The project development is usually shared using internal resources, external services and products. The approach that we verified in the large companies is mainly based on internal resources *(Figures 11* and *12, Table 11)*. Also, in this case, some industry differences are evident:

- Retail and services are mainly focused on internal development, followed by banks. It is important to underline that, even if close to 70 percent of the organisations analysed are oriented towards in-house development, they will use other approaches (packages or external services) for part of the project activities.

Figure 12
Internal and External Resources Breakdown

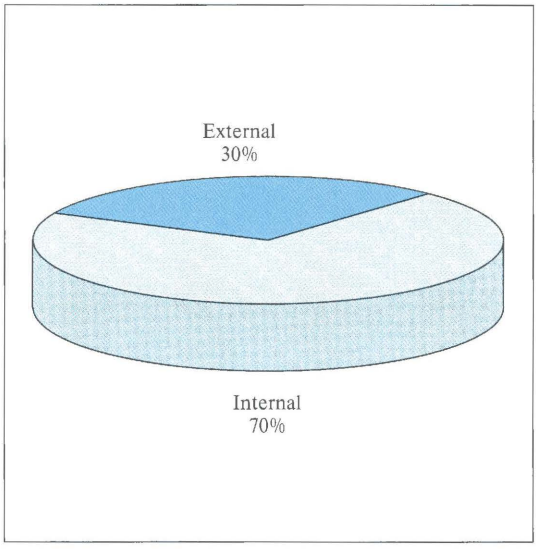
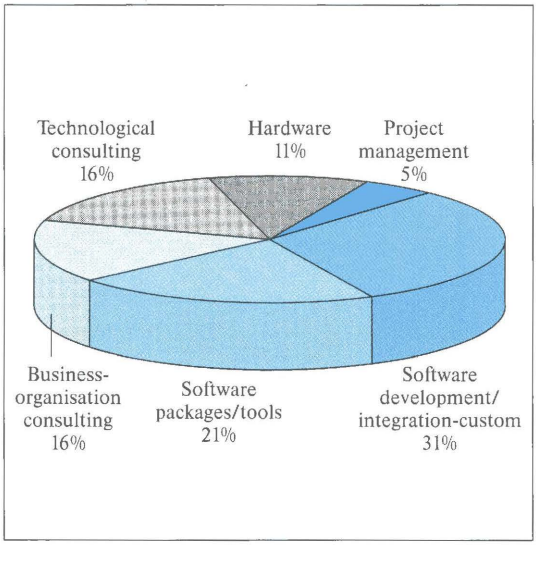


Figure 13
Which are the Areas in which Suppliers are Mainly Involved?



- Currently joint projects is the approach mainly chosen by manufacturing and sometimes by banks.
- Total outsourcing is not highly adopted in large companies (analysed here) but it means taking a chance for many small and medium companies. Sometimes professional associations, for instance in the banking sector, are developing special packages for the smallest organisations.

Finally, it can be shown that companies tend to prefer in-house development for core business-related applications (for example, the applications related to the client's management and products/services delivery), and tend to buy external products and services for the less company-specific applications such as accounting and finance.

Most companies are planning to involve most of their IT resources on a part-time basis (about 20 percent); the resources involvement is decidedly higher in the banking sector, where about 70 percent of IT resources (mainly project managers and analyst programmers) will be involved in the Euro project for about 50 percent of the time.

The required internal resources and skills involved in the Euro project are at a high level of technical skill, but only a few organisations have already planned – or begun – some training on general Euro issues for IT resources.

The survey did not find significant differences according to the various industries, except for hardware acquisition, which is decidedly higher in retail and banks (Automated Teller Machines, POS, etc.).

Some issues in selecting products and services:

- The use of software and services companies to support programming activities during the most critical stages is predominant.
- Software packages and conversion tools are adopted in companies which have chosen to replace current systems.
- Business, organisational and technological consulting is often required in projects where companies chose to replace current systems.
- Hardware vendors are mainly involved in retail companies, where replacement of devices and check-out counters is required.
- Project management is often considered strategic and thereby the responsibility of an individual company. Often, suppliers are involved in the project management by providing tools and methodologies.

4.4. Project Approach: Euro and Year 2000 Joined?

Because the Euro and the year 2000 are temporarily linked, a typical question that companies pose is: is it useful to join the to projects together, in order to gain economies of scale?

Drivers include:

- The assumption that the projects have similar characteristics and operate on the same code base and can therefore benefit from economies of scale or shared effort.
- In some European organisations, the business drivers for the Euro are much stronger than those for year 2000. It may be easier to obtain resources for Euro projects or joint projects, rather than just for year 2000 projects.
- Financial organisations wishing to make Euro changes before 1999 may not have enough time to carry out separate sequential projects.

Most companies analysed, however, decided to keep the two projects separate *(Figure 14)*.

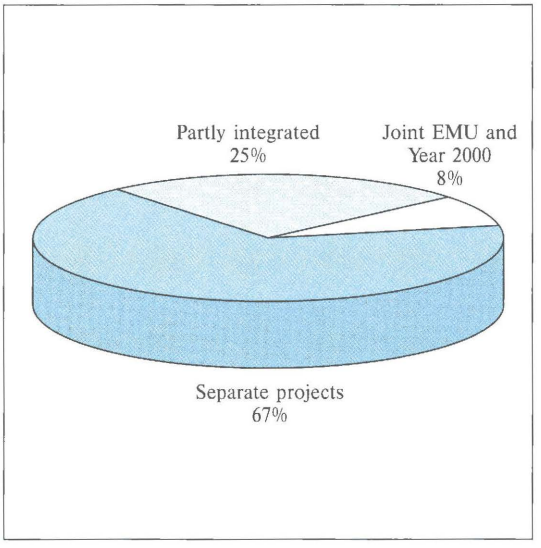


Figure 14
Euro and Year 2000 Project Joined?

Why do the companies tend to separate the two projects?

- Different issues (the Euro also has business issues) implying - for example - user involvement in the Euro, is the most important reason, especially for banks, retails and services companies;
- Different deadlines (this was not mentioned by banks which have to be ready by January 1999);
- To limit complexity.

To summarise, there is a strong rationale for keeping them separate because they are both time-critical, very complicated and have rather different characteristics (business drivers, timetable, development skills and processes, business involvement, training, etc.). Therefore, IT project risk increases in a non-linear manner with project complexity, and will increase risks and the probability of overrun.

The reasons for partial integration of the two projects - sometimes only some tasks are joined (for instance, implementation and testing) are to gain synergy, to optimise the use of internal resources, and when a company has decided on a single provider for both projects. When organisations do not have the chance of enough elapsed time to complete both tasks as separate projects or decide - for other reasons - to merge all or part of the projects, they should consider the following points:

- Stronger development and management processes to compensate for the increased risk;
- A good strategy to manage the increased risk is to merge as little as possible of the projects (as some of the interviewed companies are doing);
- Merging only specific time-critical tasks, such as database management system reorganisation;
- Partitioning the project and merging/outsourcing simpler, mechanical tasks (e.g. date expansion and decimalisation) while separating responsibility for the implementation of new business logic;
- Pipelining changes - e.g. although the two projects are overlapped, the changes on any single module are applied sequentially.

4.5. Critical Issues and Key Success Factors in Managing the Euro Project

The key problems underlined by companies *(Figure 15)* are:

- The short time frame - a key point for banks that have to be ready by January 1999, but also a critical issue for many large multinational companies that decided to be ready by 1999;
- The scarcity of internal resources (both from a quantitative and qualitative point of view);
- Remaining uncertainties (i.e. which countries will be in the first group, the start and end dates of the changeover period, government approach on payments, public debt and declarations, specific legal and technical aspects) that must be faced by companies constantly monitoring the political changes;
- The overlap with other projects (mainly the year 2000 project, but there are also many other projects that are key for companies, to ensure that they do not lose business positioning or so that companies cannot delay - many banks, for example, are merging systems, due to other banks acquisitions);
- The management of company partners (mainly referred to business partners such as key customers and providers);
- Resource scheduling and priorities assessment;
- The IT vendors' co-ordination, availability and selection.

The key success factors are *(Figure 16)*:

- Involvement of users (business departments) during the overall project (strategy, requirements analysis, development, testing, change management);
- Top management sponsorship is key (in some organisations where top management awareness is still low, the Euro Task Force has a special task in order to improve it);
- Planning and project management (this is a key issue also in selecting external partners) to address resource availability (evaluating the internal resources and planning the required training, verifying the key providers availability);

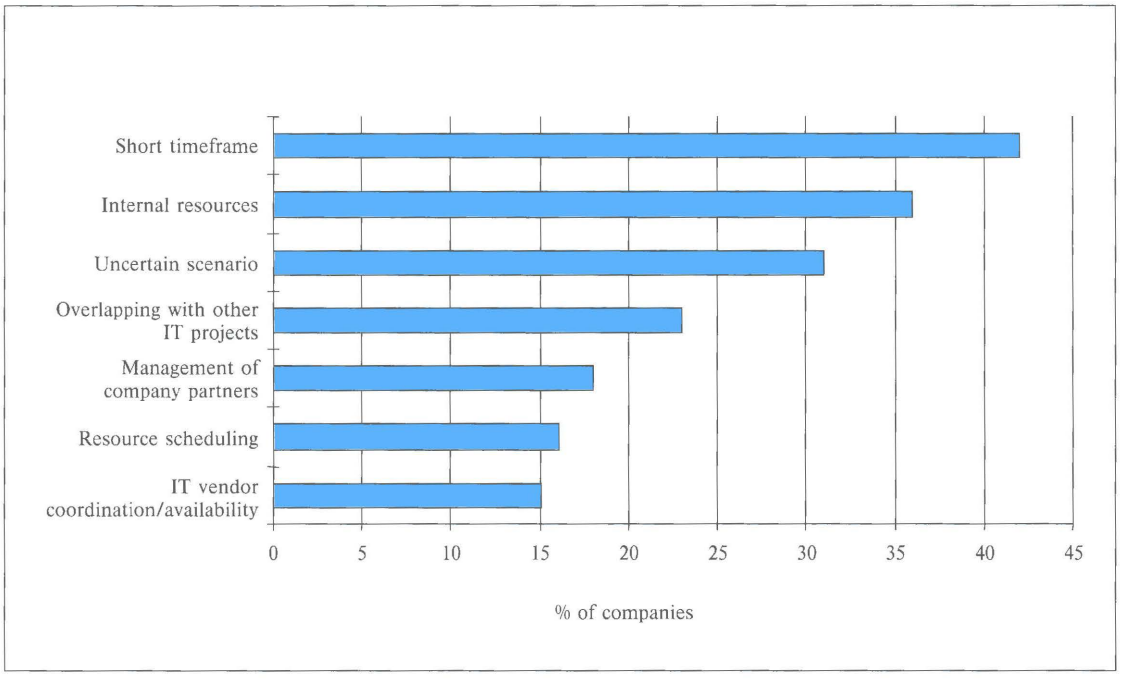


Figure 15
Critical Issues

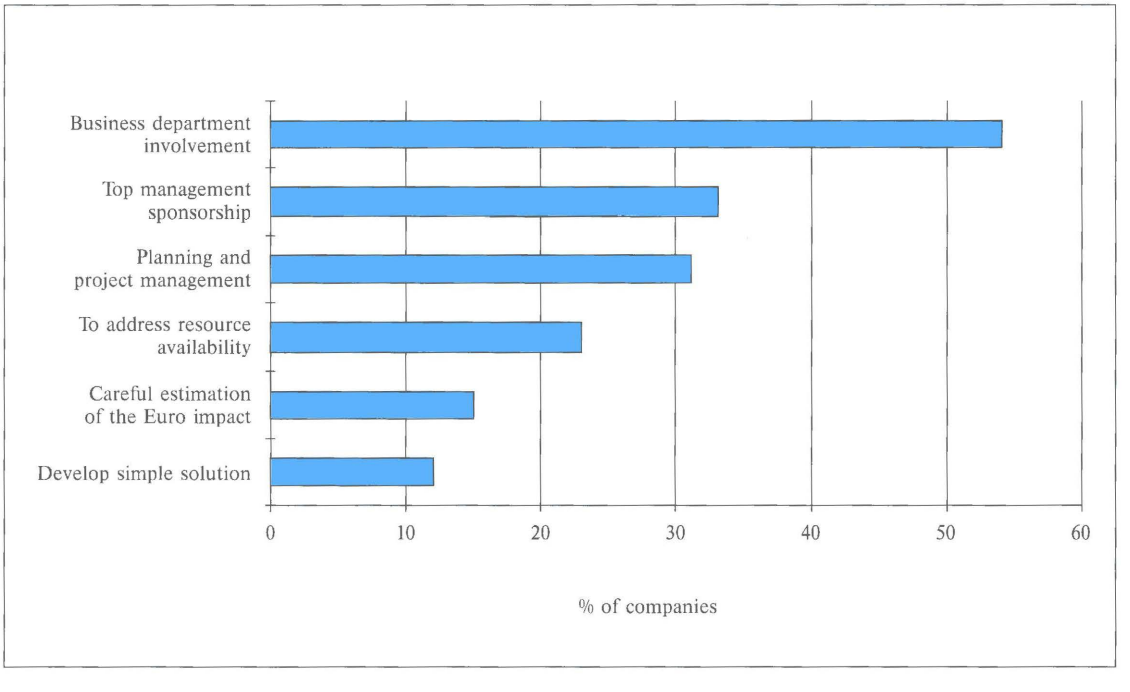


Figure 16
Key Success Factors

- Careful estimation of the Euro impact (not always easy, as various issues have to be addressed and there are many hidden costs and impacts, such as PC applications);
- Development of simple solutions (choosing the solutions according to some key issues such as time, priority, minimising risks of failure);
- To select the right partners.

4.6. Providers

Who are the key providers? Most companies have not been able to find a single source provider to fully address their Euro requirements. According to them mainly specific providers can be found, such as:

- Tools providers (mainly for the banking and financial sectors) which provide inventory programmes, conversion tools and development tools;
- Consultants for project management methodologies and tools;
- Business consultant for business issues related to the Euro;
- Application software vendors (but there are still very few ready Euro-compliant products);
- Hardware vendors (for the hardware replacement - ATM and POS - but sometimes also as system integrators and partners in the project).

Many companies look to existing suppliers, who can co-operate with the organisation to fix existing applications and can be asked to upgrade and change the provided applications, as their key Euro providers. So a company will often select providers according to its own past experiences, rather than on the basis of proven capability in and specialised skills for the Euro. For this reason, when organisations list key selection criteria, they seem to give the same importance to the specific Euro issues and to the knowledge of the company's information system, based on previous experience. Other key criteria to select providers are:

- European coverage (this is very important for multinational organisations, but also offers more chances for Euro skills and experience);
- Reference to Euro projects;
- Provider reliability and financial stability;
- Resource availability and services guarantee (considering European IT resource shortages approaching year 2000);
- Euro-compliant software packages and solutions;
- Clear and complete information and documentation on Euro offerings;
- A clear evaluation of providers - what will be delivered, when it will be available and what it will cost to obtain and install;
- Good IT project managers.

Therefore, European organisations believe that available offerings are not totally adequate to requirements, as most of them are quite late in Euro products and services preparation. They noted some issues for vendors, in order to improve their offering for the Euro:

- Focusing project management capabilities, in order to guarantee the respect of planned deadlines and develop specific planning tools for the Euro project;
- Providing clearer information on their Euro offering (where possible, showing concrete examples of tools, methodology, etc.);
- Investing in marketing and communication in order to give to market more information about the Euro offering;

- Focusing on business and not only on technical issues;
- Training resources which will be a great issue in the next few years;
- Creating Euro-dedicated departments.

5. Conclusions: Market Sizing

5.1. The IT Euro Market

In order to evaluate the Euro impact on the market, it is useful to remember some key issues of the Euro changeover timing: as underlined in the previews sections, awareness of the impact of the Euro on the IT industry is still mainly nascent and, as a result, very few orga-

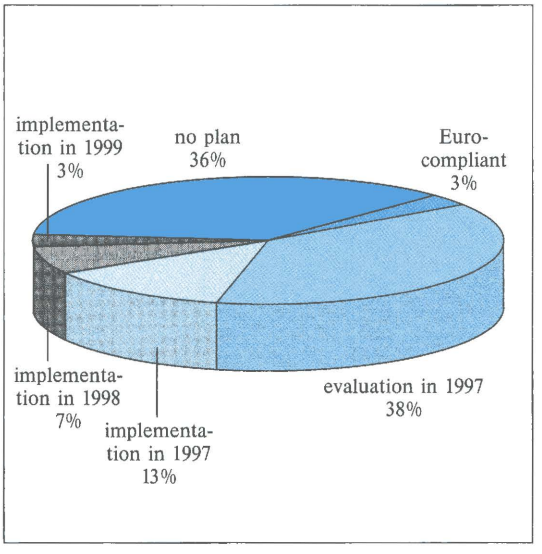


Figure 17
Current Status of Euro Projects (Summary of Major Countries). 1997

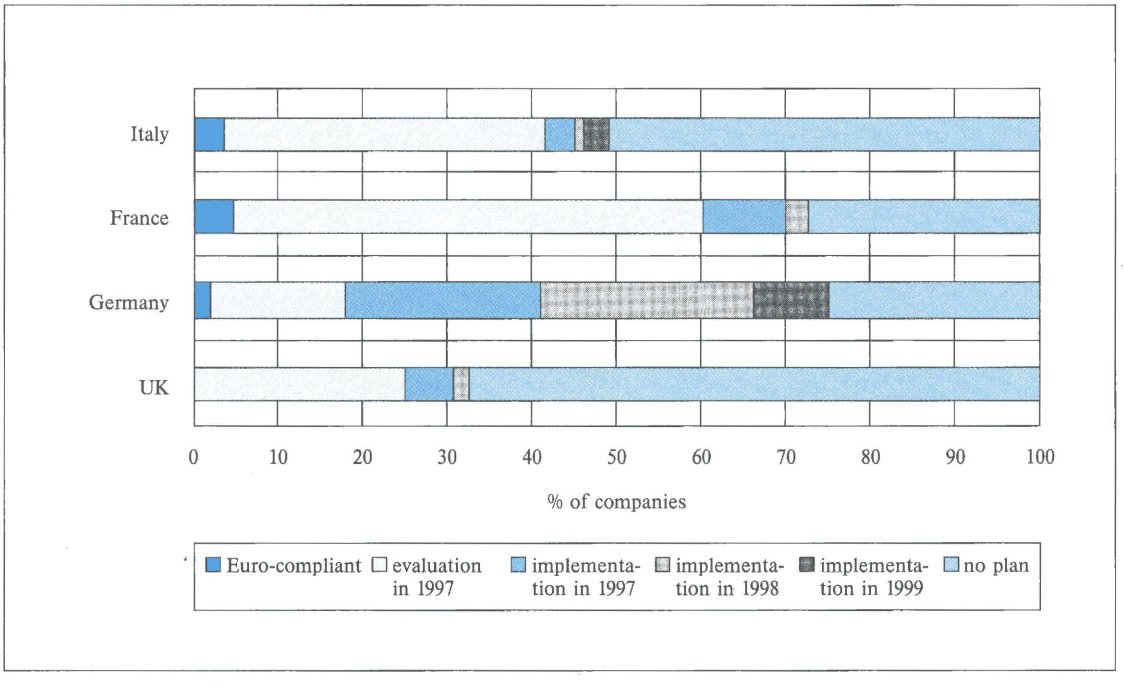


Figure 18
Current Status of Euro Projects in the Major European Countries. 1997

nisations are Euro-compliant or plan to become so in the immediate future. Vendors stand to reap huge rewards from helping IT users; this means that most expenditure will be made in the next few years.

In order to understand when the Euro-related market will take place, it is useful to have an idea of the current status of Euro projects in the major European countries *(Figures 17, 18)*. According to a survey carried out in the first quarter of 1997 (350 companies), only an extremely small number of companies have projects or initiatives in place, which means that their organisation is either already able to cope with the forthcoming Euro or soon will be. Less than five percent of organisations claim to be Euro-enabled. Even in the two countries seen to be key drivers behind monetary union – Germany and France – only small numbers of companies report that they have Euro projects in place. Italian and French companies appear to be responding at very much the same pace, while the German sample would suggest only a few companies are active. No UK companies contacted for this survey reported that they were, as of this moment, Euro-compliant.

This scepticism is reflected in UK respondents' attitudes towards the Euro in the future: whereas almost 50 percent of French companies and 37 percent of Italian companies plan to evaluate the Euro issue this year, only half of this proportion of UK companies plan to do so in 1997. Twenty-five percent of German companies plan to implement Euro-compliance in 1997, while five percent of UK companies will take this step.

The second issue to evaluate is related to the market breakdown by products and services. One of the main components of the Euro IT expenditure is related to the usage of external professional services. The banking system is a good example: although many banks' international systems already handle ECU, most of their transactions are carried out in national currencies. In order to cope with these, banks with mainly in-house developed systems (representing most large and many middle-sized banks) will need to change all such systems – consisting of millions of lines of code, including historical data, plus ancillary services such as chequebook and statement printing.

As with millennium projects, each individual Euro-driven systems change is in itself relatively trivial, but the multiplier effect from changing whole portfolios of systems makes the problem formidable. The nature of the changes that Euro-compliance requires is undoubtedly more far-reaching than the date-field fixes at the core of year 2000-compliance initiatives. Source code for hundreds of programmes will have to be searched assiduously for every instance of cash which, in a banking system, will crop up with great frequency. Where source code is missing, object codes may have to be disassembled to identify all the currency fields – a difficult task. Unlike date-fields, values in currency fields represent real money, which might be lost or misappropriated.

Many commentators have suggested that the perception that the Euro will cost 10 percent of the typical three percent IT budget, as a proportion of revenue, is extremely wide of the mark. We expect the cost of coping with the Euro to consume 30 percent to 60 percent of yearly IT development budgets. Some components of the market, such as PC shipments, will be also influenced by the Euro. The issue of Euro convergence continues, in fact, to loom over the European economic landscape and the Euro-depressed GDP growth in Europe, increasing consumer uncertainty; as a result, the major contribution to growth will be from the professional market rather than the home market. But the Euro is likely to absorb immense amounts

	1996	1997	1998	1999	2000	2001	Total
France	927	1.854	4.480	3.974	2.823	1.390	**15.448**
Germany	868	3.039	5.428	5.862	4.342	2.171	**21.710**
Italy	438	877	2.367	2.192	1.929	964	**8.768**
Spain	160	361	1.042	1.122	842	481	**4.008**
UK	326	868	2.605	3.148	2.497	1.411	**10.855**
Others*	1.136	2.271	5.224	7.041	4.542	2.498	**22.712**
Total Europe	**3.855**	**9.270**	**21.146**	**23.338**	**16.975**	**8.916**	**83.500**

* Others: Austria, Belgium, Denmark, Finland, Greece, Ireland, Luxembourg, Netherlands, Portugal, Sweden

Table 12
The IT Market Related to the Euro by Country, Million ECU

	1996	1997	1998	1999	2000	2001	Total
Banking and finance	1.684	3.599	7.183	5.889	3.295	1.731	**23.380**
Manufacturing	873	1.764	5.173	6.027	4.614	2.424	**20.875**
Retail	655	1.416	3.590	4.358	2.738	1.438	**14.195**
Services and public administration	644	2.491	5.200	7.064	6.328	3.324	**25.050**
Total	**3.855**	**9.270**	**21.146**	**23.338**	**16.975**	**8.916**	**83.500**

Table 13
The IT Market Related to the Euro by Industry, Million ECU

	1996	1997	1998	1999	2000	2001	Total
Hardware	771	1.947	4.863	5.601	4.244	2.051	**19.477**
Software packages	1.157	2.688	5.709	5.835	3.904	2.051	**21.344**
Professional services	1.928	4.635	10.573	11.902	8.827	4.815	**42.680**
Total	**3.855**	**9.270**	**21.146**	**23.338**	**16.975**	**8.916**	**83.500**

Table 14
The IT Market Related to the Euro by Products/ Services, Million ECU

of IT staff time, diverting budgeting for hardware to software projects and reducing the global spending on PCs.

According to the research, companies should follow the market estimation on the Euro-related market. In our opinion, the Euro will increase global market spending, as companies can postpone some projects, but cannot - on the whole - stop all the other projects to avoid losing market positioning and competitive advantage - e.g. new delivery channels in the banking industry, sales and marketing tools, etc.

The range of the Euro-related market varies from 60,000 to 100,000 millions of ECU considering only the external spending. The most probable scenario is estimated in *Tables 12-14; Figures 19, 20).*

Figure 19
Relativeness of the Euro IT Market, by Country

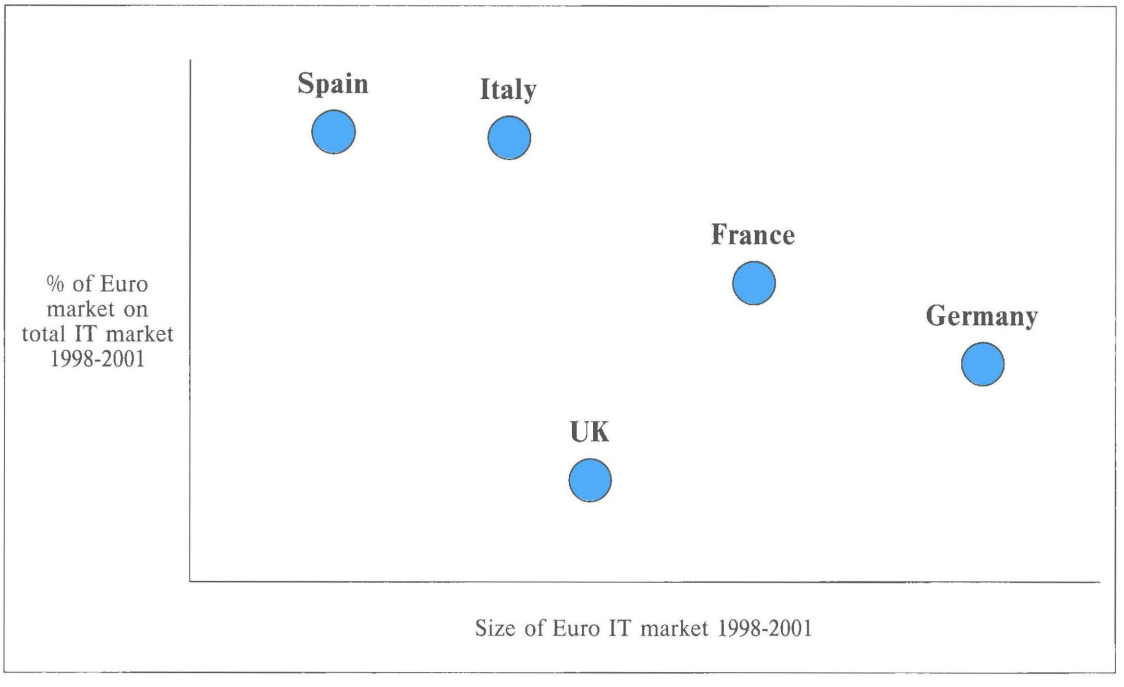
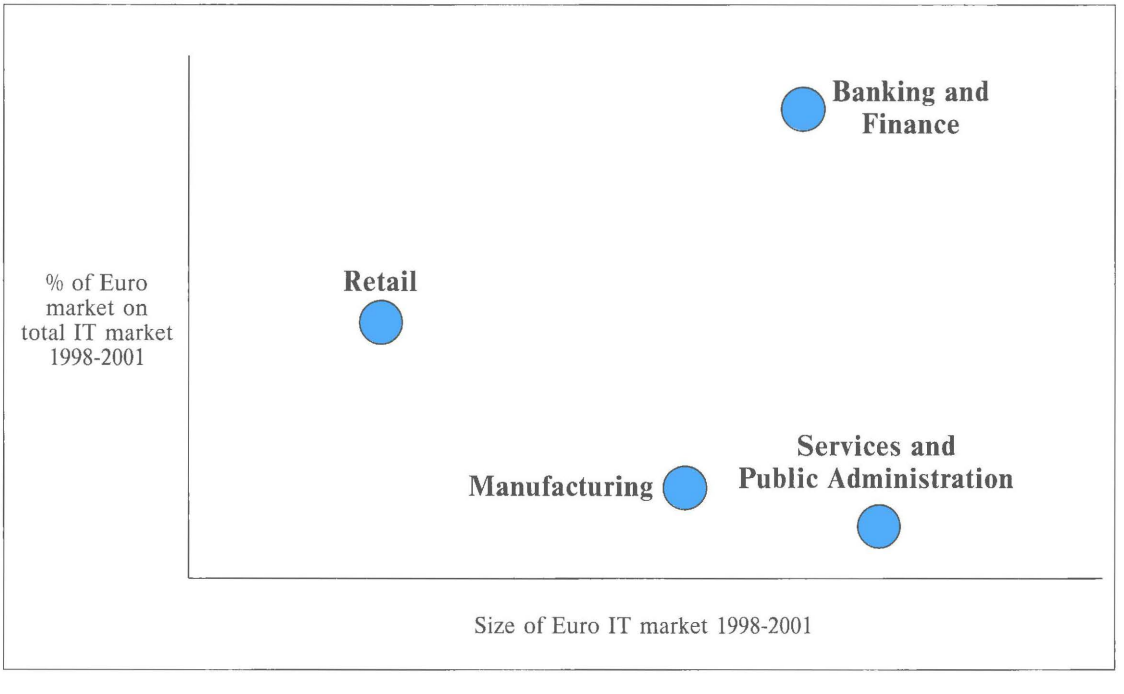


Figure 20
Relativeness of the Euro IT Market, by Sector



5.2. The IT Market – Opportunities and Threats

The Euro projects, which will involve a large part of total IT expenditure, will have a great impact on the market breakdown by industry, products/services and providers.

5.2.1. Market Opportunities by Industry

The main opportunities, as evidenced by the market analysis, will be derived firstly from the banking and financial sectors - in which the projects will be more expensive, more complex, more critical and more concentrated in 1997-1999.

In this sector, the opportunities are strongly focused on the software changes (mainly based on professional services), but there are also some opportunities related to the specialised hardware equipment replacement (POS, Automated Teller Machines, etc.).

The second sector is retail, both for the software changes (requiring, similarly to the banking sector, mainly professional services) and the hardware replacement. There are also, interestingly, some specific service companies, which are strongly involved in the Euro changeover - financial information providers, tours operators, etc.

Finally, there is manufacturing, a large part of services and utilities companies, and public administration. In many cases, there is a larger demand for software products in large companies and SMEs.

Also, as described in the previous sections, in each industry, distinctions must be made between local companies, multinational companies and large groups. In the largest groups, for example, internal financial systems are so complex that the changeover process can be compared to some components of banking.

5.2.2. Market Opportunities by Products/Services

The key components of these projects are:

- The professional services:
  - Management and technological consulting (mainly for the most business-impacted companies such as banks and retailers);
  - Outsourcing, system integration, transition outsourcing;
  - Software development, fixing existing applications;
  - Business Process Reengineering (as the consulting services mainly in companies more business-impacted);
  - Change management and training (this will be a great issue in the Euro projects);
  - Life cycle services (according to the various Euro changeover steps - first transition, changeover, final changeover, and to an increasing demand of standard application software solutions);
- The software packages:
  - Development tools, Euro converters and middleware (little demand);
  - Application software packages (i.e. many manufacturing companies are strongly addressed towards software packages for the accounting/financial area, furthermore this is a typical offering for SMEs);
- Hardware equipment:
  - Mainly POS and Automated Teller Machines, but also some personal computer devices, such as keyboards and large and medium systems upsizing, etc.

There is little impact on telecom equipment and services; in this environment, only one component is important to be underlined: the Euro is likely to improve electronic commerce and the use of payment cards in order to reduce cash management problems.

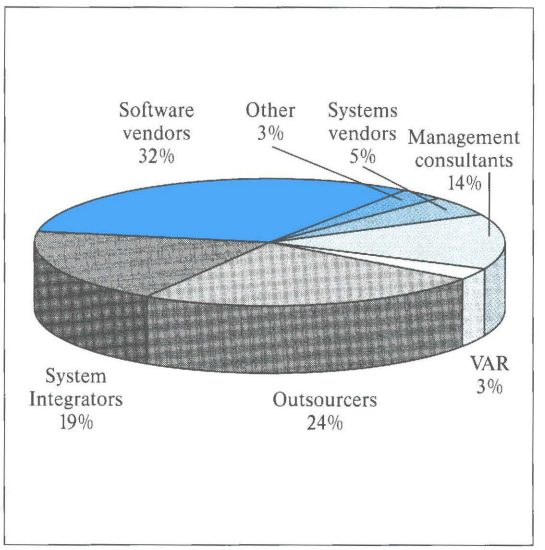


Figure 21
Primary External Supplier Involved in Euro Projects, Europe. 1997

5.2.3. Market Opportunities by Providers

In order to assess the market opportunities and threats, it is useful to define the key leaders in this market. The users' perception is not very clear but, according to some surveys, we can estimate the key vendors in these type of projects *(Figure 21)*. The uncertainty over the Euro in the marketplace is reflected in the higher utilisation of business consultants in driving Euro projects than with year 2000 engagements. This means that, among the more traditional key leaders in such big projects (system integrators, software vendors, outsourcers), there will also be the business consultants.

The role of external providers is key: just below three-quarters of the organisations analysed in recent surveys see the utilisation of outside suppliers as increasing the chances of their Euro project's success.

Other vendor characteristics can help them to have more opportunities:

- Obviously, vendors able to prepare an adequate Euro-compliant offering and internal skills in advance is advantageous. It is important to remember users have difficulty to find partners who are really global.
- European-wide vendors have more opportunity to offer Euro references, as required by users.
- A system integration approach and skills, tools and methodologies in project management.
- Skills related to the legacy systems, mainly affected in the large companies.
- A strong focus on accounting and financial systems.
- A large number of adequately-skilled resources and a strong focus on the professional services market.
- The outsourcing and facility management capabilities (both total outsourcers, that are often information system owners, and the accounting/finance area outsourcers).
- Industry knowledge.

Most threats will be to niche providers, both because the key partners will be the larger system integrators likely to be the only Euro project partners, and because many other projects which are not Euro-related are likely to be postponed.

5.2.4. Some Potential Opportunities and Threats Related to Various Euro Issues

Although the time line of the Euro is potentially slipping, those organisations which postpone the unpalatable and inevitable moment when Euro projects are signed off, will face paying expensive premiums for completing projects in a pre-Euro rush. These organisations, of course, will provide the most lucrative market for vendors. IT users, undoubtedly, will require external IT service assistance over Euro-compliance, and professional services vendors may be constrained only by their ability to resource their own, rather than their competitor's, solutions teams. However, IT services organisations face the negotiation of awkward paths to the Euro service opportunity. Services firms will

have to adopt a cautious approach to committing resources, while preparing to move extremely quickly when this demand becomes mmediate (as it undoubtedly will) and projects become mission-critical.

Much of the resentment IT users feel towards the IT supplier community over the year 2000 will transfer into the Euro arena. Services firms do understand that the Euro is perceived as a business problem, not a technical one, in which they will need to manœuvre in order to be seen as part of the solution to the problem, rather than its creator. Vendors of professional services will find a hesitant audience for Euro-based solutions initially; positioning of their capability in this period, however, will be critical in order to maximise the flood of opportunity which will appear as the true nature of Euro-compliance emerges from behind the year 2000 in 1998 and 1999.

A potential opportunity/threat for European IT vendors could come from overseas personnel.

One major concern both users and vendors have as a consequence of the conjunction of the year 2000 and the Euro is the skills crisis developing in both client/server and mainframe disciplines. While the most forward-thinking organisations, such as some of the major banks, are replacing systems with client/server and/or networking technology, many organisations are deciding that it is more cost-effective to retain legacy systems with relevant modifications. As a result, there will be new client/server and networking skills needed with a move towards value-added consulting, but there will also be mainframe skills requirements.

There is already a shortage in this area, as many organisations have decided that, they need to be at the forefront of IT implementation; many firms are also unwilling to divert core personnel from current tasks to upgrade systems for the new millennium. Freelance IT personnel with legacy skills are enjoying a new wave of demand already; organisations that developed a poor reputation during previous periods of recession are finding it hard to recruit this type of staff now that demand dynamics are reversed.

Organisations such as banks have, over the past few years, slashed head counts to reduce costs in both IT and line departments, yet IT suppliers are warning that demand for millennium skills will push costs sky-high as the deadline approaches, and the same will inevitably happen for single-currency projects. What applies to banks also applies to large multinational corporations. As a consequence of these trends, salaries of IT staff with legacy skills are set to spiral out of control: if they can be found, staff will virtually be able to name their own price.

One approach to this dilemma will be to hire staff from overseas programming shops. Programmers from countries such as Far Eastern countries are cheaper and more plentiful than in the United States or Europe. One of the largest Indian software firms, with offices in the United States and Europe, is involved in nearly 50 year 2000 projects worldwide, most of them with USA and European clients.

Undoubtedly, there are businesses that will not solve the Euro problems in time or will solve it inadequately, leading to business failure, loss of opportunity, extreme customer dissatisfaction and litigation. Increasing awareness of this problems will lead to panic as the decade progresses, making the solution to the problem an area of competitive advantage both for IT users and their suppliers. Vendors which can act as brokers in guaranteeing the integrity of a particular supply chain, by ensuring the systems compliance of participants, stand to gain a significant marketplace advantage.

Who are the key sponsors that vendors have to address for the Euro projects?

Euro projects are much more likely to be initiated by, and seen as, joint initiatives, rather than purely the domain of the IT department. Almost 40 percent of organisations, at the overall European level, report that their Euro project has a joint IT and end-user sponsor; only 20 percent of projects are being run as pure IT projects. IT vendors must remember this Euro project characteristic in approaching the marketplace. Joint approaches to IT management and line staff will be a requirement in attempting to convert Euro opportunities.

Summary

Introduction of the Euro is the most significant planned business change ever to have faced the European IT community and its customers.

It impacts every business and public sector organisations.

It presents unprecedented opportunities for IT vendors that are well prepared and can effectively market and deliver good solutions in an environment where demand for resources is certain to outstrip supply.

However, the challenges to suppliers are as important as the opportunities. Many customers - both business and public administrations - are unprepared and will be handling the Euro in crisis mode. Some suppliers will have underestimated the time end efforts required to deliver new or updated solutions that are Euro-compliant. There will be competition for resources and inevitably some losers as well as winners. The overlap of the Euro implementation with year 2000 concerns will inevitably create management pressures for suppliers as well as customers.

A central task for the industry is to assist customers to identify the opportunities presented by the Euro rather than seeing it as a problem to be solved, so that any increased expenditure associated with the Euro adds values to their business and moves Europe's use of IT forward rather than simply being absorbed as an additional cost.

6. Research Methodology

In order to prepare this paper, GartnerConsulting: used many sources of information made available by the Commission[2]; analysed several surveys from the past two years carried out by GartnerGroup and Dataquest; and carried out a custom survey of in-depth analysis of some key companies, representing different industries, geographical coverage and positioning, size and business characteristics.

Following are some Internet addresses also used:

http://amue.lf.net/
http://amue.lf.net/business/english/managing.htm
http://amue.lf.net/business/sme/english/smeindx.htm
http://amue.lf.net/news/newsindx.htm
http://amue.lf.net/nws/newslet
http://bewoner.dma.be/gedesmet
http://europa.eu.int/en/agenda/emu
http://europa.eu.int/euro/en/emu/
http://lucifer.com/if-lists/if-propose
http://shaw.iol.ie/~pobeirne/emu.htm
http://ssdc.ucsd.edu/ssdc
http://www.cordis.lu/esprit/src/
http://www.deutsche-bank.de/leistung/ewu2/
http://www.ecu-activities.be/1996_4
http://www.ecu-activities.be/ecueuren.htm
http://www.emuaware.forfas.ie/
http://www.euro.nl/
http://www.fee.be/
http://www.france.diplomatie.fr/frmonde/euro
http://www.helsinki.fi/valttdk/kvtok/stud/jheiskan/linkit.html
http://www.itworks.be/bookmark/euro/index.html
http://www.maxiq.com/emu/emuchat
http://www.mi.camcom.it/euro/
http://www.xs4all.nl/~kessels
http:/www.abnamro.com/euro/

[2] These priority information programmes had operated for two years with the objective of awareness raising and education. Specific actions included; Euro papers giving information of technical interest, the web sites, both Europa (500,000 "hits" a month) and CORDIS, and the newsletter *Infeuro* (320,000 copies, six issues a year). Brochures have been printed and distributed, including four and a half million copies of the guide "When will the Euro be in your pocket?". A range of professional bodies, often co-funded by the Commission, also had a range of web sites and other methods of making information available. Information was spread to their members and then on to individual firms by professional federations.

The Convergence of Voice and Data Communications

This chapter has been provided by Monitor Company in close co-operation with the EITO Task Force.

1. Introduction

What is the Information and Communication Technology (ICT) industry going to look like in five years? Where should leading companies be positioned by then? What choices are necessary to get there? Over the next decade, decision-makers in the industries falling under the ICT umbrella are going to find it increasingly difficult to answer the fundamental strategic questions. Key players can expect a future of relentless change as the once separate ICT industries around voice and data communications converge, reshaping the nature of competition.

2. Definition of Convergence

2.1. Convergence

"Convergence" has become one of the more heavily used words in the ICT industry press. The word is used in announcements and publications to describe almost any trend representing the ever closer contact between the computing, telecommunications and media industries (see *Table 1*). This concept now covers so many disparate trends that its value to a decision-maker is questionable.

Many of these trends are enabled by digitisation. Digital technology has made it possible to convert sound, text, graphics and moving images into coded digital messages which can be combined, stored, manipulated and transmitted quickly, efficiently and in large volumes over wired and wireless networks without loss of quality. In a world of ever increasing digitisation, "convergence" has been used to describe almost any of the resulting trends.

For the purposes of this chapter, however, convergence is defined as more than just digitisation. A narrower definition will help create a set of forecasts that will be more useful and straightforward for decision-makers to incorporate into their work.

2.2. Convergence between Voice and Data Communications Networks

Convergence refers to the emergence of networks capable of carrying digitised voice and data in real time and with equal efficiency.

This definition includes the emergence of software to operate these networks, the services running over them, and the professional services supporting them. The emerging converged networks are packet switched and capable of delivering a quality of service in both voice and data communication at least as high as in traditional networks.

Table 1
Popular Definitions of Convergence

Trend	Selected example	Enabled by digitisation	Single network optimised for voice and data	Convergence for the purposes of this chapter
Convergence of voice and data communications networks	• Transport of voice and data over a packet switched network: – e.g. transport of voice over an IP network using software developed by companies like VocalTec	✓	✓	✓
Wireless/wireline convergence	• Launch of dual mode handsets such as GSM/DECT, enabling the combination of global mobility with free on-campus calling over a company PBX	✓	✗	✗
Convergence of communications and computing hardware	• Personal digital assistants such as the Nokia 9000 communicator • Database features of Computer Telephony Integration	✓	✗	✗
Convergence of ICT technology and content	• Inroads of companies like Matsushita and Sony into content • Emergence of players such as Atari and Nintendo	✓	✗	✗
Convergence of television and computing	• Interactive information delivered alongside traditional TV, as being developed by companies like British Interactive Broadcasting • PCTV devices offered by companies such as Compaq and Fujitsu	✓	✗	✗
Convergence between industry layers	• Convergence of computer manufacturing, software development and systems integration functions in companies like IBM	✗	✗	✗
Convergence of TV and telephony	• Telephony offered alongside cable TV by companies such as C&WC in the UK	✗	✗	✗
Convergence of carrier services	• Bundling of wireline, wireless, Internet and other services in a single billing package	✗	✗	✗

Legend: ✓ True
✗ False

2.2.1. Traditional Networks

Today's communications networks are either circuit or packet switched. Circuit switching has traditionally been suited to communications that must flow constantly and in real time, such as voice. The principles of the technology go back to the origins of the telephone network, when operators would physically connect two phone lines to create an electric circuit. Today, the circuits are virtual rather than physically distinct wires, but the principle of predetermining a connection remains.

For data communications, circuit switching has proved wasteful as data tends to flow in irregular bursts of traffic. Most data communications until now have required neither a continuous connection, nor real-time transmission (e.g. e-mail, fax). Packet switching has proved a more efficient means of transport for this kind of data as it does not require dedicated connections between devices communicating with each other. Data is divided up into packets and each is then addressed and sent to its destination over a shared pipe. The shared nature of the network ensures that the pipe is always fully utilised. Frame relay, X.25 networks and the Internet are examples of packet switched networks.

2.2.2. Emergence of Converged Networks

Fully converged networks do not yet exist. Networks capable of carrying voice and data are still skewed towards either voice or data. Digital circuit switches in modern voice networks, while able to handle data in real time, are not converged as they are optimised for continuous bandwidth connections of 2-3 minutes' duration. They are inefficient handling traffic that arrives in irregular bursts, with variable and unpredictable bandwidth requirements.

Today's public data networks are not converged either. The most commonly cited converged network, the Internet, offers an insight into how converged networks might function but is itself not yet fully converged. While it is able to carry voice or data, it performs better in handling data. The quality and reliability of voice content carried over the Internet is still below acceptable levels. Section 3 of this chapter will discuss how the advent of new protocols may allow IP networks such as the Internet to make the transition to full convergence by adding real time transmission capabilities.

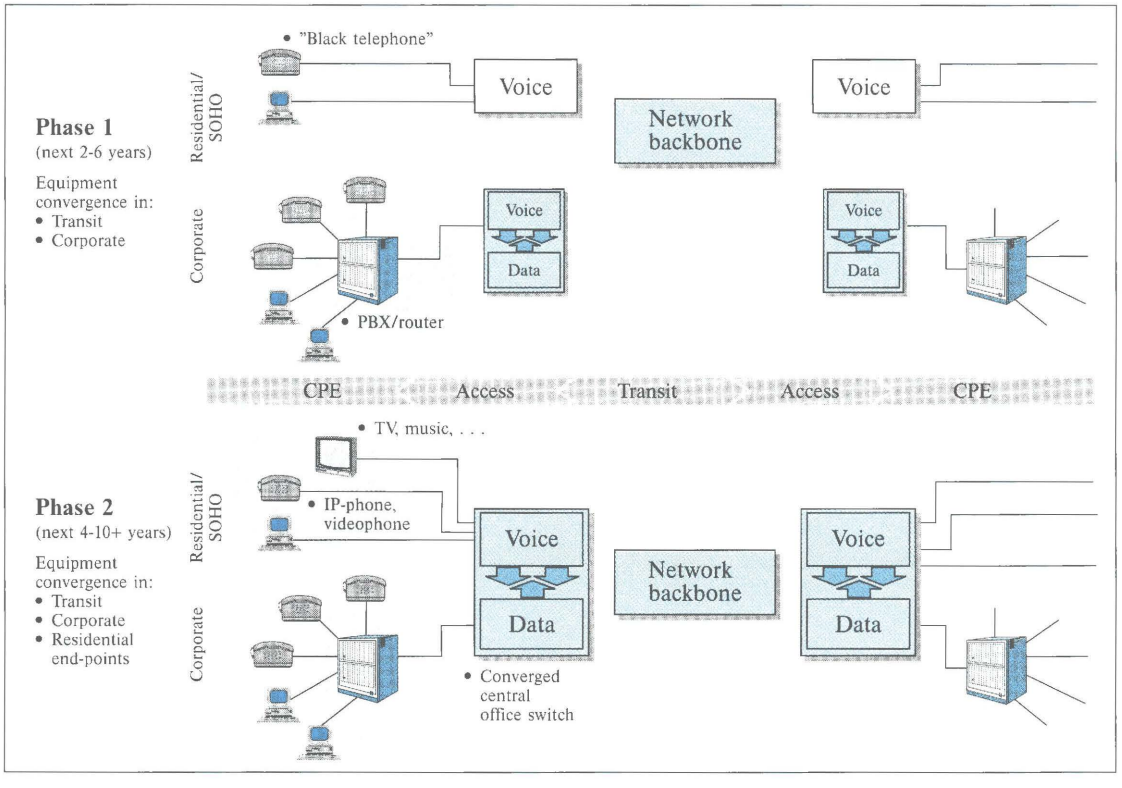
Currently, only equipment in the transport layer of today's voice and data networks can be considered as fully converged. The SDH/SONET equipment frequently used in this layer handles both voice and data efficiently in point-to-point communications.

The current situation will not last. Over the coming years, convergence will spread to other network layers in addition to the transport layer. As reliable converged technology becomes available, a new breed of packet switched network will emerge that can transport digital data in real time and at variable bandwidths. Transmission of voice traffic will increasingly be digitised and transported alongside other data on these multipurpose, converged networks. Over time, voice will become just another data application, passing over a universal network.

Convergence will occur in two phases (see *Figure 1*):

- *Phase 1: next 2-6 years*
  The transit layer at the heart of today's networks will continue to converge. In addition, private networks (e.g. corporate networks) will begin to converge as intra-company voice traffic is increasingly digitised and sent as data over leased line or packetised connections between office locations. In time, combined PBX/routers will replace the

Figure 1
Two Phases
of Convergence



single purpose PBXs and routers present in most corporations today. Conventional customer premise equipment (CPE) will still predominate among end-users during this phase (e.g. "black telephones", data LANs).

- *Phase 2: next 4-10+ years*
  The emergence of scaleable converged voice/data switches suitable for use in the central office level of public networks, combined with the widespread adoption of converged end-user equipment, will result in the emergence of fully converged public and private networks. A single converged infrastructure right into the home and onto the desktop will begin to emerge. Users will start to migrate to converged network phones and appliances that plug directly into the packet switched, converged network (for example, enabling video-on-demand entertainment, or videoconferencing). However, full migration will take place over a longer timeframe than 10 years.

Section 4 will present detailed forecasts of the pace and extent to which convergence takes place in these phases over the next decade.

As well as transporting voice and data traffic migrating from traditional networks, a universal network capable of handling variable bandwidth transfers in real time enables many new services that are currently not available. Examples of these services might include web-based calling (e.g. calling a company's toll free number directly from their website), or on-demand video

	Voice	Converged	Data
Professional Services	• Voice outsourcing/consulting A1	• Converged network outsourcing/consulting A2	• Data outsourcing/consulting A3
Communication Services	• Mobile services • Local voice services • Long distance voice services • International long distance voice services B1	• Converged Internet access • Converged backbone revenues • Converged leased line and managed data network services • Voice over the Internet • Local converged • Long distance converged • International long distance converged B2	• Internet access • Internet backbone • Leased line and managed data network services B3
Communication Software	• Voice communications software C1	• Converged communications software C2	• Data communications software C3
Equipment (Hardware + System Software)	• Voice end points • Voice concentrators • Voice switching • Voice transmission • Mobile communications infrastructure D1	• Converged end points • Converged concentrators • Converged switching • Converged transmission • Converged mobile communications infrastructure D2	• Data end points • Data concentrators • Data switching D3

Figure 2
Convergence Grid

and multimedia. The emergence of "killer" converged network services that large numbers of customers will be prepared to pay for will be an important driver of convergence and is discussed in more detail in section 3 of this chapter.

2.3. Tracking the Impact of Convergence

This chapter includes forecasts that highlight changes in the ways that revenues, and profits, are distributed between different industries as convergence takes place. The large number of industries under the "ICT industry" umbrella makes it impractical to track the impact of convergence on each individually. Grouping industries that are likely to be affected in similar ways will help to maintain accuracy in tracking the pace and extent of convergence in these industries, while avoiding the unnecessary complexity of examining individual segments and sub-segments.

2.3.1. The Convergence Grid

By grouping industries in this way, the *convergence grid (Figure 2)* helps to identify the broad shifts in revenues that convergence will bring about.

The horizontal axis of the grid distinguishes between single purpose networks and multi-purpose, converged networks. Single purpose networks specialise in carrying either data or voice. The industry built around voice networks is shown in the left column, data on the right.

The vertical axis represents each layer in the value system of each industry:

- *Equipment:* The equipment package which is sold to customers includes hardware and system software. Products include end point equipment (telephones, PCs), concentrators (PBXs, routers), switches and transmission equipment.
- *Communication software:* The next layer enables equipment to communicate with each another using a common communications protocol. Examples of products include IN services, feature upgrades for voice switching equipment and packet routing software.
- *Communications services:* Communications services enable the gathering and exchange of information by end users, using communications software and equipment. These are the services typically offered by PTTs and other carriers: voice & data communication, leased lines, Internet access, and so forth.
- *Professional services:* Outsourcing, systems integration and consulting projects for communication service providers and corporates form the final layer of the industry value system. For example, a new telephone operator in a given market may require the services of a telecommunications equipment provider to manage or even maintain its network.

2.3.2. Using the Grid to Track Convergence

The grid tracks changes in the ways that revenues, and profits, are distributed between different industry groups as convergence takes place. The size of each industry grouping (each box on the grid) will change as industries supporting traditional voice and data networks converge.

Example: the impact of convergence on the voice communications market

Basic telephony has traditionally been carried by a dedicated network (the PSTN). The emergence of converged technology over the next few years will open up an opportunity for new competitors to enter this business, offering voice calls of similar quality at substantial discounts to the charges of the incumbent PTTs and carriers (Internet telephony is one example of this).

This will cause two major changes in both the overall amount and distribution of revenues across this layer of the grid:

- First, some proportion of the revenues generated by voice traffic will migrate to new entrants providing access or communications services in the converged network arena. Corporate users will lead this migration, attracted by the low cost of interconnecting geographic locations within the enterprise using the converged network services of the new providers. Over time, consumer traffic will begin to follow this path also. This is shown on the grid by a shift in revenue to the central column in the grid.
- Secondly, incumbent PTTs and carriers will be faced with the choice of lowering tariffs close to the level of the new entrants, or losing substantial market share. Lower tariffs will cause the total size of the voice communications market to shrink, while a large proportion of the remaining revenue is likely to be captured by the incumbents. If the traditional carriers do not lower tariffs, they risk a major migration of revenue to those offering converged communication services.

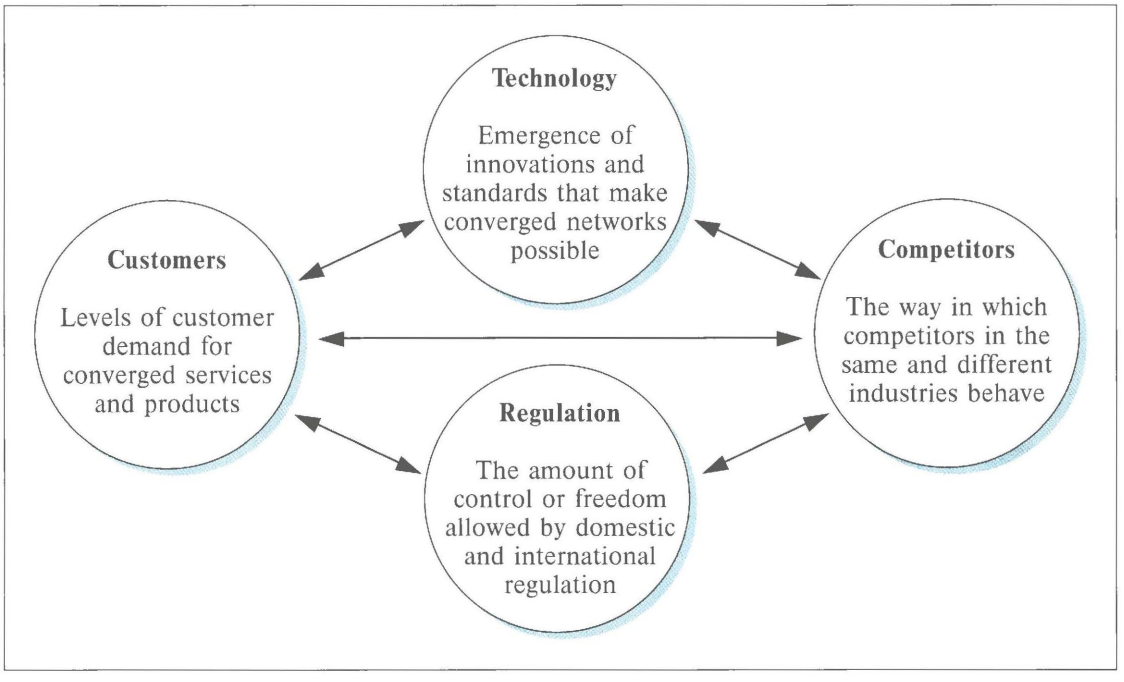


Figure 3
Drivers of Convergence

These effects will be severe (see section 4) and will have important implications for the players who compete in the voice and related industries (see section 5).

3. Drivers of Convergence

3.1. Four Drivers of Convergence

Drivers identify deeper patterns of change behind the enormous number of one-time events, periodic occurrences and continuous forces that influence the evolution of the industry. There are four key drivers that will influence convergence, the pace at which it takes place and the extent to which it will go. These are shown in *Figure 3.*

3.2. Technology

The technology that will enable widespread deployment of fully converged networks does not yet exist. Technological bottlenecks exist in developing two critical areas:

- *Equipment enhancements* that improve the quality, cost or performance of the technologies needed to make fully converged networks work.
- *Protocols* that are scaleable, reliable and capable of transporting data in real time.

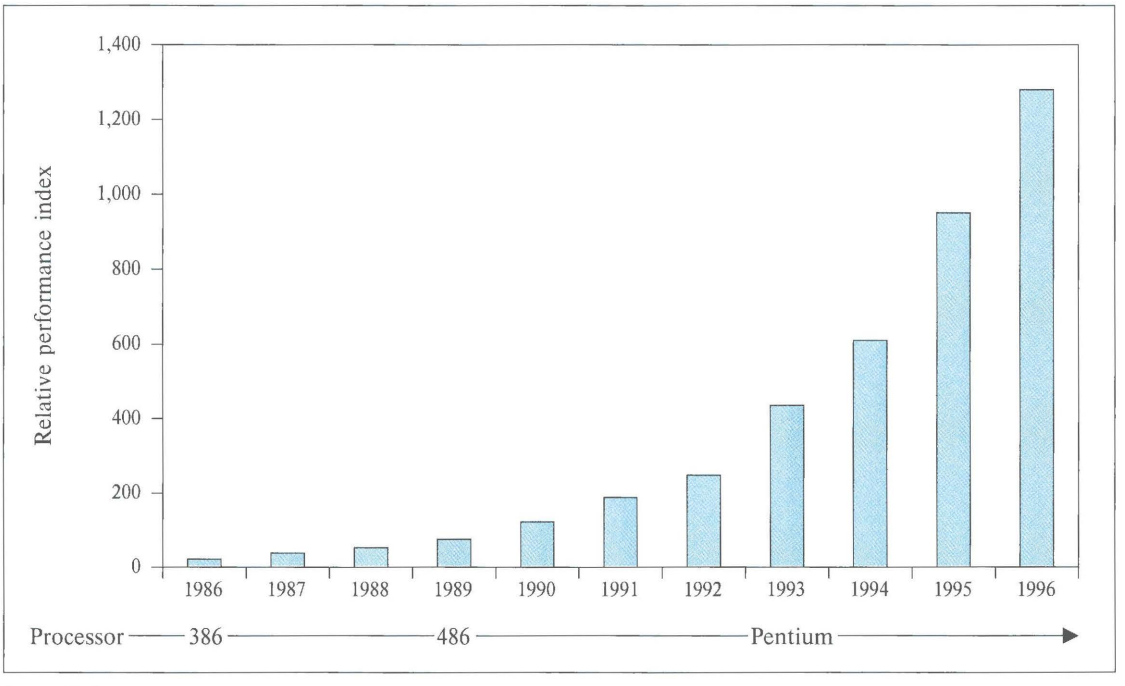


Figure 4
An Example of "Moore's Law". Increases in the Performance of Intel Microprocessors 1986-1996

Source: Intel

3.2.1. Equipment Enhancements

A number of types of hardware that are vital for full convergence are still in the development phase. The major areas under development are:

- *Bandwidth in the local loop:* To take advantage of many of the new services enabled by a converged network, end-users will require more affordable, higher bandwidth connections to the network than are currently available. Digital subscriber line (xDSL) technologies represent one potential solution, but there is uncertainty over whether these technologies can be made sufficiently affordable.
- *Very high speed transport capabilities in the backbone:* It is still not possible to build a very high speed multipoint network using true packet switching protocols, such as IP. Technologies such as gigabit routers, wave division multiplexing and photonic switching are still under development and their success remains uncertain.
- *Voice-data interworking:* For the foreseeable future, the majority of voice traffic will originate and terminate on traditional circuit switched equipment. This means that converged voice switches must be developed for the central office that can translate between packetised and circuit switched voice. Similarly, data edge switches will need to be enhanced to be able to connect directly to ordinary telephones. This kind of voice-data interworking is not yet of carrier-class and remains focused on corporate network applications.

While there is a high degree of uncertainty over the specific implementation of each of these, this should not be confused with whether these hurdles will be overcome. The rapid increase in processing power (Moore's Law) shows how fast these types of development can go in the ICT industry *(Figure 4)*.

3.2.2. Convergence Protocols

Converged networks are bound by standardised communications protocols that enable devices to communicate with each other effectively.

For large volumes of voice traffic to begin to migrate from the PSTN to a converged network, a protocol must be developed that can overcome the following obstacles:

- *Reliability:* A fully converged network needs to be as reliable as today's single purpose voice and data networks.
- *Real time transport:* Converged networks must be capable of transporting digitised voice in real time. Real time is generally considered to mean a delay of less than 200 ms.
- *Scalability:* The protocol must work in a large scale public network, not only in smaller, private networks.

Many initiatives are underway to enhance the protocols of today's public data networks. While it is impossible to predict reliably what developments will emerge from this activity, the level of development effort currently focused on overcoming these hurdles provides good reason to believe that a solution will appear.

The particular development focus on Internet Protocol (IP) also suggests that it will be an important feature of any converged network. The current version of the protocol (version 4) has no capacity to preallocate network resources, to handle the billing that would accompany resource allocation, or to handle the number of addresses that a full scale converged network would need. Attempts to remedy these shortfalls as part of an upgraded version (IP version 6) are underway, although at the time of writing they remain some way from being scaleable to function over a large network.

3.3. Regulation

Regulation refers to the many local, national and international laws, treaties and working guidelines which frame the ICT industry. Two types of regulatory action will influence the pace and extent of convergence:

- Market liberalisation;
- Other issues.

3.3.1. Market Liberalisation

Deregulation allows new competitors to exploit new, converged technologies in order to compete in previously difficult-to-enter markets. Regulatory policy can drive convergence in a few key areas:

- *Access to alternative local loop infrastructures:* The CATV infrastructure already in the ground in some European countries could allow a converged alternative to compete against the PSTN for voice traffic. Wireless local loop (WLL) technologies such as LMDS and MMDS could be deployed in a similar way. Regulatory policy will be an important factor in determining the attractiveness of these options.
- *Interconnection rate levels:* Different interconnection rate regimes can accelerate or impede convergence (*Table 2* shows the spread of rates charged across a number of European countries). Extremely low interconnection rates, for example the LRIC rates proposed in the US, will discourage new players from investing in alternative, converged infrastructure.
- *Arbitrage opportunities:* Packetised voice and fax services exploit arbitrage opportunities that exist because of the high cost of traffic over the PSTN. For example, international fax and telephony products that are currently on offer over the Internet are attractive as they do not have to cover the costs of high international settlement fees paid by PSTN

Table 2
Per Minute Interconnection Rates for Call Termination (from 1/1/1998)

Values in ECU	Local interconnection (at or near the local exchange)	Single transit interconnection (metropolitan)	Double transit interconnection (national)
United Kingdom	0.64	0.91	1.74
Spain	1.51	1.51	4.22
France	0.71	1.73	2.55
Germany	1.00	1.71	2.61
Finland	1.81	1.81	4.20
Denmark	0.98	1.82	2.22
Netherlands	2.00	2.00	2.52
Sweden	1.68	2.15	2.98
Italy*	1.54	2.52	-
Belgium	2.78	2.78	3.62
Austria	7.61	7.61	8.41

Interconnection rates shown are based on a call of 3 minutes duration

* Tariffs proposed by the operator, but not yet approved by the national regulatory authority (at October 1997)

Source: European Commission

carriers in order to terminate their traffic. By maintaining these kind of arbitrage opportunities, regulators can foster the entry of new competitors and the converged services that they will develop.

- *International participation:* Converged networks undermine national monopolies. The degree to which governments and regulators are prepared to open largely protected communications markets will influence the pace of convergence. For example, in the majority of markets around the world a new operator would today not be allowed to deploy a node of a converged network in order to compete against national incumbents. The liberalisation of European markets in 1998 goes some way towards removing this obstacle.

The current trend of liberalisation will continue to gather pace around the world. *Figure 5* shows that by 2000 almost 80% of the world's telecommunications markets (by value) will be liberalised. Although, many markets will not become fully competitive overnight, the overall trend toward increasing liberalisation will not be reversed.

3.3.2. Other Issues

The attitude of regulators on many other issues can also impact the pace and extent of convergence:

- *Attitude towards censorship:* Converged networks enable the unrestricted transfer of all varieties of information, including publications that are prohibited in traditional media by many governments. The degree to which this model of free speech is allowed to continue is uncertain. It is feasible that national governments in some parts of the world could seek to block access to converged-type networks. Any such action will arrest the migration of revenues from traditional networks in these markets.
- *Taxation:* Strict taxation requirements could impede the development of electronic commerce applications over a converged network.
- *Availability of secure encryption protocols:* Foreign export controls on security software can also impede the development of electronic commerce.

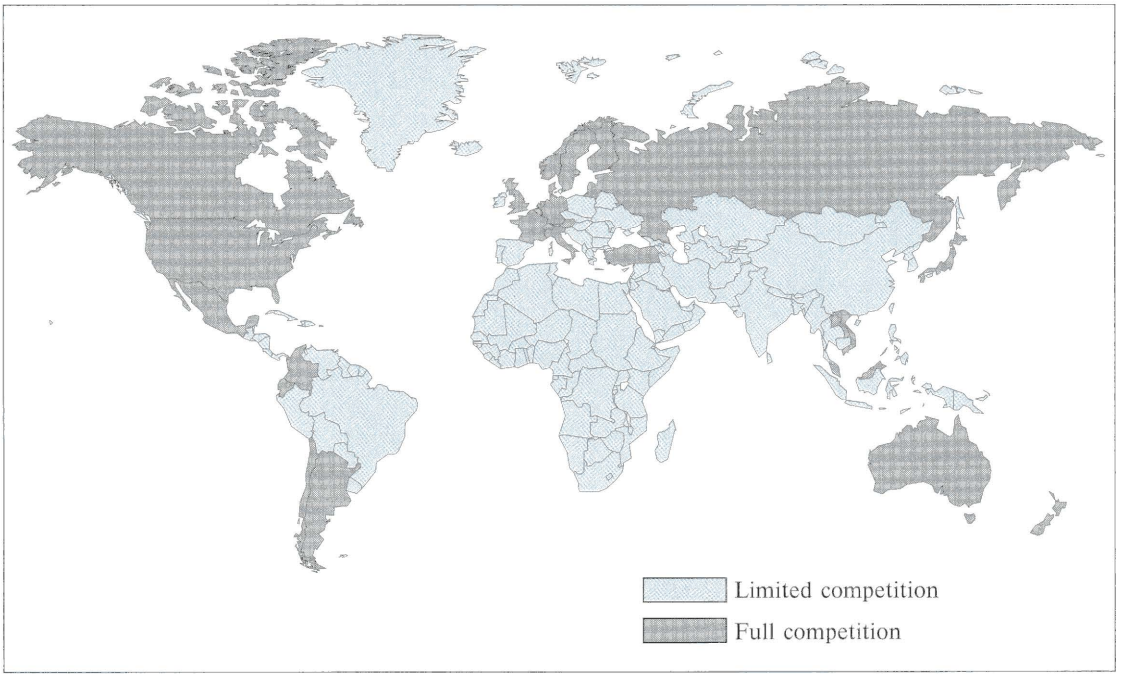


Figure 5
Forecast State of Telecommunications Liberalisation, 2000

Source: Siemens

3.4. Customers

Three groups of customers will influence the pace and extent to which voice and data communications converge:

- *Carriers and service providers:* companies who are the customers of network equipment manufacturers and software houses;
- *Corporate end-users:* users of corporate networks are the customers of both carriers/ service providers and equipment and software manufacturers;
- *Residential end-users:* individuals and small businesses who buy mostly services and some end-point equipment from the manufacturers and providers.

The key variable will be the extent to which these customers will choose converged products and services instead of today's single-purpose offerings. Customers willing to pay for services enabled by a converged network will:

- Increase the pace of convergence by causing revenues to shift to the converged sectors of the grid more quickly;
- Increase the extent of convergence by encouraging suppliers to invest further in the development of converged network equipment and services.

This variable will be driven by the benefits that different customers are able to get from using converged products and services. These can be broadly divided into benefits from new services, and benefits from lower costs.

3.4.1. New Services

Many advanced services such as videoconferencing and on-demand multimedia are today available only on certain networks. Converged networks will make these available on a widespread scale for the first time.

Equally important will be the success of companies in developing *new* services enabled by a converged network that customers will be prepared to pay for. The rapid growth in popularity of the Internet indicates that there is a latent demand for new means of communication. Although it is impossible to reliably predict what the "killer" services will be, a converged network opens up many possibilities for combining visual elements to a voice communication (one example might be "click & call" services incorporating directory assistance where a customer initiates the call by clicking on the other party's name or location).

The reaction of end-users to the new services they are offered is uncertain. The last decades are littered with new technologies for which customer demand failed to take off. However, if the reaction proves to be positive, there will be a powerful incentive for carriers and service providers to invest in the converged technology that will allow them to offer these kind of services. Detailed market research into the current and potential needs of customers is the only reliable way of predicting how customer needs will evolve in future.

3.4.2. Lower Costs

Converged networks offer carriers the potential for substantial cost savings, as traffic from today's many networks (PSTN, FR, X.25, SMDS, etc.) gradually migrates to a single converged network. A proportion of these savings will in turn be passed on to end-users.

There are three areas where carriers can lower costs by converging their voice and proprietary data networks:

- Carriers can save on the costs of operating, administering and maintaining their networks as they make the transition to managing one network instead of several single purpose networks. These savings will be partially offset by the fact that interconnection between carriers will be more difficult, due to protocol differences.
- Carriers can save on capital investment as convergence offers the prospect of using standardised, off-the-shelf network equipment. This requires a lower investment per Mb transported, although this is partially offset by faster depreciation cycles.
- The packet switching of a converged network allows for more economical transport of voice traffic, requiring only a few Kbps of bandwidth versus the 64 Kbps currently used in the PSTN.

Even when the necessary technology is available, however, carriers will not be able to reap all of these savings immediately. Multiple networks will need to be maintained during the transition from today's installed base to the new converged infrastructure.

3.5. Competitors

Competitors refer to the companies directly involved in providing voice and data communications products or services. These companies can behave in ways that drive convergence forward:

- A new entrant to the carrier market, seeking to compete against an incumbent, may decide to deploy a converged network, technology permitting. This will enable the new entrant to offer new services that are unavailable from its competitors, as well as lowering its costs.
- A major equipment vendor that invests heavily in developing converged network equipment will actively drive forward the pace at which convergence takes place.

Competitors can also behave in ways that resist progress towards convergence:

- A PTT may choose not to make higher bandwidth access (e.g. xDSL services) available at an affordable price because it does not want to encourage migration of voice traffic to networks like the Internet.
- Alternatively, it may lower its PSTN prices to a level where the opportunity for a new entrant to exploit any "arbitrage" is small, making it less attractive for new competitors using converged equipment to enter the market.

Every player under the ICT industry umbrella must choose whether to drive or resist convergence. Doing nothing amounts to resisting convergence by default. The way in which companies make these choices will have a dramatic effect on both the pace and particular path convergence will take.

Section 5 discusses ways in which competitors can remain competitive by preparing for, and in some cases pre-empting, convergence.

4. Forecast Pace and Extent of Convergence

Scenarios of convergence include:

- The ways in which the strategies of individual competitors are likely to evolve over the next decade;
- The demand for converged equipment and services that is likely to emerge among customers;
- The enabling technologies that are likely to emerge and when.

4.1. Gradual Convergence

The following assessment of how convergence is most likely to develop over the coming years has been formulated on the basis of primary research among many of the leading players in the ICT industry.

While developing this scenario as the basis of the market forecasts in this chapter, long term uncertainty persists around any forecast in this arena further than 1 year. The implications if a different sequence of events plays out will be considered in section 4.2.

4.1.1. Technology

Equipment enhancements are expected in the next 2-6 years that will result in converged network switches and access equipment becoming widely available. A number of manufacturers - from both voice and data sides - are already investing heavily in developing these technologies.

IP version 6 and a series of associated software and protocol developments will allow for the allocation of network resources for real time communications, improved security features and usage tracking/billing features.

4.1.2. Regulation

Future developments in regulatory policy seem more certain than changes in the other drivers. In the traditional voice market, deregulation is expected to take place at a pace that is just fast enough to prevent overwhelming arbitrage opportunities, but slow enough to allow traditional competitors to adjust slowly. In converged communications services markets little regulation is expected that will impede the uptake of newly emerging products and services.

4.1.3. Customers

Three key trends are expected from a customer perspective:

- *High demand for converged network equipment:* There is already a pent up demand among carriers for voice switches with interworking functions and the capability to handle data.
- *Substantial transition of corporate users to converged networks:* This shift will initially be motivated by the lower costs of routing internal voice and data traffic over a single converged network, but over time corporates are expected to become heavier users of new services enabled by a converged network.
- *Slow migration of residential voice traffic from traditional, non-converged networks to packetised voice services:* Over time, as carriers converge their existing networks, traffic will gradually migrate to packetised voice. This process will not be complete by 2005. However, the market for Internet telephony services will remain a small fraction of the total market, because traditional carriers will reduce their basic telephony tariffs to minimise the opportunity for arbitrage.

4.1.4. Competitors

The competitive landscape is expected to be largely recognisable to today's, due to three main developments:

- *Traditional carriers will react when threatened by a radical loss of market share:* In particular, traditional voice carriers in most markets will make dramatic reductions in their basic PSTN tariffs over the next 2-6 years as further developments in the quality of packetised voice begin to threaten their core markets (especially the market for corporate traffic).
- *Incumbent carriers will begin converging their own networks attracted by the opportunity to lower costs and extend services:* Certain PTTs are already converging their backbones and tandem switches, while others are planning to begin offering new, value-added services some of which can only be delivered over a converged network.
- *Equipment vendors will adapt existing technologies to work in a converged environment:* Voice equipment manufacturers will continue to invest in adding data communications capabilities to their existing voice platforms. Similarly, data networking companies will organically extend the capabilities of their products towards the voice domain (for example, Microsoft's inclusion of SS7 into its Windows NT software).

4.1.5. Forecast Impact of Convergence on the ICT Industry

Figure 6 summarises the ways in which segments of the ICT industry will grow and shrink due to Gradual Convergence. A more detailed breakdown follows in *Tables 3* and *4*.

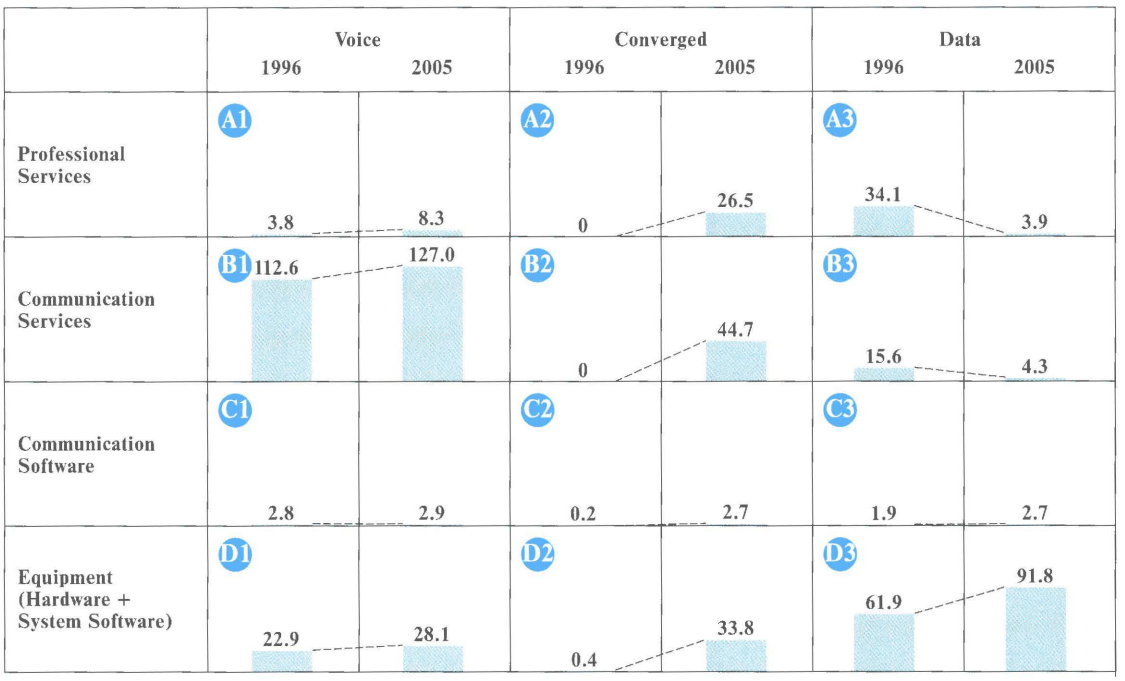


Figure 6
Impact of Gradual Convergence on Market Size. EU Market, Billion ECU, 1996-2005

4.2. Alternative Scenarios

The *Gradual Convergence* scenario for how the industry will look in the future could turn out in a dramatically different way if, for example, a key player decides to change its attitude towards convergence in a way that we do not foresee today. There are many ways in which the extent and pace of future convergence could work out.

In addition to *Gradual Convergence,* three alternative forecast scenarios are considered possible (see *Figure 7*). Together these capture the most important uncertainties in how convergence between voice and data may unfold.

4.2.1. Two Worlds Remain

In this view of the future, convergence will not take place on any significant scale. A variety of factors could lead to this scenario: for example, if the enabling technology failed to materialise, or if the competitiveness of incumbent carriers were to be artificially preserved by regulatory obstacles placed in the path of prospective new entrants.

Even as little as 12 months ago, when the technological and regulatory hurdles to be overcome were greater than those now, this might have been considered a realistic scenario. It is now difficult to envisage a world where voice and data networks do not continue to converge, except under extreme circumstances where global communications networks suffer widespread damage.

Table 3
Forecast Size of the EU ICT Market, Billion ECU, 1996-2005

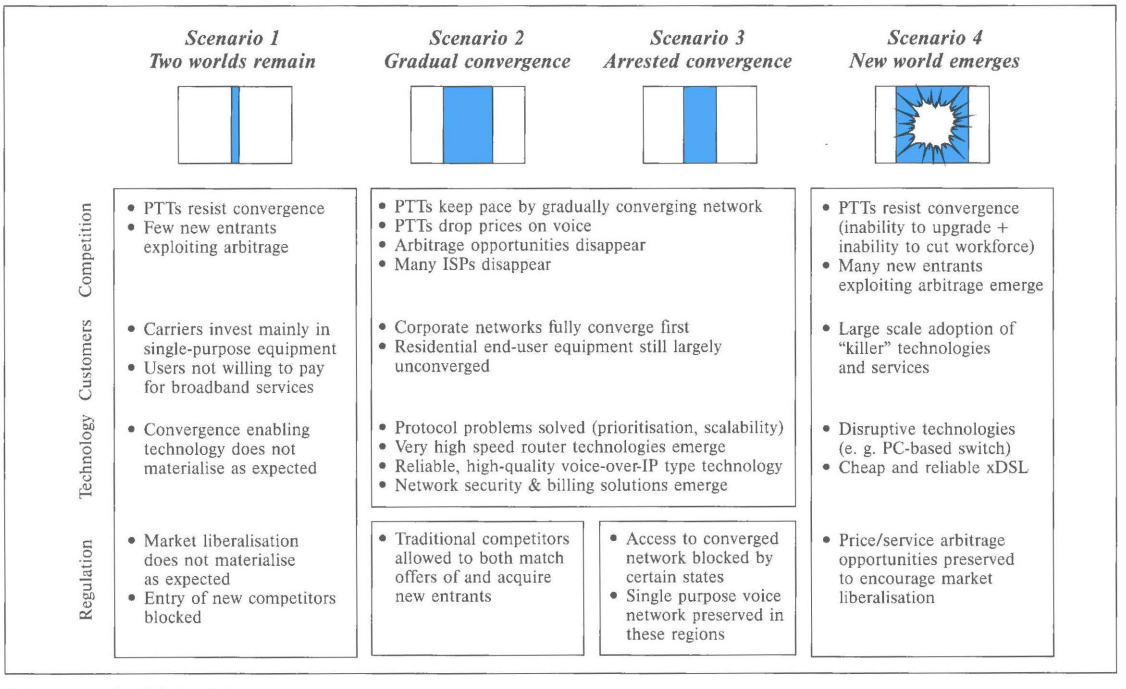
Industry	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
A1: Voice outsourcing/consulting	3.8	4.3	4.9	5.2	5.7	6.4	6.9	7.8	8.2	8.3
A2: Converged outsourcing/consulting	0.0	1.4	3.8	7.6	12.3	18.0	20.8	23.3	25.1	26.5
A3: Data outsourcing/consulting	34.1	33.3	30.5	26.1	20.5	13.8	10.5	7.7	5.5	3.9
B1.1: Mobile services	16.5	18.1	19.9	21.9	24.1	26.5	29.1	32.0	35.2	38.7
B1.2: Local voice services	36.2	38.2	40.0	41.7	43.3	44.4	45.2	45.3	44.5	43.2
B1.3: Long distance voice services	46.3	44.8	43.3	40.5	38.1	35.9	36.1	36.4	36.0	35.1
B1.4: International long distance voice services	13.5	13.5	13.6	13.1	12.4	11.6	9.9	9.8	10.0	10.1
B2.1: Converged Internet access	0.0	0.2	2.1	5.4	9.2	14.0	16.7	19.9	23.1	26.3
B2.2: Converged backbone revenues	0.0	0.0	0.2	0.5	0.9	1.3	1.4	1.5	1.7	1.9
B2.3: Converged leased line and managed data network services	0.0	0.2	0.5	0.9	1.6	2.3	2.6	2.7	2.6	2.3
B2.4: Voice over the Internet	0.0	0.6	0.9	1.1	1.4	1.5	1.5	1.6	1.6	1.6
B2.5: Local converged	0.0	0.1	0.2	0.5	0.9	1.5	2.4	3.6	4.8	6.1
B2.6: Long distance converged	0.0	0.1	0.3	0.5	0.8	1.2	1.9	2.9	3.9	5.0
B2.7: International long distance converged	0.0	0.0	0.1	0.2	0.2	0.4	0.5	0.8	1.1	1.4
B3.1: Internet access	1.6	3.0	3.5	3.6	2.0	0.0	0.0	0.0	0.0	0.0
B3.2: Internet backbone	0.1	0.1	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0
B3.3: Leased line and data services	13.9	16.6	17.8	17.6	15.7	12.9	10.2	7.8	5.8	4.3
C1: Voice communications software	2.8	2.9	2.9	3.0	3.1	3.0	3.0	2.9	2.9	2.9
C2: Converged communications software	0.2	0.3	0.5	0.7	1.2	1.5	1.8	2.0	2.4	2.7
C3: Data communications software	1.9	2.0	2.1	2.1	2.2	2.3	2.4	2.5	2.6	2.7
D1.1: Voice end-points	11.9	12.5	13.2	13.8	14.5	15.0	15.7	16.5	17.2	17.9
D1.2: Voice concentrators	3.0	3.0	3.1	3.1	3.1	3.0	3.0	2.9	2.7	2.6
D1.3: Voice switching	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.3	3.3
D1.4: Voice transmission	2.5	2.4	2.2	2.1	1.9	1.8	1.7	1.6	1.5	1.4
D1.5: Mobile communications infrastructure	2.0	2.3	2.5	2.7	2.9	2.9	2.8	2.8	2.8	2.8
D2.1: Converged end-points	0.0	0.0	0.1	0.7	4.3	9.8	13.0	16.7	21.3	22.9
D2.2: Converged concentrators	0.0	0.2	0.4	0.9	1.6	1.9	2.2	2.6	3.0	3.5
D2.3: Converged switching	0.0	0.2	0.5	1.1	2.3	3.0	3.6	4.2	4.9	5.6
D2.4: Converged transport	0.4	0.5	0.6	0.7	0.7	0.8	0.9	0.9	1.0	1.1
D2.5: Converged mobile infrastructure	0.0	0.0	0.0	0.1	0.2	0.3	0.5	0.6	0.7	0.8
D3.1: Data end-points	58.2	62.2	66.4	70.6	73.2	74.4	77.3	80.0	82.4	88.0
D3.2: Data concentrators	3.0	3.3	3.5	3.4	2.9	3.0	3.0	3.0	3.1	3.1
D3.3: Data switching	0.6	0.8	0.9	0.9	0.6	0.5	0.6	0.6	0.6	0.7

Table 4
Forecast Growth of the EU ICT Market, % Growth on Previous Year

Industry	1997	1998	1999	2000	2001	2002	2003	2004	2005
A1: Voice outsourcing/consulting	12	14	7	9	11	9	12	5	2
A2: Converged outsourcing/consulting	n.a.	177	98	63	46	15	12	8	6
A3: Data outsourcing/consulting	-2	-9	-14	-21	-33	-24	-27	-28	-30
B1.1: Mobile services	10	10	10	10	10	10	10	10	10
B1.2: Local voice services	5	5	4	4	3	2	0	-2	-3
B1.3: Long distance voice services	-3	-3	-6	-6	-6	1	1	-1	-2
B1.4: International long distance voice services	0	1	-4	-5	-7	-14	-1	2	1
B2.1: Converged Internet access	n.a.	n.a.	155	69	53	20	19	16	14
B2.2: Converged backbone revenues	0	n.a.	155	75	48	10	10	10	13
B2.3: Converged leased line and managed data network services	n.a.	94	91	82	42	14	4	-4	-9
B2.4: Voice over the Internet	n.a.	44	27	18	10	3	3	1	3
B2.5: Local converged	n.a.	n.a.	112	75	64	64	49	35	27
B2.6: Long distance converged	n.a.	n.a.	93	61	53	62	49	35	27
B2.7: International long distance converged	n.a.	n.a.	97	62	51	45	47	39	26
B3.1: Internet access	86	15	4	-46	-100	n.a.	n.a.	n.a.	n.a.
B3.2: Internet backbone	91	18	-4	-44	-100	n.a.	n.a.	n.a.	n.a.
B3.3: Leased line and data services	20	7	-1	-11	-18	-21	-23	-25	-27
C1: Voice communications software	2	2	2	2	-1	-1	-1	-1	-1
C2: Converged communications software	110	43	56	68	26	18	15	16	13
C3: Data communications software	3	3	3	3	5	5	4	4	4
D1.1: Voice end-points	5	5	5	5	3	5	5	4	4
D1.2: Voice concentrators	1	0	0	0	-1	-3	-4	-4	-4
D1.3: Voice switching	0	0	0	0	-1	-1	-1	-1	-1
D1.4: Voice transmission	-6	-7	-7	-8	-5	-6	-6	-6	-7
D1.5: Mobile communications infrastructure	11	10	9	8	-1	-1	-1	-1	-1
D2.1: Converged end-points	0	n.a.	n.a.	n.a.	129	32	29	27	7
D2.2: Converged concentrators	n.a.	91	117	89	16	18	17	16	15
D2.3: Converged switching	n.a.	191	113	98	31	20	17	17	14
D2.4: Converged transport	19	15	13	11	10	9	8	7	7
D2.5: Converged mobile infrastructure	n.a.	124	124	124	82	41	27	20	16
D3.1: Data end-points	7	7	6	4	2	4	4	3	7
D3.2: Data concentrators	8	6	-2	-15	2	2	1	1	1
D3.3: Data switching	23	11	0	-29	-12	10	5	4	1

Note: The system dynamics approach that was used to model the impact of convergence on the ICT industry may result in a rate of change that appears less linear than would be achieved in conventional forecasts. A more detailed explanation of this methodology can be found in the Appendix.

Figure 7
Scenarios of Convergence, 1998-2005



Note: see text for full description

4.2.2. Arrested Convergence

In most parts of the world, convergence will proceed as in the *Gradual convergence* scenario. The main difference being:

- *Regulation:* certain national governments will seek to block access to the global converged network for political/censorship reasons (in much the same way as access to the Internet is impeded today in China).

The producers of voice equipment in the EU will find growing markets for their single-purpose equipment in affected geographies. Investment in developing the functionality of single-purpose equipment will continue and, by achieving further economies of scale and innovative extensions to their single purpose equipment, traditional equipment vendors will make it less attractive for PTTs and new entrants to invest in converged equipment.

This in turn has an impact on the services offered and prices asked for single-purpose voice services. The result is a slower pace of convergence, even in the EU. *Figure 8* shows the impact that this scenario would have on the ICT industry.

4.2.3. New World Emerges

This final scenario represents a disruptive pace of development. The industry landscape under this scenario will be virtually unrecognisable in 2005 from today. Many new competitors will establish strongholds across the industry, competing directly against many of today's familiar competitors.

This scenario is primarily driven by the following developments:

- *Competitors:*
  - Start-up equipment vendors responsible for disruptive technologies will become

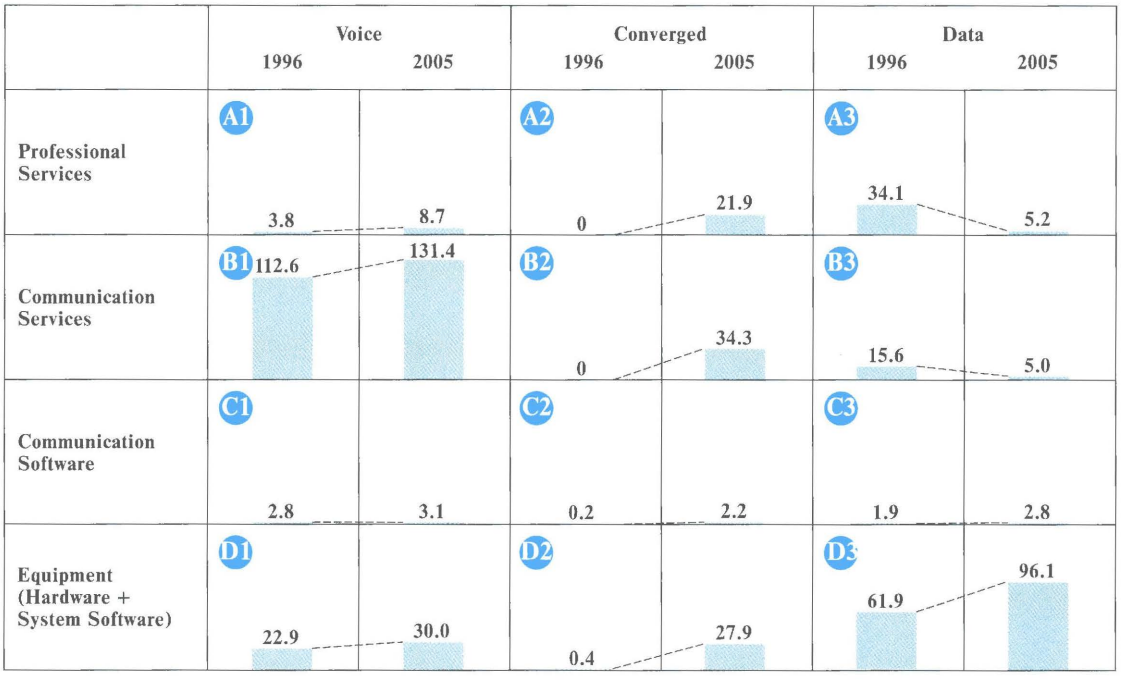


Figure 8
Impact of Arrested Convergence on Market Size. EU Market, Billion ECU, 1996-2005

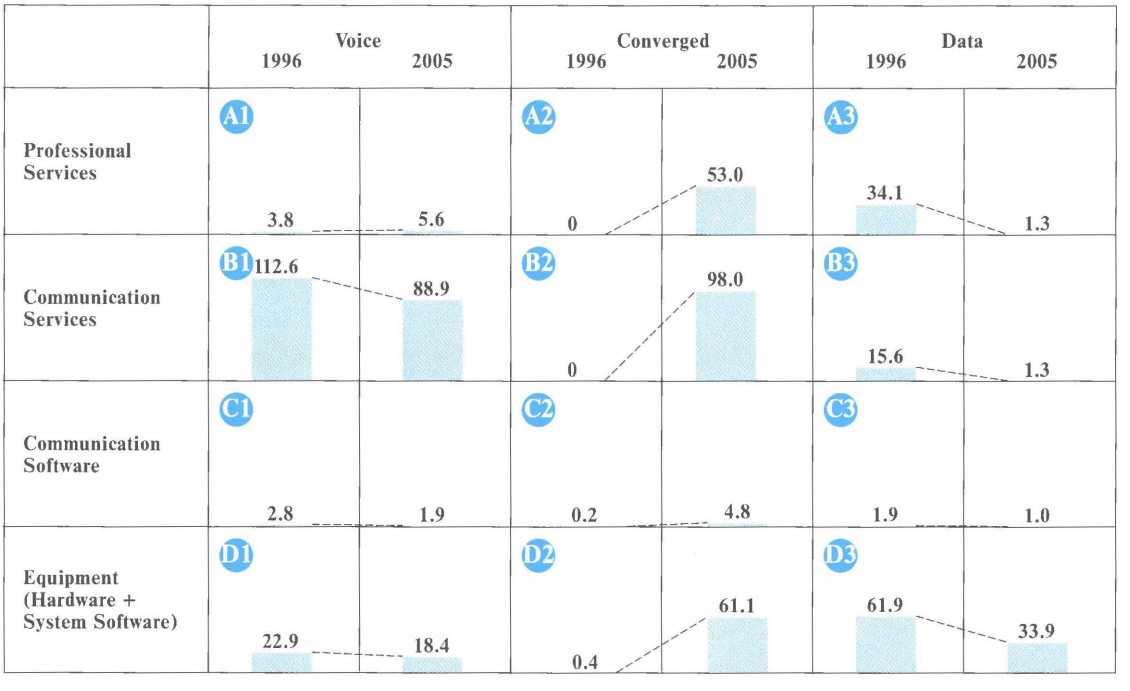
major players in this scenario (in the manner that companies like Cisco have already done in the world of Internetworking).

- Dynamic, new entrants will be able to establish strong footholds in converged communications services, both by pioneering new services enabled by these disruptive technologies, and by offering significant savings on traditional services.
- Traditional carriers such as the PTTs, will either ignore or resist convergence around them. This could be for any of a number of reasons, including regulatory policy, the difficulty in upgrading a large installed base of equipment or difficulty reducing workforce numbers. However, the high voice tariffs they will maintain and their reluctance to drive forward the provision of new services will undermine the advantage of incumbency they possess and lead to rapid market share loss.
- *Customers/technology:* demand for the innovative products and applications enabled by a converged network will take off in a disruptive manner. The demand for "killer" products will increase the market for converged services, and will encourage the development of further services enabled by a converged network.

While obviously dependent on technological innovation, this will be primarily a customer-led phenomenon. The disruptive nature of these products means that it is not possible to predict their exact nature - examples might be cheap, reliable xDSL access equipment, or PC-based voice switches.

Figure 9 shows the impact that this scenario would have on the ICT industry.

Figure 9
Impact of New World Emerges on Market Size. EU Market, Billion ECU, 1996-2005



5. Implications: Converging Competitors

5.1. Convergence Will Change the Competitive Landscape

The competitive landscape in many ICT markets will change considerably over the next decade:

- Revenues will relocate within the industry grid from non-converged sectors to the converged arena.
- Share in the overall ICT market will shift substantially between non-converged players, and those who adapt to compete in the new converged space.

5.1.1. Future Sales Growth Will Be Focused in the Converged Arena

In the forecast of Gradual Convergence, *most or all growth in the ICT market over the next decade will occur in the converged part of the grid* (see *Figure 10*). Companies seeking to achieve high single or double digit growth will find it extremely difficult without moving into the converged market aggressively.

	Voice		Converged		Data	
	1996-2000	2000-2005	1996-2000	2000-2005	1996-2000	2000-2005
Professional Services	A1 + 1.9 *+ 11%*	+ 2.6 *+ 8%*	A2 + 12.3 *-*	+ 14.2 *+ 17%*	A3 - 13.6 *- 12%*	- 16.6 *- 28%*
Communication Services	B1 + 5.3 *+ 1%*	+ 9.1 *+ 2%*	B2 + 14.9 *-*	+ 29.8 *+ 25%*	B3 + 2.2 *+ 3%*	- 13.5 *- 25%*
Communication Software	C1 + 0.2 *+ 2%*	- 0.2 *- 1%*	C2 + 1.0 *+ 67%*	+ 1.5 *+ 18%*	C3 + 0.3 *+ 3%*	+ 0.5 *+ 4%*
Equipment (Hardware + System Software)	D1 + 2.9 *+ 3%*	+ 2.2 *+ 2%*	D2 + 8.6 *+ 114%*	+ 24.8 *+ 30%*	D3 + 14.8 *+ 6%*	+ 15.1 *+ 4%*
						Change in absolute size (ECU Billion) *Compound Annual Growth Rate (%)*

Figure 10
Forecast Sales Growth, EU Market, 1996-2005

5.1.2. Companies with Competencies in Both Voice and Data Will Capture Most of This Growth

The companies who will command controlling shares across these converged industries over the next decades will be those that can adapt their organisations to build the new competencies that will be required to compete in supplying converged products and services. Companies that do not or cannot evolve are likely to find themselves in markets of diminishing importance.

Successful companies will adapt to two fundamental changes in the nature of competition over the coming years.

- *Changing technologies:* The ICT industry has traditionally been divided between the markets for voice communications products and services and the corresponding markets in the data arena. It is possible to think of this divide as the division between circuit and packet switched networks. Companies have traditionally competed primarily in one or the other. In a converged arena, companies will need to be competent in drawing characteristics from both voice and data products to be competitive.
- *Changing customers:* Companies will find that they are increasingly competing for a different set of customers, with different needs. Deregulation and lower costs brought about by advancements in technology will allow more and more competitors to become communications carriers on a smaller and smaller scale. At the same time, the emergence of converged equipment will enable new services to be offered that are not available today. The existence of these services will begin to alter the needs expressed by different customer groups.

5.1.3. Most Converged Equipment Products Will Originate from the Data World

Most converged equipment will be in the form of upgraded data products rather than upgraded voice products. Traditional voice products have been designed with a fundamentally different philosophy and customer base in mind. Vendors of these products have traditionally built reliable, large scale, circuit-switching equipment, aimed mainly at the traditional carrier market.

The converged network equipment that will represent much of the growth over the next decade will bear greater resemblance to products from today's data industry. These products are designed with a focus on lower cost, smaller scale, packet switching technology. *Figure 11* shows that the vast majority of converged end point products will originate from the data industry.

The market for converged concentrator equipment will be more balanced between upgraded data and voice products. The ubiquity of voice PBXs and their associated features will initially help sales of equipment originating from the voice industry, with PBXs being upgraded to deliver packetised output. Over the next five years, products originating from the data world will be upgraded to offer the full functionality of voice PBXs. This will cause their share of the converged concentrator market to rise accordingly.

5.1.4. Revenues from Voice Telephony Will Shrink but Will Largely Be Retained by Traditional Carriers

The availability of voice services over a converged Internet (VoI) will be a key driver in rebalancing voice telephony tariffs of traditional carriers. It also promises to play an important role in the steady migration towards packetised voice that will take place over the next several decades. It will not be enough, however, to allow converged entrants to the voice telephony market to take a large share of the market away from traditional carriers (see *Figures 12* and *13*). This is for two reasons:

- First, the threat of radical market share loss to new competitors using handset-to-handset VoI (Voice over Internet) technology will force traditional voice carriers to lower the costs of basic telephony. As the traditional carriers cut costs and invest in converged technology themselves, they will build scale advantages that will make it difficult for new entrants using VoI technology to increase market share beyond a relatively low level.
- Second, in some countries traditional carriers are likely to launch their own VoI products ("fighting" brands) to combat the flow of traffic to new competitors. A number of traditional carriers are currently experimenting with this technology.

5.2. Challenges Facing Today's Players

Against this backdrop, today's players must adapt to become competitive in the future market for converged products and services. All sectors of the ICT industry are faced with this challenge, none more so than the two of the largest groupings: traditional equipment vendors (boxes D1 and D3 in the convergence grid) and traditional voice carriers (box C1).

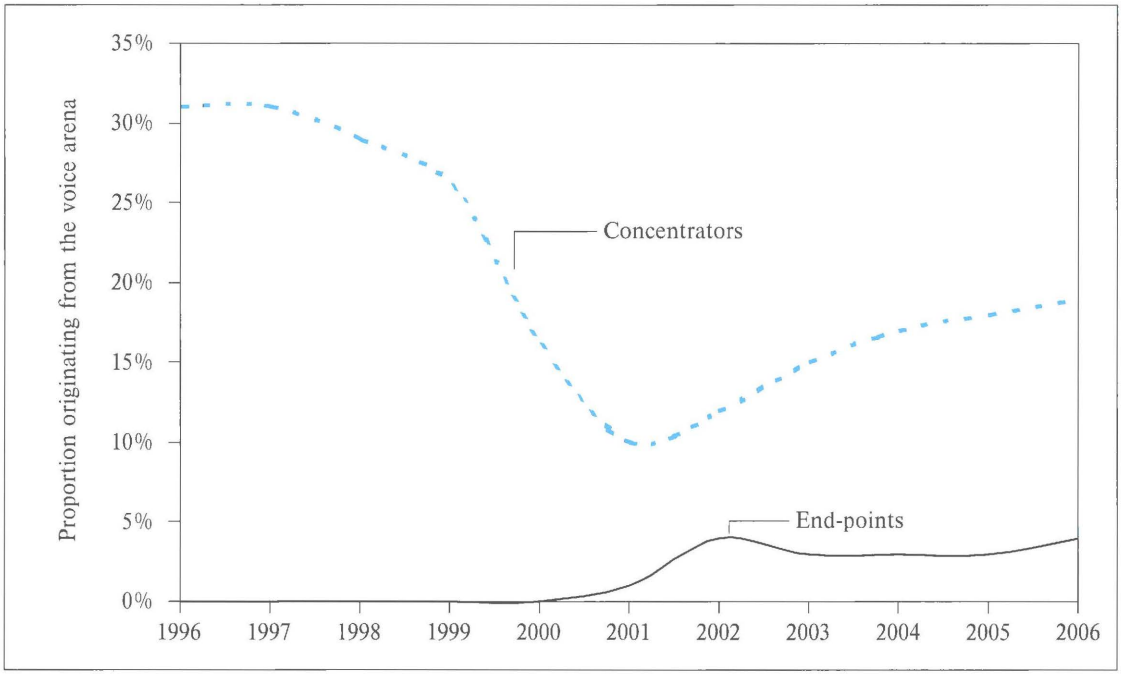


Figure 11
Converged Products Originating from the Voice World, 1996-2005

5.2.1. Traditional Equipment Vendors

Equipment vendors will increasingly need to combine the reliability, scalability and compatibility of carrier class voice switching equipment, with the flexibility, cost and innovation of packet-switching equipment.

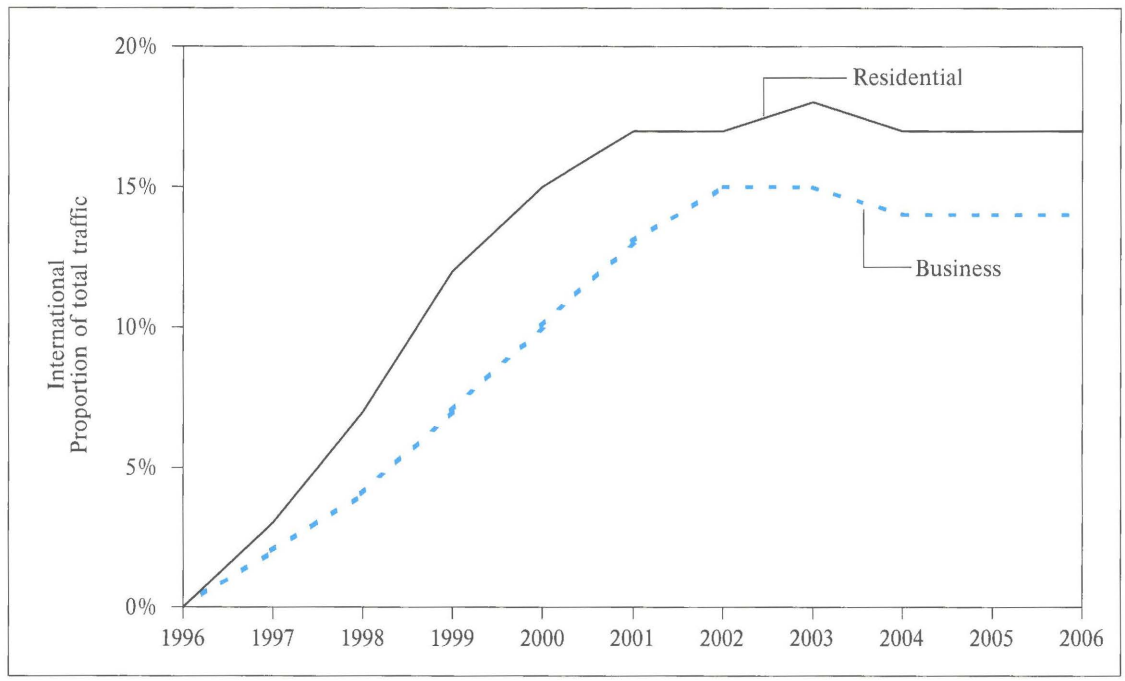
Voice equipment vendors who have until now competed for the relatively narrow customer base of traditional telecom carriers will find that they are increasingly expected to compete for a much larger number of smaller scale customers. New product lines will need to be developed that deliver equal quality on traditional services (e.g. voice), but on a smaller scale and for lower cost.

At the same time, vendors will need to cater for changing needs among traditional carrier customers. These customers will themselves need to begin offering the new services that are enabled by a converged network, such as videoconferencing or on-demand multimedia, and their needs will alter accordingly.

To achieve this, vendors will need to become competent in four core dimensions:

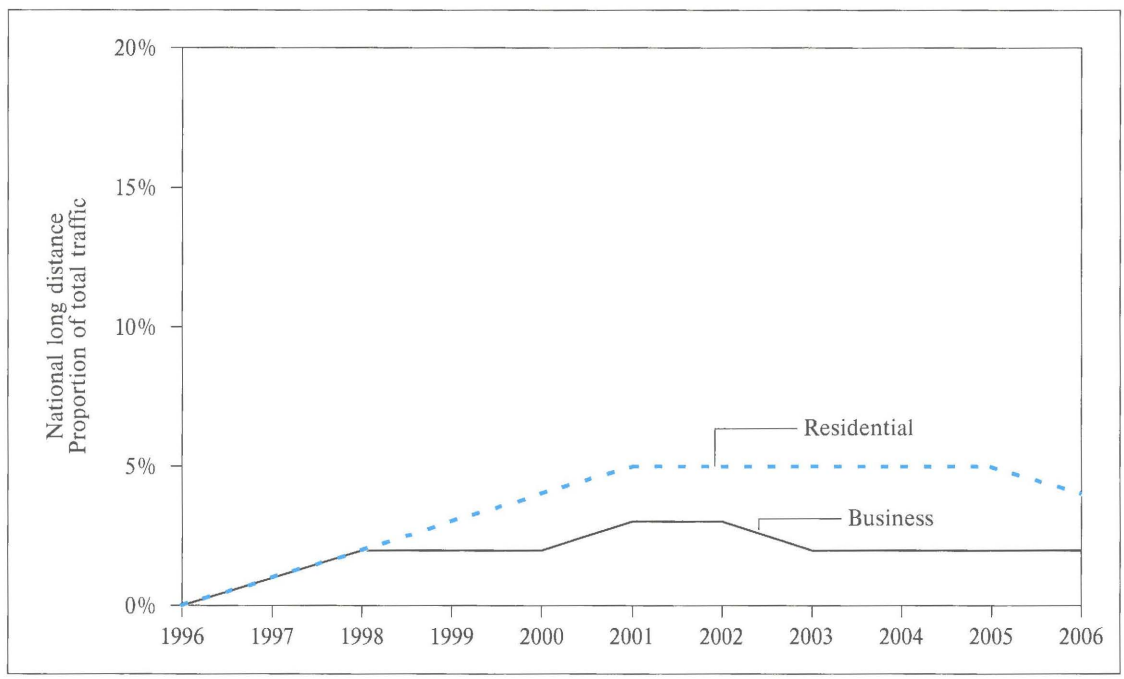
- *Build know-how in both voice and data:* Equipment vendors have traditionally been focused on either voice or data technologies. The result of this is that both voice and data players lack essential elements of know-how that will be required to compete in the converged arena. Data players often have difficulty recreating the voice network's quality and reliability on a packetised platform. They will need to overcome this lack of expertise in real-time narrowband streams. Voice players face a greater challenge. They will need to largely reinvent their products within a packet-switched paradigm. Building these competencies will involve a fundamental shift in the R&D function, which may only be possible through acquisition.

Figure 12
Internet Telephony as a Proportion of Total International Traffic, 1996-2005



Note:
1. Market share differences between business and residential mainly caused by different price sensitivity and different access cost economics for the new entrant

Figure 13
Internet Telephony as a Proportion of Total Long Distance Traffic, 1996-2005



Note:
1. Market share differences between business and residential mainly caused by different price sensitivity and different access cost economics for the new entrant
2. Local not shown because market shares of converged new entrants negligible

- *Interworking between voice and data expertise within the organisation:* Where both voice and data technologies have co-existed in the same organisation, this has usually been as separate functions, with separate R&D, sales and management teams. In order to compete in the converged arena, there must be little or no distinction between voice and data in the development of new products. In many cases, the structure of vendor organisations will need to be redesigned, in order to overcome distinctions that will become a competitive disadvantage over the coming years.
- *Pre-emption of changing customers and customer needs:* Companies that can listen to and pre-empt the needs of their customers better than their competitors will be successful in capturing share in the converged arena. Many vendors - particularly in the voice sector - have become used to dealing with a very stable customer base with a stable set of needs. These companies must build the capacity to conduct detailed analysis and research on their potential future customer base in order to safeguard their competitive position. Achieving closer relationships with the network service providers will help vendors to understand better how the needs of end customers are changing, and the effect that this has on the needs of the vendors' own customers.
- *Shift to shorter R&D lead times:* As in today's data arena, the coming years will be characterised by many new product launches, developed in ever shorter times. Again, voice equipment will be particularly affected. Manufacturers will find that they will become disadvantaged if they do not or cannot build the capacity to bring new ideas to market faster than they have historically been used to.

5.2.2. Traditional Voice Carriers

The entry of new competitors into the voice telephony market, deploying converged network equipment, will impact non-converged carriers in three ways:

- *Margin pressure:* Traditional carriers will be forced to lower margins on international and long distance telephony, or face the prospect of radical losses of market share.
- *Uncompetitive cost structure:* Despite huge scale advantages, traditional carriers will initially find that they are competing against new entrants with the lower cost structure of a converged network.
- *Inability to offer new, converged services:* Traditional carriers will be unable to match the innovative, converged service offerings of their new competitors.

To remain competitive, traditional carriers can respond in four ways. There are no generic prescriptions for action however. Each player will need to formulate their own strategy by evaluating these options in a detailed, data driven manner.

- *Converge themselves:* Within the constraints of their existing asset base, carriers can move to upgrade first their transit network, and later the access network to a broadband converged standard. This will enable carriers both to improve their cost structure, and to offer customers equally innovative services relative to new competitors.
- *Bring operational costs in line with international benchmarks:* European carriers typically have a higher level of cost built into their structure than their counterparts in more liberalised markets such as the US, UK and Scandinavia. New entrants to the market will deploy lean, low cost organisations. Traditional European carriers will be disadvantaged unless they can act to bring their own costs to a more competitive level.

- *Pre-empt changing customer needs:* Carriers can develop future services in many ways. The evolution into content, video-on-demand, multimedia, broadband Internet, and other value-added services is not new. However, there is no generic path to take. Carriers need to choose between the many available options based on solid data on local needs and circumstances. Advanced customer research and analysis techniques can help players make these decisions in a more informed way.
- *Launch a fighting brand:* To offset the impact of Internet telephony on their businesses, carriers can evaluate launching their own, VoI-based fighting brand. This will help traditional carriers to compete in this new segment of the voice market. By competing against new VoI entrants, traditional carriers can play a role in defining the direction that this new industry will move in.

6. Conclusion

Key players can expect a future of relentless change as the phenomenon of convergence reshapes the nature of competition across the range of ICT industries. To remain competitive, traditional players need to react to the competitive threats that a new technology brings.

Convergence will open up the field of competition. Over the next decade, players will begin to compete against each other in segments of the ICT industry that have traditionally been protected either by an unassailable technological advantage, or by regulation. At the same time, new entrants will threaten margins and perhaps, the long term customer base of the established players.

Today's leading players need to move now to preserve their competitive edge by setting about answering the fundamental strategic questions for their own organisations:

- What is the ICT industry going to look like in five years?
- Where should leading companies be positioned by then?
- What choices are necessary to get there?

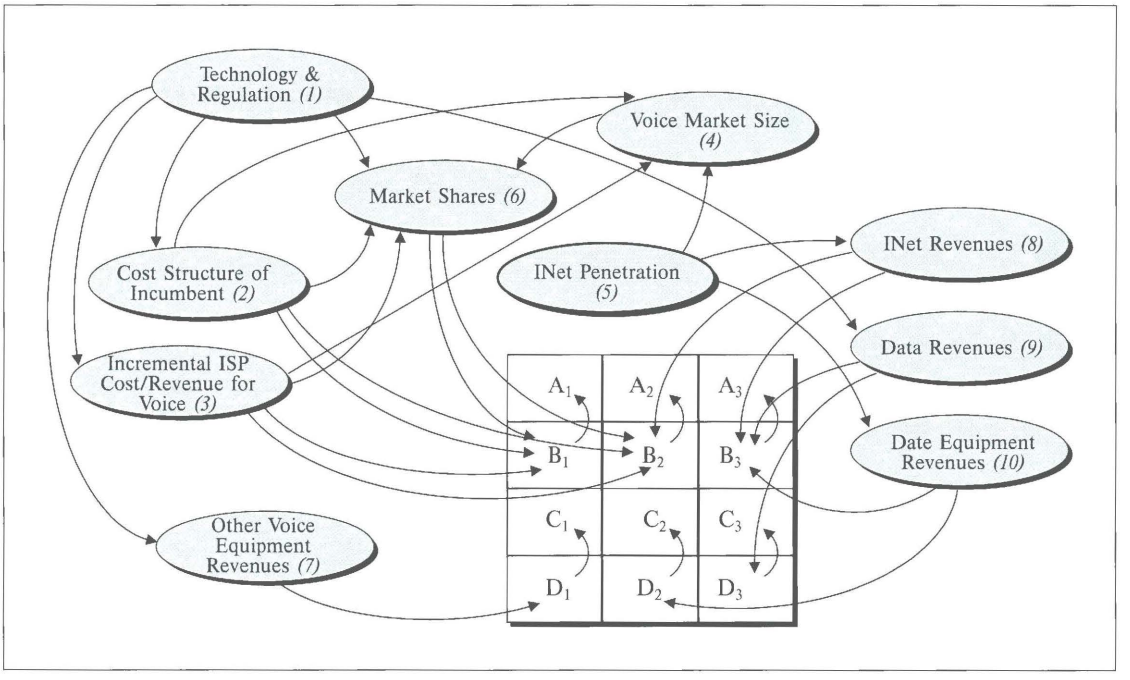


Figure 14
Relationships between the Key Drivers in the Model

7. Appendix

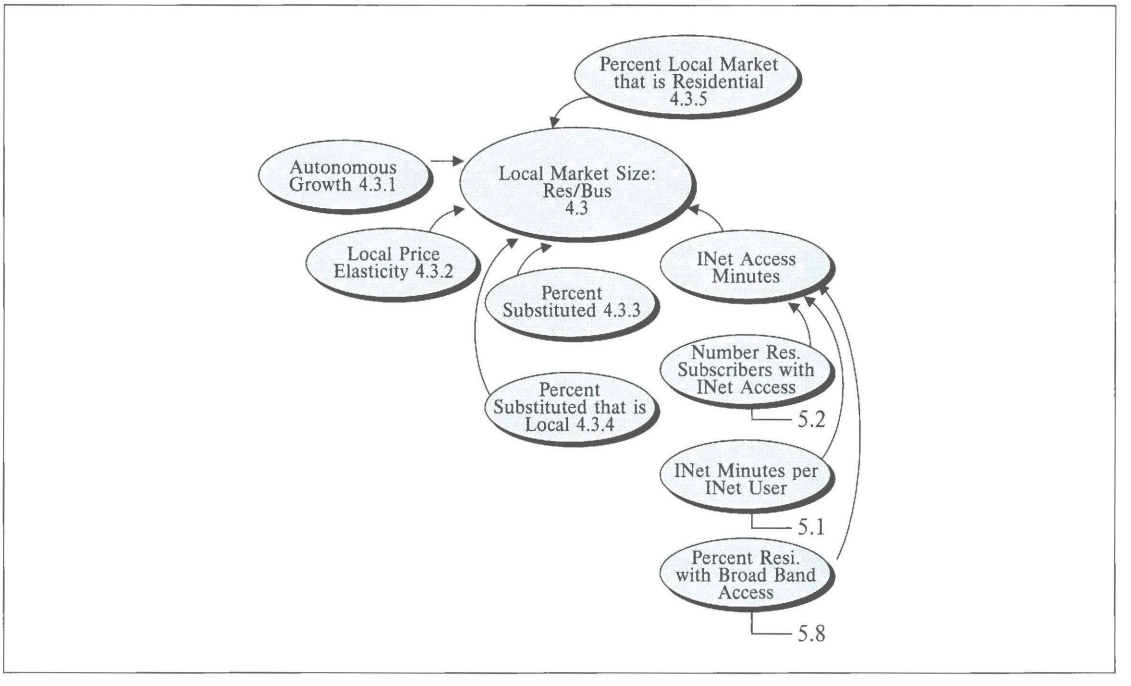
7.1. Forecast Methodology

The key drivers of uncertainty surrounding convergence are customers and competition. The forecasting tool needs to examine explicit relationships between these two drivers and to test them. Using a system dynamics view of the world, it is possible to model accurately relationships that are circular and iterative, i.e. where one action will trigger a reaction and then a next action and so forth. Using a non-linear modelling tool such as I-think can help build a deeper understanding of the underlying changes that are driving convergence at a particular pace.

Figure 14 summarises the main groups of drivers and their relationships. Only the main connections between the different drivers are shown, for reasons of clarity.

Technology and regulation (1) are the enablers of competition and increased demand. The forecast centres around competition between the currently non-converged traditional telecom carrier, and the converging new entrant, called "ISPs" for the purposes of this forecast (2, 3). Their actions trigger end-user demand, and they themselves are the customers for the switching and transmission equipment in the D layer (7). Residential end-users are depicted in 4, 5, 6 and 8. The diagram describes their demand for traditional voice and Internet services and their choice for converged or single-purpose products and services. Business customers are also depicted in 4, 5, 6 and 8 and in this case will also drive the market for data products and services (leased line and MDNS [9], corporate networks [10]).

Figure 15
Drivers of Local Residential Voice. Market Size (Minutes)



The circularity of the model logic shows clearly in the model map. This enables modelling of the realities in the ICT market as closely as possible. For example, as prices for basic voice telephony fall, the volume of the voice market will increase. This volume increase will allow incumbent players, which are largely fixed cost businesses, to lower their cost per minute. This lower cost could be used for yet another price decrease, and the cycle continues.

The above logic has most significant impact on the services (B) and equipment (D) layers of the convergence grid. Layers A and C are modelled as a dependent effect on actions in B and D.

For each of the bubbles in the previous figure, there follows a second layer, with more detailed drivers. As an example, *Figure 15* examines the more detailed drivers behind the Local Residential Market Size. Drivers that are built into the model include:

- *Autonomous growth (4.3.1):* Growth of the local voice market irrespective of the other drivers mentioned below. This growth is, for example, related to population growth and GDP per capita growth.
- *Price elasticity (4.3.2):* Growth of the volume as a result of price increases or decreases, based on global analogues from other liberalising markets.
- *Substitution (4.3.3, 4.3.4):* Convergence enables new ways of communicating. Just as data networks have led to applications like electronic mail, converged networks will breed a new generation of communications applications which might include services such as e-commerce or web-based help-desks. These new communications tools will cannibalise the voice market. The inputs used in the model have been based on independent analysis.

- *Internet penetration (5.x):* Local traffic increases due to Internet access minutes. This depends on the narrowband Internet penetration and the average usage per subscriber. As shown in the diagram, these inputs derive from Internet penetration.

Each of the main drivers has detailed drivers similar to the ones described above. These detailed drivers interact and help predict how the players will invest, what services they will offer, and what their pricing will be. Decisions on a micro-level are combined to form the market forecast presented in this chapter. They can also be used to provide invaluable insight into the competitive strengths and weaknesses of players in the industry.

Comments on the Methodology

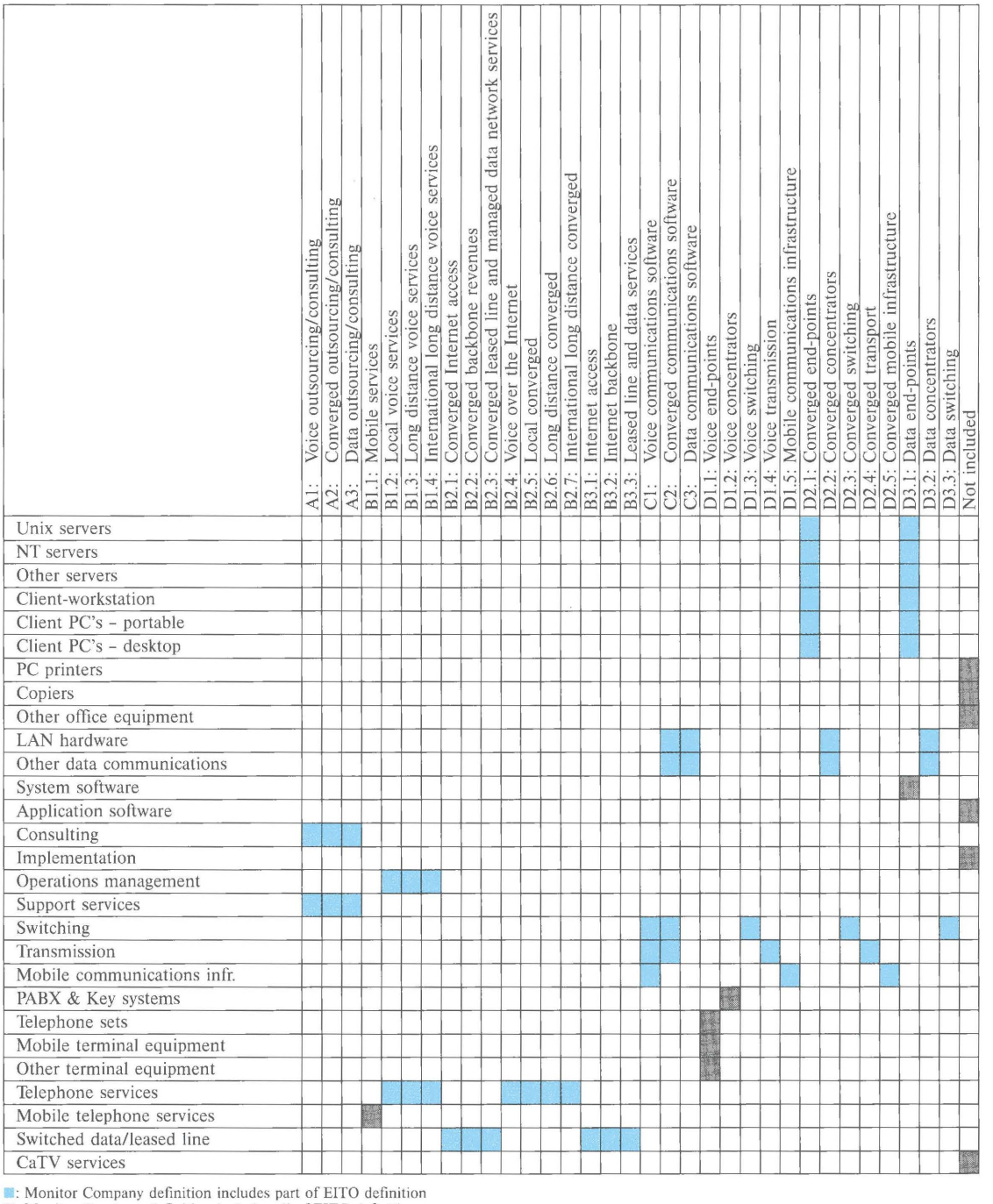
The major advantage of this methodology is that it provides an internally consistent forecast, showing the ways in which the different markets can influence each other. This builds a better understanding of what the underlying drivers of convergence are.

One disadvantage is that it is open to being interpreted with false precision. The growth rates generated in the model can create a false sense of accuracy. It has to be clearly understood that these forecasts are directionally correct and should be used for strategic planning only. They will not provide the exact answer for the 2001/2002 voice end-point growth rate. This is because the model treats the entire market as a system. Its output offers higher reliability on the value resident in the whole system in future.

Comparison of Market Forecast Definitions to the EITO Definition Set

This forecast is compatible with the EITO definitions in this book. Numbers are largely comparable between forecasts. *Table 5* shows the relationship between the definitions used by EITO and those used by Monitor Company.

Table 5
Relationship between Monitor Company and EITO Definitions



▪: Monitor Company definition includes part of EITO definition
▪: Monitor Company definition includes all of EITO definition

7.2. Glossary

ATM Asynchronous Transfer Mode - switching technology that can handle all forms of traffic (voice, video, data) within a single network at very high speeds (up to 155 Mbps)

CO Central Office (of telecommunications company).

CPE Customer Premise Equipment - hardware located at the customer's home/office - e.g. PBX, end point terminals.

Ethernet LAN data communication technology.

Frame Relay Data service designed for LAN interconnect. Current services are designed for permanent virtual circuits although switched virtual circuit implementations are planned.

Gigabit Ethernet Improved LAN technology offering speeds in excess of 1 Gbps.

IP Internet Protocol - most widely used network layer protocol in LAN interconnect and the foundation for the Internet.

ISDN Integrated services digital network - internationally agreed public network, offering switched end to end digital services for voice & data.

LAN Local area network - short-distance network used to link a group of computers together within a building. A piece of hardware called a hub serves as the common wiring point, enabling data to be sent from one machine to another over the network. LANs are typically limited to distances of less than 500 meters and provide low-cost, high-bandwidth networking capabilities within a small geographical area.

Packetised voice Transmission of voice communications over a packet switched network.

PBX Private Branch eXchange - a private phone switch which is used to connect a pool of local phones to the Public Network. PBXs often provide sophisticated features for call control and telephony/data operation.

PSTN Public Switched Telephone Network - the basic telephone network in place today. Built on circuit switched access.

PTT National bodies responsible for provisioning telecommunications services in a particular country. Ex-PTTs exist in certain markets and are the derivatives of these bodies following liberalisation or privatisation.

QoS Quality of Service - this ATM term is often referred to as Type of Service or Class of Service in Internet circles. QoS provides prioritisation schemes in IP headers that identify different types of traffic.

RSVP Resource ReSerVation Protocol - RSVP lets hosts request a specific QoS (see above) from the network. This is intended to give priority to certain types of traffic, which may include real-time telephony and video applications, or perhaps mission-critical business data packets.

SDH Synchronous digital hierarchy - gradually replacing PDH. A set of ITU-T standards for digital transmission of synchronous data streams (matching bit rates). Being deployed as the next generation transmission infrastructure by carriers.

SONET Synchronous optical network - US equivalent of SDH.

TCP (TCP/IP) Transmission Control Protocol - protocol which guarantees the integrity of data transported over an IP network.

VoIP Voice over Internet Protocol - a technology for sending voice communications over IP based networks such as the Internet (VoI) or an intranet.

xDSL Digital Subscriber Line access technologies - enable high bandwidth communications over standard copper access lines. Several variants (e.g. IDSL, HDSL, VDSL, ADSL) offer bandwidths ranging from 128 kbps through to 8 Mbps.

X.25 ITU-T standard for packet switched networks that provide low bit rate data communications services.

Telework: Status, Development and Issues

This chapter has been provided by European Telework Development (ETD) in close co-operation with the EITO Task Force.

1. Introduction

The definition of telework currently adopted by the European Commission is:

"the use of computers and telecommunications to change the accepted geography of work".[1]

The popular media notion of telework is "working at home instead of commuting to a distant office", but a broader view encompasses much wider scope for changes to work organisation. This includes:

- Working close to home in a telecentre;
- Distributed teams working in multiple locations, some of whom may be at home, some in more conventional settings;
- Location-independent, the individual can move between office base, customers, business partners, home, etc., while remaining in touch and with access to appropriate information and services;
- Mobile, working in or from hotel, airport lounge, car, train and plane.

The significant common factor is that information and communications technologies (ICTs) enable work to be done wherever it makes sense to do it, instead of people having to travel to a set "place of work".

The opportunities and issues associated with telework are best understood in six main contexts *(Table 1)*.

Telework is a focus for controversy. It is advanced by some as enabling positive change and delivering benefits for companies, individuals and society, by others as challenging the relationships between managers and employees, or as a threat to prosperity, employment and social stability. During 1996-1997 the balance of opinion in Europe appears to have moved towards the more favourable view, as more decision makers and opinion formers have gained first hand experience of the relevant technologies and applications.

The European Commission has had a policy interest in telework since 1989. It was cited by the "Bangemann report" (1994)[2] as one of "ten key applications to launch the Information Society" and has been the focus of many research projects and pilot schemes.[3] There is pressure for legislative action to address anomalies in tax and employment law that currently inhibit some aspects of telework. Possibilities have been raised in two European Commission Green Papers during 1996 and 1997.[4, 5]

[1] *Status Report on European Telework 1997*, European Commission (DGXIII-B), (http://www.eto.org.uk/twork/tw97eto)

[2] Europe and the global Information Society: Recommendations to the European Council (1994) (http://www.ispo.cec.be/infosoc/backg/bangemann.html)

[3] A list of current projects relating to telework supported by the European Commission is in the Status Report (op cit), online at http://www.eto.org.uk/twork/tw97eto

[4] *Living and working in the Information Society: People first* (1996) (http://www.ispo.cec.be/infosoc/legregl/docs/people1st.htm)

[5] *Partnership for a new organisation of work (1997)* (http://www.europa.eu.int/en/comm/dg05/social/homt.htm)

Context	Main actors/drivers	Telework aspects
Business/enterprise	Particular enterprise or other employing organisation	Competitiveness, costs, productivity, customer service . . .
Globalisation of trade and work	Global market forces	Increasing mobility of jobs and work opportunities . . .
Employment and jobs	Governments, employer organisations, worker representative organisations	Job creation, destruction, redistribution; changing relationships between employers and employees; rise in self-employment . . .
Individual worker	Personal needs and aspirations, family commitments etc.	Quality or life/work; access to work opportunities; flexibility of work/non-work boundaries . . .
Social/ environmental/ public policy	Governments, public opinion, lobbying organisations, international agencies	Transport infrastructure costs and traffic congestion; environmental benefits; local/regional economic development gains; opportunities for developing economies . . .
Technology	Research programmes, suppliers, market forces	Improvements in price-performance; enhanced capabilities; ubiquitous access to networks . . .

Table 1
Telework Contexts

Estimates of the extent of telework in Europe vary widely and are difficult to compare because of differences in definitions and methods. European Telework Development, using data from a range of sources, estimates that there were some 1.5 million people teleworking in the fifteen EU countries by 1994. EITO estimates suggest that there are close to 4 million in 1997 *(Figure 8)*.

Take-up of telework, along with other Information Society applications, is now being significantly influenced by the popularity of the Internet and the spread of personally-owned PCs and mobile phones. Familiarity with connected computers in the home and with applications such as electronic mail leads people to question the need to travel to a central office every day at peak traffic times. The ability to call someone on a mobile phone without needing to know their location enhances the idea that we can be "at work" without needing to be in a particular "place of work". Five years ago, a decision to start teleworking was followed by the acquisition of appropriate technology. Today – and increasingly in the future – the pervasive presence and use of technology suggests and facilitates a decision to telework.

2. What Is Telework?

Telework is a broad topic, with political, economic and social, as well as technology and organisational aspects. The basic model of "working at home instead of commuting" tells only part of the story and conceals rather than reveals some of the most important factors.

2.1. Definitions and Basic Principles

Discussion of telework is often hampered by misunderstandings that arise because the term is used to mean many different things and because there is no commonly agreed framework for measuring, reporting and planning. Taking

Table 2
Telework Parameters

Telework parameter	Examples
Workplace setting and perceived "work base"	- Home - Local telecentre - Employer's nearest facility - Mobile - Distributed team (settings for individuals may vary)
Employment relationship	- Employed - Outsourced - Self-employed - Portfolio worker
Proportion of time spent in telework mode	- Marginal/occasional (main work base is still the conventional office location) - Substantive (split between telework and conventional location but telework locus is established as a workplace) - Primary (telework locus has become the main workplace)
Extent of electronic networking use	- Marginal/occasional (little or no use of electronic networking within the enterprise) - Substantial (electronic networking well established) - Extensive (electronic networking is a primary mechanism for communication and work within the enterprise and with business partners and customers)
Degree of formality	- Managed scheme – there is a formally managed telework programme - Employer-endorsed – no managed programme but telework is recognised at enterprise level - Informal (by mutual agreement between individual and immediate manager but without formal endorsement by the enterprise) - Illicit (consent of local manager but "kept quiet")
Degree of support (e.g. particular assistance with technology problems, training, costs etc.)	- Supported with committed resources - Supported on a best efforts basis - Supported informally - Unsupported - Resisted – support staffs are actively unhelpful to teleworkers
Organisational acceptance (how widespread is telework in the enterprise concerned)	- Pervasive (telework is fully accepted; built into the organisation's culture and working practices) - Widespread (en route to becoming "business as usual") - Minority but well supported - Unusual (cause of comment) - Unwelcome (not thought appropriate by enterprise management)
Degree of autonomy	- Unconstrained personal choice (telework or not, proportion of telework etc.) - Personal choice by negotiation with manager - Personal choice within general conditions - Personal choice yes/no (prescribed conditions) - Employer-determined (telework is a condition of the contract of employment)

the European Commission definition as a start point ("the use of computers and telecommunications to change the accepted geography of work"), ETD has proposed a framework in which different variants of telework are defined according to standard parameters *(Table 2)*.

As an example of how this framework helps to clarify issues, we can consider two similar telework sitations:

Case A: Home-based, employed; primary telework; employer-managed scheme; supported with committed resources; minority; employer-determined;

Case B: Home-based; employed; primary telework; informal; unsupported; unwelcome; personal choice by negotiation with manager.

Superficially, Case A and Case B are much the same - an employee is teleworking. But consider a common issue that arises between employers and employees - who will pay the extra costs of the home office facility - heat, light, space etc.? And how will any employer payments be treated from a tax standpoint? In Case A the employee has a strong case for recompense of additional household costs - and for tax relief on any payments or net costs - since the employer has made working at home a condition of the contract of work. In Case B, the employer has a good case to resist payment of such costs, since the employee has chosen to work at home (presumably because of perceived advantages to the employee) and although the manager has agreed, the enterprise management is not supportive and might not even support the local manager's decision.

Given the known benefits of telework (see below), an ideal organisation might be one that has evolved to a "work where its best to work" philosophy, such that both information systems and management practices allow complete flexibility, and the decision on where to work - at home, in the nearest office, or any other location - is made purely on the basis of what makes sense to the person doing the work. Such an ideal result obviously requires a high degree of trust and shared responsibility across the organisation - a high level of personal commitment by the teleworker to the goals and priorities of the organisation, matched by a high level of confidence in the individual on the part of the enterprise.

2.2. Different Models of Telework

The most commonly encountered models of telework are shown in *Table 3*.

Interest in particular models is influenced by the role and goals of the organisation concerned. Transport planners are interested in home-based telework as a mechanism for reducing peak hour traffic congestion and pollution. Local economic developers promote telecentres and seek to attract inward investment in multinational call centres. An employer with recruitment or staffing cost problems may consider establishing a managed telecentre at a location convenient and attractive to potential recruits. An enterprise seeking to reduce overhead costs may implement "hotelling" combined with home-based working. Its quite common to find several different approaches within the same enterprise, reflecting the fact that effective adoption of telework contributes to flexibility for both employers and employees.

Table 3
Alternative Models of Telework

Home-based telework		The popular media image, working at home instead of commuting to a distant office
Telecentres	Employer-managed telecentre	Single-employer facility established in a location convenient to a critical mass of employees, who work there regardless of their functional alignment
	Multi-employer centre	Business centre providing space and facilities under contract for use by employees of different companies; typically sited close to major travel routes and interchanges; may be used on a planned or drop-in basis
	Local telecentre/telecottage	Locally managed and supported centre, often with a mix of social, training and economic purposes; provides access to technology and managed workspace for local individuals and firms; may seek to market the skills of local teleworkers
Flexible office/hotelling/hot desking		Changed approach to space and facilities allocation by an employer; individuals and groups are allocated desks, space, meeting facilities etc. on an as-required basis rather than an owner-occupier basis; in multi-site enterprises, employees may work at any office that is convenient to their purpose
Mobile, location-independent		Using a combination of mobile and fixed technologies to remain operational and in touch regardless of location/mobility
Multi-site teams, distributed teams		Using telework technologies to enable teams to work together effectively with team members distributed across several locations (which may of course be offices or homes or mobile)
Concentrative		Using the technologies to bring together at one site work or services that have conventionally been distributed closer to the customer; an example is the reduction of High Street branches in favour of telephone service centres and online services, particularly in banking and financial services
Transborder/offshore		Using the technologies to move, distribute or concentrate work internationally; examples are multinational call centres supporting software products (transborder/concentrative) and the establishment of software "factories" in India (offshore)

3. The Business and Economic Context – Telework, Teletrade and Telecooperation

The term *"teletrade"* is used to suggest something wider than the generally accepted focus of "electronic commerce" (see EITO 1997). Teletrade embraces every aspect of doing business across networks – finding customers, establishing their needs, marketing products to satisfy those needs, answering the customer's questions, securing an order or a contract for work, and managing the delivery process as well as collecting payments. From a business and economic perspective telework and teletrade are complementary aspects of the same phenomenon *(Figure 1)*.

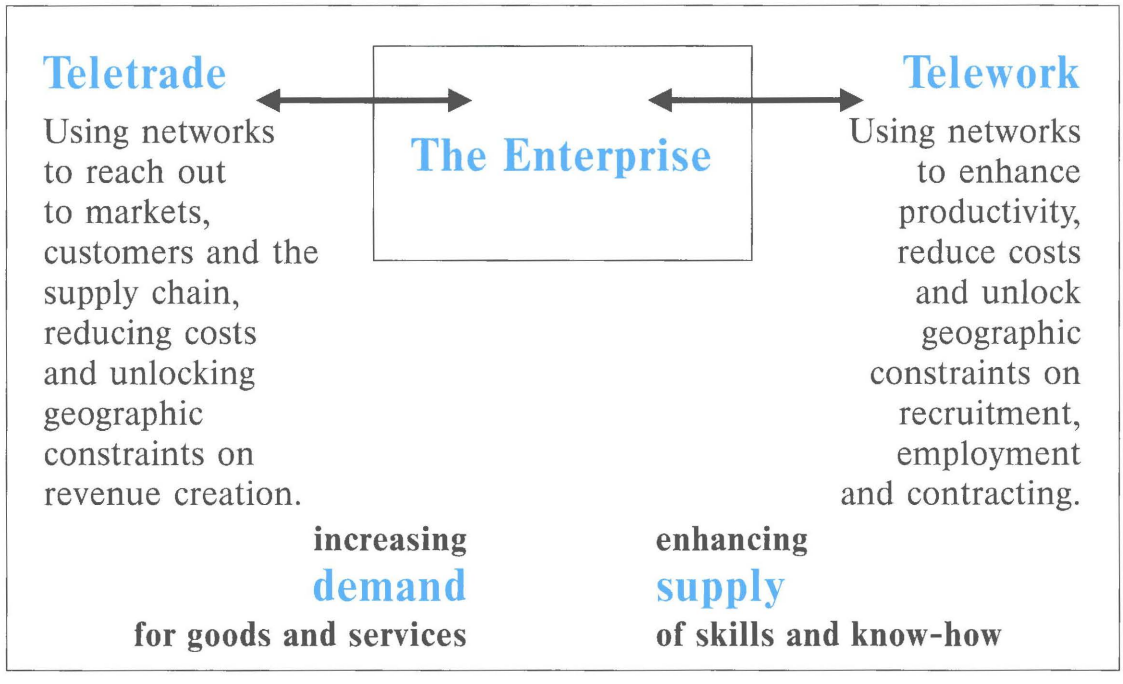


Figure 1
The Complementary Nature of Telework and Teletrade

Success in both telework and teletrade comes more naturally to an enterprise that is "effectively networked" and has adopted the techniques of telecooperation. In an "effectively networked" enterprise all the employees are connected to each other and to their external contacts and have acquired the relevant skills to be successful users of applications such as e-mail, online discussion and information sharing.

3.1. Why Do Enterprises Adopt Teleworking?

There are significant benefits to be gained from becoming an effectively networked enterprise *(Table 4)*. In particular, telework and teletrade become "natural ways of working" rather than needing to be treated as "projects" or "experiments". Note that "effectively networked" includes the appropriate use of advanced voice telephony methods, not just data communications.

Of course, the teletrade benefits require a critical mass of connected customers and suppliers in markets that are relevant to the enterprise concerned. As reported by EITO and others, many European countries have still not attained a critical mass of connected consumers and business decision-makers. However, there is a global English-language market already accessible to European suppliers of appropriate products and services and the scale of opportunity in other languages is rising quite rapidly. Meanwhile enterprises can prepare for wide adoption of teletrade by gaining the benefits of telecooperation and telework.

Table 4
Examples of Competitive Advantage for the Effectively Networked Enterprise

	Telework	Teletrade	Telecooperation
Costs	Up to 50% saving in office overheads, relocation etc. costs Up to 40% improvement in managerial and professional productivity	Order-of-magnitude reductions in customer contact and customer service costs Delivery of information (and some products) at low or zero marginal cost Elimination of information sharing costs in the supply chain	Reduces cost of internal communications and information delivery Reduces internal travel to meetings Wider opportunities for outsourcing
Business opportunities	Better retention of experienced staff Extended geographic scope for recruitment Wider outsourcing opportunities Access to scarce skills and to high value people who have opted out of the conventional career environment	Creating new markets by innovative use of ICTs Reaching geographically distant markets and customers without the need for local presence Low cost entry to new market sectors	Swifter response to opportunities Easier assembly of project and task teams Easier and quicker access to specialist or scarce know-how Novel opportunities for co-operative working with supply chain and other business partners
Innovation	Refocusing enterprise geography around access to best workforces Assembly of best know-how in multi-site project teams free of geographic constraints	Product and service innovation Process innovation Marketing innovation Supply chain innovation	Better and swifter propagation of new ideas and practices across the enterprise
Organisation and management	Greater flexibility in organising and managing work when, where and how it appears best to do so	Improved organisation and management of trading relationships and activities including outsourcing, subcontracting, partnerships, transactions, etc.	Better organisation and management of information flow and accessibility within the enterprise and between co-operation partners
Quality	Empowerment of employees to determine optimum work/lifestyle mix Reduction of time, costs and frustration of peak hours travel and the disruption of career relocations Better access to the skills of excluded groups – disabled, single parents, dispersed communities	24 hour, 365 day customer and supplier access to production and sales information Extended hours customer services delivered at low cost by time zone straddling Direct contact between customers and originators of products and services, reducing quality attenuation in supply chains	Swifter and more complete response to quality and other issues Easier direct contact across business functions Increased opportunities for direct interaction and feedback between executives and employees

Although the cluster of advantages shown in *Table 4* provides a strong rationale for investigating and adopting telework practices, there are also issues and barriers (see section 10 below) and - as with any other significant change in management or organisational practice - there is inertia to overcome. The actual adoption of telework methods usually arises in one of three ways:

1. Progressive adoption of best practice;
2. Employee-led;
3. "Sudden shock" pressure for change.

Where telework arises from progressive adoption of best practice it is usually part of an array of what are known in human resource management circles as "flexible working" methods. These can include, for example, the switch from standard contracts of employment for all employees to "personalised" contracts, the switch from standard employee benefits to a "cafeteria" approach in which the employee selects from a range of possibilities, the switch from set working hours to flextime.

The employee-led case typically arises in enterprises that have followed the "empowerment" approach to management styles and employee development, especially when the enterprise has also implemented technologies supporting telecooperation. An employee and his or her immediate manager agree that it makes sense for the employee to work at home part of the time, but no special arrangements are made other than this rather informal agreement.

The most commonly encountered "sudden shock" is an urgent need to reduce overhead costs and improve the bottom line. Examples occured in the computer industry in the early 1990s when rapidly increasing competition coupled with slower economic growth led to reduced profitability or even losses, generating an urgent need for increased profitability. Observing that on average each office-based employee actually sits at his or her desk for much less than 50% of the working day, some companies saw the opportunity to dramatically reduce their total property portfolio and associated overheads by encouraging and supporting employees to work at home when it was sensible to do so and to share office facilities that had previously been seen as "personally owned".

Whatever the underlying cause and the resulting path of adoption, enterprises commonly report the same cluster of benefits shown in *Table 4*, although the emphasis differs from case to case.

3.2. Organisational and Workforce Issues

For enterprises adopting telework on a planned (progressive best practice) basis there are issues to be addressed. These generally emerge in one or more of three main areas:

1. Managerial confidence and competence;
2. Employee concerns;
3. Legislative, regulatory or fiscal issues or uncertainties.

"Managerial resistance" is the barrier most frequently cited by advocates of telework and by would-be teleworkers whose employer is reluctant to allow teleworking. Managers whose

career experience has been based on mainly face-to-face communications lack confidence in their ability to "manage at a distance"; some managers lack confidence in their employees' commitment or ability to work without close supervision. Many managers judge employee performance on appearances, lacking experience and skills in measuring on the basis of delivered results. In such cases the introduction of teleworking may bring side benefits in the form of more appropriate and effective managerial approaches, but may also expose weaknesses in the management system or the competences of particular managers.

In some enterprises employees may be concerned that telework will prejudice their standing in the organisation and, for example, limit their career opportunities. This is especially the case where teleworking is still unusual in the enterprise and where the enterprise is not yet effectively networking. If it becomes clear that the enterprise perceives and encourages telework as a business-as-usual practice, and supports this with effective communications methods that are common to teleworkers and non-teleworkers alike, such fears are more readily addressed. Another important employee concern may be that working at home, or in a shared telework centre, outside the mainstream premises of the organisation, might be a step towards being encouraged or even pushed to go outside the organisation altogether and become self-employed. While some people welcome the independence of self-employment, others much prefer the perceived greater job security enjoyed by employees. This fear is particularly likely to arise in an organisation that is shrinking rather than growing, or in one where cost reduction is a driving priority for the enterprise. It does not arise where there is a high level of trust within the enterprise and an atmosphere of shared goals.

Legal, regulatory and fiscal issues largely relate to the fact that our current employment practices evolved during an era when the great majority of the workforce were in relatively fixed jobs, with work practices determined in detail by the employer and the working environment owned and managed by the employer. The baseline for employment practices was that the employer made all the decisions and held all the responsibility, employees were dependent on the employer to "get it right" and keep them in work, and employees needed "protection" from potential or real abuse or exploitation, unsafe machinery, unhealthy work environments etc. Although there are very many jobs where factors such as the working environment and safe practices remain largely determined by employers, including some growth sectors such as the catering industry, across much of the economy there is now a trend for decision responsibility for a wide range of activities to be assumed by the individual worker. This is reflected across many aspects of management, of which telework is only one example. The concept of employee "empowerment" explicitly promotes the idea that employees are capable of taking responsibility for their own work patterns, for day to day, minute to minute decisions and for trying out new approaches. In quality management, experience has shown that much of the key knowledge that will identify weaknesses in marketing, production and delivery processes resides with the employees doing the basic work, not exclusively with managers and specialists.

The following panel illustrates how working at home challenges the conventional assumptions on which our current regulations are based.

Regulatory examples: Who is responsible for the "office at home"?

When an someone chooses to work at home rather than working in the company office, the employee rather than the employer owns the main work environment and exercises effective control over it. The employer may still provide the "tools" (e.g. PCs) but these are inherently the same as the PCs the individual acquires and uses for private and family purposes. The legal assumption embedded in employment law in most EU countries and in recent EU directives is that the employer is responsible for the work environment. There is now a strong argument for rethinking this assumption and moving towards the recognition that for many current and future jobs responsibility is at least shared between employers and employees. These are some of the issues:

- Current law in some countries requires that a "work inspector" should make unannounced visits to the workplace to ensure that proper work practices are being followed. When the workplace is in the person's home an unanounced visit implies a right of entry which most people would see as an intrusive breach of privacy.
- Health and Safety regulations assume that the employer controls the work environment and work practices. When employees work at home the employer may still devise and promote "safe working practices" but has no effective means of monitoring and controlling their day to day, minute by minute implementation. Technology can be devised that would enable the employer to monitor the employee's behaviour but again this would be regarded as unduly intrusive and flies in the face of progressive management practice.
- In some jurisdictions personal and property tax practice assumes that the use of part of the home for work constitutes "business use", leading to higher local taxes or different treatment of the value of the home for tax purposes. In some locations there are zoning laws that prohibit business activities in homes. Frequently the employer or the employee or both are uncertain about how various levels of home-based telework would be treated. An employer may have employees living in different areas where rules may be applied differently. This may be "burdensome but bearable" for the large enterprise that has a strong commitment to adopt telework, but for the smaller firm the complexity of dealing with such issues can make it impracticable to pursue telework as a business strategy.

Although there are usually workable "answers" to such issues, so that they are not insuperable barriers, the energy and time consumed can force telework off the agenda.

There are no "generally right answers" to many of these issues, since there are still jobs in which the employer exercises effective control, and there are still employers who might exploit any weakening of worker protection rather than pursuing positive management practices. However, there are helpful steps that Governments and regulatory authorities can take to clarify existing laws as they apply to teleworking and to adopt an approach to enforcement that recognises how the working environment is changing. Employers and employer organisations, together with Unions and employee representatives, can also help by – for example – developing and disseminating best practice models such as model contracts of employment that recognise telework as an option.

3.3. A Matter of Confidence

In common with many aspects of the Information Society, widespread adoption of telework by enterprises and individuals is very much a matter of confidence. If managers have confidence in their staffs' abilities, motivation and commitment they will be less concerned at the thought of not seeing them face-to-face so frequently. If people across the enterprise have equal access to shared information, strong group and interpersonal communications, confidence in the strength of the enterprise and a high degree of trust in the employer's commitment to good employment practices, they will be less concerned that "out of sight" could mean "out of touch", leading to "out of a job". In this sense a proposal to adopt telework can be a good test of the extent to which an organisation is "fit for business" and especially "fit for the future". If there is strong resistance by managers or employees, or if there is a high level of focus on "mechanical" issues such as legal, regulatory and tax matters, this may well indicate underlying weaknesses that the organisation needs to address, whether or not telework is part of the outcome.

3.4. Europe Needs "Networked Enterprises"

The swift and successful adoption of networked enterprise methods by European enterprises is vital to the future economic success of the European Union. EITO 1997 showed projected world revenues generated by commercial websites reaching nearly three billion ECU as early as 2001, but with the USA gaining almost 70% of this revenue, and Europe less than 20%. Add to this the cost and productivity gains associated with successful teleworking and the internal and external communications advantages of telecooperation, and it becomes clear that the effectively networked enterprise enjoys a great competitive advantage over enterprises that continue to rely on conventional methods. To compete effectively in the global networked economy, Europe's enterprises must master the techniques of teletrade and gain the cost, flexibility and quality advantages of telework and telecooperation.

4. Globalisation and the Mobility of Work

The changing focus of economic growth from primary (agriculture, mining) through secondary (manufacturing) and into tertiary (services) activities has always been accompanied by changes to the geographical distribution of activities. Now there is a new focus on information-based products and services as an engine of growth, accompanied by a rapid switch to electronic networks as a primary vehicle for marketing and supporting goods and services of all kinds, including the promotion, sale and support of all types of "physical" goods - from cars to pizzas. Every industry is now information-intensive and increasingly all industries are becoming network-intensive. This means that:

1. A high and increasing proportion of all work is information-based and uses ICTs as its "tools of trade" *(Figure 2)*; and
2. Telework techniques enable such work to be undertaken anywhere in the world.

In deciding the location of "physical activities" (e.g. a manufacturing plant), "physical" factors like proximity to markets, transport infrastructure, component supply and raw materials supply have weighed strongly alongside the availability of skilled labour and assistance with start-up costs. For informational activities, physical factors are of low importance, the dominant factor is the workforce.

Of course, many other factors come into play, but increasingly, the most attractive, well-paid work of the future will gravitate to where the most "market-effective" workforce is to be found *(Table 5)*.

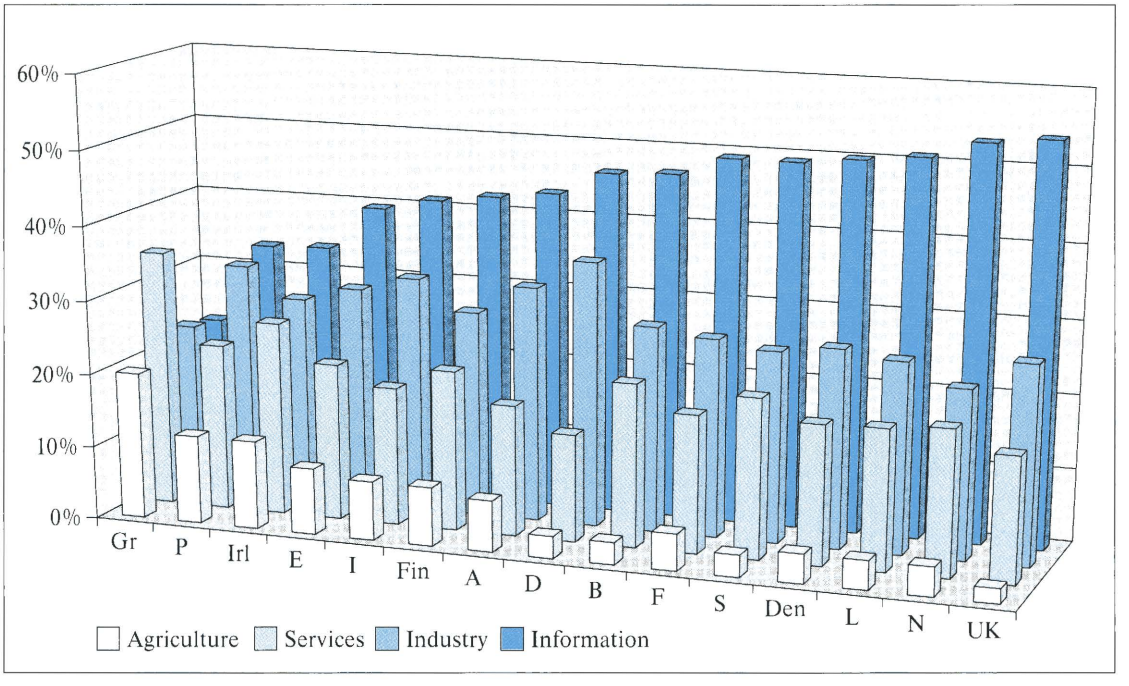


Figure 2
Growth in Teleworkable Jobs. Estimates of Information Workers. Extracted from the Conventional Economic Segments of Agriculture, Industry and Services 1995

Source: Jala International, 1998

The market-effective workforce: Enthusiastic Self-motivated Creative Innovative Responsive to change Flexible Results-oriented Customer-oriented Technologically aware Educated: literate, numerate Informed Independent minded Networked and networking Confident	**The local economic environment:** Encourages entrepreneurship Many new business start-ups World-class education system Business networks and networking High proportion of service industries High proportion of ICT-intensive industries Pro-business local authorities **The local legal and regulatory environment:** Favours enterprise Welcomes experimentation and change Challenges convention and the status quo Fosters competition **The local technology environment:** World-class telecoms infrastructure World-competitive pricing of ICTs High ICT investment by businesses High ICT penetration in homes

Table 5
Factors Contributing to a Market-effective Workforce

In Europe there is some resistance to the idea of a "competitive" workforce. This is perhaps a natural reaction in a period that has seen relatively high and rather prolonged unemployment in many European countries, coupled with the fact that as economies develop "old work" has tended to migrate to lower cost areas. If work were fixed and the main factor were workforce cost, this would be a legitimate concern. The reality is that work is constantly evolving, and it is the most innovative locations that tend to suffer from labour shortages, even though local wage rates may be high, while low-cost locations are just as prone to unemployment as high-cost ones. The relative cost of labour is at its most important in routine work using mature technologies in mature sectors (for example, hand-weaving is still an important element of GDP in some economies, invariably associated with low labour costs), but less important in new activities that use new technologies (for example, design and implementation of online services).

This analysis suggests that the key factors influencing Europe's success or otherwise in attracting and generating the new work opportunities of the Information Society are not labour costs but rather our relatively low levels of investment in ICTs, with slow adoption of new Information Society methods such as telework and teletrade, and a tendency to focus on the potential issues and difficulties of social and market innovation rather than on identifying and seizing the positive opportunities.

5. Telework, Employment and Jobs

Telework also impacts on a topic that is high on Europe's political agenda - the future of work and jobs, in particular the question of how to tackle unemployment. There are three main issues:

1. ***How much*** work: the very long-standing question of whether the application of new technologies (in this case ICTs) "destroys jobs" or creates new work opportunities.
2. ***Where*** the work will be: the question of whether telework leads to concentration of attractive, well-paid work in particular areas, with erosion of local job opportunities and prosperity in other regions, or positively assists in opening up access to work opportunities in areas of high unemployment.
3. ***What sort*** of work: the question of the quality and type of work, for example whether work is becoming more routine, push-button, low-skill and low-pay, or more varied, creative, high-skill and high-pay.

5.1. How Much Work? – Technology, Jobs and Work Opportunities

During and since the industrial revolution, technological change has led to fears about work and jobs. Mechanisation was widely expected to lead to mass unemployment; widespread use of computers was expected to lead to a "collapse of work". While it is never possible to predict the future, history shows that each of these concerns has been unfounded. New technology has consistently been the basis for new products and services, leading to overall growth in employment. To date in the computer era total employment levels in the developed economies have grown at fairly consistent levels through the 1960s, 1970s, 1980s and 1990s, even though in each of these decades some observers have forecast that computers will destroy jobs on a massive scale. Europe's long-term unemployment problems arise from other causes than new technologies; indeed the USA, which has been swiftest to invest in and use the new technologies, also has a track record of faster growth in employment.

Leeds (UK): Financial direct services	The City of Leeds in Yorkshire has become a growth centre for financial services employment because it is an attractive recruitment location for the new-style "call centre" operations that sell and support "direct" financial services in competition with conventional High Street banks and with other "direct" suppliers. Call centre employment in the UK is expected to exceed 2 million jobs within the next five years. Some of this growth displaces High Street jobs, but much is associated with market expansion enabled by innovative direct selling methods, lower costs and enhanced customer communications. The attraction of Leeds is the availability of a large potential recruitment base plus less competition for staff than in (for example) London and South East England.
Ireland: Multinational, multilingual sales and customer service centres	Ireland's Industrial Development Agency has successfully campaigned to attract inward investment by (mainly) US-based companies in multinational, multilingual sales and customer services centres. Key selling points for Ireland have been high participation in tertiary education and good language skills.
Sweden: Rebuilding a remote community	The small villages of Hågarna, Fagerland and Ollsta, in the Jämtland region of Sweden, suffered a loss of 60% of the local population between 1950-1970. A local cooperative initiative, "The villagers enter the Information Society" now employs 4 people in a local "telecottage", supports a further 11 self-employed people and has delivered ICT training to 105 out of the total 150 population. This is typical of many similar initiatives in rural areas remote from centres of commerce and population.

Table 6
Bringing New Work Opportunities to New Places

5.2. Where? – Telework and the Concentration or Dispersal of Jobs

This is also a rather familiar issue. The industrial revolution moved work from wide distribution in villages to concentrate it in industrial towns with good access to raw material and energy resources. The rise of the services sectors and office-based employment concentrated work in city centres, exemplified by the predominance in world financial trading of New York, Tokyo, Hong Kong and London and the focus within almost every nation state on one or at most two financial centres. A similar effect can be seen in the development of an Information Society, with the concentration of technology innovation and development in a few places like Silicon Valley; with the computer industry's clustering of European headquarter operations in centres like Paris and the Thames Valley; and with the emergence of Bangalore, India as a centre for software production.

However, there is also evidence of a counter-trend which is particular to the Information Society and to telework, namely the new ability of regions that have no prior history or track record in the relevant sectors to attract teletrade and telework away from traditional centres of commercial success *(Table 6)*.

The Swedish example is small in scale but potentially far-reaching if similar initiatives emerge on a widely distributed basis. The most prosperous parts of Europe tend to be quite densely populated. In comparison with (for example) the United States, social and environmental concerns place limits on the extent to which continued economic growth can be supported by more people moving physically into Europe's main centres of innovation and growth – there is resistance to yet more houses, yet more roads, yet more cars. As telework and teletrade methods become more widely understood and used, this will create business opportunities for local initiatives like the Swedish

example to deliver skills at a distance, moving the work to the people instead of the people to the work.

5.3. What Kind of Work? – Telework and Skills

One clear truth about technology change is that it does lead to changes in the nature of work and in the skills associated with attractive, rewarding employment. The whole history of both the industrial era and the present period has been about reducing the "physical labour" aspects of production, marketing and delivery and about focusing the "human element" on aspects such as know-how, judgement, communication and interpersonal skills. This is true across a wide spectrum of jobs, not just the information-intensive ones. For example in many routine, relatively low-paid jobs, "personality" and "interpersonal skills" are emphasised, whether the job concerned is more information-intensive (such as handling customer calls in a customer support or telephone sales centre) or relatively less information-intensive (customer service in one of the new-style service-oriented restaurants). Open, competitive markets coupled with increased consumerism, place a new emphasis on customer service, often strongly influenced by the skills, motivation and personality of customer-facing staff. There is also a tendency for new technology to increase the emphasis on levels of education and training and to reduce the range of opportunities (and level of reward) available to less-educated, less-trained workers.

Telework appears to be neutral in respect of task-related skills – a job requires a particular set of skills and abilities regardless of the location. But in the case of home-based teleworking there are additional – or at least more sharply focused – considerations. For the teleworker, an obvious requirement is that the individual needs to be self-motivated and self-managing to a greater extent than a colleague who is working side by side with colleagues, managers and supervisors in a conventional workplace. For the manager of teleworkers there is a particularly strong need for the skills and know-how associated with managing by results and through training, leadership and motivation rather than managing through direct detailed supervision.

As for the skills associated with information and communications technologies, while telework may place a clearer emphasis on these competences, the same skills are required across the enterprise. If only the teleworkers become proficient in telecooperation methods, they will network more with other teleworkers than with non-teleworking colleagues. This may make them more productive but it is clearly better in many ways if telecooperation pervades the whole enterprise.

6. Telework and the Individual

How telework affects the individual teleworker has received at least as much attention in Europe as the business opportunities for companies and the economic opportunities for regions. Advocates of telework claim (and successful teleworkers confirm) that a flexible approach to telework can bring many personal benefits *(Table 7)*.

Obviously these benefits arise only when the individual and the telework approach are well-matched. There has been anxiety about potential adverse consequences for individuals of inappropriate telework programmes. A "High Level Group" convened by the European Commission (DG V) expressed concern that

Telework characteristics	Benefits		
	Work style	**Life style**	**Personal, family and social relationships**
Greater reliance on self-management; measurement by results rather than by "presence and activities"	More personal control and responsibility; wider choice of how and when to undertake tasks	Work pattern (e.g. time and place) more readily adapted to personal needs of the individual rather than vice versa	More accessible to family and friends
More sharply developed personal skills and competences	Greater demand for continuous vocational education/training and for general all-round competencies	Improved ability to match personal interests and skills to work	Richer and more varied relationships
Access to more jobs (wider geographical search) and more varied work opportunities (escape from constraints of "locally traditional" work)	Greater earnings potential; ability to develop personal career portfolio	Greater personal fulfilment, well-being and prosperity; reduced risk of unemployment	Wider range of work and professional relationships and enhanced family stability; more opportunities to work with people from different cultural backgrounds
More working at home or within the local community and less commuter travel	More time and resources for productive work	Less stressful and busy life style	More time and energy to to develop friendships and family, especially relationships with children

Table 7
Telework Benefits for Individuals

> "Traditional social relations rest on a clear distinction between place and time at work and place and time off work. The Information Society tends to destructure these accepted conventions of place and time such as family space and time; work space and time; leisure space and time; training; and consumption... The possibility of home-based working also raises a whole new set of problems concerning the reconciliation of work and home life. The problems of re-integrating work into the home, even on a part time basis, have significant economic, social and psychological implications."[6]

Such statements do not ring true to those who are actively engaged in business in the 1990s. They paint a picture in which people only socialise at home, not at work, and who never "bring work home". They also appear to disregard the fact that there are large sections of the workforce for whom home and work are already closely intertwined – those who manage and work in small family businesses; field-based salespersons, self-employed people. Also, much of the concern centres on the popular media image of telework as "working at home", while the alternative forms of telework defined in *Table 3* raise fewer social issues. There are practical reasons to suggest that the home-based form of telework is unlikely for the majority of Europe's workers in the foreseeable future and that other forms merit wider attention (see Barriers to telework, below).

[6] *Building the European Information Society for Us All*, European Commission DG V, December 1995

Table 8
Social, Environmental and Local/Regional Development Benefits Associated with Telework

Telework characteristic	Societal gain	Environmental gain	Local/regional development gain
Reduced commuter travel relative to a given level of economic activity	Successful career people become more available to their families and local communities instead of commuting	Reduction or slower growth in peak hour and total travel, alleviating congestion, reducing pollution	Reduced demand for transport infrastructure investment, increased use of local facilities, higher proportion of earnings spent locally
Access to wider work opportunities and greater mobility of work	Unemployed or under-employed people in less prosperous areas can access work opportunities in areas with skill shortages without having to travel or relocate Excluded people (disabled, single parents, carers) have better access to work opportunities	Reduced pressure on infrastructure and reduced demand for over-development in high-prosperity, high-growth areas	High-growth areas can more easily find required skilled resources Reduced wage-escalation in areas with skills shortages Better employment and income opportunities in low-growth areas
Multi-site teams, distributed working, concentrative working	Reduced business travel (road, train, air) for meetings, leaving more time for useful work and for family/community	Reduced pressure on high density travel routes and infrastructure	Money that would be spent in distant meeting venues is available to spend in the local economy

7. The Social, Environmental and Local Development Context

An example of telework combining both social and local economic development elements has already been seen in Section 5. The social, environmental and local economic development opportunities presented by telework have attracted quite wide attention in Europe and have often been the basis for supporting telework programmes in both the private and public sectors, particularly in relation to regional development and environmental goals. Telework presents opportunities to address or contribute to a wide range of issues *(Table 8)*.

Governments – especially regional and local authorities – are increasingly aware of these opportunities and there are now many examples of small, local projects that have used telework to assist with local development. However there are still large areas of public policy where the potential value of ICTs has not been widely recognised. In particular there has been little serious attention paid to the potential impact of telework and other travel-reduction methods (such as video conferencing to reduce travel for business meetings) on the economic, social and environmental costs of traffic growth and traffic congestion. Individual teleworkers regularly cite reduction of travel as a key motivation for teleworkers, and some enterprises include the traffic and environmental in their assessment of the benefits. In the Netherlands, where understanding of telework is ahead of most EU countries and where traffic congestion is a recognised national issue, an association of company traffic managers is defining guidelines on using telework to reduce environmental damage.

Given Europe's commitment to play a full part in addressing environmental pollution and global warming, the substitution of distance working for some part of our travel requirements appears to be undervalued as a weapon in addressing traffic congestion and carbon emissions.

Telework also offers benefits in addressing social cohesion among different communities across Europe and in bringing some "excluded" groups into the mainstream workforce. An example of this is provided by the ISdAC initiative (see the following panel).

ISdAC: The Information Society disAbilities Challenge

ISdAC is an initiative "by people with disabilities, for people with disabilities". Its main premise is that the Information Society provides a new set of opportunities for people with disabilities to contribute actively to the economy and society and become more independent. A central tenet is that telework enables people with mobility problems can through telework secure attractive work opportunities without suffering the burdens of commuting.

ISdAC's key priorities are to:

- alert policy makers, decision makers and opinion formers to the opportunities to "include" people with disabilities in the development of the Information Society as active participants rather than only as recipients of support;
- provide inputs to the policy process direct from people with disabilities who have hands on experience of Information Society methods and technologies;
- sponsor, support and create new practical mechanisms through which people with disabilities can learn the new skills of the networked economy and use these skills to participate more effectively in work and other activities;
- influence the development of technologies, products and services to facilitate equal access for people with disabilities and make sure that the equivalent of "ramps for wheelchairs" are part of the initial design for the new environment rather than being an expensive afterthought, as is the case with our existing "built environment";
- make known the economic as well as the social case - that when someone with a disability becomes "effective online", they can switch from being a net recipient of benefits to being a net contributor to the economy and society.

ISdAC is online at http://www.isdac.org

8. Telework and the Diffusion of New Technologies

8.1. Technology Performance and Cost Factors

Rapid price-performance evolution in ICTs is a major factor affecting attitudes to teleworking. As recently as three or four years ago the additional cost of equipping home-based workers and supporting their networking needs was cited by corporate decision makers as a significant barrier to adopting a telework programme. Today this concern is much less frequently expressed. Now that many employees can and do buy computers and modems for their own private use at home, the idea that their employer cannot afford the technology to support teleworking carries less credibility.

For ***enterprises,*** the main price-performance factors now and for the foreseeable future are:

- There is still a significant difference in *relative cost and performance of networks and network services for communications in and between offices compared with to and from the home;* this is not usually a barrier to teleworking by managers and professionals (whose online access needs are intermittent), but can be a barrier to home-based teleworking for applications needing continuous fast-response access, such as telephone sales and customer services teams.
- Widespread *adoption within enterprises of the "network PC" concept could sustain the price-performance advantages of office-based against home-based users,* since deployment of this technology assumes relatively high-performance access to networks (e.g. LAN rather than dial-up performance levels).
- There can be *a relatively higher on-cost for providing technical support to home-based users,* unless the enterprise uses mature, high-reliability, well understood systems, has excellent network-based systems management and has users who resist the urge to "tinker with the technology".

The first of these challenges is being addressed in some areas through high performance cable networks, provided in residential areas for entertainment applications and coincidentally available for business use. More widely it will be addressed by deployment of cost effective wireless communications and the implementation of technologies such as Digital Subscriber Loop (see Part Two, ICT for European Homes: Devices, Services and Applications).

The support issue will be addressed, over time, by the evolution and wider acceptance of better network-based management tools and by extension of the plug-and-play approach to both systems and applications. Already, some PC operating environments and applications include facilities to connect automatically with the supplier's website, determine whether "fixes" or improvements are available, download the relevant code and integrate it with the user's existing applications, all without any technical skill or know-how on the user's part. Meanwhile it remains important for employers to make sure that appropriate steps are taken to support people who are not based in employer offices - including training and other non-technical support.

8.2. Technology Availability, Awareness and Take-up Factors

This is the critical issue for Europe. A recent benchmarking study[7] undertaken for the UK Government confirms the take-up gap between Europe and the USA that has been highlighted in several EITO reports:

- USA employees are more than twice as likely to have a computer and modem at home than in the most highly penetrated European country.
- Their employer is 50% more likely to provide remote access to company systems.
- Not surprisingly, a much higher proportion of USA employees work at home using remote access *(Figure 3).*

The relative pricing of telecommunications and network services for consumers is clearly a factor in this *(Figure 4).* Telecom liberalisation in Europe is expected to reduce prices, but results for users will be heavily dependent on the stance taken by regulatory bodies and significant price reductions may be slow in coming.

[7] *Moving into the Information Society: An international benchmarking study,* UK Department of Trade and Industry, July 1997 (http://www.isi.gov.uk/isi/mitis.htm)

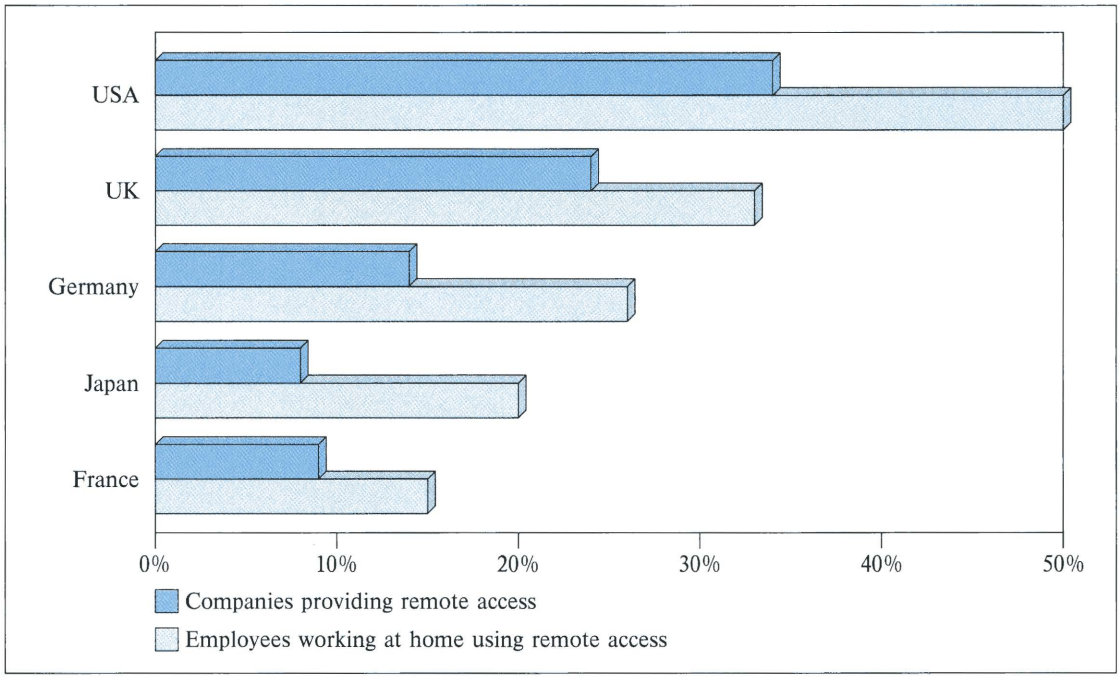


Figure 3
Relative Use of Technologies

Editorial Note:
Households with PC and modem may not match EITO homes report 1998

Source: UK Department of Trade and Industry report, 1997

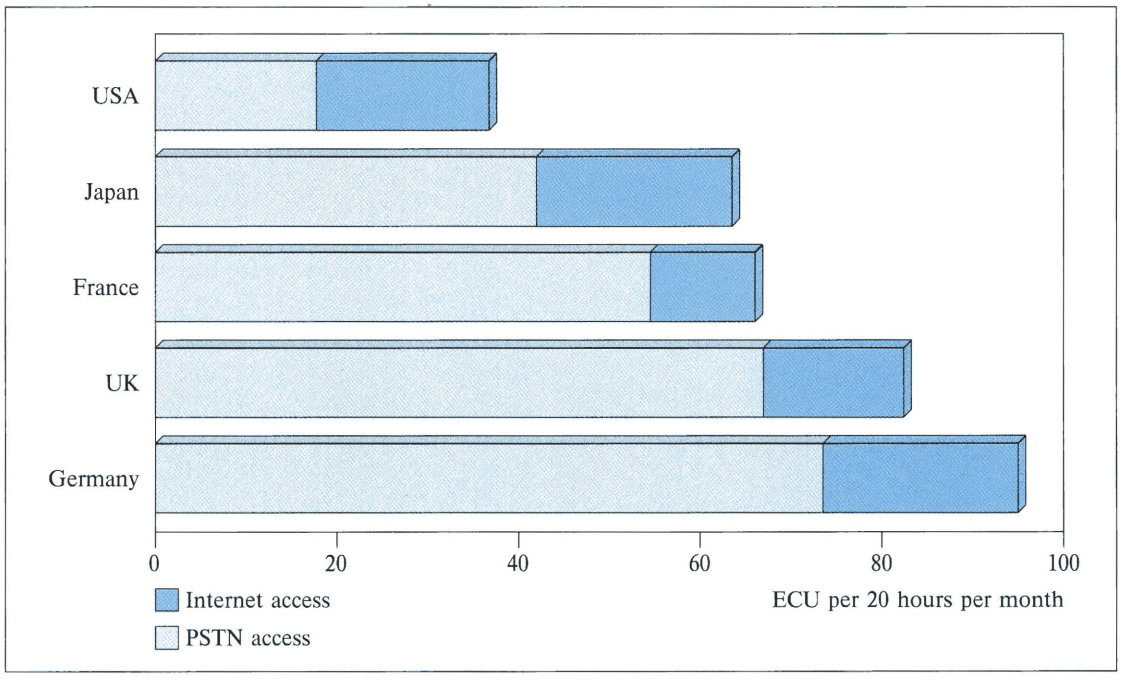


Figure 4
Relative Costs of Internet Access, Based on OECD Data

Table 9
Relative Affordability of PCs (Examples)

Country	Per capita GDP (ECU) (1996)	Perceived relative cost (USA = 100)	PCs per 100 white collar workers (EITO 1997)
Greece	6,469	324	61
Spain	10,578	198	80
Germany	21,735	96	99
Denmark	23,522	89	107
USA	20,929	100	104
The perceived relative cost of a PC is higher in countries with lower per capita production and incomes. The table assumes the price of a PC to be constant; in fact it is higher in countries where the market is smaller and less developed, further increasing the perceived relative cost.			

Sources: OECD, EITO

In contrast with telecommunications, pricing of PCs in USA and Europe has converged rather dramatically during the 1990s (see *Figures 14* and *15,* Statistical Outlook), as the PC has become a mass market product for which there is relatively little differentiation other than local market size and intensity of competition. However, even if "dollar prices" were the same across Europe as in the USA, true local "affordability" of PCs would still show considerable variation across Europe *(Table 9)*. To someone on average earnings in Greece a PC will *seem* three times as "expensive" as it does to someone in Denmark. The correlation between perceived relative cost and take up of PCs is quite striking. Similar conclusions can be drawn for advanced telephone and Internet access pricing and take-up.

Another important conclusion from the UK study, confirmed by recent analysis of online traffic patterns, is that some Far East economies have started to accelerate their take up of ICTs in new networked applications at a faster rate than in Europe *(Figure 5)*.

Technology performance is not an absolute constraint on telework, in that most of what people might want to do today is feasible with technologies that are already available and widely marketed, and the cost benefits of successful teleworking substantially outweight the additional costs. However, in Europe as a whole, relatively higher prices of network services, leading to relatively lower understanding and use, mean that (assuming other factors to be equal) take-up of telework in Europe will tend to lag take-up rates in economies with lower relative prices. Computer pricing is another constraint on take-up rates, especially in those European countries that have relatively low GDPs, and that have a particular need to gain the benefits of Information Society applications like telework and teletrade.

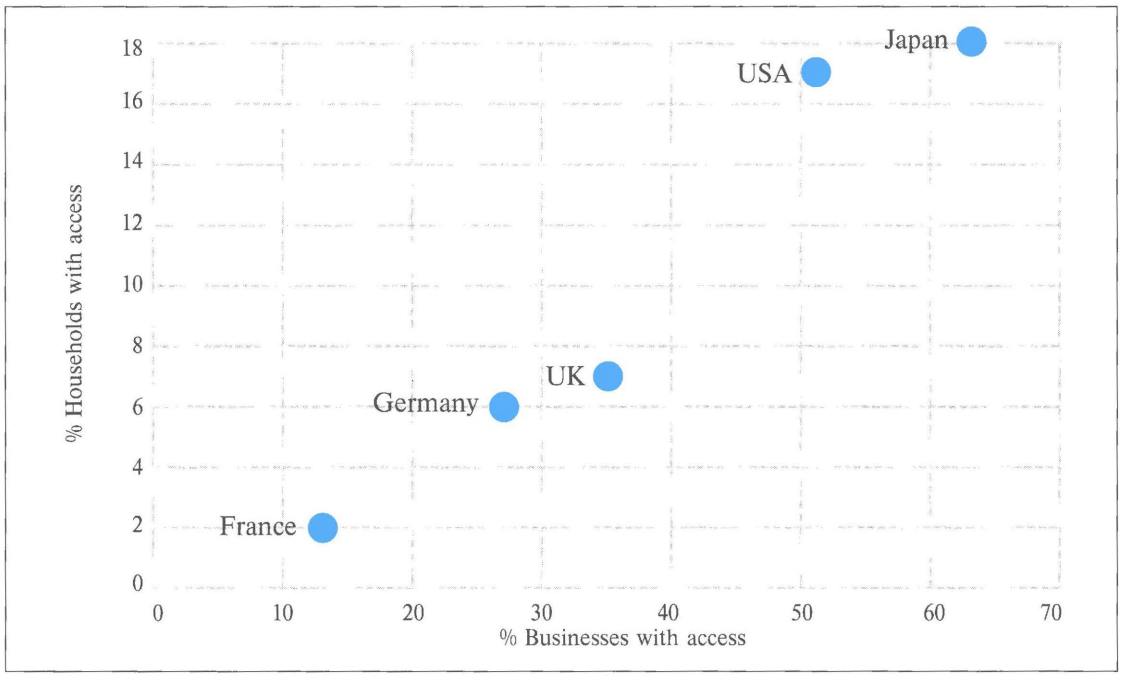


Figure 5
Consumer and Business Internet Take-up

Source: UK Department of Trade and Industry report, 1997

9. Market Status and Opportunities

There is an obvious close linkage between telework, computers and telecommunications. In the 1980s and early 1990s, mobile and home-based telework were among the new applications that pioneered the use of (then) relatively expensive and rare mobile communications and personal computers. In the late 1990s and into the next decade, widespread take-up of these now commonplace technologies is causing companies and workers to question the validity of commuting daily to a fixed place of work or travelling hundreds or perhaps thousands of miles for routine meetings. This change of emphasis is important to an understanding of telework's market impact *(Table 10)*.

9.1. The Home Office

Work within the "Telework Chain" of the European research and technology development programme ACTS (Advanced Communications Technologies and Services)[8] suggests that almost all ICT technologies are relevant to telework – either directly for use in the home or a local telecentre or in the networks and networked applications supporting telework activities. Teleworkers who are mainly home-based may well have more "personal" technology per capita than their office-based colleagues (who share such devices as copiers and printers) as well as having access across the network to the company facilities *(Table 11)*.

[8] ACTS (Advanced Communications Technologies and Services) is one of a set of RTD (Research and Technology Development) programmes in the European Commission's Fourth Framework Programme. The Telework Chain links the ACTS research projects and agenda to the telework market and its participants, see http://www.eto.org.uk/gat

Table 10
Telework Market Evolution: Driving and Constraining Factors

	Early (1980s-mid 1990s)	Middle (current)	Mature (c. 2005)
Drivers	Telework enthusiasts Telework champions in enterprises Early adopters of new technologies and methods	Increasing public acceptance of networks and related services (driven by Internet visibility and take up) Increasing familiarity with personally owned computers in homes Competitive pressure to reduce overhead costs Growth in "alternative" forms of employment - self-employment, portfolio working etc. Emergence of new forms of telework-based enterprises Public policy and programmes interest, especially in regional development opportunities	Pervasive availability of technologies and networked services Pressure to reduce environmental impacts of non-elective travel (commuting and business travel) Access to skills of people who have adopted the "telework lifestyle" Wide familiarity with "Information Society" technologies and applications Teleworking rather than travelling becomes a natural, "business as usual" matter
Constraints	Technology and telecommunications costs Network applications required technical skills Telework perceived as a fringe activity or not known about at all	Resistance by middle managers Uncertainties about legal, regulatory, trade union etc aspects Concerns about impact on job security and careers (in mature sectors and areas of high unemployment) Slow take-up of Information Society technologies and applications - lack of understanding among decision makers Continuing perception and media treatment of telework as being only about home-based and mainly a "lifestyle" matter Shortage of positive exemplars and best practice know-how, guidelines	Built-in inertia among slow-to-change organisations and individuals Practical constraints - size and facilities of homes, family requirements Possible lack of investment in support infrastructure, e.g. telecentres Varying levels of impact of liberalisation and open markets on relative pricing

Computer	Telecommunications	Other
One mid-to-high performance PC for business use Generally, one or more additional PCs for family use (teleworkers more technology-aware than general population) Personal printer (one or more printers may be shared with family use) Desk-top copier (if not integrated with printer) Fax machine (if not integrated with PC and/or printer) Office suite of applications (usually full business version not so-called "small/home office" versions)	Modem or ISDN link for business use (may be shared with family use) Dedicated business phone line/ number (to segregate work/private traffic and minimise disruption) Mobile phone for business use (often using personal numbering so that private and business calls can be routed to the same device) Access to company network services Personal and/or family subscription to at least one Internet or other online service (e.g. CompuServe, AOL or local ISP) Higher than average propensity to trial and use novel online services and applications	Separate room set aside for business use Office or equivalent furniture - desk, office chair, filing capacity etc Office consumables - paper, stapler etc. Subcriptions to "business-oriented" newspaper, magazines etc. (office copy is usually shared) Credit card for business use (often a separate card account)
If the work entails a non-trivial proportion of travel, the teleworker will also have a notebook PC and GSM modem, as well as recent-model car etc.		
The home-based teleworker also buys at or near home the items that many commuters acquire at or near the place of work - coffee, business lunches, leisure facilities, shopping for clothes etc.		

Table 11
The Well-equipped Home-based Teleworker as a Market Opportunity

Experience from telework associations indicates that teleworkers have a high propensity to be perceived as "technology experts" among their social peer group, making them an important source of word of mouth and word of e-mail recommendations for new technologies and applications.

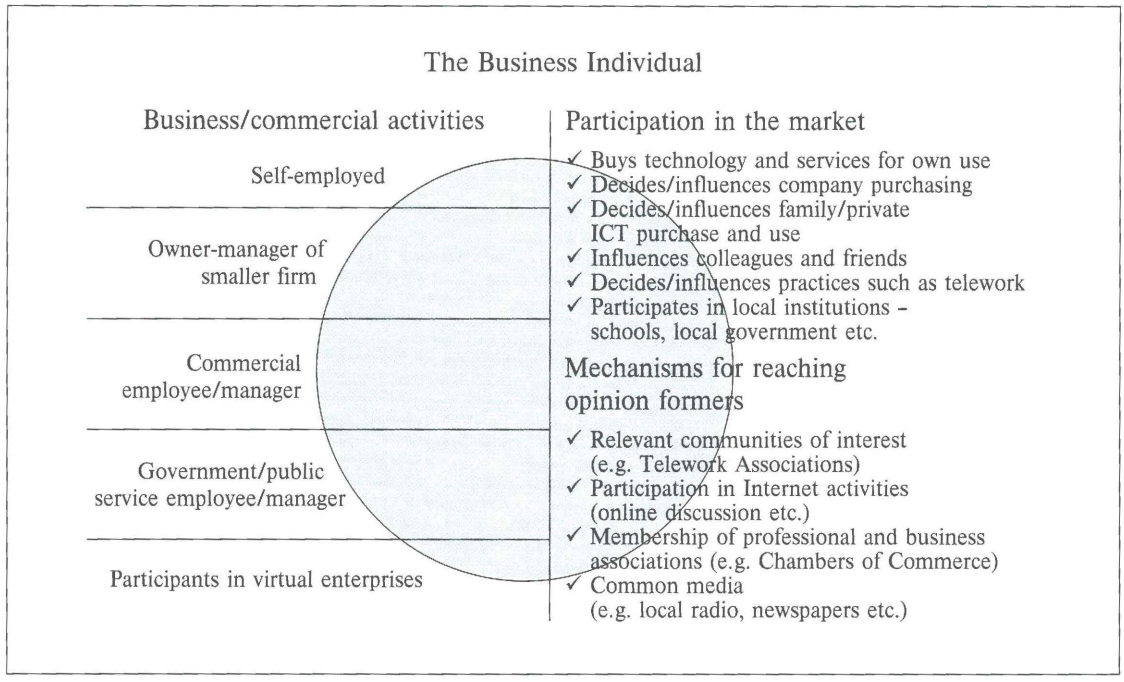
9.2. The Business Individual

Conventional market segmentation has focused on industry sectors and size of companies (large companies, SMEs, Small Office/Home Office etc.). Evidence from the telework market suggests an alternative focus, "the business individual".

Telework presents four main opportunity sets from a technology, services and applications standpoint:

- ***enterprises*** acquiring additional technology and implementing additional applications to support the extension of corporate networks from concentrated, office-based to support home and mobile working, telecentres, office "hotelling" etc.;
- ***individual employees*** acquiring technology and services to support their choice of teleworking independently of or supplemental to company provision;
- individual ***self-employed people*** working from home; and
- the emergence of ***new forms of "geography-free"*** *enterprises* that are network-based.

Figure 6
The "Business Individual" in Marketing Analysis and Targeting



In each of these, *the attitudes and preferences of individuals play a central role in the choice, acquisition and use of technologies and services.* This is obvious in the case of self-employed people, but is also true in enterprises. It is rare for a company to decide on a wholesale basis that employees generally "shall work at home". More usually, the company will evolve management practices and contracts of employment that *allow* working at home, leaving individual employees and managers to determine who will do so and to what extent. In many cases – a majority in some countries – individual managers and employees agree to some level of home-based working in the absence of any formal company policy. The process of acquiring significant new systems or applications is of course governed by company policy and decided or at least influenced by specialists, but professional and managerial use of systems and applications (and therefore level of demand) is driven by user choice as much as by company policy. Significant departmental systems may be decided by the local manager. Many small incremental purchase decisions are made on a local management or even a personal basis – buying a new software package for one's notebook computer is little different in price to buying oneself a new briefcase.

This has led to the idea of a new kind of marketing target – "the business individual" *(Figure 6)*. As a user of ICTs the business individual is becoming remarkably similar whether he or she works in local government, a commercial company or a professional services business; and the technology used is also remarkably similar. The business individual is also a householder, a parent, a consumer; he or she influences the use of technology in their local community and in the home – whether for work or leisure or "edutainment". Experience with technology at home and in the community

influences decisions on the use of technology at work, as well as vice versa. Indeed, the early use of Internet applications in companies often started because some individuals have campaigned for the same capabilities at work as they have already experienced at home.

From an ICT markets standpoint the business individual provides a common focus for understanding and a common target for promotional activities regardless of the size of company or whether the technology application is for corporate, work-at-home or purely private use. In this context the individual teleworker, who is perceived by others as knowledgeable and experienced in using the technologies, makes an attractive focus for technology marketing programmes. Telework associations and specialist telework websites can provide attractive channels to reach this market.

9.3. The Teleworking/Teletrading Enterprise

In existing organisations, telework is "grafted on" to the existing *modus operandi,* often starting with a small pilot scheme, then growing slowly (if the pilot is successful) in parallel with traditional ways of working, until it becomes fully accepted as part of the normal pattern of the organisation. This scenario has been the focus of most research into the diffusion of telework and is the environment in which barriers to take up are usually discussed. Similarly, most existing organisations tend to experiment with teletrade or electronic commerce, seeing it as an "add on" to existing operations.

However, there is a much less visible but equally important pattern now emerging in which newly formed or small and therefore more adaptable enterprises base their whole operations round the opportunities of telework and teletrade. For such businesses, telework and other uses of electronic networking quickly become "business as usual": there is no perception that telework is "something special" or that it needs special arrangements. Such businesses are difficult to classify in conventional terms and easily overlooked in measurement and reporting of telework and its impact.

This market sector is part of the wave of new small and medium-sized enterprises (SMEs), typically established during the last five to ten years. These include SMEs set up as a result of the out-sourcing of many tasks from larger companies during the 1980s and 1990s, as well as those in the ICT sectors themselves which are at the forefront of exploration of new markets and new jobs, for example based on the Internet, multi-media and forms of electronic trading and cooperation. These newer, high-tech SMEs are often more advanced in the use of both electronic commerce and telework than the majority of larger companies. In many cases they set the lead in how the common tools, work processes and organisational forms of both telework and electronic commerce can be exploited.

The teleworking/teletrading enterprise fully exploits networking tools and processes, both within the organisation itself and, crucially, across organisational boundaries, directly linking to other enterprises and partners, all using similar methods. Methods of working are flexibly adjusted to suit constantly changing needs and opportunities, including mobile, home and satellite office working, so that the location of individuals is largely of no consequence for the work done. The work is often organised in so-called "virtual teams". Where such teams become more formally constituted, although not necessarily permanent, a new "virtual enterprise" may be established.

Table 12
Relative Penetration of Teleworking, All Teleworkers, 1994

Country	Labour force	Teleworkers	% teleworking	Services as % of employment (1995)
Sweden	3,316,000	125,000	3.77	71
Finland	2,400,000	60,000	2.50	65
UK	25,630,000	563,182	2.20	71
Ireland	824,000	15,000	1.40	60
Netherlands	6,561,000	80,000	1.22	74
France	22,021,000	215,143	0.98	68
Spain	12,458,000	101,571	0.82	61
Portugal*	4,509,000	25,107	0.56	56
Luxembourg	165,000	832	0.50	71
Belgium*	3,770,000	18,044	0.48	69
Italy	21,015,000	96,722	0.46	60
Greece*	3,680,000	16,830	0.46	56
Germany	36,528,000	149,013	0.41	61
Denmark	2,584,000	9,800	0.37	69
Austria	3,278,000	8,195	0.25	61
TOTAL EU	**148,739,000**	**1,484,439**	**1.00**	
US	121,600,000	5,518,860	4.54	75
Canada	14,907,000	521,745[1]	3.50	66

Teleworker numbers compiled by European Telework Development for the European Commission Telework 1997 status report. Sources: Germany, France, Italy, Spain, UK - TELDET study;
Asterisked countries: TELDET extrapolation; Ireland: Telefutures study, Forbairt and Telecom Éireann

9.4. Market Development and the Market Today

Good data about teleworking are hard to find, because most studies have been very limited snapshots and because there is no common basis for collecting and reporting on telework. A 1994-1995 study funded by the European Commission (TELDET)[9] estimated numbers of teleworkers on a consistent basis in five EU countries, and analysed changes in the attitudes of employers and employees over ten years from 1985-1994. Using this and a range of other sources, ETD has compiled a table showing estimates of relative penetration of telework in EU countries as at 1994 *(Table 12)*. This was of course before the Internet came into wide public visibility with the appearance of commercial web browsers.

[9] For details of the TELDET study and its conclusions see *Telework: penetration, potential and practice in Europe*, Korte and Wynne, IOS Press, 1996

Country	Numbers of teleworkers in company schemes ('000s)		
	1992	1996	2000
UK	47	298	1,236
Germany	120	638	1,972

Source: Ovum, 1997

Table 13 Teleworker Estimates and Forecasts - Employed Teleworkers in Company Schemes

The rate of take-up and growth of telework is very variable from country to country in Europe, strongly influenced by local laws and regulations by cultural norms, employment levels and the structure of the economy, as well as by relative take-up of ICTs. The impact of differences in definitions is apparent from the differences between *Table 12* and *Table 13,* excerpted from estimates by the research company Ovum for teleworkers in company schemes. Where the TELDET data *(Table 12)* shows the UK having more than 500,000 teleworkers by 1994, the Ovum estimate for 1996 was only 298,000. For Germany, the Ovum data suggests a very swift increase in teleworking between 1994-1996, but ETD field reports suggest that the 1996 number may be an overstatement. However, it is the case that in the UK employment culture there is almost certainly more "informal" telework than formally organised and supported telework, whereas in Germany telework currently is less likely to happen on an informal basis and predominantly develops through formally contracted programmes.

Some countries are starting to collect teleworker data as part of national statistics. The UK Labour Force Survey's first such report (Spring 1997) reported that 987,000 people worked at least one full day at home during its reference week, using the telephone and a computer. Note that this excludes people who work in telecottages or telecentres, teleservices centres and company distributed office environments.

EITO overall estimates for telework in Europe are given below.

Occupation type	% of total workforce	
	1993	2001
Managers and administrators	16.6%	19.8%
Professionals	9.1%	11.3%
Associate professionals/ technical	9.3%	10.9%
Clerical/secretarial	16.2%	15.7%
Total	41.9%	57.7%
Number (millions)	10.5	15.1

Source: UK Department of Education and Employment, 1996

Table 14 Growth in Readily Teleworkable Jobs, UK

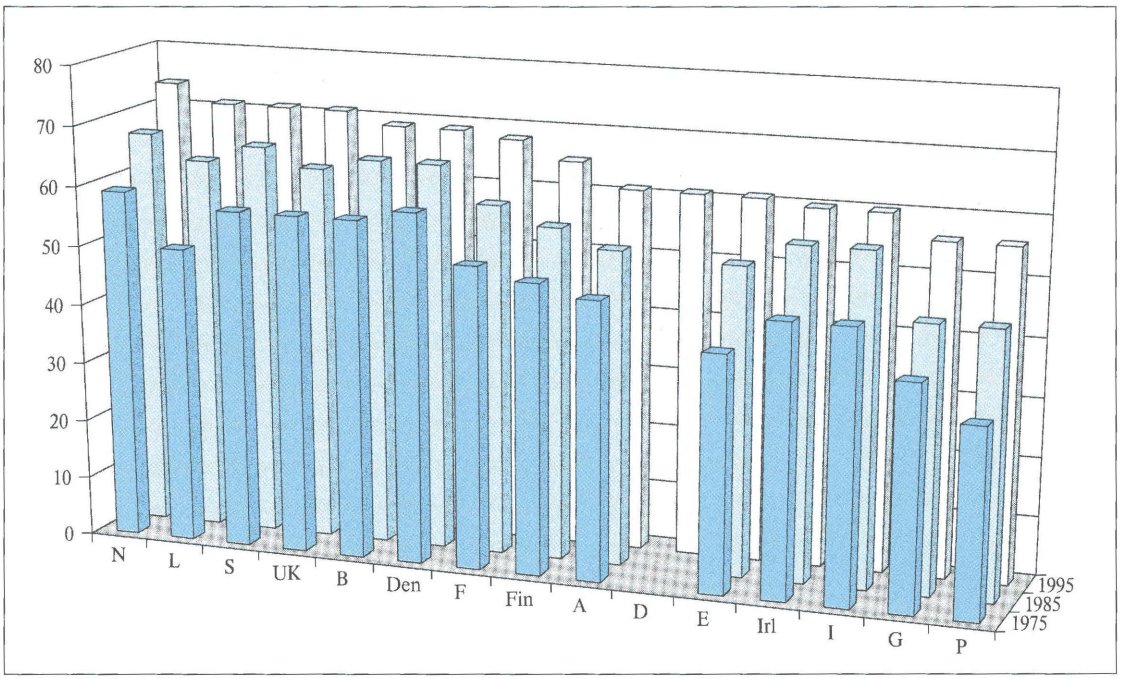
9.5. Market Potential

The potential for teleworking is large and growing. The occupations that lend themselves most readily to telework (for example managerial and professional jobs) are a high proportion of the total workforce and growing rapidly. 1996 estimates by the UK Education and Employment Department[10] show management, professional, secretarial and associated jobs growing from 42% of the UK workforce in 1993 to 58% by 2001 - from around ten million to around fifteen million people *(Table 14).*

If only one in five of these individuals decides to work at home sufficiently to justify an additional PC and an additional phone line for business use, this represents a market demand of 3 million business-oriented PCs - equivalent to total UK annual demand - as well as 3 million

[10] *Labour Market and Skill Trends 1995-1996,* UK Employment Department

Figure 7
Growth in Services as % of Employment 1975-1995



Note: Data for Germany in 1975, 1985 not available

Source: Employment in Europe, 1996

additional phone lines. Given that a high proportion of the growth comes from new entrants to the workforce, who will be familiar with computers and networks from experience at home, school and college, it can be expected that the logic of working at or close to home instead of commuting will be increasingly apparent in the workforce.

Across Europe the trend is similar, albeit with different starting points according to the pace at which each country has been moving from an agricultural to an industrial and services focus *(Figure 7)*.

Both the definitions used above ("employees in company schemes", *Table 13* and "people who worked at home on at least one day" in a particular week) represent only a proportion of the total telework opportunity. To "employees in company schemes" must be added those who telework at home on an informal basis and to these can be added:

- People working in telework centres established for local economic development and related purposes;
- Employees in telework-based marketing and customer service centres;
- Self-employed teleworkers.

Figure 8 provides an EITO estimate of the segmentation of telework activity in Europe, showing the relative significance of the alternative forms of teleworking.

Taking European telework as a whole, there is wide scope for variation in the extent and pace at which companies and individuals will adopt telework, dependent on both policy decisions and economic circumstances. *Figure 9* illustrates the range of potential outcomes, starting from a conservative view (the minimum anticipated take-up) and indicating how this could rise if appropriate policies are adopted in a timely way.

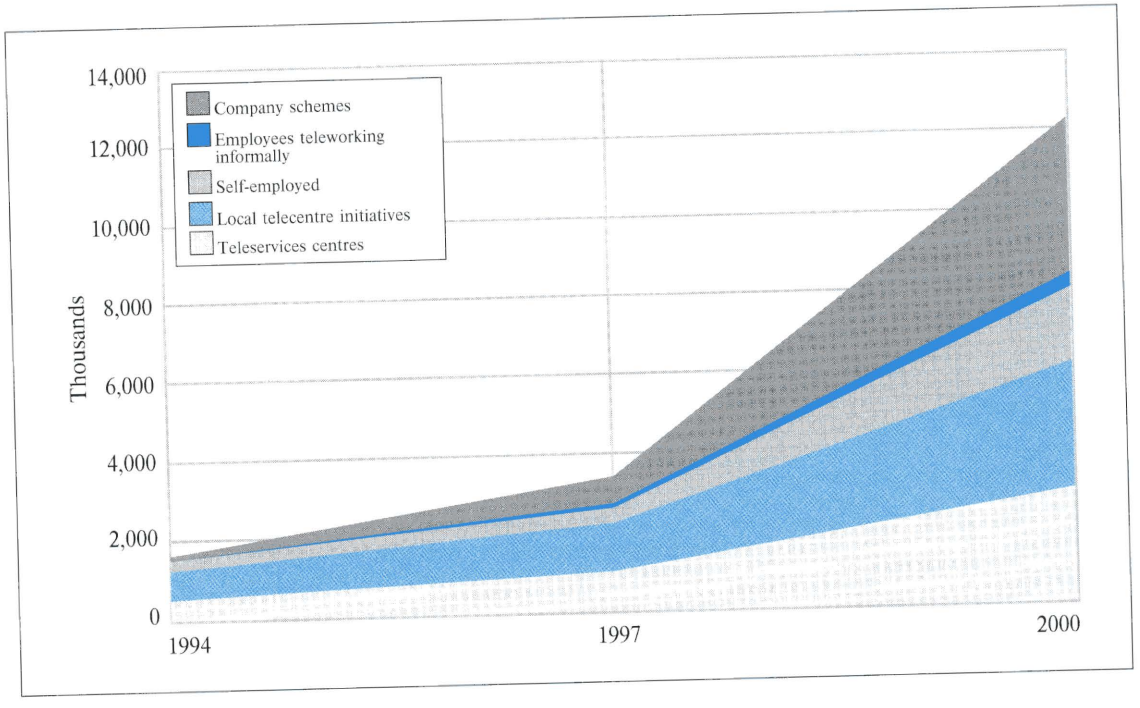


Figure 8
Telework in Europe, Development by Segment, 1994-2000 Mid-Range Estimates (EU 15)

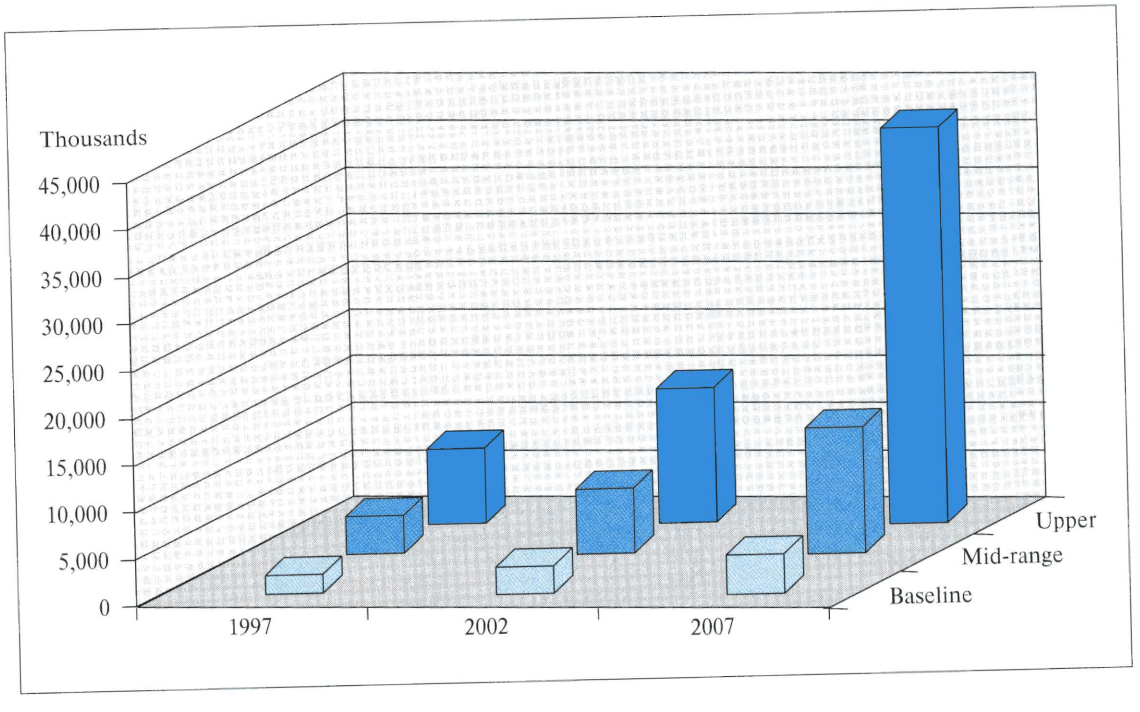


Figure 9
Telework Growth Potential, EU 15, 1997-2007

9.6. European Policy, Research and Promotional Activities

The European Commission has taken an active interest in telework since 1989, when consideration of the possibility that new technologies might be used to address issues of economic exclusion in rural and peripheral regions led to later investigations within the research and technology development programme RACE. Telework was identified as an important focus for Europe in the White Paper on Growth, Competitiveness, Employment in 1993 and as one of ten applications that would launch the Information Society in the Bangemann report (1994). In 1996-1997 a series of Commission Green Papers have continued this focus, emphasising both the social and economic opportunities.

In practical terms the European Commission has supported a series of European Telework Weeks, starting in 1995 (see the following panel), as well as an annual European Telework Assembly at which policy issues have been debated. There is a European Festival of Teleworking held in the French Alps each Spring. 1997 saw the launch of a European Telework Charter, which is being promoted by a team supported through the ACTS programme (Advanced Communications Technologies and Services), and the first International Online Cooperation conference, held in Berlin. Additionally, through the European Telework Development initiative, there is a network of Telework national coordinators in each Member State, supporting local market development initiatives. Telework, teletrade and telecooperation are all expected to receive strong focus in Europe's Fifth Framework Programme, due to be launched in 1998.

European Telework Week

Each year, European Telework Week (ETW) is the focal point for programmes aimed at raising awareness of telework and helping Governments, companies and individuals to understand and apply telework methods effectively.

The third European Telework Week (3-10 November 1997) involved more than 150 events, ranging from a major International conference in London to "open days" at telecentres and telecottages in towns and villages across Europe. A new element in 1997 was the first European Telework Awards.

European Telework Award Winners 1997:

Best contribution to competitiveness

IBM Belgium-Luxembourg:
Shared Office implementation

Most original telework application

ISdAC: the Information Society Disabilities Challenge

Best contribution to sustainability

Rijkswaterstaat directorate of North Netherlands

Best technological contribution

Siemens AG/Private Networks of Austria

Best media coverage

Teleworkx magazine of Germany

The fourth European Telework Week is being held from 2-9 November 1998 (http://www.etw.org).

Table 15
Barriers to Adoption of Telework

Issues as seen by different participants			**Solutions**
Enterprise decision-makers	*Individual managers*	*Teleworkers and potential teleworkers*	
Unaware of the rationale for telework; lack of pressure to adopt telework	Absence of a clear company policy	Management unsupportive or resistant	Better information, especially positive exemplars; promotion of benefits by Governments, suppliers etc.
Concerns about middle management ability to cope with change	Perceived difficulty in "managing at a distance"; fears about loss of control	Concerns about impact on career – concern that being "out of sight" will mean being out of touch	Wider adoption of "networked enterprise" methods (see *Table 4*)
Reluctance to add to the topics being discussed with Unions	Uncertainty about employment contract implications, employee responses	Confusion about relative responsibilities of individual, manager and company	Increasingly positive and engaged stance from Unions; model and example contracts of employment covering telework
Uncertainties about legal, regulatory, tax framework; in some cases taxes or regulations that appear to discriminate against telework or inadequately cope with the telework environment			European and national actions to clarify status of teleworkers and update relevant legislation to reflect current practice
Difficulties in supporting widely dispersed home-based employees	Perceived and actual problems in communicating with employees	Practical concerns about home-based working – family impact, space availability, differentiation between work/private life etc.	Wider investment in local telework centres; continuing improvements in technology; awareness and education in best practice

Source: Synthesis of European and national studies

10. Barriers to Adoption of Telework

Many studies at national and European levels have examined the barriers to adoption of telework, focusing particularly on the issues as seen by corporate employers and their employees. *Table 15* summarises the barriers to wider adoption of home-based teleworking as seen from the different perspectives of enterprise decision-makers, individual managers and potential teleworkers. The focus here is on home-based teleworking because this is the aspect where the barriers are most clearly seen. The nature and extent of the barriers varies according to the model of telework concerned. Telework in, for example, a neighbourhood telecentre does not raise the same issues of taxation as home-based teleworking.

Studies by Empirica in 1985 and 1994 showed a substantial evolution in perceived barriers to telework take-up over that ten-year period.[11] In 1985 the number one obstacle affecting enterprise decision-makers was the lack of any pressure to change. Costs and concerns about the effectiveness and reliability of computer systems were significant additional issues. By 1994, lack of pressure to change had become the fifth most significant factor, the cost of computers and telecommunications fourth, but the three highest-ranking issues were to do with organisational aspects – lack of knowledge, perceived management problems and perceived problems in communicating with teleworkers. Today, there is much wider awareness of the pressure to reduce costs and improve market responsiveness. The extent to which telework is seen as an attractive way to do this depends to a considerable extent on whether the enterprise concerned has already become effectively networked – in effectively networked enterprises the remaining barriers to telework are seen as being easier to overcome.

This is necessarily a highly summarised description of perceived barriers and available solutions. A more detailed treatment is published at the European Telework Online website (http://www.eto.org.uk). Underlying barriers related to the use of technologies – for example the relatively low use of ICTs in some sectors and regions – have been excluded from *Table 15,* as they are addressed elsewhere.

[11] Korte and Wynne, op.cit.

11. Telework Development

The market evolution process shown in *Table 10* suggests that telework could "mature" to become a widely accepted practice in Europe within the next five to ten years. However, we can expect continued wide variations in take up in different countries, at least until policy decisions at European level lead to more consistency in the legal and regulatory framework. Our employment laws and regulations have evolved to support the industrial era concept that employers not only provide and manage the workplace, but also determine on a quite detailed basis what work is done, by whom and how. Today's and tomorrow's business environment, in which more than half the workforce have managerial, professional or related tasks, requires that individuals decide for themselves their own priorities – where and how a task is to be done, who should be involved and what to do about problems that arise.

Taking a 1997 European baseline of some 4 million teleworkers (all segments), we can expect to see this expand to between 8 million and 15 million by 2002, and between 16 million and 37 million by 2007. The wide range of these projections reflects the impact of public policy decisions that may be made or deferred during the next few years, but even the higher figure suggests that no more than half the potential for teleworking will have been realised within ten years, even on the most positive assumptions about policies. *Table 16* summarises the critical policy factors.

There is considerable evidence of accelerating public policy interest in teleworking. Nine out of fifteen EU countries now have telework associations or some other kind of national organisation for promoting telework. The European Telework Online website[12] was answering

[12] http://www.eto.org.uk

Policy area	Outcomes that would accelerate telework take-up
Employment law and regulatory framework	Early re-regulation to encourage flexible working and to support new working patterns; clarification of existing laws and tax etc. policies affecting teleworkers; simplification of compliance by workers and employers in trans-border employment and work contracts
Traffic congestion and environmental impacts	Recognition that telework and other ICT applications (e.g. video conferencing) can substitute for peak hour and peak route travel and deliver a net saving in transport use; inclusion of transport-telecommunications substitution among fiscal and other programmes aimed at environmental protection and traffic reduction
Telecommunications liberalisation	Progressive regulatory policies to increase competition, reduce prices and enhance services/performance
Information Society programmes	Actions at national and local levels to ensure low-cost, high-performance network access in all areas but especially in remote and rural areas; rapid implementation of online public services for citizens and enterprises
Regional development and social cohesion	Greater attention to Information Society applications in regional development programmes; focus on telework/teletrade as economic development opportunities for rural, peripheral and under-developed regions; assistance for adoption of ICT applications in regions with lower GDP and/or lower intensity of services sector employment; support to networking and outreach activities by telework centres and equivalent initiatives
Internet-related laws and regulatory framework	Early adoption of agreed European and international mechanisms for matters such as security, IPR, digital signatures, electronic payments and the nature and validity of contracts made "online"
Research and Technology Development (RTD)	Technologies and mechanisms to reduce interoperability and other technology adoption and migration difficulties for home-based and other individuals who lack adequate technical support; continued focus on better and cheaper language translation technologies to facilitate work and business relationships across Europe for individuals and small firms; continuing improvements in price-performance, especially in the deliver of low-cost bandwidth in areas with low concentrations of economic activity and population

Table 16
Public Policy Developments and their Impact on Telework

some 100,000 information requests each month by year end 1997, and national telework websites in each country of the EU are linked to each other and to equivalent sites worldwide.[13] A "telework charter" initiative supported by the European Commission is gathering support for consensus on appropriate policies and regulatory actions.[14]

[13] National telework websites are listed and linked at http://www.eto.org.uk/nat

[14] The Telework Charter Initiative is run by a project (DIPLOMAT) which is supported by the European Commission as part of the ACTS programme (see footnote 8), for details see http://www.telework-forum.org/diplomat

12. Conclusions

Up to one half or more of future jobs in Europe are "potentially teleworkable". In existing enterprises telework in its various forms becomes an obvious option once the enterprise becomes successfully networked and a reasonable proportion of its employees have acquired personally owned PCs and started to use Internet access at home as well as at work. The appropriate use of telework can significantly reduce overheads and increase productivity. New kinds of "teleworking enterprises" are emerging and many of the new Internet-based businesses treat telework as the obvious way to work.

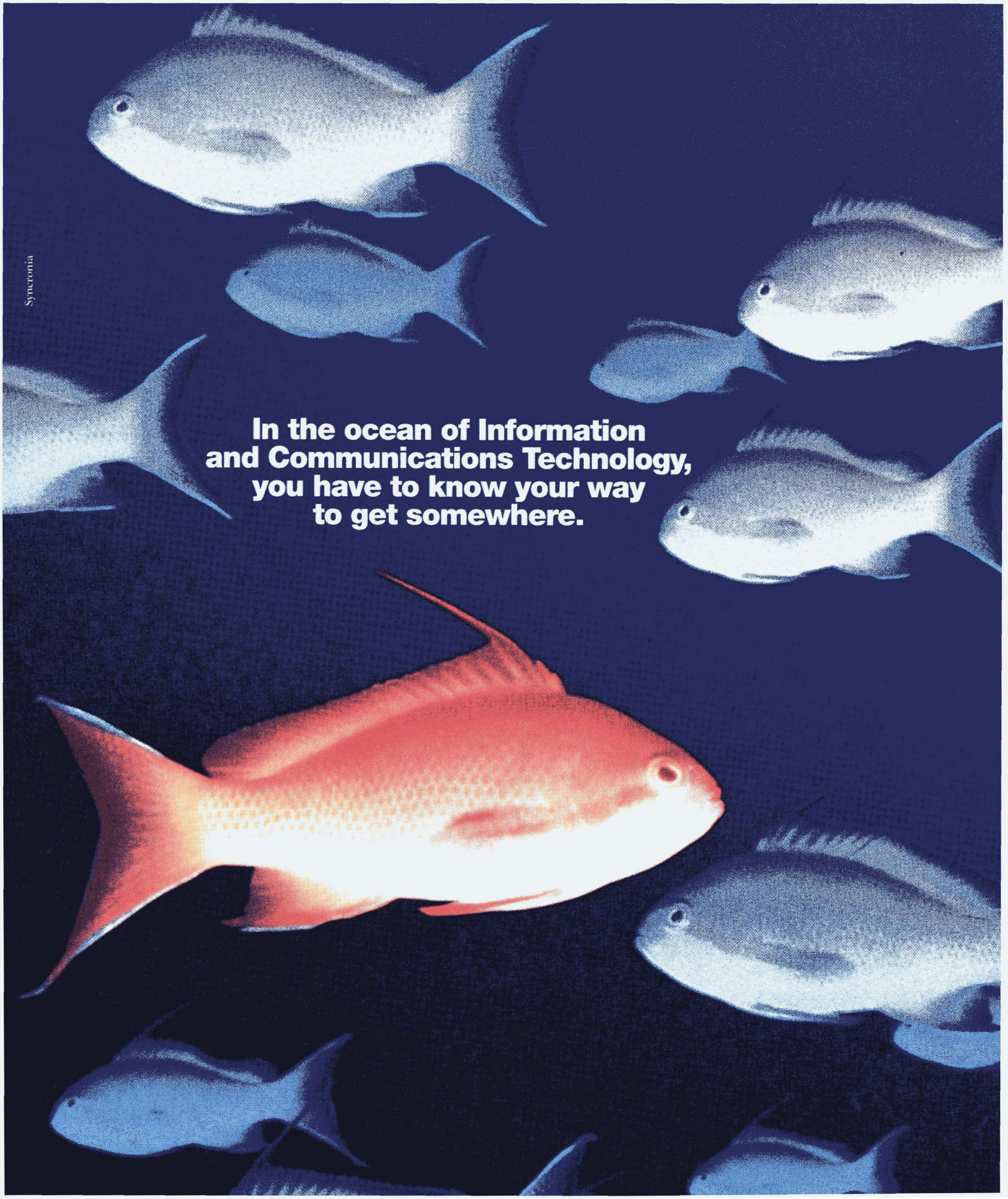
Successful telework depends to a great extent on recognising the different personal needs and preferences of workers and on a high degree of mutual trust between employees and managers. For those whose home environment and family needs allow it, home-based telework has many attractions, particularly when the working time is split, with some time spent at home, some at a conventional workplace. For others it is more desirable to travel a short distance to the nearest available telecentre, which may be company-owned or a shared facility.

Telework can increase employment opportunities, by improving the competitiveness of enterprises and by enabling access to work for people who might otherwise be excluded, since the new kinds of information work can be done from anywhere in the world. There are opportunities to significantly enhance local economies and attract this location-independent work by developing and promoting the skills of a market-effective workforce.

However, the growth of home-based telework in Europe is ultimately constrained by purely practical factors such as the size of homes and their suitability for family members to telework. The extent to which telework will create new work opportunities in Europe is therefore dependent on public and private investment in telecentres and similar infrastructure. Above all, job creation depends on marketing: understanding the new dynamics of an increasingly global market; understanding what skills are required and how to "package" those skills in the appropriate ways; mastering the new techniques of building customer relationships across networks and managing an increasingly self-actualising workforce across networks.

Areas that have low levels of investment in technology, infrastructure and workforce development will miss these opportunities. In this context telework is inextricably linked with teletrade (using the networks to do business at a distance) and telecooperation (using the networks to support effective co-operation across enterprises and communities of interest regardless of geographic boundaries).

Europe needs to create or attract – and retain – a high proportion of the new work opportunities presented by the emerging global networked economy. This can only be achieved through accelerating take-up of the relevant technologies and, through experience and familiarity, building competence and confidence in the new techniques among decision-makers, managers and individual workers.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Part Three

Statistical Outlook

The data and forecasts presented in this section have been jointly prepared by IDC and the EITO Task Force on the basis of the information available at mid-December 1997.

ICT Market size and growth trends by country and technology reflect the opinion of both the EITO Task Force and IDC. The data and trends in the Statistical Outlook are the result of the overall statistical framework provided by IDC, and the considerations and assumptions of the EITO Task Force.

1. Introduction

This section presents statistics which illustrate the shape and structures behind the IT and communications markets in Europe. The subject is presented in three main sub-sections:

- The shape of the various national ICT markets, within an international context, and the patterns of trade between them;
- The individual market structures with an eye to the competitive aspects, as well as comparative measures of ICT penetration;
- The role of technological advancement in altering the underlying economics of ICT.

Terms are defined at the end of the section.

2. Methodology

The following analysis attempts to shed light on some of the more important aspects of the European markets for telecommunications and information technology products, including substantial elements of the associated market for office automation products.

The basis for the study is the marketplace; the results are expressed in end-user spending. Valuation is largely based upon the performance of primary vendors, with research results cross-checked against a continuous programme of end-user interviews and distribution channel monitoring. Data on trade flows have also been collected, and matched as closely as possible to market-oriented segmentation, since these data can provide information relating to the position of Europe with respect to the world. What is presented then, is a comprehensive body of data which aims to illuminate the European ICT market.

The adaptation of some new IDC research methodologies has led to the restatement of some current and historical magnitudes and growth trends. These have occurred either because of the availability of better research evidence to justify the new values, or because of changes in the markets researched.

The most significant changes are related to the server market, with the adoption of a classification based on operating system platforms, and on the services market.

Historical reconciliation is still admissable at the macro category level, although a change in the perimeter of the services market needs to be considered. This change is due to the shift of the "network services" category from services under the IT section, in the past editions, to switched data and leased line service (within which segment it is not itemised) under the telecommunication section.

A detailed description of the new re-defined market segments is available under "Definitions" at the end of this section.

3. European ICT Markets and Patterns of Trade

All forecast data are prepared in local currencies and subsequently converted at constant 1996 ECU exchange rates as listed at the end of the definitions. Growth rates therefore correspond to local currency growth rates. No adjustment is made for the effects of inflation. Trade data are reported in current ECU, according to the standard reporting conventions.

In terms of classes of product, again a full definition account appears later in this volume. Here we note that the definition of the hardware marketplace has been expanded beyond the traditional IT systems arena, to include a broad category of office hardware technologies such as photocopiers, typewriters and calculating machines, and tele- and data communications equipment and services.

The heading EU refers to Austria, Belgium and Luxembourg, Denmark, Finland, France, Germany, Greece, Italy, the Republic of Ireland, the Netherlands, Spain, Sweden, Portugal, the UK. The sole exception is Part 8 ICT Trade Flows where definitions of the EU are governed by the methodology of Eurostat. Non-EU is represented by data on Norway and Switzerland. Western Europe figures are the sum of EU countries plus Norway and Switzerland. Eastern Europe is considered to refer to the Czech Republic, Hungary, Poland, Russia and Slovakia. Bulgaria and Romania are not covered by the analysis.

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6. Economic Background

Table 1
Real GDP Growth
in %, 1991–1999

	1991	1992	1993	1994	1995	1996	1997*	1998*	1999*
Austria	3.4	1.3	0.5	2.5	2.1	1.6	2.1	3.0	2.8
Belgium	1.6	1.5	-1.5	2.4	2.1	1.5	2.4	2.8	2.7
Denmark	1.4	1.3	1.3	3.5	3.1	3.4	3.4	2.8	2.7
Finland	-3.1	-3.6	-1.2	4.5	5.1	3.3	4.6	3.9	3.2
France	0.8	1.2	-1.3	2.8	2.1	1.5	2.3	2.0	3.8
Germany	5.0	2.2	-1.2	2.7	1.8	1.4	2.4	3.0	2.9
Greece	3.1	0.7	-1.6	1.7	1.8	2.6	3.4	3.4	3.2
Ireland	1.3	3.7	2.9	6.3	9.8	7.9	7.5	7.3	6.1
Italy	1.1	0.6	-1.2	2.2	2.9	0.7	1.3	2.1	2.6
The Netherlands	2.3	2.0	0.8	3.2	2.3	3.3	3.2	3.7	3.6
Norway	3.1	3.3	2.7	5.5	3.6	5.3	4.0	4.7	3.6
Portugal	2.3	1.8	0.3	0.7	1.9	3.0	3.4	3.7	3.2
Spain	2.3	0.7	-1.2	2.2	2.7	2.3	3.2	3.6	3.6
Sweden	-1.1	-1.4	-2.2	3.3	3.9	1.3	1.8	2.6	2.4
Switzerland	-0.8	0.1	-0.5	0.5	0.8	-0.2	0.5	1.7	2.0
United Kingdom	-2.0	-0.5	2.1	4.3	2.7	2.3	3.4	2.2	2.1
European Union	1.6	1.0	-0.5	2.9	2.5	1.7	2.6	2.8	2.8
USA	-0.9	2.7	2.3	3.5	2.0	2.8	3.8	2.7	1.9
Japan	3.8	1.0	0.3	0.6	1.4	3.5	0.5	1.7	2.1

Source: OECD, December 1997 * Estimates and projections

Table 2
Nominal GDP Growth
in %, 1991–1999

	1991	1992	1993	1994	1995	1996	1997*	1998*	1999*
Austria	7.3	5.7	3.3	5.4	4.2	3.8	3.7	4.6	4.3
Belgium	4.8	5.2	2.6	4.8	3.8	3.1	4.2	4.5	4.5
Denmark	3.9	3.5	2.1	6.1	5.2	5.4	5.9	5.6	6.1
Finland	-4.8	-2.9	1.2	5.9	7.6	4.5	5.8	6.5	6.2
France	4.1	3.3	1.1	4.4	3.7	2.8	3.3	4.3	4.2
Germany	9.1	7.9	2.8	5.2	3.9	2.4	3.3	4.3	4.5
Greece	23.5	15.7	12.6	13.2	11.1	11.3	10.1	8.6	7.2
Ireland	3.8	6.2	7.5	8.2	10.9	9.1	8.1	8.5	7.5
Italy	8.9	5.3	3.2	5.7	8.1	5.8	4.0	4.7	4.9
The Netherlands	5.0	4.3	2.7	5.6	3.9	4.6	5.8	6.2	6.0
Norway	5.6	2.8	4.9	5.3	7.1	9.6	7.8	7.9	6.8
Portugal	14.7	12.6	6.3	6.6	7.0	6.4	6.5	6.7	6.1
Spain	9.5	7.6	3.1	6.3	7.7	5.5	5.2	6.2	6.2
Sweden	6.4	-0.4	0.3	5.9	7.8	2.3	3.6	5.1	4.8
Switzerland	5.2	2.6	2.2	2.1	2.1	-0.2	0.7	2.7	3.5
UK	4.5	4.0	5.4	6.0	5.2	5.4	5.8	4.6	4.7
European Union	7.1	5.5	3.2	5.6	5.5	4.2	4.4	4.9	4.9
USA	3.0	5.5	5.0	5.9	4.6	5.1	5.8	4.6	4.2
Japan	6.6	2.8	0.9	0.8	0.8	3.6	1.6	2.5	2.6

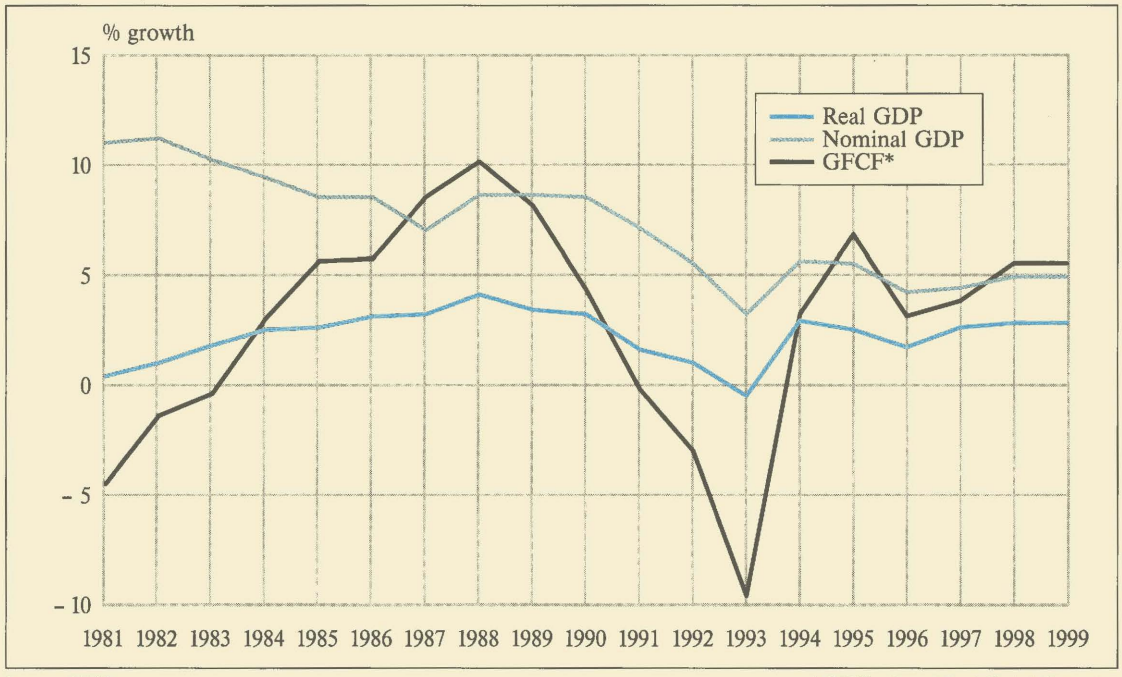
Source: OECD, December 1997 * Estimates and projections

	1991	1992	1993	1994	1995	1996*	1997*	1998*	1999*
Austria	5.2	- 2.2	- 5.5	10.1	3.7	3.3	5.2	7.7	6.4
Belgium	- 4.2	- 0.9	- 6.7	-3.4	5.1	4.7	3.6	4.2	4.0
Denmark	- 0.4	- 3.8	1.5	-1.4	16.8	7.1	8.5	6.0	5.0
Finland	-24.2	-21.3	-22.6	2.3	25.1	12.1	4.9	4.6	3.2
France	0.4	- 4.0	- 8.2	1.5	3.5	-0.4	0.5	4.1	5.2
Germany	7.5	0.0	-10.2	0.6	0.9	-0.8	1.9	5.9	5.9
Greece	4.9	2.3	1.0	2.3	8.2	10.2	12.7	10.8	9.5
Ireland	-12.8	- 6.5	- 4.1	3.9	9.6	21.5	15.5	12.4	9.1
Italy	- 0.1	- 1.2	-18.5	5.1	13.5	1.9	0.3	4.4	6.1
Netherlands	2.0	- 3.0	- 4.2	0.3	7.4	9.2	8.8	5.6	5.5
Norway	-17.9	8.3	22.4	17.4	15.3	3.7	1.5	6.2	8.6
Portugal [1]	2.4	5.4	- 4.8	3.5	7.5	8.0	7.5	n.a.	n.a.
Spain	2.9	2.0	15.0	4.0	12.2	5.2	5.4	6.5	7.0
Sweden	-15.2	-15.5	-13.0	18.6	27.7	4.7	5.0	7.0	7.0
Switzerland	- 4.3	-11.6	- 8.6	1.4	9.8	-2.9	0.2	2.0	3.2
UK	- 9.5	- 6.2	- 1.4	5.5	3.9	8.3	9.7	5.7	3.5
European Union	- 0.2	- 3.0	- 9.6	3.2	6.8	3.1	3.8	5.5	5.5
USA	- 6.4	1.9	7.6	8.0	9.0	9.2	10.7	11.2	5.6
Japan	6.3	- 5.6	-10.2	-5.3	3.9	6.6	3.9	4.5	5.6

Source: OECD, December 1997

* Estimates and projections. [1] Data refers to OECD. December 1996

Table 3
Real Gross Private Non-residential Fixed Capital Formation (Growth in %), 1991–1999

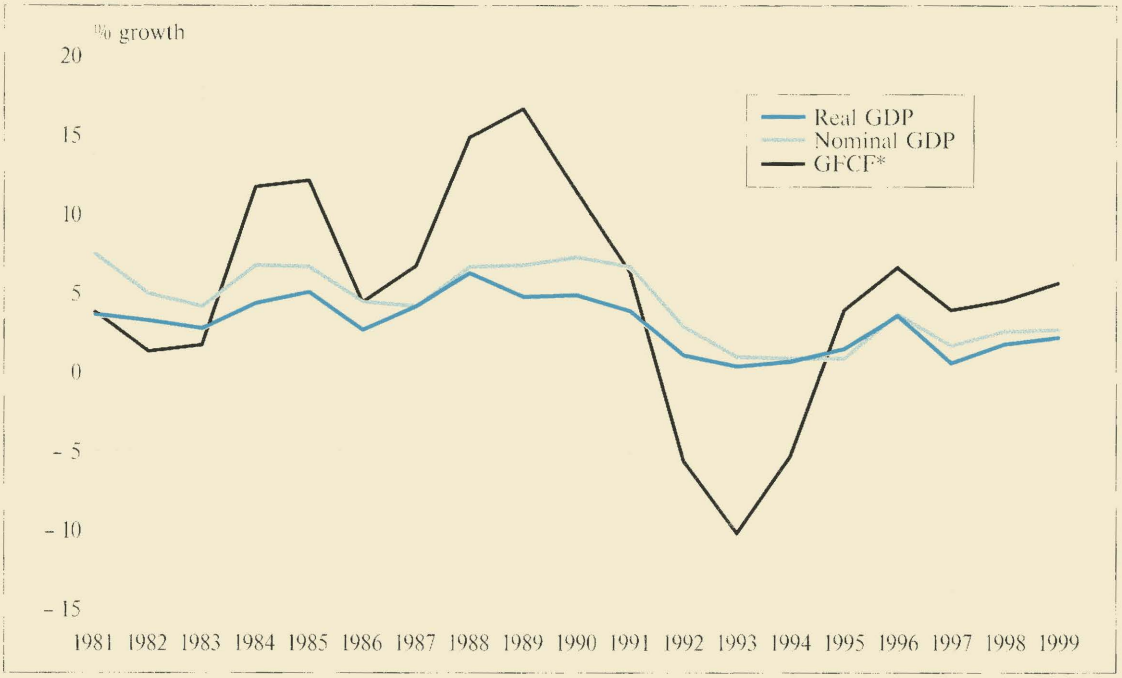


Source: OECD

* GFCF - Gross Fixed Capital Formation

Figure 1
Economic Developments in the European Union, 1981–1999

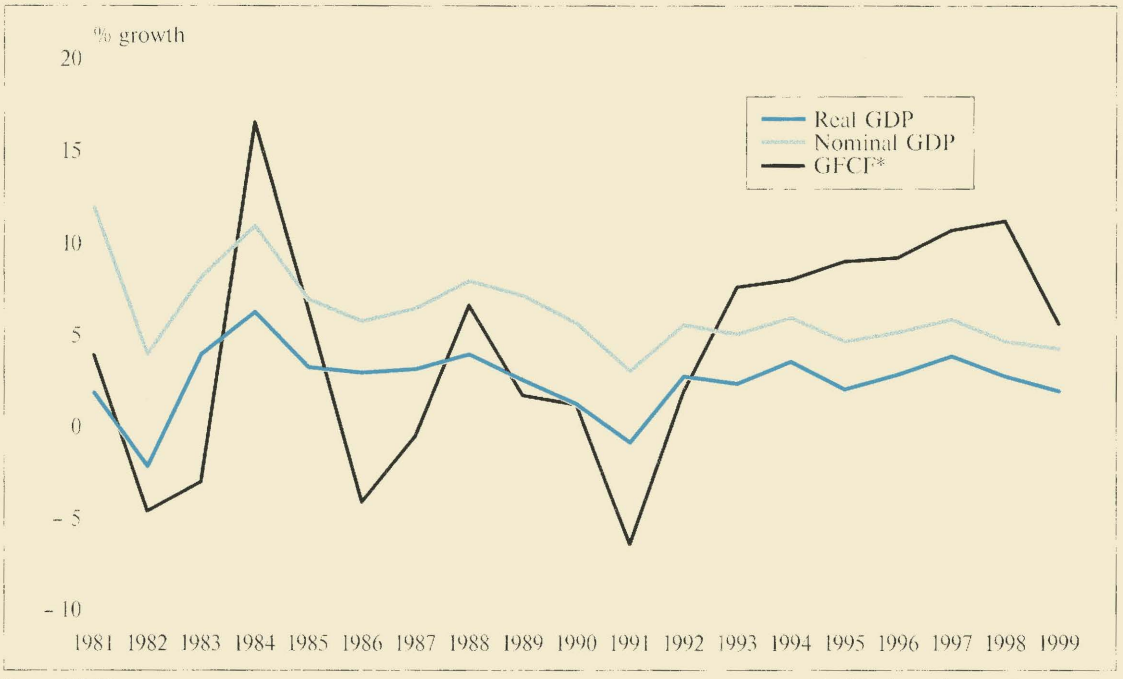
Figure 2
Economic Developments in Japan, 1981–1999



Source: OECD

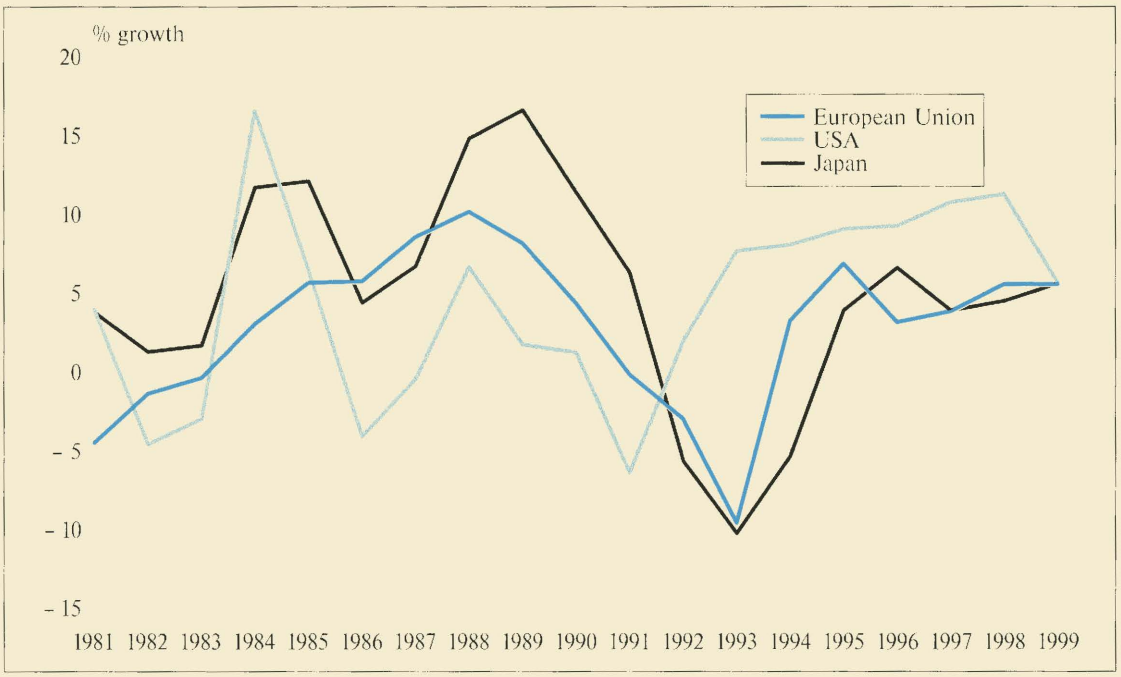
* GFCF = Gross Fixed Capital Formation

Figure 3
Economic Developments in the USA, 1981–1999



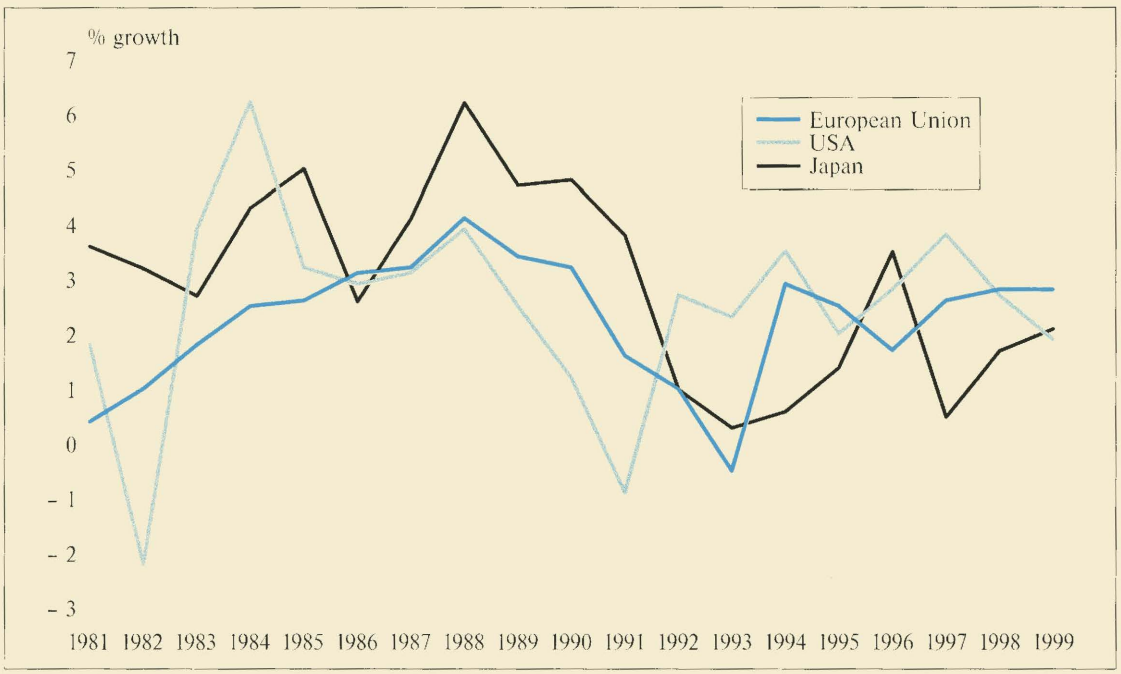
Source: OECD

* GFCF = Gross Fixed Capital Formation



Source: OECD

Figure 4
Growth of Gross Private Non-residential Fixed Capital Formation in the European Union, the USA and Japan, 1981–1999

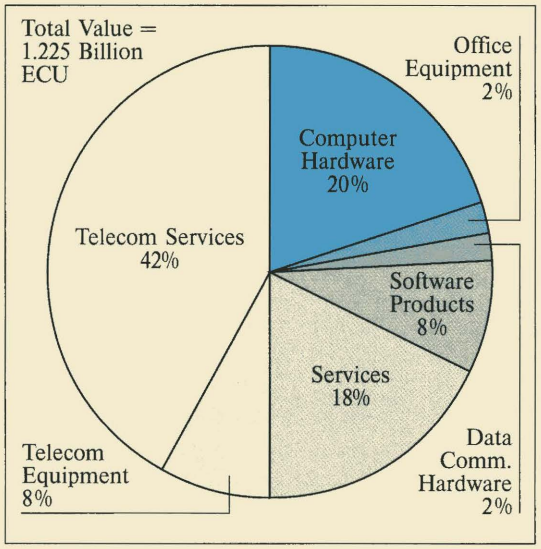


Source: OECD

Figure 5
Growth of Real Gross Domestic Product in the European Union, the USA and Japan, 1981–1999

7. International ICT Markets

Figure 6
Worldwide ICT Market by Product, 1997



Source: EITO

Million ECU	1994	1995	1996	1997	1998	1999
Europe (incl. Eastern Europe)	144,646	156,430	167,469	181,540	198,326	217,565
US	181,828	207,919	233,493	259,200	285,896	314,251
Japan	74,755	81,733	90,267	95,144	100,381	106,579
Rest of World	52,701	62,345	72,820	84,961	98,817	114,911
Total	**453,930**	**508,427**	**564,050**	**620,845**	**683,420**	**753,306**
	% growth					
Europe (incl. Eastern Europe)	5.9	8.1	7.1	8.4	9.2	9.7
US	10.0	14.3	12.3	11.0	10.3	9.9
Japan	4.7	9.3	10.4	5.4	5.5	6.2
Rest of World	14.7	18.3	16.8	16.7	16.3	16.3
Total	**8.4**	**12.0**	**10.9**	**10.1**	**10.1**	**10.2**
	% breakdown					
Europe (incl. Eastern Europe)	31.9	30.8	29.7	29.2	29.0	28.9
US	40.1	40.9	41.4	41.7	41.8	41.7
Japan	16.5	16.1	16.0	15.3	14.7	14.1
Rest of World	11.6	12.3	12.9	13.7	14.5	15.3
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 4
*Worldwide IT Market Growth Trends. Market Value. Million ECU at Constant 1996 Exchange Rates**

* See Definitions 11.3.6. Exchange Rates

Million ECU	1994	1995	1996	1997	1998	1999
Europe (incl. Eastern Europe)	148,219	161,325	175,084	189,438	203,258	215,904
US	139,525	146,360	155,795	165,002	174,857	185,704
Japan	66,398	69,720	72,799	75,470	78,541	82,600
Rest of World	125,307	140,140	156,896	174,485	192,667	208,635
Total	**479,449**	**517,545**	**560,574**	**604,395**	**649,323**	**692,843**
	% growth					
Europe (incl. Eastern Europe)	8.7	8.8	8.5	8.2	7.3	6.2
US	3.2	4.9	6.4	5.9	6.0	6.2
Japan	6.4	5.0	4.4	3.7	4.1	5.2
Rest of World	8.1	11.8	12.0	11.2	10.4	8.3
Total	**6.1**	**7.9**	**8.3**	**7.8**	**7.4**	**6.7**
	% breakdown					
Europe (incl. Eastern Europe)	30.9	31.2	31.2	31.3	31.3	31.2
US	29.1	28.3	27.8	27.3	26.9	26.8
Japan	13.8	13.5	13.0	12.5	12.1	11.9
Rest of World	26.1	27.1	28.0	28.9	29.7	30.1
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 5
*Worldwide Telecommunications Market Growth Trends. Market Value. Million ECU at Constant 1996 Exchange Rates**

* See Definitions 11.3.6. Exchange Rates

Table 6
*Worldwide ICT Market Growth Trends. Market Value. Million ECU at Constant 1996 Exchange Rates**

Million ECU	1994	1995	1996	1997	1998	1999
Europe (incl. Eastern Europe)	292,865	317,755	342,554	370,979	401,584	433,469
US	321,353	354,279	389,288	424,202	460,753	499,955
Japan	141,153	151,453	163,066	170,615	178,922	189,179
Rest of World	178,008	202,485	229,716	259,446	291,485	323,546
Total	**933,379**	**1,025,972**	**1,124,624**	**1,225,242**	**1,332,743**	**1,446,149**
	% growth					
Europe (incl. Eastern Europe)	7.3	8.5	7.8	8.3	8.3	7.9
US	6.2	10.2	9.9	9.0	8.6	8.5
Japan	5.5	7.3	7.7	4.6	4.9	5.7
Rest of World	10.1	13.8	13.4	12.9	12.3	11.0
Total	**7.2**	**9.9**	**9.6**	**8.9**	**8.8**	**8.5**
	% breakdown					
Europe (incl. Eastern Europe)	31.4	31.0	30.5	30.3	30.1	30.0
US	34.4	34.5	34.6	34.6	34.6	34.6
Japan	15.1	14.8	14.5	13.9	13.4	13.1
Rest of World	19.1	19.7	20.4	21.2	21.9	22.4
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

* See Definitions 11.3.6. Exchange Rates

1997	Western Europe	Eastern Europe	US	Japan	Rest of World	World
IT Hardware	80,015	4,823	115,113	52,080	50,792	302,823
Software	33,607	599	46,060	9,885	11,645	101,797
IT Services	61,132	1,365	98,027	33,179	22,524	216,227
Telecom Equipment	30,639	2,536	19,619	10,216	33,009	96,019
Telecom Services	150,569	5,694	145,383	65,254	141,476	508,376
Total	**355,962**	**15,017**	**424,202**	**170,615**	**259,446**	**1,225,242**
1999	Western Europe	Eastern Europe	US	Japan	Rest of World	World
IT Hardware	90,484	6,148	130,879	58,936	67,262	353,709
Software	41,621	732	60,034	11,474	14,545	128,406
IT Services	76,781	1,799	123,338	36,169	33,104	271,191
Telecom Equipment	33,845	2,967	19,751	10,309	37,713	104,585
Telecom Services	172,340	6,752	165,953	72,291	170,922	589,258
Total	**415,071**	**18,398**	**499,955**	**189,179**	**323,546**	**1,446,149**

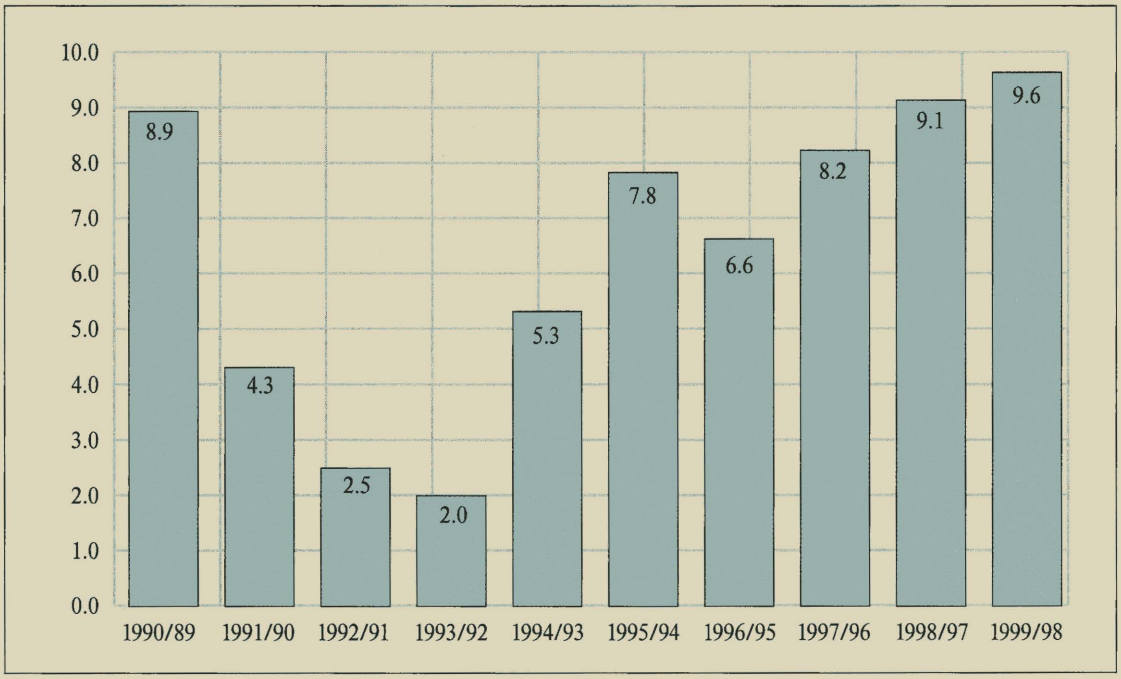
Table 7
*Major Regional ICT Markets by Product, 1997 and 1999. Million ECU at Constant 1996 Exchange Rates**

* See Definitions 11.3.6. Exchange Rates

	Western Europe	Eastern Europe	US	Japan	Rest of World	World
IT Hardware	6.3	12.9	6.6	6.4	15.1	8.1
Software	11.3	10.5	14.2	7.7	11.8	12.3
IT Services	12.1	14.8	12.2	4.4	21.2	12.0
IT	9.3	13.1	10.1	5.8	16.3	10.2
Telecom Equipment	5.1	8.5	0.3	0.4	6.9	4.2
Telecom Services	7.0	8.9	6.8	5.3	9.9	7.7
Telecom	6.7	8.7	6.1	4.6	9.3	7.1
Total	**8.0**	**10.7**	**8.6**	**5.3**	**11.7**	**8.6**

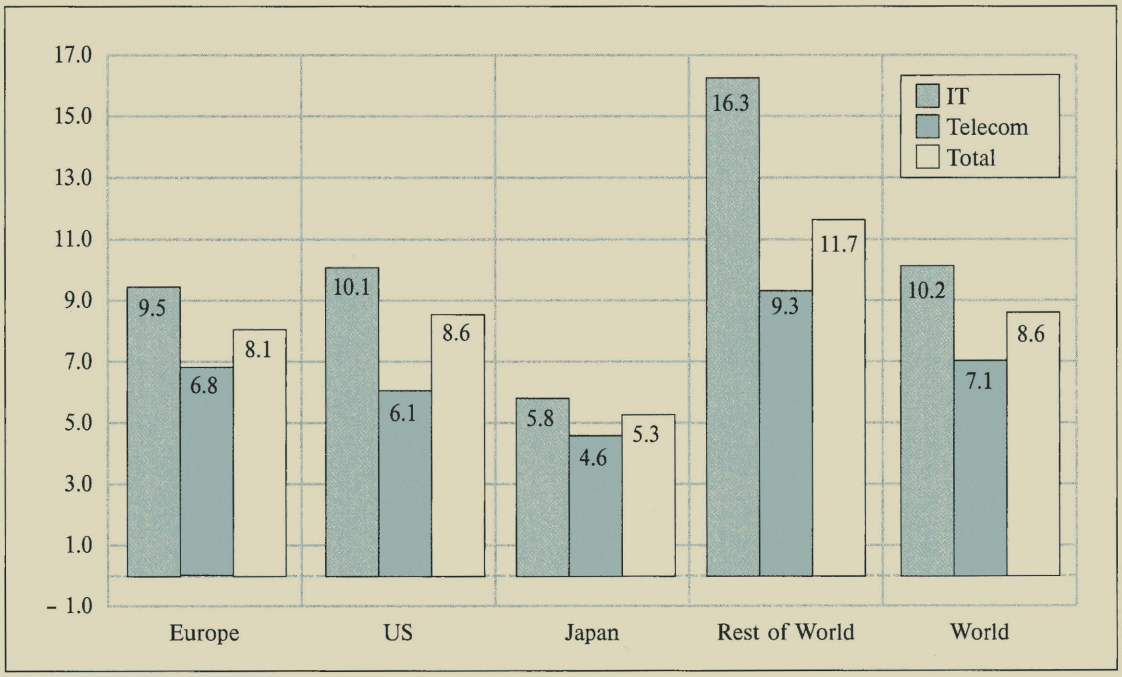
Table 8
Major Regional ICT Markets by Product. % Average Annual Growth by Value, 1997–1999

Figure 7
Western European IT Market Growth Rates in %, 1989–1999



Source: EITO

Figure 8
World Annual ICT Markets Average Annual Growth in %, 1997–1999



Source: EITO

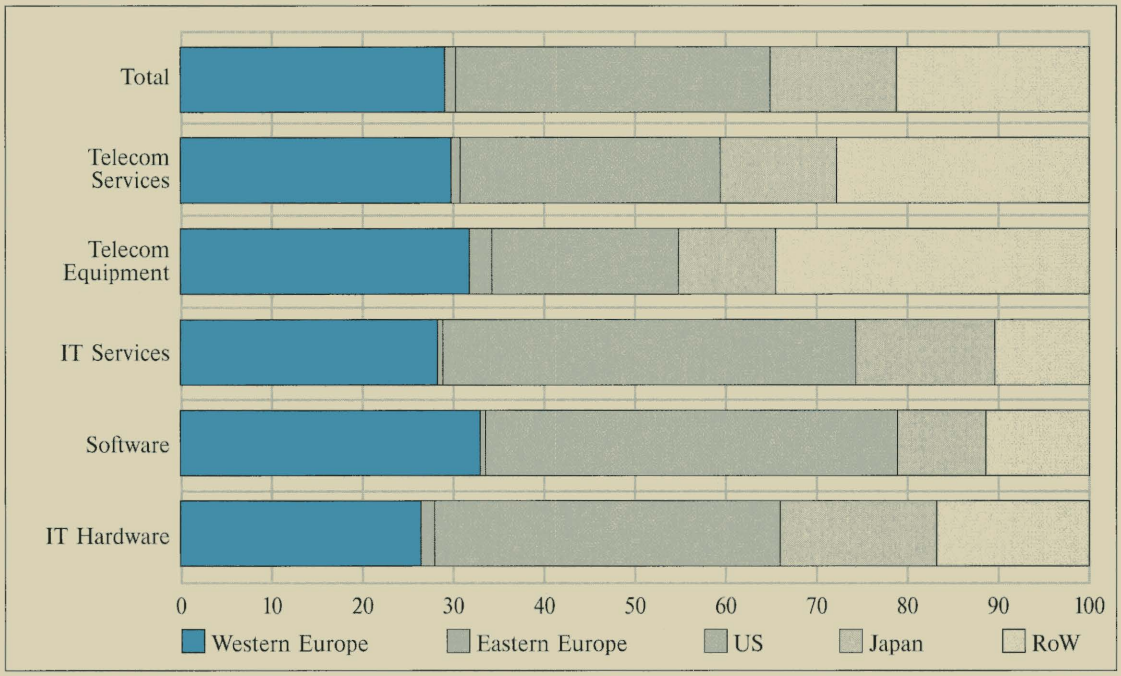


Figure 9
World ICT Market
Regional Proportions
by Product in %, 1997

Source: EITO

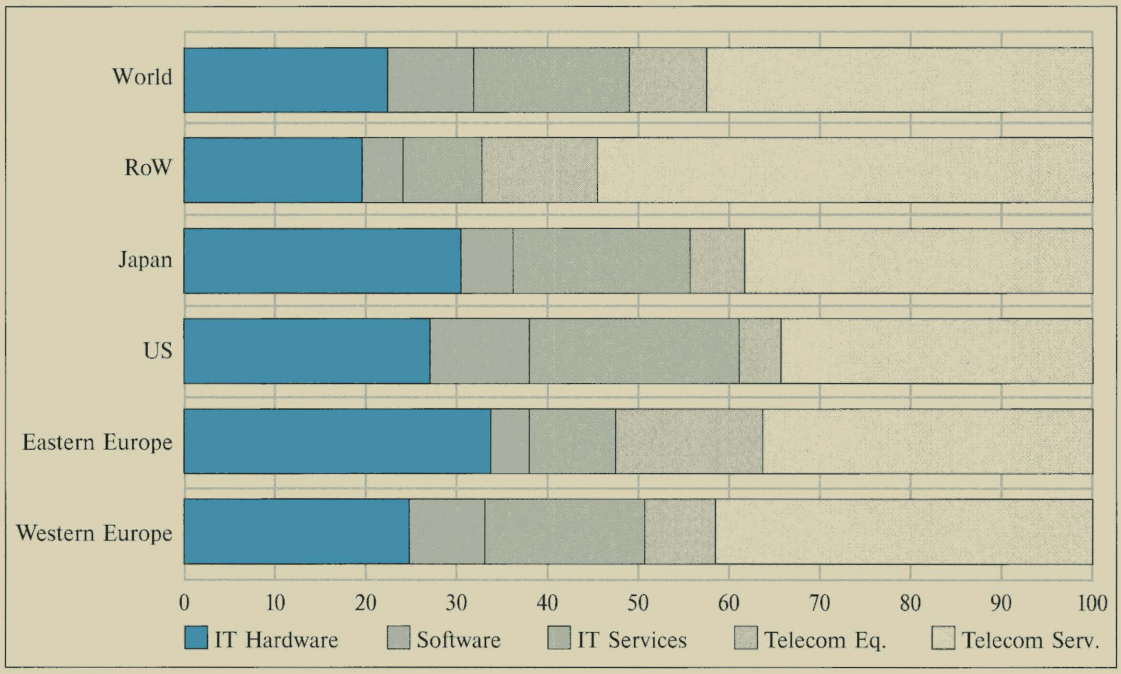
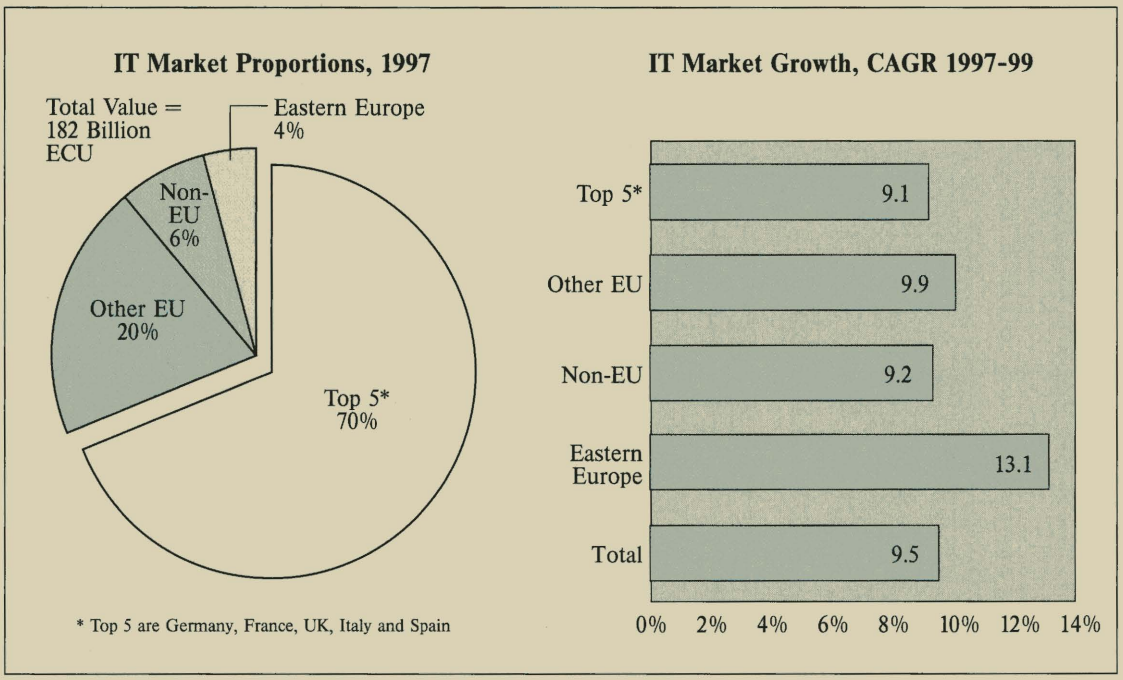


Figure 10
World ICT Market
Product Proportions
by Region in %, 1997

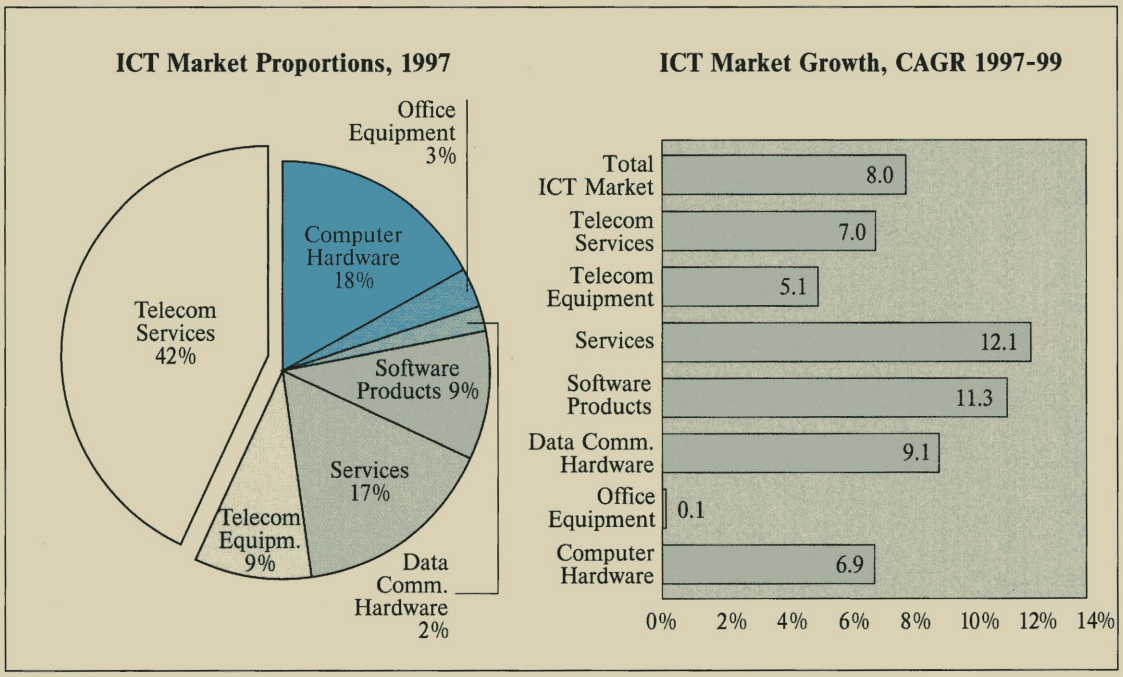
Source: EITO

Figure 11
European IT Market by Region, 1997 and Market Growth, 1997–1999



Source: EITO

Figure 12
Western European ICT Market Proportions by Class of Business, 1997 and Market Growth, 1997–1999



Source: EITO

Table 9
IT Market by Country (Million ECU)

Western Europe	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Austria	3,093	3,369	3,546	3,886	4,300	4,747	8.9	5.3	9.6	10.6	10.4
Belgium	4,192	4,392	4,683	5,190	5,776	6,399	4.8	6.6	10.8	11.3	10.8
Denmark	3,306	3,651	3,930	4,291	4,675	5,081	10.4	7.6	9.2	9.0	8.7
Finland	1,984	2,239	2,448	2,712	3,017	3,317	12.9	9.3	10.8	11.3	9.9
France	26,035	27,525	29,352	31,793	34,695	38,114	5.7	6.6	8.3	9.1	9.9
Germany	35,299	38,224	40,224	42,725	45,863	49,702	8.3	5.2	6.2	7.3	8.4
Greece	669	742	805	900	1,014	1,150	10.9	8.4	11.9	12.6	13.5
Ireland	903	965	1,040	1,144	1,272	1,419	7.0	7.7	10.0	11.2	11.5
Italy	12,724	13,393	13,992	14,879	16,126	17,588	5.3	4.5	6.3	8.4	9.1
Netherlands	7,337	7,944	8,583	9,476	10,440	11,503	8.3	8.0	10.4	10.2	10.2
Norway	2,555	2,816	3,057	3,361	3,665	3,990	10.2	8.6	9.9	9.0	8.9
Portugal	977	1,051	1,148	1,282	1,430	1,603	7.5	9.2	11.6	11.6	12.1
Spain	5,282	5,702	6,193	6,843	7,655	8,602	7.9	8.6	10.5	11.9	12.4
Sweden	5,623	6,318	6,629	7,110	7,677	8,347	12.4	4.9	7.3	8.0	8.7
Switzerland	6,330	6,728	7,197	7,671	8,360	9,185	6.3	7.0	6.6	9.0	9.9
UK	24,207	26,459	28,682	31,490	34,656	38,140	9.3	8.4	9.8	10.1	10.1
Western Europe	140,514	151,517	161,510	174,753	190,622	208,886	7.8	6.6	8.2	9.1	9.6

Table 10
Telecommunications Market by Country (Million ECU)

Western Europe	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Austria	2,813	3,039	3,323	3,700	4,088	4,508	8.0	9.3	11.4	10.5	10.3
Belgium	3,802	4,199	4,757	5,237	5,760	6,207	10.4	13.3	10.1	10.0	7.8
Denmark	2,727	2,915	3,214	3,476	3,729	3,983	6.9	10.3	8.1	7.3	6.8
Finland	2,035	2,193	2,412	2,602	2,805	3,013	7.8	10.0	7.9	7.8	7.4
France	22,457	24,239	25,793	28,075	30,023	31,791	7.9	6.4	8.8	6.9	5.9
Germany	37,075	40,191	40,840	43,102	45,092	47,039	8.4	1.6	5.5	4.6	4.3
Greece	2,056	2,405	2,842	3,305	3,783	4,262	17.0	18.1	16.3	14.5	12.7
Ireland	1,451	1,607	1,923	2,138	2,370	2,605	10.8	19.6	11.2	10.9	9.9
Italy	18,043	19,603	21,647	23,674	26,048	28,301	8.7	10.4	9.4	10.0	8.6
Netherlands	6,678	7,328	8,210	9,087	9,868	10,480	9.7	12.0	10.7	8.6	6.2
Norway	2,187	2,447	2,779	2,949	3,099	3,237	11.9	13.6	6.1	5.1	4.4
Portugal	2,141	2,441	2,783	3,121	3,522	3,874	14.0	14.0	12.1	12.9	10.0
Spain	8,233	9,139	10,788	11,511	12,496	13,333	11.0	18.0	6.7	8.6	6.7
Sweden	4,680	4,985	5,309	5,647	6,003	6,330	6.5	6.5	6.4	6.3	5.5
Switzerland	5,813	5,944	6,310	6,783	7,206	7,574	2.3	6.2	7.5	6.2	5.1
UK	19,785	22,365	25,120	26,803	28,277	29,648	13.0	12.3	6.7	5.5	4.8
Western Europe	141,973	155,042	168,048	181,208	194,169	206,185	9.2	8.4	7.8	7.2	6.2

Table 11
ICT Market by Country (Million ECU)

Western Europe	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Austria	5,906	6,408	6,869	7,586	8,388	9,254	8.5	7.2	10.4	10.6	10.3
Belgium	7,993	8,591	9,440	10,428	11,535	12,606	7.5	9.9	10.5	10.6	9.3
Denmark	6,033	6,566	7,145	7,767	8,404	9,064	8.8	8.8	8.7	8.2	7.9
Finland	4,019	4,432	4,860	5,314	5,822	6,330	10.3	9.7	9.3	9.6	8.7
France	48,492	51,764	55,145	59,868	64,719	69,905	6.7	6.5	8.6	8.1	8.0
Germany	72,374	78,415	81,064	85,826	90,955	96,741	8.3	3.4	5.9	6.0	6.4
Greece	2,725	3,147	3,646	4,205	4,797	5,412	15.5	15.9	15.3	14.1	12.8
Ireland	2,354	2,573	2,963	3,282	3,642	4,024	9.3	15.2	10.8	11.0	10.5
Italy	30,767	32,996	35,639	38,553	42,174	45,889	7.2	8.0	8.2	9.4	8.8
Netherlands	14,014	15,273	16,793	18,563	20,308	21,983	9.0	10.0	10.5	9.4	8.2
Norway	4,742	5,263	5,836	6,310	6,764	7,226	11.0	10.9	8.1	7.2	6.8
Portugal	3,118	3,492	3,931	4,402	4,952	5,478	12.0	12.6	12.0	12.5	10.6
Spain	13,516	14,841	16,981	18,354	20,151	21,935	9.8	14.4	8.1	9.8	8.9
Sweden	10,303	11,303	11,938	12,757	13,680	14,677	9.7	5.6	6.9	7.2	7.3
Switzerland	12,143	12,672	13,507	14,454	15,566	16,758	4.4	6.6	7.0	7.7	7.7
UK	43,992	48,824	53,802	58,293	62,933	67,788	11.0	10.2	8.3	8.0	7.7
Western Europe	282,487	306,559	329,559	355,962	384,792	415,071	8.5	7.5	8.0	8.1	7.9

Austria	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	436	428	474	542	612	675	- 1.8	10.7	14.5	12.8	10.4
Unix servers	72	101	120	137	160	186	41.2	18.7	14.0	16.7	16.1
NT servers	2	6	20	40	58	74	265.3	210.0	99.2	45.9	27.9
Other servers	196	157	163	173	178	179	-19.8	3.5	6.0	3.1	0.2
Server add-ons	166	163	170	192	216	237	- 2.0	4.7	13.0	12.1	9.8
Workstations	43	49	50	43	40	38	14.4	2.5	-13.6	-8.7	-4.9
PCs	601	707	666	693	742	768	17.6	-5.8	4.0	7.1	3.5
portable	113	130	125	132	144	158	15.3	-3.4	5.6	9.1	9.7
desktop	489	577	541	561	597	610	18.1	-6.3	3.7	6.6	2.1
PC/workstation add-ons	171	198	217	241	269	289	15.7	9.3	11.1	11.6	7.6
PC printers	109	123	138	155	170	177	12.8	12.1	12.0	10.0	4.0
Other add-ons	62	75	79	86	99	112	20.9	4.8	9.5	14.4	13.7
Computer hardware	**1,251**	**1,382**	**1,407**	**1,520**	**1,662**	**1,771**	**10.5**	**1.8**	**8.0**	**9.4**	**6.5**
Copiers	86	87	89	91	92	91	1.5	2.2	1.7	2.0	-1.1
Other office equipment	90	92	90	90	89	88	1.8	-2.1	- 0.4	-1.1	-1.0
Office equipment	**176**	**179**	**179**	**180**	**181**	**179**	**1.6**	**-0.0**	**0.6**	**0.5**	**-1.0**
LAN hardware	43	55	84	97	111	120	29.0	51.2	16.2	13.9	9.0
Other data communications	23	22	22	23	23	22	- 4.3	4.0	3.5	- 1.1	-3.2
Data communications hardware	**65**	**77**	**106**	**120**	**134**	**143**	**17.5**	**37.9**	**13.5**	**11.0**	**6.9**
IT hardware	**1,493**	**1,638**	**1,692**	**1,820**	**1,977**	**2,093**	**9.7**	**3.3**	**7.6**	**8.6**	**5.9**
Systems software	253	291	320	353	390	429	15.4	9.7	10.3	10.5	9.9
Application software	235	269	295	325	361	400	14.2	10.0	10.1	10.9	10.9
Software products	**488**	**560**	**615**	**678**	**751**	**829**	**14.8**	**9.8**	**10.2**	**10.7**	**10.4**
Consulting	83	89	102	116	133	155	7.6	14.7	13.4	14.6	16.6
Implementation	282	304	321	401	496	603	7.7	5.8	24.6	23.9	21.4
Operations management	387	411	454	515	579	688	6.1	10.4	13.6	12.3	18.9
Support services	360	367	361	355	364	379	1.9	-1.4	- 1.6	2.3	4.3
Services	**1,112**	**1,171**	**1,239**	**1,388**	**1,572**	**1,825**	**5.3**	**5.9**	**12.0**	**13.3**	**16.1**
Software and services	**1,600**	**1,731**	**1,854**	**2,066**	**2,323**	**2,654**	**8.2**	**7.1**	**11.4**	**12.4**	**14.3**
Total IT market	**3,093**	**3,369**	**3,546**	**3,886**	**4,300**	**4,747**	**8.9**	**5.3**	**9.6**	**10.6**	**10.4**
Switching	126	121	109	101	95	95	- 3.7	-9.8	- 7.5	-5.8	0.1
Transmission	100	106	108	113	118	123	6.2	2.3	4.1	4.6	4.3
Mobile communications infrastructure	50	69	80	97	113	129	37.4	16.7	21.4	16.1	14.4
Public network equipment	**275**	**296**	**298**	**311**	**326**	**347**	**7.3**	**0.7**	**4.5**	**4.8**	**6.6**
PABX and key systems	56	54	54	55	57	58	- 3.3	-1.3	2.5	2.9	2.3
Telephone sets	75	81	82	81	82	84	8.1	0.4	- 1.0	1.4	1.8
Mobile terminal equipment	23	27	38	55	70	89	18.8	39.9	45.5	27.3	26.1
Other terminal equipment	65	69	75	79	86	103	6.3	8.7	6.0	8.4	19.1
Private network equipment	**219**	**232**	**248**	**271**	**295**	**333**	**5.8**	**7.1**	**9.0**	**9.0**	**12.7**
Telecom equipment	**495**	**528**	**546**	**582**	**621**	**680**	**6.6**	**3.5**	**6.5**	**6.8**	**9.5**
Telephone services	1,836	1,914	2,031	2,114	2,199	2,290	4.3	6.1	4.1	4.0	4.1
Mobile telephone services	124	173	263	433	603	760	40.0	51.8	64.7	39.2	26.0
Switched data and leased line services	255	295	320	373	423	472	15.5	8.8	16.3	13.7	11.4
CaTV services	104	129	162	198	241	306	25.0	25.2	22.2	21.8	26.8
Telecom services	**2,318**	**2,511**	**2,777**	**3,118**	**3,467**	**3,828**	**8.3**	**10.6**	**12.3**	**11.2**	**10.4**
Total telecom	**2,813**	**3,039**	**3,323**	**3,700**	**4,088**	**4,508**	**8.0**	**9.3**	**11.4**	**10.5**	**10.3**
Total ICT	**5,906**	**6,408**	**6,869**	**7,586**	**8,388**	**9,254**	**8.5**	**7.2**	**10.4**	**10.6**	**10.3**

Table 12
Austria
ICT Market Value (Million ECU)

Belgium/Luxembourg	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	542	535	591	673	718	757	- 1.3	10.6	13.9	6.6	5.4
Unix servers	77	125	151	181	206	230	62.6	20.7	19.5	13.8	12.0
NT servers	3	14	31	54	71	82	415.7	119.3	76.4	32.6	14.8
Other servers	251	194	208	218	204	186	-22.7	7.3	4.7	-6.4	-8.9
Server add-ons	212	202	202	221	237	259	- 4.6	-0.1	9.7	7.1	9.2
Workstations	77	80	75	68	64	63	3.1	-5.7	-9.3	-5.8	-1.7
PCs	586	652	716	796	847	886	11.3	9.9	11.2	6.3	4.7
portable	121	128	153	180	197	216	6.3	19.0	17.5	9.8	9.3
desktop	465	524	564	617	650	671	12.6	7.6	9.5	5.3	3.3
PC/workstation add-ons	202	232	245	285	319	349	15.1	5.3	16.5	11.9	9.3
PC printers	139	154	157	170	175	175	10.9	2.0	8.7	2.5	0.3
Other add-ons	63	78	88	115	144	173	24.3	11.9	30.6	26.0	20.2
Computer hardware	**1,407**	**1,499**	**1,627**	**1,823**	**1,948**	**2,055**	**6.5**	**8.6**	**12.0**	**6.8**	**5.5**
Copiers	155	159	161	164	168	161	2.8	1.5	1.7	2.2	-3.8
Other office equipment	150	150	148	147	147	147	0.1	-1.1	-1.3	0.1	0.1
Office equipment	**304**	**309**	**310**	**311**	**314**	**308**	**1.5**	**0.3**	**0.3**	**1.2**	**-2.0**
LAN hardware	106	125	150	173	194	209	17.1	20.2	15.3	12.5	7.4
Other data communications	31	31	33	35	35	34	0.4	5.1	5.7	-0.2	-0.4
Data communications hardware	**137**	**156**	**182**	**207**	**229**	**243**	**13.3**	**17.2**	**13.6**	**10.4**	**6.2**
IT hardware	**1,849**	**1,963**	**2,120**	**2,341**	**2,491**	**2,606**	**6.2**	**8.0**	**10.4**	**6.4**	**4.6**
Systems software	565	587	626	704	795	899	3.9	6.6	12.5	12.9	13.1
Application software	447	461	485	545	615	696	3.0	5.3	12.2	13.0	13.1
Software products	**1,012**	**1,048**	**1,111**	**1,248**	**1,410**	**1,595**	**3.5**	**6.0**	**12.4**	**12.9**	**13.1**
Consulting	83	91	100	124	153	167	9.8	9.9	24.4	23.1	9.1
Implementation	574	586	609	699	873	1,082	2.1	3.9	14.6	24.9	24.0
Operations management	154	172	189	209	252	312	12.1	9.6	10.5	20.7	24.0
Support services	520	531	555	570	597	636	2.1	4.4	2.7	4.8	6.6
Services	**1,331**	**1,381**	**1,453**	**1,601**	**1,875**	**2,198**	**3.7**	**5.2**	**10.2**	**17.1**	**17.2**
Software and services	**2,343**	**2,428**	**2,564**	**2,849**	**3,285**	**3,793**	**3.6**	**5.6**	**11.1**	**15.3**	**15.5**
Total IT market	**4,192**	**4,392**	**4,683**	**5,190**	**5,776**	**6,399**	**4.8**	**6.6**	**10.8**	**11.3**	**10.8**
Switching	137	127	118	108	103	103	- 7.1	-7.5	-8.3	-4.6	0.1
Transmission	119	123	126	128	133	137	3.4	2.5	1.6	3.4	3.6
Mobile communications infrastructure	23	36	59	71	86	103	56.6	62.1	20.8	21.6	19.4
Public network equipment	**279**	**287**	**303**	**307**	**322**	**344**	**2.6**	**5.6**	**1.5**	**4.8**	**6.7**
PABX and key systems	65	63	63	63	65	66	- 2.9	-0.6	0.8	2.4	2.0
Telephone sets	87	94	101	106	109	114	7.9	7.8	4.6	3.5	4.2
Mobile terminal equipment	23	39	55	70	82	97	69.7	41.5	25.9	17.0	19.2
Other terminal equipment	36	38	43	53	66	79	6.2	12.7	23.4	23.2	20.4
Private network equipment	**212**	**235**	**263**	**293**	**322**	**357**	**11.0**	**11.9**	**11.3**	**10.1**	**10.9**
Telecom equipment	**491**	**522**	**566**	**600**	**644**	**701**	**6.3**	**8.5**	**6.0**	**7.4**	**8.8**
Telephone services	2,368	2,500	2,633	2,729	2,838	2,930	5.6	5.3	3.6	4.0	3.2
Mobile telephone services	171	266	467	682	919	1,108	55.3	75.9	45.9	34.9	20.5
Switched data and leased line services	406	491	632	737	836	910	20.8	28.7	16.7	13.4	8.9
CaTV services	366	421	459	489	522	558	15.0	9.2	6.5	6.6	7.0
Telecom services	**3,311**	**3,677**	**4,191**	**4,637**	**5,116**	**5,506**	**11.1**	**14.0**	**10.6**	**10.3**	**7.6**
Total telecom	**3,802**	**4,199**	**4,757**	**5,237**	**5,760**	**6,207**	**10.4**	**13.3**	**10.1**	**10.0**	**7.8**
Total ICT	**7,993**	**8,591**	**9,440**	**10,428**	**11,535**	**12,606**	**7.5**	**9.9**	**10.5**	**10.6**	**9.3**

Table 13
Belgium/Luxembourg
ICT Market Value (Million ECU)

Denmark	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	342	329	373	442	489	540	- 3.9	13.4	18.4	10.7	10.4
Unix servers	56	67	73	79	93	111	19.5	10.1	7.5	18.2	18.9
NT servers	1	9	23	45	67	87	694.5	141.6	98.2	47.7	30.3
Other servers	152	125	144	159	155	155	-17.6	15.6	10.2	-2.8	-0.1
Server add-ons	134	128	132	158	174	187	- 4.3	3.4	19.4	10.1	7.4
Workstations	44	44	34	29	27	26	0.0	-21.2	-16.8	-6.0	-1.8
PCs	678	896	1,015	1,076	1,075	1,031	32.2	13.2	6.0	-0.0	-4.2
portable	128	154	186	199	205	209	19.7	21.0	7.1	2.8	2.0
desktop	550	743	829	876	871	822	35.1	11.6	5.7	-0.7	-5.6
PC/workstation add-ons	195	229	234	266	296	329	17.5	2.1	14.0	11.2	10.9
PC printers	122	139	137	152	157	160	14.0	- 1.8	11.1	3.4	1.7
Other add-ons	73	90	97	115	139	169	23.4	8.2	18.2	21.5	21.4
Computer hardware	**1,259**	**1,498**	**1,656**	**1,812**	**1,888**	**1,925**	**19.0**	**10.6**	**9.4**	**4.2**	**2.0**
Copiers	103	106	109	112	115	112	2.8	2.6	2.9	3.1	-2.8
Other office equipment	96	95	92	91	90	91	- 0.4	- 3.7	- 1.0	-0.6	0.6
Office equipment	**199**	**201**	**200**	**203**	**205**	**203**	**1.3**	**- 0.4**	**1.1**	**1.4**	**-1.3**
LAN hardware	80	97	117	137	153	159	20.4	21.5	16.7	12.0	3.6
Other data communications	35	37	38	39	39	40	5.3	3.4	2.5	0.6	1.8
Data communications hardware	**115**	**133**	**155**	**176**	**193**	**199**	**15.9**	**16.5**	**13.2**	**9.5**	**3.3**
IT hardware	**1,572**	**1,832**	**2,012**	**2,191**	**2,286**	**2,327**	**16.5**	**9.8**	**8.9**	**4.3**	**1.8**
Systems software	244	255	270	301	341	384	4.3	6.2	11.2	13.3	12.8
Application software	233	250	269	304	346	408	7.2	7.7	13.1	13.9	17.9
Software products	**477**	**504**	**539**	**605**	**687**	**793**	**5.7**	**6.9**	**12.1**	**13.6**	**15.4**
Consulting	117	128	139	151	166	185	9.4	8.6	9.1	10.0	11.0
Implementation	454	481	511	569	671	794	6.1	6.2	11.3	17.9	18.4
Operations management	314	344	372	411	480	573	9.6	8.0	10.6	16.7	19.3
Support services	371	361	357	364	385	410	- 2.8	- 1.1	1.8	6.0	6.4
Services	**1,256**	**1,314**	**1,379**	**1,495**	**1,703**	**1,961**	**4.6**	**4.9**	**8.4**	**13.9**	**15.2**
Software and services	**1,733**	**1,819**	**1,918**	**2,100**	**2,390**	**2,754**	**4.9**	**5.5**	**9.5**	**13.8**	**15.2**
Total IT market	**3,306**	**3,651**	**3,930**	**4,291**	**4,675**	**5,081**	**10.4**	**7.6**	**9.2**	**9.0**	**8.7**
Switching	105	101	98	95	95	96	- 3.8	- 2.7	- 2.8	-0.1	0.8
Transmission	91	94	95	96	98	100	3.4	0.7	1.4	2.4	2.2
Mobile communications infrastructure	47	60	68	78	85	93	28.0	14.0	13.7	9.8	9.1
Public network equipment	**242**	**255**	**261**	**269**	**279**	**289**	**5.0**	**2.5**	**3.0**	**3.7**	**3.8**
PABX and key systems	42	41	40	40	40	41	- 2.2	- 2.2	- 0.3	1.5	1.6
Telephone sets	57	62	66	70	74	78	8.0	7.9	5.8	5.3	5.2
Mobile terminal equipment	71	69	65	67	75	85	- 1.6	- 6.3	3.1	11.8	13.6
Other terminal equipment	34	36	40	48	57	67	6.3	10.8	19.7	19.9	17.4
Private network equipment	**203**	**208**	**211**	**225**	**246**	**271**	**2.3**	**1.7**	**6.4**	**9.7**	**10.0**
Telecom equipment	**445**	**462**	**472**	**493**	**525**	**560**	**3.8**	**2.1**	**4.6**	**6.4**	**6.7**
Telephone services	1,662	1,703	1,751	1,819	1,892	1,948	2.4	2.8	3.9	4.0	3.0
Mobile telephone services	310	370	508	615	695	761	19.2	37.3	21.1	13.0	9.5
Switched data and leased line services	183	229	302	331	363	389	25.0	31.9	9.8	9.7	7.0
CaTV services	127	152	182	217	254	326	20.0	20.0	19.0	17.2	28.0
Telecom services	**2,282**	**2,453**	**2,742**	**2,982**	**3,204**	**3,423**	**7.5**	**11.8**	**8.7**	**7.4**	**6.8**
Total telecom	**2,727**	**2,915**	**3,214**	**3,476**	**3,729**	**3,983**	**6.9**	**10.3**	**8.1**	**7.3**	**6.8**
Total ICT	**6,033**	**6,566**	**7,145**	**7,767**	**8,404**	**9,064**	**8.8**	**8.8**	**8.7**	**8.2**	**7.9**

Table 14
Denmark
ICT Market Value (Million ECU)

Finland	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	189	184	235	291	348	398	- 2.9	28.2	23.8	19.4	14.4
Unix servers	42	58	66	73	83	97	38.7	14.2	9.7	14.9	16.4
NT servers	2	8	21	40	59	72	442.0	152.4	92.1	47.6	22.6
Other servers	74	50	71	80	87	91	-33.0	42.1	13.3	8.2	4.6
Server add-ons	72	68	78	99	119	139	- 5.3	15.0	27.2	20.6	16.2
Workstations	47	52	48	42	40	39	12.6	-8.3	-13.2	-5.2	-0.4
PCs	401	528	580	626	659	667	31.5	9.9	7.9	5.3	1.3
portable	70	87	109	124	130	136	22.8	26.2	13.6	5.2	4.1
desktop	331	441	471	501	528	531	33.4	6.7	6.5	5.3	0.6
PC/workstation add-ons	104	139	150	171	205	237	32.9	8.5	13.4	20.3	15.7
PC printers	63	84	89	101	115	121	33.1	6.1	12.4	14.8	4.5
Other add-ons	41	54	61	70	90	117	32.6	12.2	14.8	28.2	30.0
Computer hardware	**741**	**902**	**1,014**	**1,129**	**1,251**	**1,342**	**21.8**	**12.4**	**11.4**	**10.8**	**7.2**
Copiers	62	63	63	65	67	66	2.2	-0.5	2.6	3.6	-0.9
Other office equipment	59	59	58	57	58	58	- 0.4	-2.6	- 0.3	0.5	0.5
Office equipment	**121**	**122**	**121**	**122**	**125**	**124**	**0.9**	**-1.5**	**1.2**	**2.1**	**-0.3**
LAN hardware	68	96	118	136	153	165	41.0	22.7	15.7	12.2	7.8
Other data communications	37	40	41	43	43	42	6.5	3.2	4.0	0.4	-1.2
Data communications hardware	**105**	**136**	**159**	**179**	**196**	**207**	**28.8**	**17.0**	**12.7**	**9.4**	**5.8**
IT hardware	**968**	**1,160**	**1,293**	**1,430**	**1,572**	**1,673**	**19.9**	**11.4**	**10.6**	**9.9**	**6.5**
Systems software	146	158	174	195	217	235	8.3	10.0	12.2	10.9	8.4
Application software	166	176	188	207	230	264	6.5	6.7	10.0	11.0	14.6
Software products	**312**	**335**	**362**	**402**	**446**	**498**	**7.3**	**8.2**	**11.1**	**11.0**	**11.6**
Consulting	81	88	99	112	127	139	9.3	12.5	12.7	13.4	9.9
Implementation	244	267	285	326	390	466	9.4	6.8	14.4	19.6	19.5
Operations management	165	171	187	213	246	294	3.3	9.2	13.9	16.0	19.2
Support services	214	218	222	229	236	247	1.8	1.8	3.2	3.1	4.4
Services	**704**	**744**	**793**	**879**	**999**	**1,146**	**5.6**	**6.6**	**10.9**	**13.6**	**14.6**
Software and services	**1,016**	**1,079**	**1,155**	**1,282**	**1,446**	**1,644**	**6.2**	**7.1**	**11.0**	**12.8**	**13.7**
Total IT market	**1,984**	**2,239**	**2,448**	**2,712**	**3,017**	**3,317**	**12.9**	**9.3**	**10.8**	**11.3**	**9.9**
Switching	91	88	83	84	85	86	- 3.8	-5.8	1.2	1.2	1.6
Transmission	79	82	83	83	83	85	3.4	1.7	- 0.9	1.0	1.3
Mobile communications infrastructure	51	62	64	68	72	77	22.2	2.4	7.3	5.5	7.1
Public network equipment	**222**	**232**	**230**	**235**	**241**	**248**	**4.7**	**- 0.9**	**2.1**	**2.4**	**3.2**
PABX and key systems	49	48	47	46	47	48	- 2.9	-3.0	- 0.9	1.8	1.6
Telephone sets	53	57	62	65	67	70	8.0	8.5	4.1	4.1	3.9
Mobile terminal equipment	99	95	98	106	117	130	- 3.1	2.9	8.2	10.5	10.4
Other terminal equipment	39	42	47	52	57	64	6.3	11.6	10.7	11.2	12.0
Private network equipment	**240**	**243**	**254**	**269**	**289**	**312**	**0.9**	**4.6**	**6.0**	**7.6**	**7.8**
Telecom equipment	**462**	**475**	**484**	**504**	**530**	**560**	**2.7**	**1.9**	**4.1**	**5.2**	**5.7**
Telephone services	1,001	1,016	1,040	1,073	1,116	1,155	1.5	2.3	3.3	4.0	3.5
Mobile telephone services	281	360	463	546	624	687	27.9	28.5	17.9	14.4	10.1
Switched data and leased line services	213	245	304	339	374	408	15.2	24.2	11.4	10.3	9.0
CaTV services	78	97	122	140	161	203	25.0	25.0	15.4	14.8	26.1
Telecom services	**1,573**	**1,718**	**1,928**	**2,098**	**2,275**	**2,453**	**9.2**	**12.2**	**8.8**	**8.4**	**7.8**
Total telecom	**2,035**	**2,193**	**2,412**	**2,602**	**2,805**	**3,013**	**7.8**	**10.0**	**7.9**	**7.8**	**7.4**
Total ICT	**4,019**	**4,432**	**4,860**	**5,314**	**5,822**	**6,330**	**10.3**	**9.7**	**9.3**	**9.6**	**8.7**

Table 15
Finland
ICT Market Value (Million ECU)

France	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	2,992	3,016	3,043	3,283	3,478	3,669	0.8	0.9	7.9	5.9	5.5
Unix servers	482	611	696	750	775	788	26.6	14.0	7.8	3.3	1.8
NT servers	11	60	114	223	325	423	452.7	88.5	96.7	45.3	30.3
Other servers	1,268	1,164	1,100	1,100	1,097	1,071	-8.3	-5.5	- 0.0	-0.2	-2.4
Server add-ons	1,231	1,182	1,133	1,210	1,281	1,387	-4.0	-4.1	6.7	5.9	8.2
Workstations	426	434	407	351	321	319	1.9	-6.3	-13.8	-8.4	-0.7
PCs	3,175	3,528	3,932	4,245	4,595	5,041	11.1	11.5	8.0	8.3	9.7
portable	615	641	794	852	928	1,017	4.1	23.9	7.3	8.9	9.7
desktop	2,559	2,887	3,138	3,393	3,668	4,024	12.8	8.7	8.1	8.1	9.7
PC/workstation add-ons	1,034	1,206	1,355	1,519	1,712	1,925	16.7	12.4	12.1	12.7	12.4
PC printers	662	797	874	910	950	990	20.5	9.6	4.2	4.4	4.2
Other add-ons	372	409	482	609	762	935	9.9	17.8	26.5	25.0	22.7
Computer hardware	**7,626**	**8,184**	**8,737**	**9,398**	**10,106**	**10,954**	**7.3**	**6.7**	**7.6**	**7.5**	**8.4**
Copiers	935	937	939	957	979	952	0.2	0.2	1.9	2.3	-2.7
Other office equipment	815	813	796	809	822	809	-0.3	-2.0	1.6	1.6	-1.5
Office equipment	**1,750**	**1,750**	**1,735**	**1,766**	**1,801**	**1,761**	**-0.0**	**-0.8**	**1.8**	**2.0**	**-2.2**
LAN hardware	371	453	543	636	728	819	22.2	19.8	17.1	14.5	12.5
Other data communications	284	293	305	318	327	315	3.2	4.2	4.3	2.7	-3.8
Data communications hardware	**655**	**746**	**848**	**954**	**1,055**	**1,133**	**14.0**	**13.7**	**12.5**	**10.6**	**7.4**
IT hardware	**10,031**	**10,680**	**11,320**	**12,118**	**12,962**	**13,849**	**6.5**	**6.0**	**7.1**	**7.0**	**6.8**
Systems software	1,954	2,165	2,285	2,403	2,569	2,805	10.8	5.5	5.2	6.9	9.1
Application software	1,974	2,176	2,445	2,719	3,018	3,442	10.2	12.4	11.2	11.0	14.0
Software products	**3,928**	**4,341**	**4,729**	**5,122**	**5,587**	**6,246**	**10.5**	**9.0**	**8.3**	**9.1**	**11.8**
Consulting	937	1,060	1,210	1,400	1,617	1,813	13.1	14.1	15.7	15.6	12.1
Implementation	2,924	3,184	3,508	4,049	4,860	5,593	8.9	10.2	15.4	20.0	15.1
Operations management	4,901	5,049	5,320	5,732	6,186	6,981	3.0	5.4	7.8	7.9	12.9
Support services	3,313	3,210	3,265	3,373	3,484	3,632	-3.1	1.7	3.3	3.3	4.3
Services	**12,075**	**12,504**	**13,303**	**14,554**	**16,146**	**18,019**	**3.5**	**6.4**	**9.4**	**10.9**	**11.6**
Software and services	**16,003**	**16,844**	**18,032**	**19,675**	**21,734**	**24,266**	**5.3**	**7.1**	**9.1**	**10.5**	**11.6**
Total IT market	**26,035**	**27,525**	**29,352**	**31,793**	**34,695**	**38,114**	**5.7**	**6.6**	**8.3**	**9.1**	**9.9**
Switching	854	791	798	711	669	671	-7.4	1.0	-10.9	-5.9	0.3
Transmission	436	472	501	535	574	609	8.3	6.2	6.7	7.3	6.1
Mobile communications infrastructure	294	359	452	572	674	785	21.8	26.1	26.5	17.9	16.5
Public network equipment	**1,584**	**1,621**	**1,752**	**1,818**	**1,917**	**2,066**	**2.4**	**8.1**	**3.8**	**5.5**	**7.7**
PABX and key systems	609	597	584	574	579	585	-2.0	-2.1	- 1.8	1.0	1.0
Telephone sets	780	825	852	859	873	887	5.7	3.3	0.9	1.6	1.6
Mobile terminal equipment	286	412	531	689	774	880	44.0	28.9	29.9	12.3	13.6
Other terminal equipment	719	784	893	1,034	1,203	1,383	9.0	14.0	15.7	16.4	14.9
Private network equipment	**2,394**	**2,617**	**2,861**	**3,156**	**3,429**	**3,735**	**9.3**	**9.3**	**10.3**	**8.7**	**8.9**
Telecom equipment	**3,978**	**4,238**	**4,612**	**4,974**	**5,347**	**5,801**	**6.5**	**8.8**	**7.8**	**7.5**	**8.5**
Telephone services	15,029	15,667	15,522	15,867	16,233	16,612	4.2	-0.9	2.2	2.3	2.3
Mobile telephone services	834	1,232	1,885	2,585	3,105	3,421	47.7	53.1	37.1	20.1	10.2
Switched data and leased line services	2,400	2,864	3,490	4,324	4,974	5,555	19.3	21.8	23.9	15.0	11.7
CaTV services	216	238	283	325	365	403	10.4	19.0	14.6	12.4	10.3
Telecom services	**18,479**	**20,002**	**21,181**	**23,101**	**24,676**	**25,990**	**8.2**	**5.9**	**9.1**	**6.8**	**5.3**
Total telecom	**22,457**	**24,239**	**25,793**	**28,075**	**30,023**	**31,791**	**7.9**	**6.4**	**8.8**	**6.9**	**5.9**
Total ICT	**48,492**	**51,764**	**55,145**	**59,868**	**64,719**	**69,905**	**6.7**	**6.5**	**8.6**	**8.1**	**8.0**

Table 16
France
ICT Market Value (Million ECU)

Germany	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	6,052	6,235	6,280	6,511	6,774	7,057	3.0	0.7	3.7	4.0	4.2
Unix servers	1,295	1,520	1,614	1,695	1,754	1,794	17.4	6.2	5.0	3.5	2.3
NT servers	21	115	205	365	552	763	440.2	77.8	78.6	51.0	38.2
Other servers	2,757	2,476	2,180	2,112	2,059	2,018	-10.2	-12.0	- 3.1	- 2.5	-2.0
Server add-ons	1,979	2,124	2,282	2,339	2,409	2,481	7.3	7.4	2.5	3.0	3.0
Workstations	760	912	912	803	733	681	20.0	0.0	-12.0	- 8.7	-7.1
PCs	4,844	5,658	6,030	6,550	7,161	7,873	16.8	6.6	8.6	9.3	9.9
portable	1,174	1,460	1,632	1,840	2,083	2,369	24.3	11.8	12.8	13.2	13.7
desktop	3,669	4,198	4,398	4,710	5,078	5,504	14.4	4.8	7.1	7.8	8.4
PC/workstation add-ons	2,028	2,405	2,582	2,689	2,811	2,950	18.6	7.4	4.1	4.5	4.9
PC printers	1,476	1,727	1,848	1,904	1,969	2,043	17.0	7.0	3.0	3.4	3.8
Other add-ons	552	678	734	785	842	907	22.8	8.2	7.0	7.3	7.7
Computer hardware	**13,685**	**15,210**	**15,804**	**16,553**	**17,478**	**18,561**	**11.1**	**3.9**	**4.7**	**5.6**	**6.2**
Copiers	1,348	1,348	1,375	1,403	1,445	1,488	0.0	2.0	2.0	3.0	3.0
Other office equipment	587	605	617	617	623	631	3.0	2.0	0.0	1.0	1.3
Office equipment	**1,935**	**1,953**	**1,992**	**2,019**	**2,067**	**2,119**	**0.9**	**2.0**	**1.4**	**2.4**	**2.5**
LAN hardware	639	705	800	930	1,071	1,199	10.5	13.4	16.3	15.2	11.9
Other data communications	174	172	165	161	158	163	- 1.1	- 3.9	- 2.8	- 1.9	3.2
Data communications hardware	**813**	**878**	**965**	**1,091**	**1,229**	**1,362**	**8.0**	**10.0**	**13.0**	**12.6**	**10.8**
IT hardware	**16,432**	**18,040**	**18,761**	**19,664**	**20,775**	**22,041**	**9.8**	**4.0**	**4.8**	**5.7**	**6.1**
Systems software	3,864	4,101	4,338	4,590	4,859	5,198	6.1	5.8	5.8	5.9	7.0
Application software	4,294	4,843	5,279	5,755	6,330	7,021	12.8	9.0	9.0	10.0	10.9
Software products	**8,158**	**8,945**	**9,617**	**10,344**	**11,189**	**12,219**	**9.6**	**7.5**	**7.6**	**8.2**	**9.2**
Consulting	1,025	1,087	1,168	1,294	1,425	1,596	6.1	7.4	10.8	10.1	12.0
Implementation	3,150	3,452	3,774	4,196	4,633	5,253	9.6	9.3	11.2	10.4	13.4
Operations management	2,591	2,807	3,034	3,354	3,934	4,642	8.3	8.1	10.6	17.3	18.0
Support services	3,943	3,893	3,871	3,873	3,908	3,951	- 1.3	- 0.6	0.1	0.9	1.1
Services	**10,709**	**11,238**	**11,846**	**12,717**	**13,899**	**15,441**	**4.9**	**5.4**	**7.3**	**9.3**	**11.1**
Software and services	**18,867**	**20,183**	**21,463**	**23,061**	**25,088**	**27,660**	**7.0**	**6.3**	**7.4**	**8.8**	**10.3**
Total IT market	**35,299**	**38,224**	**40,224**	**42,725**	**45,863**	**49,702**	**8.3**	**5.2**	**6.2**	**7.3**	**8.4**
Switching	3,126	2,787	2,550	2,338	1,817	1,643	-10.9	- 8.5	- 8.3	-22.3	-9.5
Transmission	684	630	594	521	607	666	- 8.0	- 5.6	-12.3	16.6	9.7
Mobile communications infrastructure	459	487	524	681	864	1,019	6.1	7.4	30.0	26.9	18.0
Public network equipment	**4,270**	**3,904**	**3,668**	**3,539**	**3,288**	**3,329**	**- 8.6**	**- 6.1**	**- 3.5**	**- 7.1**	**1.2**
PABX and key systems	840	908	939	960	979	996	8.1	3.4	2.2	2.0	1.7
Telephone sets	1,381	1,478	1,557	1,633	1,709	1,768	7.0	5.3	4.9	4.7	3.4
Mobile terminal equipment	402	443	460	472	476	482	10.0	4.0	2.5	0.8	1.3
Other terminal equipment	1,033	1,148	1,284	1,441	1,583	1,737	11.2	11.9	12.2	9.9	9.7
Private network equipment	**3,656**	**3,977**	**4,240**	**4,506**	**4,747**	**4,982**	**8.8**	**6.6**	**6.3**	**5.4**	**5.0**
Telecom equipment	**7,926**	**7,881**	**7,908**	**8,045**	**8,035**	**8,311**	**- 0.6**	**0.3**	**1.7**	**- 0.1**	**3.4**
Telephone services	23,183	24,003	23,109	23,903	24,579	25,250	3.5	- 3.7	3.4	2.8	2.7
Mobile telephone services	1,894	2,822	3,496	4,059	4,644	5,062	49.0	23.9	16.1	14.4	9.0
Switched data and leased line services	2,882	4,015	4,760	5,424	6,065	6,544	39.3	18.5	14.0	11.8	7.9
CaTV services	1,189	1,470	1,567	1,670	1,770	1,873	23.6	6.6	6.6	6.0	5.8
Telecom services	**29,148**	**32,310**	**32,932**	**35,057**	**37,058**	**38,729**	**10.8**	**1.9**	**6.5**	**5.7**	**4.5**
Total telecom	**37,075**	**40,191**	**40,840**	**43,102**	**45,092**	**47,039**	**8.4**	**1.6**	**5.5**	**4.6**	**4.3**
Total ICT	**72,374**	**78,415**	**81,064**	**85,826**	**90,955**	**96,741**	**8.3**	**3.4**	**5.9**	**6.0**	**6.4**

Table 17
Germany
ICT Market Value (Million ECU)

Greece	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	56	57	58	69	75	80	0.6	2.8	17.7	9.2	7.1
Unix servers	16	18	16	16	14	12	12.4	-15.0	3.1	-10.5	-16.0
NT servers	0	1	4	8	12	15	355.2	508.4	128.3	47.1	19.8
Other servers	18	10	15	18	20	21	-45.3	51.6	21.6	9.9	9.1
Server add-ons	22	28	24	26	29	32	25.9	-13.1	8.0	8.8	11.9
Workstations	14	16	16	14	14	15	17.1	- 3.3	-9.3	- 2.7	4.9
PCs	142	152	162	185	208	239	7.0	6.5	14.2	12.6	14.8
portable	10	12	14	17	21	26	20.0	19.1	19.0	23.5	23.8
desktop	132	140	148	168	187	213	6.0	5.4	13.7	11.5	13.8
PC/workstation add-ons	66	79	89	104	122	144	18.7	12.6	17.3	17.3	17.9
PC printers	42	51	58	67	76	89	22.3	13.8	14.9	14.1	16.5
Other add-ons	24	27	30	37	45	55	12.6	10.3	22.0	22.9	20.2
Computer hardware	**279**	**304**	**325**	**372**	**419**	**478**	**9.0**	**6.9**	**14.5**	**12.7**	**14.0**
Copiers	51	52	53	55	57	58	3.5	1.8	3.0	3.2	2.8
Other office equipment	55	56	56	57	58	59	1.6	0.6	1.1	2.8	2.0
Office equipment	**105**	**108**	**109**	**111**	**115**	**118**	**2.5**	**1.2**	**2.0**	**3.0**	**2.4**
LAN hardware	9	11	13	15	17	18	18.1	21.4	11.8	10.5	9.5
Other data communications	2	2	2	2	2	2	16.7	2.5	0.8	0.8	2.8
Data communications hardware	**11**	**13**	**16**	**17**	**19**	**21**	**17.9**	**18.2**	**10.1**	**9.2**	**8.7**
IT hardware	**396**	**425**	**450**	**501**	**553**	**616**	**7.5**	**5.8**	**11.3**	**10.4**	**11.4**
Systems software	29	35	40	48	57	66	18.7	15.9	18.6	19.0	16.0
Application software	38	47	55	66	77	92	23.8	16.7	19.3	17.4	19.4
Software products	**67**	**82**	**95**	**113**	**134**	**158**	**21.6**	**16.3**	**19.0**	**18.1**	**18.0**
Consulting	17	21	23	25	30	34	22.7	8.5	11.1	18.1	13.8
Implementation	58	65	72	87	103	119	12.0	10.8	19.7	19.2	14.9
Operations management	70	85	99	106	121	146	20.8	17.2	6.5	14.6	20.1
Support services	60	64	65	68	72	78	5.2	1.8	5.1	6.3	7.7
Services	**206**	**235**	**259**	**286**	**327**	**376**	**13.9**	**10.5**	**10.2**	**14.3**	**15.1**
Software and services	**273**	**317**	**355**	**399**	**461**	**534**	**15.8**	**12.0**	**12.6**	**15.4**	**16.0**
Total IT market	**669**	**742**	**805**	**900**	**1,014**	**1,150**	**10.9**	**8.4**	**11.9**	**12.6**	**13.5**
Switching	93	90	86	87	90	92	- 3.8	- 3.8	0.6	3.5	2.2
Transmission	81	84	84	87	89	91	3.4	0.5	3.0	2.3	3.0
Mobile communications infrastructure	46	50	59	71	84	101	9.5	18.1	19.4	18.3	20.2
Public network equipment	**220**	**224**	**230**	**244**	**262**	**284**	**1.6**	**2.7**	**6.3**	**7.4**	**8.2**
PABX and key systems	22	22	22	23	25	27	0.0	1.0	4.9	6.6	7.0
Telephone sets	51	55	59	62	66	70	8.0	7.8	5.6	6.0	6.0
Mobile terminal equipment	16	20	23	29	36	43	28.0	14.4	26.4	21.7	20.2
Other terminal equipment	30	32	35	44	53	63	6.3	10.8	23.9	20.9	17.9
Private network equipment	**119**	**129**	**140**	**159**	**180**	**202**	**8.7**	**8.4**	**13.6**	**13.1**	**12.5**
Telecom equipment	**339**	**353**	**370**	**403**	**442**	**486**	**4.1**	**4.8**	**9.1**	**9.6**	**9.9**
Telephone services	1,595	1,778	1,968	2,134	2,309	2,487	11.5	10.6	8.4	8.2	7.7
Mobile telephone services	93	217	420	659	893	1,121	132.5	93.7	57.0	35.4	25.6
Switched data and leased line services	28	57	84	108	134	160	104.7	47.0	28.3	23.7	19.5
CaTV services	0	0	0	0	5	7	–	–	–	–	52.0
Telecom services	**1,717**	**2,053**	**2,472**	**2,901**	**3,341**	**3,776**	**19.6**	**20.4**	**17.4**	**15.1**	**13.0**
Total telecom	**2,056**	**2,405**	**2,842**	**3,305**	**3,783**	**4,262**	**17.0**	**18.1**	**16.3**	**14.5**	**12.7**
Total ICT	**2,725**	**3,147**	**3,646**	**4,205**	**4,797**	**5,412**	**15.5**	**15.9**	**15.3**	**14.1**	**12.8**

Table 18
Greece
ICT Market Value (Million ECU)

Ireland	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	98	106	114	128	149	170	8.2	8.2	11.6	16.6	14.4
Unix servers	33	23	25	25	26	29	-28.7	6.9	-1.1	5.3	9.5
NT servers	1	7	11	20	31	43	1295.8	51.9	85.4	57.0	38.7
Other servers	32	44	41	39	40	40	37.1	-6.6	-5.8	3.6	1.2
Server add-ons	32	31	38	44	52	58	- 3.0	20.0	18.1	16.1	12.3
Workstations	17	18	17	15	14	14	1.0	-4.5	-9.6	-6.5	-1.3
PCs	231	252	280	310	340	375	9.1	10.9	10.6	10.0	10.0
portable	34	41	46	53	63	74	19.9	13.2	16.2	18.3	16.8
desktop	198	212	234	256	277	301	7.2	10.5	9.5	8.2	8.5
PC/workstation add-ons	54	59	67	81	97	112	8.1	13.7	21.3	19.6	15.1
PC printers	31	33	35	39	44	46	6.9	7.3	11.4	12.2	5.5
Other add-ons	24	26	32	42	53	65	9.5	21.7	32.3	26.5	23.1
Computer hardware	**401**	**435**	**478**	**534**	**601**	**671**	**8.4**	**10.0**	**11.6**	**12.5**	**11.7**
Copiers	81	82	82	80	81	83	1.4	0.2	-2.9	2.1	1.9
Other office equipment	82	81	80	79	78	78	- 0.5	-2.0	-1.0	-0.5	-0.5
Office equipment	**162**	**163**	**162**	**158**	**160**	**161**	**0.4**	**-0.9**	**-2.0**	**0.8**	**0.7**
LAN hardware	11	13	15	17	19	20	12.0	20.0	12.5	11.1	5.4
Other data communications	5	6	6	6	6	6	14.3	1.4	-1.4	-0.0	0.0
Data communications hardware	**16**	**19**	**21**	**23**	**25**	**26**	**12.7**	**14.2**	**8.6**	**8.3**	**4.2**
IT hardware	**580**	**616**	**661**	**715**	**785**	**857**	**6.3**	**7.2**	**8.2**	**9.8**	**9.2**
Systems software	61	68	74	83	92	100	11.8	9.4	11.8	10.6	9.6
Application software	47	53	58	65	73	84	12.0	10.6	12.3	12.2	15.1
Software products	**108**	**120**	**132**	**148**	**165**	**185**	**11.9**	**9.9**	**12.0**	**11.3**	**12.0**
Consulting	18	20	22	25	28	33	10.3	8.8	13.3	14.2	16.3
Implementation	58	63	69	87	104	125	9.1	9.5	25.1	20.8	19.5
Operations management	84	89	96	107	122	147	5.9	7.8	11.1	14.8	20.4
Support services	55	57	60	63	67	71	3.0	5.8	5.1	5.9	6.8
Services	**215**	**229**	**247**	**281**	**322**	**376**	**6.4**	**7.9**	**13.8**	**14.6**	**16.9**
Software and services	**323**	**349**	**379**	**429**	**487**	**561**	**8.2**	**8.6**	**13.2**	**13.4**	**15.3**
Total IT market	**903**	**965**	**1,040**	**1,144**	**1,272**	**1,419**	**7.0**	**7.7**	**10.0**	**11.2**	**11.5**
Switching	78	75	76	77	80	83	- 3.8	0.5	2.1	3.2	3.8
Transmission	68	70	70	73	78	84	3.4	-0.4	4.7	6.8	7.3
Mobile communications infrastructure	23	25	31	36	39	44	7.7	25.6	15.9	10.1	12.0
Public network equipment	**169**	**170**	**177**	**187**	**198**	**211**	**0.6**	**3.7**	**5.5**	**5.9**	**6.9**
PABX and key systems	26	26	25	27	30	33	- 1.8	-1.5	6.9	10.6	10.1
Telephone sets	43	46	50	54	59	64	8.0	7.3	9.8	9.4	7.1
Mobile terminal equipment	13	15	20	24	27	30	20.0	28.5	20.4	13.2	12.2
Other terminal equipment	25	27	30	36	41	48	6.3	11.4	18.9	15.0	16.2
Private network equipment	**107**	**114**	**125**	**141**	**157**	**175**	**6.6**	**9.2**	**13.1**	**11.7**	**10.9**
Telecom equipment	**277**	**285**	**302**	**328**	**355**	**386**	**2.9**	**5.9**	**8.7**	**8.4**	**8.7**
Telephone services	1,021	1,102	1,265	1,344	1,430	1,501	7.9	14.8	6.2	6.5	4.9
Mobile telephone services	65	114	202	281	365	435	76.8	76.6	39.3	30.1	19.0
Switched data and leased line services	59	69	106	125	149	176	16.7	53.2	17.9	19.3	18.7
CaTV services	30	38	49	61	70	107	25.0	30.0	23.4	15.4	51.6
Telecom services	**1,175**	**1,323**	**1,621**	**1,810**	**2,015**	**2,219**	**12.6**	**22.6**	**11.6**	**11.3**	**10.1**
Total telecom	**1,451**	**1,607**	**1,923**	**2,138**	**2,370**	**2,605**	**10.8**	**19.6**	**11.2**	**10.9**	**9.9**
Total ICT	**2,354**	**2,573**	**2,963**	**3,282**	**3,642**	**4,024**	**9.3**	**15.2**	**10.8**	**11.0**	**10.5**

Table 19
Ireland
ICT Market Value (Million ECU)

Italy	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	2,284	2,217	2,053	2,066	2,147	2,217	- 3.0	- 7.4	0.6	3.9	3.3
Unix servers	268	357	301	302	319	328	33.6	-15.7	0.3	5.5	3.0
NT servers	6	22	61	120	177	208	248.0	175.1	98.2	47.4	17.7
Other servers	1,143	969	870	879	869	879	-15.2	-10.2	1.0	-1.1	1.1
Server add-ons	868	868	821	764	782	802	0.1	- 5.4	-6.9	2.3	2.5
Workstations	217	234	237	232	234	244	7.9	1.1	-2.1	1.1	4.2
PCs	1,387	1,629	1,736	1,905	2,077	2,242	17.5	6.5	9.7	9.1	7.9
portable	235	297	334	380	419	472	26.4	12.4	14.0	10.0	12.8
desktop	1,152	1,332	1,402	1,524	1,659	1,770	15.6	5.2	8.7	8.8	6.7
PC/workstation add-ons	633	716	788	846	909	966	13.1	10.0	7.4	7.4	6.3
PC printers	474	531	568	599	633	657	11.9	7.1	5.4	5.7	3.8
Other add-ons	159	185	219	247	276	309	16.9	18.2	12.9	11.5	11.9
Computer hardware	**4,521**	**4,796**	**4,813**	**5,048**	**5,367**	**5,669**	**6.1**	**0.4**	**4.9**	**6.3**	**5.6**
Copiers	390	437	457	469	478	481	12.0	4.7	2.6	2.0	0.5
Other office equipment	287	266	243	232	232	236	- 7.3	- 8.9	-4.4	0.1	1.7
Office equipment	**677**	**703**	**700**	**701**	**710**	**717**	**3.8**	**- 0.5**	**0.2**	**1.3**	**0.9**
LAN hardware	172	210	254	306	356	420	22.0	21.0	20.5	16.4	18.1
Other data communications	86	87	92	96	97	100	2.0	5.3	4.4	1.2	3.2
Data communications hardware	**258**	**297**	**346**	**402**	**454**	**521**	**15.3**	**16.4**	**16.2**	**12.8**	**14.9**
IT hardware	**5,456**	**5,796**	**5,859**	**6,151**	**6,531**	**6,906**	**6.2**	**1.1**	**5.0**	**6.2**	**5.8**
Systems software	1,394	1,445	1,513	1,585	1,708	1,850	3.7	4.7	4.7	7.7	8.4
Application software	984	1,031	1,097	1,165	1,276	1,439	4.8	6.4	6.1	9.6	12.8
Software products	**2,378**	**2,476**	**2,611**	**2,750**	**2,984**	**3,290**	**4.1**	**5.4**	**5.3**	**8.5**	**10.3**
Consulting	376	405	449	490	551	607	7.8	10.8	9.1	12.5	10.1
Implementation	1,155	1,258	1,386	1,542	1,748	2,022	9.0	10.2	11.2	13.4	15.6
Operations management	1,780	1,886	2,116	2,363	2,695	3,089	6.0	12.2	11.7	14.1	14.6
Support services	1,579	1,570	1,571	1,583	1,617	1,674	- 0.5	0.0	0.8	2.1	3.6
Services	**4,890**	**5,120**	**5,522**	**5,978**	**6,611**	**7,392**	**4.7**	**7.9**	**8.3**	**10.6**	**11.8**
Software and services	**7,268**	**7,596**	**8,133**	**8,728**	**9,595**	**10,682**	**4.5**	**7.1**	**7.3**	**9.9**	**11.3**
Total IT market	**12,724**	**13,393**	**13,992**	**14,879**	**16,126**	**17,588**	**5.3**	**4.5**	**6.3**	**8.4**	**9.1**
Switching	843	809	798	795	813	831	- 4.1	- 1.3	-0.5	2.3	2.2
Transmission	506	492	495	510	546	583	- 2.8	0.6	3.2	6.9	6.9
Mobile communications infrastructure	219	401	483	550	677	839	82.6	20.6	13.8	23.1	24.0
Public network equipment	**1,568**	**1,701**	**1,776**	**1,855**	**2,035**	**2,253**	**8.5**	**4.4**	**4.4**	**9.7**	**10.7**
PABX and key systems	234	223	217	215	232	251	- 4.7	- 2.7	-0.9	7.5	8.5
Telephone sets	430	455	476	497	536	588	5.8	4.6	4.5	7.9	9.6
Mobile terminal equipment	512	577	757	835	869	873	12.9	31.0	10.4	4.1	0.4
Other terminal equipment	388	413	444	479	534	591	6.4	7.4	8.0	11.3	10.8
Private network equipment	**1,564**	**1,668**	**1,894**	**2,026**	**2,171**	**2,304**	**6.7**	**13.5**	**7.0**	**7.1**	**6.1**
Telecom equipment	**3,132**	**3,370**	**3,670**	**3,881**	**4,206**	**4,557**	**7.6**	**8.9**	**5.8**	**8.3**	**8.3**
Telephone services	12,477	12,842	13,035	13,297	13,624	13,957	2.9	1.5	2.0	2.5	2.4
Mobile telephone services	1,441	2,272	3,503	4,611	5,879	7,051	57.7	54.2	31.6	27.5	19.9
Switched data and leased line services	988	1,113	1,426	1,862	2,304	2,686	12.7	28.1	30.6	23.7	16.5
CaTV services	5	6	13	23	36	51	25.1	116.6	74.9	57.3	42.4
Telecom services	**14,911**	**16,233**	**17,977**	**19,793**	**21,842**	**23,744**	**8.9**	**10.7**	**10.1**	**10.4**	**8.7**
Total telecom	**18,043**	**19,603**	**21,647**	**23,674**	**26,048**	**28,301**	**8.7**	**10.4**	**9.4**	**10.0**	**8.6**
Total ICT	**30,767**	**32,996**	**35,639**	**38,553**	**42,174**	**45,889**	**7.2**	**8.0**	**8.2**	**9.4**	**8.8**

Table 20
Italy
ICT Market Value (Million ECU)

Netherlands	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	910	868	932	1,063	1,172	1,268	- 4.6	7.3	14.1	10.2	8.2
Unix servers	144	182	192	206	224	241	26.7	5.7	7.3	8.7	7.6
NT servers	6	28	63	122	178	224	337.4	128.2	93.9	45.6	25.7
Other servers	387	326	331	348	348	343	-15.7	1.4	5.0	0.1	-1.3
Server add-ons	373	332	345	387	421	459	-11.0	3.9	11.9	9.0	8.9
Workstations	108	115	118	104	95	92	7.2	2.4	-12.4	-8.1	-3.0
PCs	1,171	1,449	1,689	1,863	1,999	2,080	23.7	16.6	10.3	7.3	4.1
portable	218	275	344	380	419	461	26.3	24.8	10.7	10.2	10.0
desktop	953	1,173	1,346	1,483	1,580	1,619	23.1	14.7	10.2	6.5	2.5
PC/workstation add-ons	383	439	435	453	499	540	14.8	- 0.9	4.2	10.1	8.2
PC printers	249	282	272	288	321	350	13.3	- 3.6	5.8	11.5	9.0
Other add-ons	134	157	163	166	178	190	17.8	3.8	1.4	7.5	6.8
Computer hardware	**2,572**	**2,872**	**3,175**	**3,483**	**3,764**	**3,980**	**11.7**	**10.6**	**9.7**	**8.1**	**5.7**
Copiers	390	397	389	393	392	377	1.7	- 2.1	1.1	-0.1	-4.0
Other office equipment	341	341	334	337	337	336	- 0.1	- 1.9	0.7	0.1	-0.5
Office equipment	**732**	**738**	**723**	**730**	**730**	**712**	**0.8**	**- 2.0**	**0.9**	**-0.0**	**-2.4**
LAN hardware	195	247	310	355	400	440	26.6	25.6	14.6	12.5	10.0
Other data communications	134	139	118	119	122	118	3.7	-15.2	1.4	1.9	-2.8
Data communications hardware	**329**	**385**	**428**	**474**	**521**	**558**	**17.3**	**10.9**	**11.0**	**9.8**	**7.0**
IT hardware	**3,632**	**3,995**	**4,325**	**4,687**	**5,015**	**5,250**	**10.0**	**8.3**	**8.4**	**7.0**	**4.7**
Systems software	822	903	1,014	1,153	1,289	1,474	9.9	12.2	13.7	11.8	14.4
Application software	752	834	936	1,023	1,144	1,344	10.8	12.2	9.3	11.8	17.5
Software products	**1,575**	**1,737**	**1,950**	**2,176**	**2,432**	**2,818**	**10.3**	**12.2**	**11.6**	**11.8**	**15.9**
Consulting	202	221	242	286	351	393	9.7	9.6	17.9	22.7	12.0
Implementation	791	854	903	1,067	1,286	1,540	8.0	5.7	18.2	20.5	19.7
Operations management	456	472	492	574	651	764	3.6	4.2	16.7	13.3	17.3
Support services	682	665	671	686	705	739	- 2.5	0.9	2.3	2.8	4.8
Services	**2,130**	**2,212**	**2,308**	**2,613**	**2,993**	**3,435**	**3.8**	**4.3**	**13.2**	**14.5**	**14.8**
Software and services	**3,705**	**3,949**	**4,258**	**4,789**	**5,425**	**6,254**	**6.6**	**7.8**	**12.5**	**13.3**	**15.3**
Total IT market	**7,337**	**7,944**	**8,583**	**9,476**	**10,440**	**11,503**	**8.3**	**8.0**	**10.4**	**10.2**	**10.2**
Switching	237	235	234	227	223	220	- 0.7	- 0.6	- 2.9	-1.7	-1.3
Transmission	146	157	161	164	169	175	7.9	2.6	1.7	3.3	3.1
Mobile communications infrastructure	42	74	76	83	91	98	74.3	2.3	9.2	9.5	8.0
Public network equipment	**425**	**466**	**471**	**474**	**483**	**493**	**9.7**	**0.9**	**0.7**	**2.0**	**2.0**
PABX and key systems	205	207	209	211	213	215	0.9	0.9	0.9	1.2	1.0
Telephone sets	162	177	193	204	215	224	9.3	9.1	5.3	5.5	4.3
Mobile terminal equipment	142	193	227	248	270	297	36.0	18.1	9.2	8.7	9.8
Other terminal equipment	139	163	200	236	275	314	16.8	23.2	17.7	16.6	14.1
Private network equipment	**648**	**740**	**830**	**899**	**973**	**1,050**	**14.1**	**12.3**	**8.3**	**8.3**	**7.9**
Telecom equipment	**1,073**	**1,206**	**1,301**	**1,373**	**1,456**	**1,543**	**12.4**	**7.9**	**5.5**	**6.1**	**5.9**
Telephone services	4,152	4,317	4,458	4,593	4,718	4,837	4.0	3.3	3.0	2.7	2.5
Mobile telephone services	415	633	1,046	1,478	1,822	2,042	52.3	65.3	41.3	23.3	12.1
Switched data and leased line services	517	575	768	967	1,155	1,305	11.2	33.6	25.8	19.5	13.0
CaTV services	520	597	637	677	717	753	15.0	6.7	6.2	5.9	5.1
Telecom services	**5,604**	**6,122**	**6,909**	**7,714**	**8,411**	**8,937**	**9.2**	**12.9**	**11.6**	**9.0**	**6.3**
Total telecom	**6,678**	**7,328**	**8,210**	**9,087**	**9,868**	**10,480**	**9.7**	**12.0**	**10.7**	**8.6**	**6.2**
Total ICT	**14,014**	**15,273**	**16,793**	**18,563**	**20,308**	**21,983**	**9.0**	**10.0**	**10.5**	**9.4**	**8.2**

Table 21
Netherlands
ICT Market Value (Million ECU)

Norway	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	224	212	272	334	382	427	- 5.3	28.2	22.9	14.1	12.0
Unix servers	45	54	61	68	76	85	19.4	13.5	11.7	11.7	11.1
NT servers	2	11	25	49	71	93	353.4	135.9	95.4	46.8	30.6
Other servers	97	70	92	98	102	102	-28.0	32.6	6.3	3.7	0.3
Server add-ons	80	78	94	120	132	148	- 2.0	19.8	27.4	10.7	11.6
Workstations	51	51	52	46	42	40	0.3	0.5	-10.2	-9.0	-4.8
PCs	504	654	701	749	751	726	29.8	7.2	6.9	0.3	-3.4
portable	101	119	132	143	145	147	17.3	11.7	7.9	1.6	1.1
desktop	403	535	569	607	606	579	32.9	6.2	6.7	-0.0	-4.5
PC/workstation add-ons	132	162	178	205	227	243	22.6	9.4	15.6	10.3	7.3
PC printers	77	96	102	117	128	133	23.8	6.4	14.7	9.4	4.2
Other add-ons	55	67	76	88	99	110	20.9	13.6	16.7	11.6	11.4
Computer hardware	**912**	**1,080**	**1,202**	**1,336**	**1,402**	**1,436**	**18.5**	**11.3**	**11.1**	**5.0**	**2.5**
Copiers	70	65	63	64	63	61	- 6.8	- 3.3	1.1	-1.5	-3.5
Other office equipment	74	72	70	71	73	74	- 2.8	- 2.7	1.4	2.6	2.5
Office equipment	**144**	**137**	**133**	**135**	**135**	**135**	**- 4.7**	**- 3.0**	**1.3**	**0.7**	**-0.3**
LAN hardware	56	83	102	113	122	126	49.2	22.6	11.6	7.5	3.2
Other data communications	35	37	38	40	41	40	5.7	4.7	5.1	3.1	-3.1
Data communications hardware	**90**	**119**	**140**	**154**	**163**	**166**	**32.5**	**17.2**	**9.8**	**6.3**	**1.6**
IT hardware	**1,146**	**1,336**	**1,475**	**1,624**	**1,701**	**1,738**	**16.7**	**10.4**	**10.1**	**4.7**	**2.2**
Systems software	199	212	228	262	303	353	6.3	7.8	14.8	15.6	16.5
Application software	204	213	232	259	297	352	4.5	8.5	11.9	14.6	18.6
Software products	**404**	**425**	**460**	**522**	**600**	**706**	**5.4**	**8.1**	**13.4**	**15.1**	**17.6**
Consulting	106	114	126	140	158	176	8.1	10.3	11.3	12.9	11.4
Implementation	366	392	426	471	545	637	7.1	8.6	10.4	15.9	16.7
Operations management	251	265	284	316	366	427	5.7	7.4	11.0	16.1	16.5
Support services	283	283	285	289	294	306	- 0.1	0.8	1.5	1.4	4.3
Services	**1,006**	**1,054**	**1,122**	**1,216**	**1,364**	**1,546**	**4.8**	**6.4**	**8.4**	**12.2**	**13.4**
Software and services	**1,409**	**1,479**	**1,582**	**1,738**	**1,964**	**2,252**	**5.0**	**6.9**	**9.8**	**13.0**	**14.7**
Total IT market	**2,555**	**2,816**	**3,057**	**3,361**	**3,665**	**3,990**	**10.2**	**8.6**	**9.9**	**9.0**	**8.9**
Switching	112	108	102	96	93	93	- 3.8	- 5.3	- 5.7	-3.7	0.6
Transmission	97	101	100	104	112	117	3.4	- 0.4	3.6	7.6	4.9
Mobile communications infrastructure	44	47	49	53	60	66	8.5	3.3	8.0	13.7	9.8
Public network equipment	**253**	**256**	**251**	**253**	**264**	**276**	**1.1**	**- 1.8**	**0.7**	**4.6**	**4.5**
PABX and key systems	32	31	30	30	30	31	- 2.0	- 2.0	- 0.3	0.2	1.0
Telephone sets	61	66	72	76	78	82	8.0	8.8	5.4	3.9	4.3
Mobile terminal equipment	118	105	92	87	86	86	-10.4	-13.0	- 5.3	-0.8	0.4
Other terminal equipment	45	48	55	65	79	92	6.3	14.1	19.5	20.0	17.0
Private network equipment	**255**	**250**	**248**	**258**	**273**	**291**	**- 2.0**	**- 0.7**	**3.9**	**6.0**	**6.3**
Telecom equipment	**508**	**506**	**500**	**511**	**538**	**567**	**- 0.5**	**- 1.2**	**2.3**	**5.3**	**5.4**
Telephone services	1,294	1,378	1,462	1,494	1,527	1,560	6.5	6.1	2.2	2.2	2.1
Mobile telephone services	265	383	487	565	618	661	44.6	27.0	16.0	9.4	7.0
Switched data and leased line services	78	135	277	318	347	372	72.3	105.4	14.6	9.4	7.0
CaTV services	41	45	54	61	69	77	10.0	18.3	14.4	12.3	11.4
Telecom services	**1,679**	**1,942**	**2,280**	**2,438**	**2,562**	**2,669**	**15.7**	**17.4**	**6.9**	**5.1**	**4.2**
Total telecom	**2,187**	**2,447**	**2,779**	**2,949**	**3,099**	**3,237**	**11.9**	**13.6**	**6.1**	**5.1**	**4.4**
Total ICT	**4,742**	**5,263**	**5,836**	**6,310**	**6,764**	**7,226**	**11.0**	**10.9**	**8.1**	**7.2**	**6.8**

Table 22
Norway
ICT Market Value (Million ECU)

Portugal	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	123	135	182	219	251	290	10.0	34.9	20.5	14.4	15.3
Unix servers	44	39	58	67	78	94	-9.8	48.7	14.6	17.3	20.1
NT servers	1	3	11	20	29	43	230.7	277.0	74.5	46.5	48.6
Other servers	48	53	50	54	58	58	11.6	-5.7	8.1	5.9	0.8
Server add-ons	31	39	62	78	86	94	28.9	57.4	26.2	9.8	9.4
Workstations	15	17	16	15	13	13	8.3	-3.1	-10.1	-8.0	-6.4
PCs	246	276	292	316	344	377	12.3	5.6	8.1	9.0	9.5
portable	10	13	15	16	19	21	30.0	15.4	9.5	13.5	12.7
desktop	236	263	277	299	325	356	11.5	5.2	8.1	8.7	9.4
PC/workstation add-ons	58	61	65	75	90	109	6.4	6.5	15.6	19.9	20.8
PC printers	16	17	18	20	21	23	10.6	4.5	8.7	8.0	7.4
Other add-ons	42	44	47	56	69	86	4.9	7.2	18.3	24.1	24.9
Computer hardware	**442**	**489**	**556**	**625**	**699**	**788**	**10.7**	**13.5**	**12.5**	**11.8**	**12.8**
Copiers	63	64	65	66	68	70	2.8	1.1	2.0	2.0	3.1
Other office equipment	65	66	66	67	68	69	2.6	-0.8	2.3	1.5	1.0
Office equipment	**127**	**131**	**131**	**134**	**136**	**139**	**2.7**	**0.1**	**2.2**	**1.8**	**2.0**
LAN hardware	11	12	13	15	17	18	4.3	13.3	14.7	8.7	8.5
Other data communications	8	8	8	8	9	9	3.3	-1.8	6.3	4.0	3.9
Data communications hardware	**19**	**20**	**21**	**24**	**25**	**27**	**3.9**	**7.3**	**11.6**	**7.1**	**6.9**
IT hardware	**588**	**640**	**708**	**782**	**860**	**954**	**8.8**	**10.6**	**10.6**	**10.0**	**10.9**
Systems software	69	73	79	90	103	113	6.2	7.3	14.0	14.9	9.9
Application software	49	53	58	68	76	84	7.3	8.6	17.8	12.8	9.3
Software products	**118**	**126**	**136**	**158**	**180**	**197**	**6.7**	**7.9**	**15.6**	**14.0**	**9.6**
Consulting	24	25	27	31	33	36	5.2	7.5	13.8	8.1	9.4
Implementation	72	77	82	96	114	136	6.9	7.2	17.2	18.8	19.1
Operations management	102	108	116	131	154	186	5.7	7.6	12.7	17.6	20.2
Support services	73	75	79	83	88	94	3.1	5.0	6.0	6.1	6.2
Services	**271**	**285**	**304**	**342**	**390**	**452**	**5.3**	**6.8**	**12.3**	**14.3**	**15.8**
Software and services	**389**	**411**	**441**	**499**	**570**	**649**	**5.7**	**7.1**	**13.3**	**14.2**	**13.9**
Total IT market	**977**	**1,051**	**1,148**	**1,282**	**1,430**	**1,603**	**7.5**	**9.2**	**11.6**	**11.6**	**12.1**
Switching	111	107	133	111	113	115	-3.8	24.4	-16.7	1.9	1.2
Transmission	97	98	101	105	116	121	1.5	3.3	3.7	9.8	4.4
Mobile communications infrastructure	71	73	75	80	85	92	3.2	2.1	6.5	6.2	8.6
Public network equipment	**279**	**279**	**310**	**296**	**313**	**327**	**-0.2**	**11.1**	**- 4.4**	**5.9**	**4.4**
PABX and key systems	46	47	48	49	50	52	1.9	1.9	1.7	2.9	2.8
Telephone sets	64	70	76	80	84	87	8.0	9.0	5.8	4.9	3.5
Mobile terminal equipment	6	9	13	16	18	20	44.0	42.7	23.4	9.7	9.6
Other terminal equipment	45	48	53	64	74	82	6.3	11.3	21.1	15.6	10.3
Private network equipment	**162**	**174**	**190**	**210**	**227**	**241**	**7.2**	**9.5**	**10.3**	**8.1**	**6.1**
Telecom equipment	**441**	**452**	**500**	**506**	**540**	**568**	**2.5**	**10.5**	**1.2**	**6.8**	**5.1**
Telephone services	1,467	1,636	1,810	1,924	2,043	2,158	11.5	10.6	6.3	6.2	5.6
Mobile telephone services	80	180	269	465	684	863	123.3	49.6	73.0	47.1	26.2
Switched data and leased line services	152	174	204	223	251	279	14.2	17.7	9.3	12.4	11.2
CaTV services	0	0	0	2	4	7	-	-	-	66.7	86.1
Telecom services	**1,699**	**1,989**	**2,283**	**2,615**	**2,982**	**3,307**	**17.0**	**14.8**	**14.6**	**14.0**	**10.9**
Total telecom	**2,141**	**2,441**	**2,783**	**3,121**	**3,522**	**3,874**	**14.0**	**14.0**	**12.1**	**12.9**	**10.0**
Total ICT	**3,118**	**3,492**	**3,931**	**4,402**	**4,952**	**5,478**	**12.0**	**12.6**	**12.0**	**12.5**	**10.6**

Table 23
Portugal
ICT Market Value (Million ECU)

Spain	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	824	829	899	1,029	1,149	1,235	0.7	8.4	14.5	11.7	7.4
Unix servers	120	173	168	175	192	215	43.7	- 2.6	4.0	9.7	12.0
NT servers	3	14	39	82	125	162	354.1	176.1	108.5	53.1	29.6
Other servers	393	336	370	404	429	426	-14.6	10.1	9.4	6.0	-0.7
Server add-ons	308	307	322	368	404	432	- 0.2	4.9	14.3	9.7	7.0
Workstations	113	113	109	95	86	82	0.0	- 3.3	-13.6	-9.2	-4.5
PCs	920	1,024	1,129	1,246	1,334	1,435	11.3	10.2	10.3	7.1	7.6
portable	125	160	200	220	241	272	28.1	24.6	10.4	9.5	12.6
desktop	795	864	930	1,025	1,092	1,163	8.7	7.6	10.3	6.5	6.5
PC/workstation add-ons	328	399	441	492	579	643	21.7	10.6	11.5	17.7	11.2
PC printers	233	283	308	343	399	446	21.4	8.7	11.2	16.6	11.6
Other add-ons	94	115	133	149	179	198	22.4	15.4	12.1	20.2	10.4
Computer hardware	**2,184**	**2,365**	**2,579**	**2,861**	**3,148**	**3,396**	**8.3**	**9.0**	**11.0**	**10.0**	**7.9**
Copiers	298	304	302	300	297	289	1.9	- 0.6	- 0.8	-0.9	-2.6
Other office equipment	285	285	278	278	275	267	- 0.0	- 2.4	0.1	-1.1	-3.1
Office equipment	**583**	**589**	**580**	**578**	**572**	**556**	**1.0**	**- 1.5**	**- 0.4**	**-1.0**	**-2.8**
LAN hardware	101	133	170	210	257	282	32.0	27.8	23.7	22.1	9.8
Other data communications	55	57	61	65	69	65	2.4	8.1	6.9	5.1	-5.4
Data communications hardware	**156**	**190**	**231**	**276**	**326**	**347**	**21.5**	**21.9**	**19.3**	**18.1**	**6.6**
IT hardware	**2,923**	**3,144**	**3,390**	**3,715**	**4,045**	**4,298**	**7.5**	**7.8**	**9.6**	**8.9**	**6.3**
Systems software	360	425	481	526	578	658	18.3	13.0	9.5	9.9	13.8
Application software	302	364	416	461	516	611	20.4	14.3	10.8	12.0	18.5
Software products	**662**	**789**	**896**	**987**	**1,094**	**1,269**	**19.2**	**13.6**	**10.1**	**10.9**	**16.0**
Consulting	141	151	169	190	221	250	7.1	11.6	12.7	16.2	13.2
Implementation	457	489	559	681	854	1,098	7.1	14.2	21.9	25.5	28.5
Operations management	692	711	750	823	979	1,207	2.8	5.5	9.7	19.0	23.3
Support services	407	417	429	447	460	479	2.4	3.0	4.0	3.0	4.1
Services	**1,697**	**1,769**	**1,907**	**2,141**	**2,515**	**3,034**	**4.2**	**7.8**	**12.3**	**17.5**	**20.6**
Software and services	**2,359**	**2,558**	**2,803**	**3,128**	**3,609**	**4,304**	**8.4**	**9.6**	**11.6**	**15.4**	**19.2**
Total IT market	**5,282**	**5,702**	**6,193**	**6,843**	**7,655**	**8,602**	**7.9**	**8.6**	**10.5**	**11.9**	**12.4**
Switching	505	402	340	325	326	328	-20.6	-15.4	- 4.5	0.5	0.4
Transmission	264	274	277	284	300	310	3.7	1.3	2.3	5.8	3.2
Mobile communications infrastructure	87	247	280	299	329	358	182.7	13.5	6.8	9.9	8.8
Public network equipment	**857**	**922**	**897**	**908**	**956**	**995**	**7.7**	**- 2.7**	**1.2**	**5.2**	**4.2**
PABX and key systems	190	187	230	186	199	212	- 1.7	23.5	-19.5	7.3	6.5
Telephone sets	207	214	226	222	246	264	3.3	5.3	- 1.4	10.5	7.3
Mobile terminal equipment	62	80	112	144	179	214	28.0	40.3	29.2	24.2	19.6
Other terminal equipment	107	118	139	160	195	234	10.2	18.6	15.0	21.5	20.1
Private network equipment	**566**	**598**	**707**	**712**	**819**	**924**	**5.6**	**18.3**	**0.8**	**14.9**	**12.9**
Telecom equipment	**1,423**	**1,520**	**1,604**	**1,620**	**1,774**	**1,920**	**6.9**	**5.6**	**1.0**	**9.5**	**8.2**
Telephone services	5,968	6,427	6,911	7,075	7,282	7,488	7.7	7.5	2.4	2.9	2.8
Mobile telephone services	250	500	1,310	1,703	2,166	2,498	100.3	162.0	30.0	27.2	15.3
Switched data and leased line services	579	658	854	993	1,142	1,287	13.6	29.9	16.3	15.1	12.6
CaTV services	14	34	108	119	131	141	147.3	215.8	10.4	10.0	7.7
Telecom services	**6,811**	**7,619**	**9,183**	**9,890**	**10,722**	**11,413**	**11.9**	**20.5**	**7.7**	**8.4**	**6.4**
Total telecom	**8,233**	**9,139**	**10,788**	**11,511**	**12,496**	**13,333**	**11.0**	**18.0**	**6.7**	**8.6**	**6.7**
Total ICT	**13,516**	**14,841**	**16,981**	**18,354**	**20,151**	**21,935**	**9.8**	**14.4**	**8.1**	**9.8**	**8.9**

Table 24
Spain
ICT Market Value (Million ECU)

Sweden	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	698	674	625	689	759	839	- 3.4	- 7.3	10.2	10.2	10.5
Unix servers	106	144	139	148	168	187	35.9	- 3.8	6.3	13.9	11.2
NT servers	4	23	45	90	132	182	564.2	93.8	99.1	46.5	38.0
Other servers	356	258	186	192	195	193	-27.6	-28.0	3.4	1.3	-0.6
Server add-ons	231	248	255	259	264	276	7.2	2.7	1.5	2.1	4.4
Workstations	150	163	150	135	125	120	8.9	- 8.0	-10.2	-6.9	-4.0
PCs	1,024	1,431	1,410	1,449	1,447	1,393	39.7	- 1.5	2.8	-0.1	-3.7
portable	243	343	370	381	386	396	41.0	8.0	2.8	1.4	2.5
desktop	781	1,088	1,039	1,068	1,061	998	39.3	- 4.5	2.8	-0.7	-6.0
PC/workstation add-ons	290	342	364	393	413	440	18.2	6.3	8.2	4.9	6.7
PC printers	162	198	208	225	227	232	22.3	4.9	8.1	1.1	2.2
Other add-ons	128	144	156	169	186	208	12.9	8.1	8.4	10.0	12.2
Computer hardware	**2,161**	**2,610**	**2,548**	**2,666**	**2,744**	**2,793**	**20.8**	**- 2.4**	**4.6**	**2.9**	**1.8**
Copiers	132	133	132	132	126	118	1.4	- 1.0	- 0.4	-4.4	-6.4
Other office equipment	134	132	128	125	123	122	- 1.4	- 3.2	- 2.4	-1.0	-1.3
Office equipment	**265**	**265**	**260**	**256**	**249**	**240**	**0.0**	**- 2.1**	**- 1.4**	**-2.8**	**-3.9**
LAN hardware	165	203	249	288	312	321	23.1	22.4	15.5	8.6	2.8
Other data communications	59	62	66	69	70	67	4.9	6.4	4.4	1.7	-3.7
Data communications hardware	**224**	**265**	**315**	**356**	**382**	**388**	**18.3**	**18.7**	**13.2**	**7.3**	**1.7**
IT hardware	**2,650**	**3,141**	**3,123**	**3,278**	**3,376**	**3,421**	**18.5**	**- 0.6**	**5.0**	**3.0**	**1.3**
Systems software	330	358	399	434	487	560	8.5	11.4	8.7	12.2	15.1
Application software	328	358	396	437	494	579	9.1	10.5	10.3	13.2	17.1
Software products	**659**	**716**	**795**	**871**	**981**	**1,139**	**8.8**	**11.0**	**9.5**	**12.7**	**16.2**
Consulting	189	215	245	272	299	329	14.0	13.9	11.3	9.8	10.0
Implementation	964	1,021	1,131	1,252	1,444	1,712	6.0	10.8	10.6	15.4	18.6
Operations management	491	553	644	731	852	993	12.5	16.5	13.4	16.6	16.5
Support services	670	672	691	706	725	753	0.4	2.8	2.2	2.7	3.8
Services	**2,313**	**2,461**	**2,711**	**2,961**	**3,321**	**3,787**	**6.4**	**10.2**	**9.2**	**12.2**	**14.0**
Software and services	**2,972**	**3,178**	**3,507**	**3,832**	**4,302**	**4,926**	**6.9**	**10.4**	**9.3**	**12.3**	**14.5**
Total IT market	**5,623**	**6,318**	**6,629**	**7,110**	**7,677**	**8,347**	**12.4**	**4.9**	**7.3**	**8.0**	**8.7**
Switching	193	177	175	176	179	181	- 8.1	- 1.1	0.3	1.4	1.5
Transmission	160	163	165	170	175	180	1.9	1.1	3.4	3.0	2.6
Mobile communications infrastructure	81	83	83	87	91	93	2.0	1.0	4.8	4.1	2.4
Public network equipment	**434**	**423**	**424**	**434**	**445**	**454**	**- 2.5**	**0.1**	**2.4**	**2.6**	**2.1**
PABX and key systems	135	129	124	117	112	107	- 4.3	- 4.4	- 5.3	-4.7	-4.4
Telephone sets	157	166	189	182	186	190	5.4	13.9	- 3.4	2.0	2.2
Mobile terminal equipment	182	243	243	240	238	239	33.5	- 0.0	- 1.3	-0.7	0.3
Other terminal equipment	134	150	170	188	211	232	11.6	13.8	10.2	12.1	10.2
Private network equipment	**609**	**688**	**726**	**727**	**746**	**768**	**13.0**	**5.5**	**0.2**	**2.6**	**2.9**
Telecom equipment	**1,043**	**1,111**	**1,150**	**1,161**	**1,191**	**1,222**	**6.5**	**3.5**	**1.0**	**2.6**	**2.6**
Telephone services	2,391	2,453	2,470	2,524	2,594	2,649	2.6	0.7	2.2	2.7	2.1
Mobile telephone services	814	900	997	1,130	1,234	1,326	10.6	10.8	13.4	9.2	7.4
Switched data and leased line services	217	270	391	464	524	581	24.2	44.8	18.7	13.0	10.8
CaTV services	215	251	302	367	459	552	16.9	20.0	21.7	25.0	20.2
Telecom services	**3,637**	**3,874**	**4,159**	**4,486**	**4,811**	**5,108**	**6.5**	**7.4**	**7.9**	**7.3**	**6.2**
Total telecom	**4,680**	**4,985**	**5,309**	**5,647**	**6,003**	**6,330**	**6.5**	**6.5**	**6.4**	**6.3**	**5.5**
Total ICT	**10,303**	**11,303**	**11,938**	**12,757**	**13,680**	**14,677**	**9.7**	**5.6**	**6.9**	**7.2**	**7.3**

Table 25
Sweden
ICT Market Value (Million ECU)

Switzerland	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	828	813	924	1,031	1,167	1,283	- 1.8	13.8	11.6	13.1	9.9
Unix servers	130	182	286	338	403	455	40.2	57.2	18.3	19.1	13.1
NT servers	6	21	44	86	129	170	265.5	105.5	95.8	49.2	31.8
Other servers	402	309	298	314	307	295	-23.2	-3.7	5.5	- 2.0	-4.2
Server add-ons	290	300	297	293	328	363	3.7	-1.2	- 1.3	11.9	10.7
Workstations	149	166	154	134	121	120	11.7	-7.5	-12.5	-10.1	-0.7
PCs	1,081	1,162	1,193	1,243	1,291	1,294	7.5	2.7	4.2	3.8	0.3
portable	241	296	316	330	344	361	22.8	6.8	4.4	4.2	5.0
desktop	840	866	877	913	947	933	3.1	1.2	4.1	3.7	-1.4
PC/workstation add-ons	297	352	375	386	423	470	18.5	6.6	2.8	9.7	11.0
PC printers	178	215	235	237	251	266	20.5	9.4	0.9	5.6	6.2
Other add-ons	119	137	140	148	172	203	15.4	2.1	5.9	16.2	18.0
Computer hardware	**2,355**	**2,493**	**2,646**	**2,794**	**3,002**	**3,167**	**5.9**	**6.2**	**5.6**	**7.4**	**5.5**
Copiers	109	110	112	112	110	105	1.2	1.6	- 0.1	- 1.8	-4.0
Other office equipment	211	211	210	207	213	214	- 0.3	-0.0	- 1.5	2.5	0.9
Office equipment	**320**	**320**	**322**	**319**	**322**	**320**	**0.2**	**0.5**	**- 1.0**	**1.0**	**-0.7**
LAN hardware	93	130	155	185	213	234	39.9	19.2	19.7	15.1	9.9
Other data communications	30	31	31	31	30	28	4.1	2.0	- 1.7	- 4.2	-5.3
Data communications hardware	**122**	**161**	**186**	**216**	**243**	**262**	**31.3**	**15.9**	**16.1**	**12.4**	**8.0**
IT hardware	**2,797**	**2,974**	**3,155**	**3,330**	**3,567**	**3,749**	**6.3**	**6.1**	**5.5**	**7.1**	**5.1**
Systems software	545	613	674	733	800	907	12.5	10.1	8.7	9.1	13.4
Application software	546	612	678	742	844	981	12.2	10.7	9.4	13.8	16.2
Software products	**1,091**	**1,225**	**1,352**	**1,475**	**1,644**	**1,888**	**12.3**	**10.4**	**9.1**	**11.5**	**14.9**
Consulting	260	273	289	300	319	337	5.1	5.8	4.0	6.1	5.9
Implementation	624	671	759	830	989	1,184	7.5	13.2	9.4	19.1	19.7
Operations management	959	983	1,015	1,089	1,168	1,316	2.5	3.3	7.3	7.3	12.6
Support services	600	603	627	647	674	710	0.5	4.0	3.2	4.2	5.3
Services	**2,443**	**2,530**	**2,690**	**2,867**	**3,150**	**3,547**	**3.6**	**6.4**	**6.6**	**9.9**	**12.6**
Software and services	**3,533**	**3,755**	**4,043**	**4,341**	**4,794**	**5,435**	**6.3**	**7.7**	**7.4**	**10.4**	**13.4**
Total IT market	**6,330**	**6,728**	**7,197**	**7,671**	**8,360**	**9,185**	**6.3**	**7.0**	**6.6**	**9.0**	**9.9**
Switching	328	300	271	248	235	224	- 8.4	-9.7	- 8.7	- 5.0	-4.9
Transmission	285	295	294	301	312	321	3.7	-0.4	2.4	3.5	3.0
Mobile communications infrastructure	79	81	82	85	87	90	2.4	2.1	2.8	2.3	4.6
Public network equipment	691	676	647	633	633	635	- 2.2	-4.2	- 2.2	0.0	0.3
PABX and key systems	104	102	100	98	98	98	- 1.6	-1.8	- 2.0	0.0	-0.0
Telephone sets	204	221	231	238	245	254	8.2	4.6	3.0	3.1	3.5
Mobile terminal equipment	81	82	85	91	102	108	1.9	3.3	7.3	11.7	6.2
Other terminal equipment	121	129	144	167	194	223	6.6	11.4	16.1	16.2	15.0
Private network equipment	**510**	**534**	**560**	**594**	**639**	**683**	**4.8**	**4.8**	**6.1**	**7.6**	**6.9**
Telecom equipment	**1,201**	**1,210**	**1,207**	**1,228**	**1,273**	**1,318**	**0.8**	**-0.2**	**1.7**	**3.7**	**3.6**
Telephone services	3,662	3,414	3,181	3,292	3,397	3,499	- 6.7	-6.8	3.5	3.2	3.0
Mobile telephone services	233	360	554	727	855	940	54.4	53.6	31.3	17.6	9.9
Switched data and leased line services	414	564	905	1,016	1,112	1,196	36.3	60.5	12.2	9.5	7.5
CaTV services	303	395	462	521	568	620	30.3	17.0	12.6	9.2	9.1
Telecom services	**4,612**	**4,734**	**5,102**	**5,556**	**5,933**	**6,255**	**2.6**	**7.8**	**8.9**	**6.8**	**5.4**
Total telecom	**5,813**	**5,944**	**6,310**	**6,783**	**7,206**	**7,574**	**2.3**	**6.2**	**7.5**	**6.2**	**5.1**
Total ICT	**12,143**	**12,672**	**13,507**	**14,454**	**15,566**	**16,758**	**4.4**	**6.6**	**7.0**	**7.7**	**7.7**

Table 26
Switzerland
ICT Market Value (Million ECU)

United Kingdom	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	3,655	3,672	3,830	4,264	4,782	5,276	0.5	4.3	11.3	12.1	10.3
Unix servers	823	965	911	986	1,118	1,281	17.3	-5.6	8.2	13.3	14.6
NT servers	20	82	188	363	543	677	313.4	127.8	93.4	49.3	24.8
Other servers	1,476	1,268	1,324	1,379	1,457	1,499	-14.1	4.4	4.2	5.6	2.9
Server add-ons	1,336	1,357	1,408	1,535	1,665	1,819	1.5	3.7	9.1	8.4	9.3
Workstations	403	469	483	425	389	384	16.3	2.9	-12.0	-8.6	-1.2
PCs	4,109	4,775	5,551	5,992	6,427	6,770	16.2	16.3	7.9	7.3	5.3
portable	1,008	1,154	1,467	1,592	1,720	1,916	14.4	27.1	8.5	8.1	11.4
desktop	3,100	3,621	4,084	4,400	4,707	4,854	16.8	12.8	7.7	7.0	3.1
PC/workstation add-ons	1,235	1,409	1,513	1,622	1,855	2,075	14.1	7.4	7.2	14.3	11.9
PC printers	788	902	963	999	1,112	1,228	14.5	6.7	3.7	11.4	10.4
Other add-ons	446	507	550	624	742	847	13.6	8.6	13.3	19.0	14.1
Computer hardware	**9,402**	**10,326**	**11,378**	**12,303**	**13,452**	**14,505**	**9.8**	**10.2**	**8.1**	**9.3**	**7.8**
Copiers	827	845	846	840	822	787	2.1	0.2	- 0.7	-2.1	-4.2
Other office equipment	778	775	763	781	796	787	- 0.4	-1.5	2.3	1.9	-1.1
Office equipment	**1,605**	**1,620**	**1,610**	**1,621**	**1,618**	**1,575**	**0.9**	**-0.6**	**0.7**	**-0.2**	**-2.7**
LAN hardware	707	904	1,136	1,327	1,514	1,635	27.8	25.7	16.8	14.1	7.9
Other data communications	444	423	407	417	415	391	- 4.8	-3.8	2.5	-0.6	-5.6
Data communications hardware	**1,151**	**1,327**	**1,543**	**1,744**	**1,929**	**2,026**	**15.3**	**16.3**	**13.0**	**10.6**	**5.0**
IT hardware	**12,158**	**13,272**	**14,531**	**15,668**	**16,999**	**18,106**	**9.2**	**9.5**	**7.8**	**8.5**	**6.5**
Systems software	2,252	2,506	2,755	3,100	3,467	3,940	11.3	9.9	12.5	11.8	13.6
Application software	2,099	2,313	2,558	2,908	3,282	3,851	10.2	10.6	13.7	12.9	17.3
Software products	**4,351**	**4,820**	**5,313**	**6,008**	**6,749**	**7,790**	**10.8**	**10.2**	**13.1**	**12.3**	**15.4**
Consulting	564	688	820	933	1,026	1,150	22.1	19.1	13.8	9.9	12.1
Implementation	1,758	2,083	2,309	2,835	3,487	4,185	18.5	10.9	22.8	23.0	20.0
Operations management	3,073	3,263	3,379	3,665	3,947	4,379	6.2	3.6	8.5	7.7	10.9
Support services	2,304	2,333	2,330	2,380	2,448	2,529	1.3	-0.1	2.2	2.8	3.3
Services	**7,698**	**8,367**	**8,838**	**9,814**	**10,908**	**12,244**	**8.7**	**5.6**	**11.0**	**11.2**	**12.2**
Software and services	**12,049**	**13,187**	**14,151**	**15,822**	**17,657**	**20,034**	**9.4**	**7.3**	**11.8**	**11.6**	**13.5**
Total IT market	**24,207**	**26,459**	**28,682**	**31,490**	**34,656**	**38,140**	**9.3**	**8.4**	**9.8**	**10.1**	**10.1**
Switching	702	698	698	707	709	715	- 0.5	-0.1	1.3	0.4	0.8
Transmission	468	494	500	511	516	522	5.7	1.2	2.2	1.0	1.2
Mobile communications infrastructure	410	468	483	505	528	540	14.1	3.1	4.7	4.4	2.3
Public network equipment	**1,580**	**1,661**	**1,681**	**1,723**	**1,753**	**1,777**	**5.1**	**1.2**	**2.6**	**1.7**	**1.4**
PABX and key systems	463	445	428	414	401	389	- 4.0	-3.7	- 3.3	-3.2	-3.0
Telephone sets	486	526	568	603	612	624	8.3	8.0	6.1	1.5	2.0
Mobile terminal equipment	695	722	665	608	572	535	4.0	-8.0	- 8.5	-6.1	-6.3
Other terminal equipment	630	733	893	1,082	1,201	1,340	16.4	21.8	21.2	11.0	11.5
Private network equipment	**2,273**	**2,426**	**2,554**	**2,707**	**2,786**	**2,888**	**6.7**	**5.3**	**6.0**	**2.9**	**3.7**
Telecom equipment	**3,853**	**4,087**	**4,234**	**4,431**	**4,539**	**4,666**	**6.1**	**3.6**	**4.6**	**2.4**	**2.8**
Telephone services	12,058	12,323	12,600	12,906	13,248	13,581	2.2	2.3	2.4	2.7	2.5
Mobile telephone services	1,624	2,789	3,657	4,136	4,550	4,868	71.7	31.1	13.1	10.0	7.0
Switched data and leased line services	2,062	2,796	3,956	4,463	4,849	5,184	35.6	41.5	12.8	8.6	6.9
CaTV services	188	370	672	867	1,091	1,349	96.9	81.5	29.0	25.9	23.6
Telecom services	**15,932**	**18,279**	**20,886**	**22,372**	**23,738**	**24,982**	**14.7**	**14.3**	**7.1**	**6.1**	**5.2**
Total telecom	**19,785**	**22,365**	**25,120**	**26,803**	**28,277**	**29,648**	**13.0**	**12.3**	**6.7**	**5.5**	**4.8**
Total ICT	**43,992**	**48,824**	**53,802**	**58,293**	**62,933**	**67,788**	**11.0**	**10.2**	**8.3**	**8.0**	**7.7**

Table 27
United Kingdom
ICT Market Value (Million ECU)

Table 28
Czech Republic
IT Market Value (Million ECU)

Czech Republic	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	117	115	121	117	136	147	- 2.0	5.1	- 2.6	15.9	8.4
Unix servers	40	45	47	47	54	59	14.1	3.8	0.3	13.3	10.3
NT servers	0	2	13	15	17	20	10900.0	672.7	11.8	15.8	18.2
Other servers	64	52	45	36	42	42	-18.9	-13.6	-18.9	16.6	-1.0
Server add-ons	13	16	15	19	23	26	17.6	- 2.9	23.5	20.8	13.8
Workstations	9	14	14	15	15	16	52.6	1.6	2.3	3.8	7.3
PCs	234	267	308	317	328	359	14.0	15.3	3.2	3.2	9.6
portable	43	52	65	58	58	63	20.0	25.0	-11.5	1.4	8.1
desktop	191	215	243	260	269	296	12.6	13.0	7.1	3.6	9.9
PC/workstation add-ons	86	111	103	110	116	127	29.4	- 7.3	6.8	5.2	9.5
PC printers	64	84	75	80	83	91	32.1	-11.5	7.3	4.2	9.2
Other add-ons	22	27	28	30	32	36	21.4	5.8	5.6	7.9	10.2
Computer hardware	**446**	**507**	**545**	**559**	**595**	**650**	**13.5**	**7.7**	**2.6**	**6.3**	**9.2**
Copiers	42	44	47	50	54	59	6.4	4.8	8.3	7.2	8.5
Other office equipment	20	22	22	23	24	26	11.6	- 0.7	4.0	5.9	7.5
Office equipment	**61**	**66**	**68**	**73**	**78**	**84**	**8.1**	**3.0**	**6.9**	**6.8**	**8.2**
LAN hardware	44	54	58	65	75	86	21.4	9.1	11.7	15.4	13.9
Other data communications	11	13	14	15	17	18	21.4	5.8	5.6	10.5	9.5
Data communications hardware	**55**	**67**	**73**	**80**	**92**	**104**	**21.4**	**8.5**	**10.5**	**14.5**	**13.1**
IT hardware	**563**	**640**	**686**	**713**	**765**	**838**	**13.7**	**7.3**	**3.8**	**7.3**	**9.6**
Systems software	48	57	62	67	74	81	18.0	9.7	7.4	10.6	9.3
Application software	48	59	67	72	77	84	23.0	13.3	8.3	6.5	8.2
Software products	**96**	**116**	**129**	**139**	**151**	**164**	**20.5**	**11.5**	**7.9**	**8.5**	**8.7**
Consulting	36	41	70	72	91	98	14.7	69.0	3.6	25.0	7.8
Implementation	115	152	157	161	193	227	32.0	3.2	2.6	19.6	17.6
Operations management	24	30	66	70	77	90	27.5	115.7	6.9	10.4	16.5
Support services	42	59	91	94	101	112	40.8	54.5	3.3	7.6	10.9
Services	**217**	**283**	**383**	**398**	**462**	**526**	**30.3**	**35.6**	**3.7**	**16.1**	**14.0**
Software and services	**313**	**399**	**513**	**537**	**613**	**691**	**27.3**	**28.6**	**4.7**	**14.1**	**12.7**
Total IT market	**876**	**1,039**	**1,199**	**1,250**	**1,377**	**1,529**	**18.6**	**15.5**	**4.2**	**10.2**	**11.0**

Hungary	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	89	65	83	82	89	107	-27.0	27.1	- 1.4	9.3	20.3
Unix servers	25	14	23	27	28	31	-44.8	63.8	17.2	5.9	8.3
NT servers	0	1	10	12	14	17	2900.0	754.7	17.0	20.0	22.2
Other servers	52	36	36	30	32	43	-31.3	1.7	-17.7	7.9	34.1
Server add-ons	12	14	13	13	14	16	20.0	- 5.6	- 2.9	9.7	11.0
Workstations	10	7	6	8	10	11	-24.2	-16.5	32.7	22.3	9.5
PCs	167	131	147	147	153	160	-21.9	12.3	0.5	4.0	4.7
portable	19	16	18	21	24	26	-15.0	9.3	20.6	13.4	6.6
desktop	148	114	129	126	129	135	-22.7	12.8	- 2.2	2.4	4.3
PC/workstation add-ons	73	72	73	78	85	97	- 2.2	1.7	7.6	8.1	14.7
PC printers	54	48	49	52	57	67	-11.6	2.5	6.5	9.1	17.6
Other add-ons	19	24	24	26	28	30	25.0	0.0	10.0	6.1	8.6
Computer hardware	**339**	**275**	**308**	**316**	**337**	**376**	**-19.0**	**12.3**	**2.3**	**6.8**	**11.5**
Copiers	38	37	36	39	42	45	- 0.8	- 2.9	6.3	7.7	8.9
Other office equipment	12	13	13	14	15	16	13.3	- 1.8	7.8	6.7	5.2
Office equipment	**50**	**51**	**50**	**53**	**57**	**61**	**2.5**	**- 2.6**	**6.7**	**7.5**	**7.9**
LAN hardware	15	18	22	26	32	37	21.1	19.6	17.8	23.5	16.2
Other data communications	9	11	13	14	15	16	16.7	21.4	5.9	8.3	2.6
Data communications hardware	**24**	**29**	**35**	**40**	**47**	**52**	**19.4**	**20.3**	**13.3**	**18.1**	**11.7**
IT hardware	**413**	**355**	**393**	**408**	**441**	**489**	**-14.2**	**10.8**	**3.8**	**8.0**	**11.0**
Systems software	37	42	44	47	50	55	12.8	5.7	5.9	6.7	9.6
Application software	46	50	54	57	62	67	10.3	6.3	5.9	9.2	8.1
Software products	**83**	**92**	**98**	**103**	**112**	**122**	**11.4**	**6.0**	**5.9**	**8.1**	**8.8**
Consulting	25	25	50	54	59	63	- 3.4	101.4	9.0	8.5	8.3
Implementation	44	70	88	104	118	136	58.7	26.7	17.8	13.6	14.6
Operations management	12	17	30	32	40	45	38.3	78.8	6.4	23.6	12.8
Support services	37	43	54	57	63	67	17.3	25.5	4.8	10.5	7.0
Services	**119**	**155**	**223**	**248**	**280**	**312**	**30.4**	**44.0**	**11.1**	**13.1**	**11.3**
Software and services	**201**	**247**	**320**	**351**	**392**	**433**	**22.6**	**29.8**	**9.5**	**11.6**	**10.6**
Total IT market	**615**	**602**	**713**	**759**	**832**	**923**	**- 2.1**	**18.6**	**6.4**	**9.7**	**10.8**

Table 29
Hungary
IT Market Value (Million ECU)

Table 30
Poland
IT Market Value (Million ECU)

Poland	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	86	95	134	137	159	178	10.4	41.0	2.4	16.1	11.8
Unix servers	38	41	49	47	52	59	8.3	19.7	-3.2	10.0	13.6
NT servers	0	2	9	12	15	18	7650.0	287.1	31.7	23.4	17.9
Other servers	34	36	57	57	65	71	5.3	59.3	-0.6	14.3	9.1
Server add-ons	14	16	18	20	27	30	11.1	16.5	11.6	30.8	11.5
Workstations	7	10	13	15	17	17	54.8	22.0	18.4	10.5	4.8
PCs	258	320	399	466	525	577	23.9	24.9	16.6	12.7	10.1
portable	20	34	45	52	58	65	65.4	32.6	15.8	12.1	12.2
desktop	238	286	355	414	466	512	20.3	24.0	16.7	12.8	9.8
PC/workstation add-ons	107	133	140	145	153	166	24.3	5.4	3.0	5.6	9.0
PC printers	78	99	105	108	113	123	27.3	5.7	2.5	5.0	9.0
Other add-ons	29	34	35	37	40	43	16.2	4.7	4.4	7.4	8.9
Computer hardware	**458**	**558**	**686**	**762**	**853**	**939**	**21.9**	**23.0**	**11.1**	**11.9**	**10.1**
Copiers	44	50	57	64	72	81	12.7	14.1	12.5	13.5	12.4
Other office equipment	22	25	32	35	37	40	13.2	29.0	7.6	7.0	7.0
Office equipment	**66**	**75**	**89**	**98**	**110**	**121**	**12.9**	**19.1**	**10.7**	**11.2**	**10.6**
LAN hardware	38	48	61	71	87	100	27.1	27.9	15.1	22.4	15.1
Other data communications	17	20	23	24	26	28	19.0	16.0	6.9	6.5	9.1
Data communications hardware	**54**	**68**	**84**	**95**	**113**	**128**	**24.6**	**24.4**	**12.9**	**18.3**	**13.7**
IT hardware	**578**	**701**	**860**	**956**	**1,075**	**1,188**	**21.1**	**22.7**	**11.2**	**12.5**	**10.5**
Systems software	43	46	56	65	74	84	7.4	22.4	16.9	13.3	12.8
Application software	35	44	68	88	102	112	24.4	53.6	30.2	15.2	10.1
Software products	**78**	**90**	**124**	**154**	**176**	**195**	**15.2**	**37.7**	**24.2**	**14.4**	**11.2**
Consulting	9	10	35	41	49	59	18.9	243.2	17.4	20.0	20.2
Implementation	41	80	133	171	200	230	94.6	66.0	29.0	16.6	15.4
Operations management	12	16	30	37	40	45	33.4	83.8	22.9	7.9	13.2
Support services	28	61	71	82	94	100	122.9	15.4	15.5	14.4	6.7
Services	**89**	**168**	**268**	**331**	**382**	**435**	**87.7**	**60.0**	**23.3**	**15.5**	**13.7**
Software and services	**167**	**258**	**392**	**485**	**558**	**630**	**53.9**	**52.2**	**23.6**	**15.2**	**12.9**
Total IT market	**746**	**958**	**1,252**	**1,440**	**1,633**	**1,818**	**28.5**	**30.6**	**15.1**	**13.4**	**11.3**

Russia	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	162	226	204	278	354	462	39.9	- 9.8	36.4	27.3	30.6
Unix servers	47	60	65	95	112	126	27.1	8.7	44.6	18.3	12.7
NT servers	0	9	33	43	57	60	29150.0	259.0	31.0	30.9	5.6
Other servers	95	127	67	95	132	210	32.9	-47.2	42.4	38.8	58.9
Server add-ons	19	30	38	45	53	66	58.3	28.6	16.7	17.9	24.4
Workstations	18	24	17	20	23	27	34.5	-26.2	12.9	16.8	16.4
PCs	676	760	1,091	1,335	1,549	1,824	12.4	43.6	22.4	16.0	17.8
portable	69	76	98	106	114	130	10.3	30.2	8.0	7.4	13.8
desktop	607	684	993	1,229	1,435	1,694	12.7	45.1	23.8	16.7	18.1
PC/workstation add-ons	221	240	257	300	328	360	8.5	6.8	16.9	9.5	9.7
PC printers	167	176	182	216	234	257	5.2	3.4	18.6	8.5	9.9
Other add-ons	54	65	75	84	95	103	18.8	15.9	12.6	12.1	9.2
Computer hardware	**1,076**	**1,250**	**1,569**	**1,933**	**2,254**	**2,673**	**16.1**	**25.5**	**23.2**	**16.6**	**18.6**
Copiers	195	219	230	265	306	261	12.6	5.0	15.4	15.1	-14.7
Other office equipment	77	84	92	108	124	140	8.2	10.4	17.1	15.3	12.7
Office equipment	**272**	**303**	**322**	**373**	**430**	**401**	**11.3**	**6.5**	**15.9**	**15.2**	**- 6.8**
LAN hardware	68	95	112	129	143	161	40.7	17.4	15.5	10.4	13.3
Other data communications	25	46	58	60	62	65	81.3	27.6	2.7	3.9	5.1
Data communications hardware	**93**	**141**	**170**	**189**	**205**	**227**	**51.7**	**20.7**	**11.1**	**8.3**	**10.8**
IT hardware	**1,441**	**1,693**	**2,061**	**2,495**	**2,889**	**3,301**	**17.5**	**21.7**	**21.1**	**15.8**	**14.3**
Systems software	40	52	56	61	65	71	29.4	7.6	9.9	6.4	9.0
Application software	62	85	94	101	113	127	36.7	10.2	7.6	11.7	12.6
Software products	**102**	**137**	**150**	**162**	**178**	**198**	**33.8**	**9.2**	**8.4**	**9.7**	**11.3**
Consulting	11	20	24	29	35	41	78.6	20.0	23.3	21.6	15.6
Implementation	73	106	127	155	185	215	44.0	20.1	22.3	19.3	16.2
Operations management	10	20	31	36	44	50	102.1	54.4	15.1	21.9	14.4
Support services	71	92	99	116	129	147	30.0	7.7	16.7	11.6	14.0
Services	**165**	**238**	**281**	**336**	**394**	**454**	**43.8**	**18.2**	**19.6**	**17.1**	**15.2**
Software and services	**268**	**375**	**431**	**499**	**572**	**652**	**40.0**	**14.9**	**15.7**	**14.7**	**14.0**
Total IT market	**1,709**	**2,068**	**2,492**	**2,994**	**3,461**	**3,953**	**21.0**	**20.5**	**20.1**	**15.6**	**14.2**

Table 31
Russia
IT Market Value (Million ECU)

Table 32
Slovakia
IT Market Value (Million ECU)

Slovakia	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	27	44	50	47	51	57	61.0	13.1	- 5.2	8.2	11.1
Unix servers	13	24	18	18	18	18	84.1	-25.1	0.0	0.0	0.0
NT servers	0	0	5	7	10	12	2550.0	1032.1	50.0	41.1	22.0
Other servers	12	16	22	17	17	19	37.5	35.7	-25.0	1.4	12.2
Server add-ons	2	3	5	5	6	8	33.3	54.8	11.5	13.0	23.1
Workstations	2	3	5	5	5	6	68.1	52.5	0.0	11.5	16.2
PCs	52	63	90	110	132	153	21.5	41.8	22.8	19.3	16.2
portable	6	10	18	24	28	33	62.5	76.9	30.4	16.7	20.0
desktop	46	53	72	87	104	120	15.8	35.0	20.9	20.0	15.2
PC/workstation add-ons	20	26	30	34	40	46	24.8	16.4	14.0	17.5	14.7
PC printers	16	20	24	26	30	34	27.3	19.0	10.9	13.2	15.1
Other add-ons	5	6	6	7	10	11	16.7	7.1	26.7	32.6	13.5
Computer hardware	**102**	**136**	**174**	**196**	**228**	**262**	**33.6**	**28.0**	**12.7**	**16.1**	**14.8**
Copiers	13	15	16	17	19	20	11.8	5.3	10.0	9.1	8.3
Other office equipment	9	9	10	11	11	12	9.1	8.3	7.7	0.0	7.1
Office equipment	**22**	**24**	**26**	**28**	**30**	**32**	**10.7**	**6.5**	**9.1**	**5.6**	**7.9**
LAN hardware	12	17	20	24	29	34	36.4	22.6	16.5	23.3	16.5
Other data communications	2	2	2	2	3	3	50.0	-10.0	14.8	16.1	16.7
Data communications hardware	**14**	**19**	**22**	**26**	**32**	**37**	**37.9**	**18.5**	**16.4**	**22.6**	**16.5**
IT hardware	**138**	**179**	**223**	**251**	**290**	**331**	**30.4**	**24.1**	**12.6**	**15.6**	**14.3**
Systems software	9	12	17	21	25	27	36.4	46.7	21.8	17.9	10.1
Application software	7	14	18	20	23	25	100.0	27.8	8.7	15.2	11.1
Software products	**16**	**26**	**35**	**41**	**48**	**53**	**65.0**	**36.4**	**15.1**	**16.6**	**10.6**
Consulting	3	4	5	6	8	10	25.0	20.0	33.3	25.0	30.0
Implementation	18	23	24	27	33	39	25.8	3.4	13.2	23.4	16.6
Operations management	5	6	7	8	8	9	26.0	12.9	11.4	8.2	8.5
Support services	7	8	9	11	13	15	11.1	20.0	20.8	15.2	13.8
Services	**33**	**41**	**45**	**52**	**63**	**73**	**22.6**	**9.6**	**16.7**	**19.5**	**16.6**
Software and services	**49**	**67**	**80**	**93**	**110**	**126**	**36.2**	**20.0**	**16.0**	**18.3**	**14.0**
Total IT market	**187**	**246**	**303**	**344**	**400**	**457**	**31.9**	**23.0**	**13.5**	**16.3**	**14.2**

EU	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	19,202	19,285	19,690	21,269	22,902	24,470	0.4	2.1	8.0	7.7	6.8
Unix servers	3,576	4,384	4,532	4,840	5,211	5,594	22.6	3.4	6.8	7.7	7.4
NT servers	80	394	834	1,593	2,359	3,056	391.2	111.8	91.1	48.1	29.6
Other servers	8,551	7,429	7,052	7,155	7,193	7,158	-13.1	-5.1	1.5	0.5	-0.5
Server add-ons	6,995	7,078	7,272	7,682	8,139	8,661	1.2	2.7	5.6	6.0	6.4
Workstations	2,435	2,717	2,674	2,370	2,195	2,131	11.6	-1.6	-11.4	-7.3	-3.0
PCs	19,515	22,956	25,188	27,250	29,256	31,178	17.6	9.7	8.2	7.4	6.6
portable	4,105	4,894	5,788	6,368	6,976	7,742	19.2	18.3	10.0	9.5	11.0
desktop	15,410	18,063	19,400	20,882	22,280	23,436	17.2	7.4	7.6	6.7	5.2
PC/workstation add-ons	6,780	7,913	8,544	9,239	10,175	11,107	16.7	8.0	8.1	10.1	9.2
PC printers	4,566	5,323	5,674	5,969	6,370	6,735	16.6	6.6	5.2	6.7	5.7
Other add-ons	2,213	2,591	2,870	3,269	3,805	4,372	17.1	10.8	13.9	16.4	14.9
Computer hardware	**47,931**	**52,872**	**56,096**	**60,128**	**64,528**	**68,886**	**10.3**	**6.1**	**7.2**	**7.3**	**6.8**
Copiers	4,919	5,015	5,062	5,124	5,187	5,134	1.9	1.0	1.2	1.2	-1.0
Other office equipment	3,824	3,815	3,748	3,765	3,797	3,777	- 0.2	-1.8	0.5	0.8	-0.5
Office equipment	**8,743**	**8,830**	**8,810**	**8,889**	**8,983**	**8,911**	**1.0**	**-0.2**	**0.9**	**1.1**	**-0.8**
LAN hardware	2,679	3,264	3,972	4,643	5,302	5,825	21.8	21.7	16.9	14.2	9.9
Other data communications	1,376	1,378	1,364	1,402	1,413	1,375	0.1	-1.0	2.7	0.8	-2.7
Data communications hardware	**4,055**	**4,642**	**5,337**	**6,044**	**6,715**	**7,200**	**14.5**	**15.0**	**13.3**	**11.1**	**7.2**
IT hardware	**60,729**	**66,343**	**70,243**	**75,062**	**80,226**	**84,998**	**9.2**	**5.9**	**6.9**	**6.9**	**5.9**
Systems software	12,342	13,372	14,368	15,565	16,951	18,711	8.3	7.4	8.3	8.9	10.4
Application software	11,950	13,229	14,536	16,046	17,839	20,316	10.7	9.9	10.4	11.2	13.9
Software products	**24,292**	**26,600**	**28,903**	**31,611**	**34,790**	**39,027**	**9.5**	**8.7**	**9.4**	**10.1**	**12.2**
Consulting	3,855	4,291	4,814	5,450	6,162	6,888	11.3	12.2	13.2	13.1	11.8
Implementation	12,941	14,185	15,522	17,884	21,065	24,729	9.6	9.4	15.2	17.8	17.4
Operations management	15,261	16,122	17,248	18,934	21,199	24,399	5.6	7.0	9.8	12.0	15.1
Support services	14,551	14,432	14,526	14,781	15,156	15,672	- 0.8	0.7	1.8	2.5	3.4
Services	**46,607**	**49,029**	**52,110**	**57,049**	**63,581**	**71,687**	**5.2**	**6.3**	**9.5**	**11.4**	**12.7**
Software and services	**70,900**	**75,630**	**81,014**	**88,660**	**98,371**	**110,714**	**6.7**	**7.1**	**9.4**	**11.0**	**12.5**
Total IT market	**131,629**	**141,973**	**151,256**	**163,721**	**178,597**	**195,712**	**7.9**	**6.5**	**8.2**	**9.1**	**9.6**
Switching	7,202	6,608	6,297	5,942	5,398	5,260	- 8.2	-4.7	- 5.6	-9.2	-2.5
Transmission	3,298	3,338	3,362	3,380	3,603	3,787	1.2	0.7	0.6	6.6	5.1
Mobile communications infrastructure	1,905	2,493	2,817	3,278	3,817	4,372	30.9	13.0	16.4	16.5	14.5
Public network equipment	**12,405**	**12,440**	**12,475**	**12,600**	**12,818**	**13,418**	**0.3**	**0.3**	**1.0**	**1.7**	**4.7**
PABX and key systems	2,984	2,998	3,031	2,980	3,028	3,079	0.4	1.1	- 1.7	1.6	1.7
Telephone sets	4,033	4,305	4,556	4,719	4,920	5,112	6.7	5.8	3.6	4.3	3.9
Mobile terminal equipment	2,531	2,946	3,308	3,605	3,803	4,014	16.4	12.3	9.0	5.5	5.5
Other terminal equipment	3,424	3,800	4,348	4,996	5,637	6,336	11.0	14.4	14.9	12.8	12.4
Private network equipment	**12,973**	**14,048**	**15,243**	**16,301**	**17,389**	**18,541**	**8.3**	**8.5**	**6.9**	**6.7**	**6.6**
Telecom equipment	**25,378**	**26,488**	**27,719**	**28,901**	**30,207**	**31,960**	**4.4**	**4.6**	**4.3**	**4.5**	**5.8**
Telephone services	86,208	89,681	90,603	93,303	96,105	98,841	4.0	1.0	3.0	3.0	2.8
Mobile telephone services	8,396	12,826	18,484	23,382	28,182	32,003	52.8	44.1	26.5	20.5	13.6
Switched data and leased line services	10,941	13,850	17,597	20,734	23,545	25,935	26.6	27.0	17.8	13.6	10.2
CaTV services	3,050	3,805	4,557	5,156	5,826	6,636	24.7	19.8	13.1	13.0	13.9
Telecom services	**108,596**	**120,162**	**131,241**	**142,575**	**153,658**	**163,415**	**10.7**	**9.2**	**8.6**	**7.8**	**6.4**
Total telecom	**133,973**	**146,650**	**158,960**	**171,477**	**183,864**	**195,375**	**9.5**	**8.4**	**7.9**	**7.2**	**6.3**
Total ICT	**265,602**	**288,623**	**310,216**	**335,198**	**362,461**	**391,087**	**8.7**	**7.5**	**8.1**	**8.1**	**7.9**

Table 33
EU
ICT Market Value (Million ECU)

Western Europe	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	20,254	20,309	20,886	22,635	24,451	26,180	0.3	2.8	8.4	8.0	7.1
Unix servers	3,751	4,620	4,878	5,246	5,689	6,134	23.2	5.6	7.5	8.5	7.8
NT servers	88	426	903	1,728	2,559	3,319	381.8	112.1	91.4	48.1	29.7
Other servers	9,050	7,807	7,442	7,567	7,603	7,555	-13.7	-4.7	1.7	0.5	-0.6
Server add-ons	7,364	7,457	7,663	8,094	8,599	9,172	1.3	2.8	5.6	6.2	6.7
Workstations	2,634	2,935	2,879	2,550	2,359	2,291	11.4	-1.9	-11.4	-7.5	-2.9
PCs	21,100	24,773	27,082	29,243	31,298	33,198	17.4	9.3	8.0	7.0	6.1
portable	4,447	5,308	6,236	6,841	7,465	8,250	19.4	17.5	9.7	9.1	10.5
desktop	16,653	19,464	20,846	22,402	23,833	24,948	16.9	7.1	7.5	6.4	4.7
PC/workstation add-ons	7,209	8,428	9,097	9,830	10,825	11,820	16.9	7.9	8.1	10.1	9.2
PC printers	4,822	5,634	6,011	6,324	6,749	7,135	16.8	6.7	5.2	6.7	5.7
Other add-ons	2,387	2,795	3,086	3,506	4,076	4,685	17.1	10.4	13.6	16.3	15.0
Computer hardware	**51,198**	**56,445**	**59,944**	**64,258**	**68,932**	**73,490**	**10.2**	**6.2**	**7.2**	**7.3**	**6.6**
Copiers	5,098	5,190	5,237	5,300	5,359	5,300	1.8	0.9	1.2	1.1	-1.1
Other office equipment	4,108	4,098	4,028	4,043	4,082	4,066	- 0.3	-1.7	0.4	1.0	-0.4
Office equipment	**9,206**	**9,287**	**9,265**	**9,343**	**9,441**	**9,366**	**0.9**	**-0.2**	**0.8**	**1.1**	**-0.8**
LAN hardware	2,828	3,477	4,229	4,942	5,637	6,185	23.0	21.6	16.9	14.1	9.7
Other data communications	1,440	1,445	1,434	1,473	1,484	1,444	0.3	-0.8	2.7	0.8	-2.7
Data communications hardware	**4,268**	**4,922**	**5,663**	**6,414**	**7,121**	**7,629**	**15.3**	**15.1**	**13.3**	**11.0**	**7.1**
IT hardware	**64,672**	**70,654**	**74,872**	**80,015**	**85,494**	**90,484**	**9.2**	**6.0**	**6.9**	**6.8**	**5.8**
Systems software	13,086	14,196	15,271	16,560	18,054	19,972	8.5	7.6	8.4	9.0	10.6
Application software	12,700	14,054	15,445	17,047	18,980	21,649	10.7	9.9	10.4	11.3	14.1
Software products	**25,787**	**28,251**	**30,716**	**33,607**	**37,034**	**41,621**	**9.6**	**8.7**	**9.4**	**10.2**	**12.4**
Consulting	4,221	4,678	5,229	5,890	6,638	7,402	10.8	11.8	12.6	12.7	11.5
Implementation	13,931	15,248	16,707	19,185	22,599	26,549	9.5	9.6	14.8	17.8	17.5
Operations management	16,470	17,369	18,548	20,339	22,734	26,141	5.5	6.8	9.7	11.8	15.0
Support services	15,434	15,318	15,439	15,717	16,124	16,688	- 0.7	0.8	1.8	2.6	3.5
Services	**50,056**	**52,613**	**55,922**	**61,132**	**68,095**	**76,781**	**5.1**	**6.3**	**9.3**	**11.4**	**12.8**
Software and services	**75,842**	**80,864**	**86,638**	**94,739**	**105,129**	**118,402**	**6.6**	**7.1**	**9.3**	**11.0**	**12.6**
Total IT market	**140,514**	**151,517**	**161,510**	**174,753**	**190,622**	**208,886**	**7.8**	**6.6**	**8.2**	**9.1**	**9.6**
Switching	7,642	7,016	6,670	6,286	5,726	5,577	- 8.2	-4.9	- 5.8	-8.9	-2.6
Transmission	3,680	3,734	3,756	3,785	4,026	4,225	1.5	0.6	0.8	6.4	4.9
Mobile communications infrastructure	2,027	2,621	2,948	3,415	3,964	4,528	29.3	12.5	15.8	16.1	14.2
Public network equipment	**13,349**	**13,372**	**13,374**	**13,486**	**13,716**	**14,330**	**0.2**	**0.0**	**0.8**	**1.7**	**4.5**
PABX and key systems	3,120	3,131	3,162	3,109	3,157	3,208	0.4	1.0	- 1.7	1.5	1.6
Telephone sets	4,299	4,591	4,859	5,033	5,244	5,448	6.8	5.8	3.6	4.2	3.9
Mobile terminal equipment	2,729	3,133	3,484	3,783	3,991	4,208	14.8	11.2	8.6	5.5	5.4
Other terminal equipment	3,590	3,977	4,547	5,229	5,909	6,651	10.8	14.3	15.0	13.0	12.6
Private network equipment	**13,738**	**14,833**	**16,052**	**17,154**	**18,301**	**19,515**	**8.0**	**8.2**	**6.9**	**6.7**	**6.6**
Telecom equipment	**27,087**	**28,204**	**29,425**	**30,639**	**32,017**	**33,845**	**4.1**	**4.3**	**4.1**	**4.5**	**5.7**
Telephone services	91,164	94,473	95,246	98,090	101,030	103,901	3.6	0.8	3.0	3.0	2.8
Mobile telephone services	8,895	13,570	19,525	24,674	29,655	33,603	52.6	43.9	26.4	20.2	13.3
Switched data and leased line services	11,433	14,549	18,779	22,067	25,004	27,503	27.3	29.1	17.5	13.3	10.0
CaTV services	3,394	4,245	5,073	5,738	6,463	7,333	25.1	19.5	13.1	12.6	13.5
Telecom services	**114,886**	**126,837**	**138,623**	**150,569**	**162,152**	**172,340**	**10.4**	**9.3**	**8.6**	**7.7**	**6.3**
Total telecom	**141,973**	**155,042**	**168,048**	**181,208**	**194,169**	**206,185**	**9.2**	**8.4**	**7.8**	**7.2**	**6.2**
Total ICT	**282,487**	**306,559**	**329,559**	**355,962**	**384,792**	**415,071**	**8.5**	**7.5**	**8.0**	**8.1**	**7.9**

Table 34
Western Europe
ICT Market Value (Million ECU)

Eastern Europe	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Total server	481	545	591	661	789	952	13.2	8.5	11.9	19.3	20.6
Unix servers	163	185	202	234	264	293	13.1	9.7	15.6	12.8	11.0
NT servers	0	15	71	90	114	128	11094.1	372.0	26.7	26.7	12.7
Other servers	257	267	227	235	289	385	3.6	-14.7	3.3	22.9	33.4
Server add-ons	61	79	90	103	123	145	29.9	14.8	13.6	19.7	18.0
Workstations	45	59	55	62	70	77	30.1	- 5.5	12.5	12.5	10.7
PCs	1,387	1,540	2,035	2,376	2,686	3,074	11.0	32.1	16.8	13.0	14.4
portable	158	188	244	261	282	317	19.2	29.9	6.8	8.3	12.3
desktop	1,230	1,352	1,791	2,115	2,404	2,757	10.0	32.4	18.1	13.6	14.7
PC/workstation add-ons	508	582	603	667	721	796	14.5	3.6	10.7	8.2	10.4
PC printers	379	427	434	482	517	573	12.8	1.6	11.0	7.3	10.8
Other add-ons	129	154	168	185	204	223	19.5	8.9	9.8	10.5	9.4
Computer hardware	**2,421**	**2,725**	**3,283**	**3,766**	**4,267**	**4,899**	**12.5**	**20.5**	**14.7**	**13.3**	**14.8**
Copiers	332	366	385	436	493	467	10.2	5.4	13.0	13.1	-5.3
Other office equipment	139	153	170	190	212	234	9.9	10.6	12.3	11.2	10.3
Office equipment	**471**	**519**	**555**	**626**	**704**	**700**	**10.2**	**7.0**	**12.8**	**12.5**	**-0.6**
LAN hardware	177	232	274	314	365	418	31.0	18.2	14.9	16.2	14.3
Other data communications	64	92	111	116	123	131	44.4	20.2	4.6	6.1	6.5
Data communications hardware	**241**	**324**	**385**	**430**	**488**	**549**	**34.6**	**18.8**	**11.9**	**13.5**	**12.3**
IT hardware	**3,133**	**3,568**	**4,223**	**4,823**	**5,459**	**6,148**	**13.9**	**18.4**	**14.2**	**13.2**	**12.6**
Systems software	176	208	236	261	288	318	17.9	13.2	11.0	10.2	10.3
Application software	199	253	300	338	376	414	27.4	18.7	12.6	11.3	10.2
Software products	**375**	**461**	**536**	**599**	**664**	**732**	**22.9**	**16.2**	**11.9**	**10.8**	**10.2**
Consulting	84	100	183	203	242	271	18.4	83.1	11.0	19.1	12.3
Implementation	292	431	529	619	729	847	47.4	22.8	17.0	17.8	16.1
Operations management	63	90	164	183	210	240	42.5	82.2	11.5	14.4	14.4
Support services	184	264	325	360	400	442	43.1	23.2	10.8	11.1	10.4
Services	**624**	**884**	**1,201**	**1,365**	**1,580**	**1,799**	**41.7**	**35.8**	**13.7**	**15.8**	**13.9**
Software and services	**999**	**1,345**	**1,736**	**1,964**	**2,245**	**2,531**	**34.7**	**29.1**	**13.1**	**14.3**	**12.8**
Total IT market	**4,132**	**4,913**	**5,959**	**6,787**	**7,704**	**8,679**	**18.9**	**21.3**	**13.9**	**13.5**	**12.7**
Total Telecom	**6,246**	**6,238**	**7,036**	**8,230**	**9,089**	**9,719**	**0.6**	**12.0**	**17.0**	**10.4**	**6.9**
Total ICT	**10,378**	**11,196**	**12,995**	**15,017**	**16,793**	**18,398**	**7.9**	**16.1**	**15.6**	**11.8**	**9.6**

Table 35
Eastern Europe
ICT Market Value (Million ECU)

Table 36
Austria
IT Hardware Shipments (Units)

Austria	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	2,336	3,514	3,819	4,150	4,270	4,390	50.4	8.7	8.7	2.9	2.8
NT servers	279	911	2,611	4,920	6,580	7,170	227.0	186.6	88.5	33.7	9.0
Other servers	3,823	4,232	6,921	8,827	9,043	9,287	10.7	63.5	27.5	2.4	2.7
Workstations	3,181	3,694	3,406	3,474	3,557	3,636	16.1	- 7.8	2.0	2.4	2.2
PCs	323,317	392,255	360,346	387,882	407,919	439,134	21.3	- 8.1	7.6	5.2	7.7
portable	46,000	50,600	51,881	59,653	61,431	69,420	10.0	2.5	15.0	3.0	13.0
desktop	277,317	341,655	308,465	328,229	346,488	369,714	23.2	- 9.7	6.4	5.6	6.7
PC printers	224,077	263,914	315,169	373,445	425,834	479,446	17.8	19.4	18.5	14.0	12.6
Typewriters	24,745	20,926	17,755	14,417	11,694	9,805	-15.4	-15.2	-18.8	-18.9	-16.2
Calculators	418,666	426,309	434,213	441,987	451,367	460,033	1.8	1.9	1.8	2.1	1.9
Copiers	21,221	21,860	22,834	23,413	23,902	24,698	3.0	4.5	2.5	2.1	3.3
LAN cards	108,000	134,000	170,000	205,000	227,000	263,000	24.1	26.9	20.6	10.7	15.9

Table 37
Belgium/Luxembourg
IT Hardware Shipments (Units)

Belgium/ Luxembourg	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	2,506	4,227	4,821	4,950	4,950	4,950	68.7	14.0	2.7	0.0	0.0
NT servers	458	1,892	3,980	7,250	7,300	7,300	313.4	110.3	82.2	0.7	0.0
Other servers	5,900	6,949	8,739	11,394	11,379	11,379	17.8	25.8	30.4	-0.1	0.0
Workstations	5,455	6,289	5,777	5,916	6,058	6,252	15.3	-8.1	2.4	2.4	3.2
PCs	304,132	354,379	383,640	424,199	466,589	489,221	16.5	8.3	10.6	10.0	4.9
portable	54,666	57,465	64,654	82,094	88,028	88,297	5.1	12.5	27.0	7.2	0.3
desktop	249,466	296,914	318,987	342,105	378,560	400,924	19.0	7.4	7.2	10.7	5.9
PC printers	268,146	305,225	369,156	434,092	480,442	525,589	13.8	20.9	17.6	10.7	9.4
Typewriters	43,129	40,714	38,159	35,787	33,195	31,227	-5.6	-6.3	-6.2	-7.2	-5.9
Calculators	569,895	590,228	614,993	640,042	664,277	688,344	3.6	4.2	4.1	3.8	3.6
Copiers	34,692	35,664	36,612	37,439	38,771	39,845	2.8	2.7	2.3	3.6	2.8
LAN cards	201,000	253,000	300,000	384,000	442,000	501,000	25.9	18.6	28.0	15.1	13.3

Table 38
Denmark
IT Hardware Shipments (Units)

Denmark	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	1,654	2,545	2,552	2,400	2,370	2,450	53.9	0.3	- 6.0	- 1.3	3.4
NT servers	184	1,285	2,805	5,130	6,870	7,540	599.9	118.3	82.9	33.9	9.8
Other servers	3,378	5,658	7,324	8,805	9,034	9,258	67.5	29.4	20.2	2.6	2.5
Workstations	2,287	2,749	2,290	2,329	2,384	2,435	20.2	-16.7	1.7	2.4	2.1
PCs	323,317	392,255	439,146	444,578	424,842	429,982	21.3	12.0	1.2	- 4.4	1.2
portable	46,000	50,600	62,440	69,950	69,900	73,885	10.0	23.4	12.0	- 0.1	5.7
desktop	277,317	341,655	376,706	374,628	354,942	356,098	23.2	10.3	- 0.6	- 5.3	0.3
PC printers	250,345	274,520	322,676	382,815	417,623	455,285	9.7	17.5	18.6	9.1	9.0
Typewriters	24,653	22,255	19,863	17,178	14,866	13,446	-9.7	-10.7	-13.5	-13.5	-9.6
Calculators	437,233	442,042	455,166	468,783	482,076	495,876	1.1	3.0	3.0	2.8	2.9
Copiers	22,410	24,023	25,027	26,484	27,331	28,047	7.2	4.2	5.8	3.2	2.6
LAN cards	203,000	234,700	280,000	309,000	316,000	334,000	15.6	19.3	10.4	2.3	5.7

Finland	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	1,283	1,998	2,291	2,586	2,650	2,760	55.8	14.6	12.9	2.5	4.2
NT servers	233	1,265	2,513	4,740	6,330	6,820	443.8	98.6	88.6	33.5	7.7
Other servers	2,903	3,357	5,203	7,131	7,338	7,489	15.7	55.0	37.1	2.9	2.1
Workstations	3,246	3,776	3,619	3,733	3,824	3,901	16.3	-4.2	3.2	2.4	2.0
PCs	202,878	284,855	330,936	367,305	390,123	421,558	40.4	16.2	11.0	6.2	8.1
portable	24,920	34,290	42,296	48,196	51,880	57,561	37.6	23.3	13.9	7.6	10.9
desktop	177,958	250,565	288,640	319,109	338,243	363,997	40.8	15.2	10.6	6.0	7.6
PC printers	123,198	185,207	202,529	245,053	297,162	336,023	50.3	9.4	21.0	21.3	13.1
Typewriters	15,869	15,075	14,270	13,294	12,835	12,563	-5.0	-5.3	-6.8	-3.5	-2.1
Calculators	320,398	323,602	327,520	330,781	334,227	338,768	1.0	1.2	1.0	1.0	1.4
Copiers	23,227	23,924	24,636	25,429	26,428	27,597	3.0	3.0	3.2	3.9	4.4
LAN cards	174,000	266,000	267,000	288,000	318,000	364,000	52.9	0.4	7.9	10.4	14.5

Table 39
Finland
IT Hardware Shipments (Units)

France	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	13,834	17,549	21,477	21,800	20,800	17,840	26.9	22.4	1.5	-4.6	-14.2
NT servers	2,126	9,786	14,751	28,100	37,600	41,000	360.3	50.7	90.5	33.8	9.0
Other servers	29,733	31,888	39,756	48,093	49,076	50,266	7.2	24.7	21.0	2.0	2.4
Workstations	27,548	32,693	31,331	32,401	33,255	33,861	18.7	-4.2	3.4	2.6	1.8
PCs	1,949,290	2,315,268	2,647,621	3,076,569	3,543,599	3,965,119	18.8	14.4	16.2	15.2	11.9
portable	272,882	295,804	345,565	400,752	469,825	528,693	8.4	16.8	16.0	17.2	12.5
desktop	1,676,408	2,019,464	2,302,056	2,675,817	3,073,774	3,436,426	20.5	14.0	16.2	14.9	11.8
PC printers	1,328,297	1,648,938	1,981,024	2,279,677	2,483,042	2,714,661	24.1	20.1	15.1	8.9	9.3
Typewriters	212,691	192,060	175,564	158,641	143,240	130,987	-9.7	-8.6	-9.6	-9.7	- 8.6
Calculators	3,312,789	3,528,121	3,656,456	3,907,665	4,168,353	4,393,897	6.5	3.6	6.9	6.7	5.4
Copiers	189,638	195,327	200,123	204,930	208,324	211,370	3.0	2.5	2.4	1.7	1.5
LAN cards	914,000	1,188,900	1,451,000	1,913,000	2,363,000	2,793,000	30.1	22.0	31.8	23.5	18.2

Table 40
France
IT Hardware Shipments (Units)

Germany	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	34,511	36,715	32,146	33,200	32,100	30,900	6.4	-12.4	3.3	- 3.3	- 3.7
NT servers	2,530	12,156	19,824	39,200	52,400	57,200	380.5	63.1	97.7	33.7	9.2
Other servers	61,123	73,997	60,872	82,720	84,896	86,802	21.1	-17.7	35.9	2.6	2.2
Workstations	44,761	53,192	52,970	53,836	55,001	56,221	18.8	- 0.4	1.6	2.2	2.2
PCs	3,512,481	3,860,648	4,010,763	4,515,356	4,988,233	5,501,035	9.9	3.9	12.6	10.5	10.3
portable	484,896	557,732	568,533	643,363	734,961	843,111	15.0	1.9	13.2	14.2	14.7
desktop	3,027,585	3,302,916	3,442,230	3,871,992	4,253,272	4,657,923	9.1	4.2	12.5	9.8	9.5
PC printers	2,600,933	2,951,592	3,980,206	4,736,096	5,348,955	5,987,197	13.5	34.8	19.0	12.9	11.9
Typewriters	666,289	546,222	443,993	361,261	295,943	249,879	-18.0	-18.7	-18.6	-18.1	-15.6
Calculators	8,888,342	8,446,698	8,014,313	7,601,241	7,199,240	6,878,567	- 5.0	- 5.1	- 5.2	- 5.3	- 4.5
Copiers	346,817	360,343	371,153	381,545	385,361	391,142	3.9	3.0	2.8	1.0	1.5
LAN cards	1,712,000	2,113,300	2,618,000	3,342,000	3,771,000	4,455,000	23.4	23.9	27.7	12.8	18.1

Table 41
Germany
IT Hardware Shipments (Units)

Table 42
Greece
IT Hardware Shipments (Units)

Greece	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	558	898	913	895	772	682	60.8	1.8	-2.0	-13.7	-11.7
NT servers	15	74	571	1,080	1,440	1,540	406.5	669.6	89.3	33.3	6.9
Other servers	574	524	1,220	1,490	1,477	1,488	-8.7	132.7	22.1	- 0.9	0.7
Workstations	1,004	1,252	1,125	1,172	1,209	1,236	24.7	-10.2	4.2	3.2	2.2
PCs	81,214	92,825	109,579	125,589	142,852	166,424	14.3	18.0	14.6	13.7	16.5
portable	4,904	6,133	9,079	10,915	13,480	16,890	25.1	48.0	20.2	23.5	25.3
desktop	76,310	86,692	100,500	114,674	129,373	149,534	13.6	15.9	14.1	12.8	15.6
PC printers	73,108	99,017	115,209	132,757	145,990	164,889	35.4	16.4	15.2	10.0	12.9
Typewriters	153,399	166,160	173,305	177,980	182,224	185,467	8.3	4.3	2.7	2.4	1.8
Calculators	114,506	125,996	138,292	150,587	162,077	174,646	10.0	9.8	8.9	7.6	7.8
Copiers	13,251	12,994	12,621	13,039	13,513	14,015	-1.9	- 2.9	3.3	3.6	3.7
LAN cards	22,579	26,969	34,210	39,264	43,843	47,970	19.4	26.8	14.8	11.7	9.4

Table 43
Ireland
IT Hardware Shipments (Units)

Ireland	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	789	808	884	860	820	810	2.4	9.4	- 2.7	- 4.7	-1.2
NT servers	65	866	1,119	1,940	2,600	2,860	1235.9	29.2	73.4	34.0	10.0
Other servers	1,106	1,802	2,388	3,208	3,282	3,365	62.9	32.5	34.3	2.3	2.5
Workstations	2,733	2,764	2,538	2,597	2,670	2,751	1.1	- 8.2	2.3	2.8	3.0
PCs	96,684	109,959	124,584	144,373	169,865	197,888	13.7	13.3	15.9	17.7	16.5
portable	12,143	14,728	17,266	21,026	26,945	32,434	21.3	17.2	21.8	28.2	20.4
desktop	84,541	95,230	107,318	123,347	142,920	165,454	12.6	12.7	14.9	15.9	15.8
PC printers	54,829	64,700	69,372	79,172	89,391	96,064	18.0	7.2	14.1	12.9	7.5
Typewriters	40,738	32,620	25,896	20,367	16,402	15,646	-19.9	-20.6	-21.4	-19.5	-4.6
Calculators	425,515	450,395	463,462	480,263	485,135	497,868	5.8	2.9	3.6	1.0	2.6
Copiers	21,541	21,513	20,936	21,094	21,683	22,279	- 0.1	- 2.7	0.8	2.8	2.7
LAN cards	23,005	23,931	27,845	31,249	35,817	38,386	4.0	16.4	12.2	14.6	7.2

Table 44
Italy
IT Hardware Shipments (Units)

Italy	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	9,025	11,413	11,326	11,102	10,884	10,642	26.5	- 0.8	-2.0	-2.0	-2.2
NT servers	881	3,185	9,409	17,800	23,700	25,400	261.4	195.4	89.2	33.1	7.2
Other servers	23,742	29,080	31,572	38,829	40,185	41,355	22.5	8.6	23.0	3.5	2.9
Workstations	14,178	15,984	16,483	17,129	17,648	18,147	12.7	3.1	3.9	3.0	2.8
PCs	973,777	1,228,636	1,324,794	1,521,150	1,691,581	1,830,977	26.2	7.8	14.8	11.2	8.2
portable	148,991	182,513	207,130	246,485	284,690	333,087	22.5	13.5	19.0	15.5	17.0
desktop	824,786	1,046,123	1,117,664	1,274,665	1,406,891	1,497,890	26.8	6.8	14.0	10.4	6.5
PC printers	852,146	1,025,483	1,367,074	1,627,657	1,769,189	1,847,485	20.3	33.3	19.1	8.7	4.4
Typewriters	142,600	136,585	118,268	107,825	98,986	96,757	-4.2	-13.4	-8.8	-8.2	-2.3
Calculators	2,036,000	2,099,132	2,073,704	2,085,102	2,101,434	2,102,954	3.1	- 1.2	0.5	0.8	0.1
Copiers	147,452	167,447	174,910	186,829	194,981	202,328	13.6	4.5	6.8	4.4	3.8
LAN cards	387,000	564,000	692,000	835,000	961,000	1,150,000	45.7	22.7	20.7	15.1	19.7

Netherlands	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	4,174	4,934	6,341	6,150	5,920	5,860	18.2	28.5	- 3.0	- 3.7	- 1.0
NT servers	1,082	4,152	8,063	15,000	20,000	21,600	283.7	94.2	86.0	33.3	8.0
Other servers	11,744	13,063	16,496	21,079	21,554	21,986	11.2	26.3	27.8	2.3	2.0
Workstations	7,810	9,040	8,433	8,721	8,899	9,070	15.7	- 6.7	3.4	2.0	1.9
PCs	737,938	934,230	1,059,930	1,117,803	1,119,936	1,185,872	26.6	13.5	5.5	0.2	5.9
portable	97,848	121,429	160,960	193,635	203,898	228,426	24.1	32.6	20.3	5.3	12.0
desktop	639,497	812,801	898,970	924,168	916,038	957,446	27.1	10.6	2.8	- 0.9	4.5
PC printers	495,113	549,322	658,365	786,907	902,253	1,014,134	10.9	19.9	19.5	14.7	12.4
Typewriters	96,950	89,756	69,624	50,773	35,527	31,095	-7.4	-22.4	-27.1	-30.0	-12.5
Calculators	1,172,700	1,184,427	1,186,688	1,188,859	1,179,619	1,168,948	1.0	0.2	0.2	- 0.8	- 0.9
Copiers	82,093	87,296	89,008	91,384	93,862	95,677	6.3	2.0	2.7	2.7	1.9
LAN cards	476,000	637,700	786,000	949,000	1,004,000	1,136,000	34.0	23.3	20.7	5.8	13.1

Table 45 Netherlands IT Hardware Shipments (Units)

Norway	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	1,605	1,747	2,107	2,200	2,180	2,280	8.8	20.6	4.4	-0.9	4.6
NT servers	320	1,268	3,054	5,800	7,760	8,450	296.5	141.0	89.9	33.8	8.9
Other servers	3,696	4,520	6,033	7,820	8,012	8,168	22.3	33.5	29.6	2.5	1.9
Workstations	3,899	3,964	4,195	4,288	4,371	4,455	1.7	5.8	2.2	1.9	1.9
PCs	276,219	348,865	387,100	408,458	375,968	344,896	26.3	11.0	5.5	-8.0	-8.3
portable	46,300	47,411	52,450	60,748	55,904	52,662	2.4	10.6	15.8	-8.0	-5.8
desktop	236,620	301,454	334,650	347,711	320,065	292,234	27.4	11.0	3.9	-8.0	-8.7
PC printers	157,281	201,873	235,044	288,928	332,281	372,339	28.4	16.4	22.9	15.0	12.1
Typewriters	21,367	19,665	18,708	17,683	16,740	15,989	-8.0	-4.9	-5.5	-5.3	-4.5
Calculators	354,635	343,287	321,102	298,176	268,835	254,786	-3.2	-6.5	-7.1	-9.8	-5.2
Copiers	16,503	16,272	16,572	16,919	17,226	17,474	-1.4	1.8	2.1	1.8	1.4
LAN cards	188,000	241,000	272,000	318,000	321,000	321,000	28.2	12.9	16.9	0.9	0.0

Table 46 Norway IT Hardware Shipments (Units)

Portugal	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	831	1,149	1,712	1,770	1,830	1,880	38.4	49.0	3.4	3.4	2.7
NT servers	89	357	1,363	2,145	2,920	3,470	301.5	282.1	57.4	36.1	18.8
Other servers	1,366	2,699	3,472	3,420	3,435	3,503	97.6	28.6	-1.5	0.4	2.0
Workstations	1,000	1,251	1,133	1,182	1,229	1,264	25.1	-9.4	4.3	3.9	2.9
PCs	136,700	150,700	157,514	175,644	195,518	221,065	10.2	4.5	11.5	11.3	13.1
portable	4,700	6,400	8,200	8,878	9,966	11,189	36.2	28.1	8.3	12.3	12.3
desktop	132,000	144,300	149,314	166,766	185,552	209,876	9.3	3.5	11.7	11.3	13.1
PC printers	49,100	55,637	59,994	65,404	70,614	76,987	13.3	7.8	9.0	8.0	9.0
Typewriters	165,685	191,035	200,969	201,572	201,280	200,564	15.3	5.2	0.3	-0.1	-0.4
Calculators	121,509	147,998	170,494	188,965	207,517	226,067	21.8	15.2	10.8	9.8	8.9
Copiers	15,143	15,711	16,513	17,208	17,895	18,510	3.8	5.1	4.2	4.0	3.4
LAN cards	28,819	32,127	39,435	45,743	51,741	58,786	11.5	22.7	16.0	13.1	13.6

Table 47 Portugal IT Hardware Shipments (Units)

Table 48
Spain
IT Hardware Shipments (Units)

Spain	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	4,196	6,004	7,597	6,450	6,300	6,080	43.1	26.5	-15.1	- 2.3	- 3.5
NT servers	493	2,081	5,522	10,400	14,000	15,500	322.2	165.4	88.3	34.6	10.7
Other servers	8,899	10,101	19,369	25,358	25,831	26,396	13.5	91.8	30.9	1.9	2.2
Workstations	7,822	7,984	6,813	7,216	7,594	7,892	2.1	-14.7	5.9	5.2	3.9
PCs	605,042	674,622	730,800	790,754	849,346	923,085	11.5	8.3	8.2	7.4	8.7
portable	68,549	85,755	103,020	113,362	122,442	134,457	25.1	20.1	10.0	8.0	9.8
desktop	533,394	588,867	627,780	677,392	726,904	788,628	10.4	6.6	7.9	7.3	8.5
PC printers	580,806	686,019	885,875	1,051,920	1,161,698	1,292,943	18.1	29.1	18.7	10.4	11.3
Typewriters	115,140	94,415	77,349	62,226	51,984	45,343	-18.0	-18.1	-19.6	-16.5	-12.8
Calculators	1,468,296	1,515,282	1,564,653	1,613,022	1,657,174	1,680,046	3.2	3.3	3.1	2.7	1.4
Copiers	66,074	69,001	69,120	69,046	69,711	70,308	4.4	0.2	- 0.1	1.0	0.9
LAN cards	273,000	388,760	552,000	614,000	722,000	866,000	42.4	42.0	11.2	17.6	19.9

Table 49
Sweden
IT Hardware Shipments (Units)

Sweden	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	2,923	3,697	4,809	4,500	4,450	4,320	26.5	30.1	- 6.4	- 1.1	- 2.9
NT servers	483	3,034	5,048	9,400	12,600	13,800	527.6	66.4	86.2	34.0	9.5
Other servers	7,481	8,135	10,728	12,986	13,384	13,646	8.7	31.9	21.0	3.1	2.0
Workstations	11,025	12,607	13,090	13,445	13,719	13,969	14.3	3.8	2.7	2.0	1.8
PCs	537,595	694,573	712,350	771,340	828,690	901,038	29.2	2.6	8.3	7.4	8.7
portable	92,910	116,416	126,120	138,781	149,896	164,606	25.3	8.3	10.0	8.0	9.8
desktop	436,345	578,157	586,230	632,559	678,794	736,432	32.5	1.4	7.9	7.3	8.5
PC printers	310,072	392,403	476,217	559,974	609,766	669,149	26.6	21.4	17.6	8.9	9.7
Typewriters	86,482	70,915	57,997	44,444	36,397	32,434	-18.0	-18.2	-23.4	-18.1	-10.9
Calculators	1,409,564	1,454,670	1,580,803	1,802,503	2,070,041	2,345,398	3.2	8.7	14.0	14.8	13.3
Copiers	30,558	31,169	31,324	31,895	32,339	32,759	2.0	0.5	1.8	1.4	1.3
LAN cards	422,000	506,000	478,000	577,000	626,000	684,000	19.9	- 5.5	20.7	8.5	9.3

Table 50
Switzerland
IT Hardware Shipments (Units)

Switzerland	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	3,538	4,814	7,586	7,950	8,520	8,800	36.1	57.6	4.8	7.2	3.3
NT servers	884	3,049	5,556	9,800	13,100	14,250	244.9	82.2	76.4	33.7	8.8
Other servers	9,116	10,349	13,517	16,537	16,915	17,292	13.5	30.6	22.3	2.3	2.2
Workstations	11,338	13,758	12,046	12,368	12,692	12,994	21.3	-12.4	2.7	2.6	2.4
PCs	509,368	559,286	598,680	638,073	632,843	669,988	9.8	7.0	6.6	-0.8	5.9
portable	98,936	125,197	130,560	138,446	146,678	157,277	26.5	4.3	6.0	5.9	7.2
desktop	406,451	434,090	468,120	499,628	486,165	512,712	6.8	7.8	6.7	-2.7	5.5
PC printers	309,365	374,610	503,236	624,887	723,841	820,821	21.1	34.3	24.2	15.8	13.4
Typewriters	62,516	56,414	52,088	47,241	43,303	40,232	-9.8	- 7.7	-9.3	-8.3	-7.1
Calculators	748,780	766,001	783,793	802,175	827,326	850,232	2.3	2.3	2.3	3.1	2.8
Copiers	29,150	28,749	28,552	28,521	28,844	29,186	-1.4	- 0.7	-0.1	1.1	1.2
LAN cards	216,000	264,000	271,000	329,000	363,000	427,000	22.2	2.7	21.4	10.3	17.6

Table 51
United Kingdom
IT Hardware Shipments (Units)

United Kingdom	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	19,155	21,601	22,912	20,900	20,500	21,200	12.8	6.1	- 8.8	- 1.9	3.4
NT servers	3,188	11,769	21,996	42,600	56,900	61,600	269.2	86.9	93.7	33.6	8.3
Other servers	39,313	40,373	46,696	62,611	64,410	66,282	2.7	15.7	34.1	2.9	2.9
Workstations	33,062	41,470	34,539	35,130	35,967	36,725	25.4	-16.7	1.7	2.4	2.1
PCs	2,429,746	2,837,943	3,155,450	3,412,388	3,596,191	3,830,167	16.8	11.2	8.1	5.4	6.5
portable	430,848	472,640	577,560	665,349	689,435	759,426	9.7	22.2	15.2	3.6	10.2
desktop	2,023,356	2,365,303	2,577,890	2,747,039	2,906,756	3,070,741	16.9	9.0	6.6	5.8	5.6
PC printers	1,573,947	1,838,815	2,439,678	2,950,981	3,299,466	3,666,800	16.8	32.7	21.0	11.8	11.1
Typewriters	269,070	238,665	209,226	180,817	158,263	144,568	-11.3	-12.3	-13.6	-12.5	-8.7
Calculators	3,602,037	3,648,863	3,684,065	3,707,424	3,757,021	3,802,434	1.3	1.0	0.6	1.3	1.2
Copiers	160,053	168,056	174,447	179,051	184,750	188,072	5.0	3.8	2.6	3.2	1.8
LAN cards	1,720,000	2,155,012	2,517,000	3,434,000	3,823,000	4,394,000	25.3	16.8	36.4	11.3	14.9

Table 52
Czech Republic
IT Hardware Shipments (Units)

Czech Republic	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	1,124	1,167	1,338	1,343	1,507	1,826	3.8	14.7	0.4	12.2	21.2
NT servers	2	365	1,691	1,940	2,315	2,760	18150.0	363.3	14.7	19.3	19.2
Other servers	2,978	4,215	3,373	3,292	3,802	4,305	41.5	-20.0	- 2.4	15.5	13.2
Workstations	1,042	1,191	1,125	1,200	1,310	1,410	14.3	- 5.5	6.7	9.2	7.6
PCs	180,660	208,175	235,588	246,950	264,000	298,100	15.2	13.2	4.8	6.9	12.9
portable	25,554	27,495	30,270	26,250	28,000	30,100	7.6	10.1	-13.3	6.7	7.5
desktop	155,106	180,680	205,318	220,700	236,000	268,000	16.5	13.6	7.5	6.9	13.6
PC printers	166,486	200,964	227,700	242,820	258,160	280,690	20.7	13.3	6.6	6.3	8.7
Copiers	22,610	24,225	26,100	27,550	28,930	30,710	7.1	7.7	5.6	5.0	6.2
LAN cards	117,429	143,641	172,148	187,565	214,919	255,238	22.3	19.8	9.0	14.6	18.8

Table 53
Hungary
IT Hardware Shipments (Units)

Hungary	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	461	476	624	624	887	952	3.3	31.1	0.0	42.1	7.3
NT servers	5	360	1,737	2,028	2,482	3,100	7100.0	382.5	16.8	22.4	24.9
Other servers	1,689	3,249	3,669	4,140	4,662	5,748	92.4	12.9	12.8	12.6	23.3
Workstations	690	612	536	710	870	980	-11.3	-12.4	32.5	22.5	12.6
PCs	115,450	102,016	115,398	126,480	142,150	158,600	-11.6	13.1	9.6	12.4	11.6
portable	9,052	6,930	7,190	8,250	9,650	10,600	-23.4	3.8	14.7	17.0	9.8
desktop	106,398	95,086	108,208	118,230	132,500	148,000	-10.6	13.8	9.3	12.1	11.7
PC printers	90,937	97,334	116,005	125,660	140,919	157,872	7.0	19.2	8.3	12.1	12.0
Copiers	18,500	17,080	17,265	17,990	18,900	19,950	- 7.7	1.1	4.2	5.1	5.6
LAN cards	64,652	53,048	56,913	61,778	70,321	99,701	-17.9	7.3	8.5	13.8	41.8

Table 54
Poland
IT Hardware Shipments (Units)

Poland	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	1,163	1,658	1,732	1,717	1,890	2,173	42.6	4.5	-0.9	10.1	15.0
NT servers	4	511	1,693	2,622	3,242	3,770	12675.0	231.3	54.9	23.6	16.3
Other servers	893	3,165	6,105	5,922	6,482	7,413	254.4	92.9	-3.0	9.5	14.4
Workstations	722	733	1,147	1,320	1,480	1,620	1.5	56.5	15.1	12.1	9.5
PCs	244,610	300,935	358,233	410,150	457,300	512,800	23.0	19.0	14.5	11.5	12.1
portable	13,075	22,012	22,177	26,150	30,600	34,800	68.4	0.7	17.9	17.0	13.7
desktop	231,535	278,923	336,056	384,000	426,700	478,000	20.5	20.5	14.3	11.1	12.0
PC printers	217,878	265,194	332,570	356,700	412,550	454,700	21.7	25.4	7.3	15.7	10.2
Copiers	18,215	20,410	25,470	29,745	34,405	39,195	12.1	24.8	16.8	15.7	13.9
LAN cards	136,982	165,514	200,113	236,959	284,334	363,377	20.8	20.9	18.4	20.0	27.8

Table 55
Russia
IT Hardware Shipments (Units)

Russia	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	1,478	1,934	1,756	2,318	2,998	3,093	30.9	- 9.2	32.0	29.3	3.2
NT servers	6	2,736	5,233	7,544	9,990	10,140	45500.0	91.3	44.2	32.4	1.5
Other servers	9,061	17,245	10,921	17,537	28,866	48,775	90.3	-36.7	60.6	64.6	69.0
Workstations	1,350	1,573	1,493	1,620	1,960	2,340	16.5	- 5.1	8.5	21.0	19.4
PCs	642,559	837,000	1,033,668	1,274,000	1,460,000	1,640,000	30.3	23.5	23.3	14.6	12.3
portable	36,000	43,000	43,396	54,000	70,000	85,000	19.4	0.9	24.4	29.6	21.4
desktop	606,559	794,000	990,272	1,220,000	1,390,000	1,555,000	30.9	24.7	23.2	13.9	11.9
PC printers	458,500	523,610	548,902	641,800	715,950	801,300	14.2	4.8	16.9	11.6	11.9
Copiers	117,700	133,025	137,678	158,280	176,620	195,370	13.0	3.5	15.0	11.6	10.6
LAN cards	173,491	234,360	280,917	365,192	493,009	650,772	35.1	19.9	30.0	35.0	32.0

Table 56
Slovakia
IT Hardware Shipments (Units)

Slovakia	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	352	543	341	350	359	399	54.3	-37.2	2.6	2.6	11.1
NT servers	2	90	528	947	1,666	2,051	4400.0	486.7	79.4	75.9	23.1
Other servers	742	1,189	941	1,009	885	1,190	60.2	-20.9	7.2	-12.3	34.5
Workstations	135	231	369	390	420	500	71.1	59.7	5.7	7.7	19.0
PCs	45,890	51,278	62,690	75,705	90,850	108,980	11.7	22.3	20.8	20.0	20.0
portable	4,000	5,405	7,410	9,705	11,650	13,980	35.1	37.1	31.0	20.0	20.0
desktop	41,890	45,873	55,280	66,000	79,200	95,000	9.5	20.5	19.4	20.0	19.9
PC printers	49,182	53,870	62,250	69,455	78,760	91,170	9.5	15.6	11.6	13.4	15.8
Copiers	7,250	8,100	8,950	9,550	9,950	10,750	11.7	10.5	6.7	4.2	8.0
LAN cards	22,945	29,741	41,283	53,080	67,529	78,800	29.6	38.8	28.6	27.2	16.7

EU	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	97,775	117,053	123,599	121,713	118,616	114,764	19.7	5.6	- 1.5	- 2.5	-3.2
NT servers	12,105	52,813	99,574	189,705	251,240	272,800	336.3	88.5	90.5	32.4	8.6
Other servers	201,085	231,859	260,757	335,951	344,324	352,502	15.3	12.5	28.8	2.5	2.4
Workstations	165,112	194,746	183,546	188,280	193,014	197,359	17.9	- 5.8	2.6	2.5	2.3
PCs	12,214,112	14,323,147	15,547,454	17,274,929	18,815,284	20,502,565	17.3	8.5	11.1	8.9	9.0
portable	1,790,257	2,052,506	2,344,704	2,702,439	2,976,777	3,341,483	14.6	14.2	15.3	10.2	12.3
desktop	10,436,280	12,270,641	13,202,750	14,572,490	15,838,507	17,161,083	17.6	7.6	10.4	8.7	8.4
PC printers	8,784,117	10,340,791	13,242,544	15,705,951	17,501,425	19,326,651	17.7	28.1	18.6	11.4	10.4
Typewriters	2,057,440	1,857,404	1,642,238	1,446,581	1,292,835	1,199,781	-9.7	-11.6	-11.9	-10.6	-7.2
Calculators	24,297,450	24,383,763	24,364,823	24,607,226	24,919,560	25,253,846	0.4	- 0.1	1.0	1.3	1.3
Copiers	1,174,170	1,234,327	1,269,265	1,308,787	1,338,853	1,366,646	5.1	2.8	3.1	2.3	2.1
LAN cards	6,664,403	8,524,399	10,212,490	12,966,256	14,704,400	17,085,142	27.9	19.8	27.0	13.4	16.2

Table 57
EU
IT Hardware Shipments (Units)

Western Europe	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	102,918	123,614	133,292	131,863	129,316	125,844	20.1	7.8	- 1.1	- 1.9	-2.7
NT servers	13,309	57,130	108,185	205,305	272,100	295,500	329.3	89.4	89.8	32.5	8.6
Other servers	213,897	246,728	280,308	360,308	369,251	377,962	15.3	13.6	28.5	2.5	2.4
Workstations	180,349	212,468	199,788	204,937	210,077	214,808	17.8	- 6.0	2.6	2.5	2.3
PCs	12,999,700	15,231,299	16,533,234	18,321,460	19,824,095	21,517,449	17.2	8.5	10.8	8.2	8.5
portable	1,935,493	2,225,114	2,527,714	2,901,632	3,179,358	3,551,421	15.0	13.6	14.8	9.6	11.7
desktop	11,079,351	13,006,185	14,005,520	15,419,828	16,644,737	17,966,028	17.4	7.7	10.1	7.9	7.9
PC printers	9,250,763	10,917,274	13,980,824	16,619,766	18,557,547	20,519,811	18.0	28.1	18.9	11.7	10.6
Typewriters	2,141,323	1,933,483	1,713,034	1,511,505	1,352,879	1,256,002	-9.7	-11.4	-11.8	-10.5	-7.2
Calculators	25,400,865	25,493,051	25,469,719	25,707,576	26,015,721	26,358,864	0.4	- 0.1	0.9	1.2	1.3
Copiers	1,219,823	1,279,348	1,314,390	1,354,227	1,384,923	1,413,306	4.9	2.7	3.0	2.3	2.0
LAN cards	7,068,403	9,029,399	10,755,490	13,613,256	15,388,400	17,833,142	27.7	19.1	26.6	13.0	15.9

Table 58
Western Europe
IT Hardware Shipments (Units)

Eastern Europe	1994	1995	1996	1997	1998	1999	1995/94 %	1996/95 %	1997/96 %	1998/97 %	1999/98 %
Unix servers	4,578	5,778	5,791	6,352	7,641	8,443	26.2	0.2	9.7	20.3	10.5
NT servers	19	4,062	10,882	15,081	19,695	21,821	21278.9	167.9	38.6	30.6	10.8
Other servers	15,363	29,063	25,009	31,900	44,697	67,431	89.2	-13.9	27.6	40.1	50.9
Workstations	3,939	4,340	4,670	5,240	6,040	6,850	10.2	7.6	12.2	15.3	13.4
PCs	1,229,169	1,499,404	1,805,577	2,133,285	2,414,300	2,718,480	22.0	20.4	18.1	13.2	12.6
portable	87,681	104,842	110,443	124,355	149,900	174,480	19.6	5.3	12.6	20.5	16.4
desktop	1,141,488	1,394,562	1,695,134	2,008,930	2,264,400	2,544,000	22.2	21.6	18.5	12.7	12.3
PC printers	982,983	1,140,972	1,287,427	1,436,435	1,606,339	1,785,732	16.1	12.8	11.6	11.8	11.2
Copiers	184,275	202,840	215,463	243,115	268,805	295,975	10.1	6.2	12.8	10.6	10.1
LAN cards	515,499	626,305	751,374	904,574	1,130,112	1,447,888	21.5	20.0	20.4	24.9	28.1

Table 59
Eastern Europe
IT Hardware Shipments (Units)

8. ICT Trade Flows

The data presented on trade are based on the Combined Nomenclature, an international standard for such data. Details concerning the product categories included are given at the end of the statistical section. In general terms, the trade data can be considered to match well but not exactly with the classification used for IT and telecommunications hardware throughout the statistical section. Data processing equipment, electronic office equipment and components and related spares are all included. Semiconductor devices and other electronic components are not included.

Figures are presented in current ECU, according to standard valuation rules. Imports are generally stated at customs value or by reference to the concept of customs value (cif); exports are stated at the value of the goods at the place and time that they leave the statistical area of the exporting member state (fob). Data availability for this exercise has been governed by the framework of the European Commission's statistical systems which now includes EU countries only.

The term intra-EU refers to trade between member states. Extra-EU trade is that between a member state and a non-member state. It should be noted that intra-EU import statistics are based upon the country of consignment, and not necessarily on the country of origin.

Table 60
Austria
Trade in ICT Hardware
(Thousand ECU)

Austria	1994	1995	1996
Imports from EU	844,591	1,370,502	1,452,872
Imports from other countries	1,062,612	456,486	449,985
Imports total	1,907,203	1,826,988	1,902,857
Exports intra-EU	245,953	299,148	274,241
Exports extra-EU	350,602	355,304	331,075
Exports total	596,555	654,452	605,316
Extra-EU/intra-EU exports	142.5%	118.8%	120.7%
Extra-EU/intra-EU imports	125.8%	33.3%	31.0%
Trade balance	-1,310,648	-1,172,536	-1,297,541
EU trade balance	- 598,638	-1,071,354	-1,178,631

Table 61
Belgium/Luxembourg
Trade in ICT Hardware
(Thousand ECU)

Belgium/Luxembourg	1994	1995	1996
Imports intra-EU	1,779,553	2,377,669	2,965,418
Imports extra-EU	754,058	872,183	880,897
Imports total	2,533,611	3,249,851	3,846,315
Exports intra-EU	1,203,070	1,734,824	2,197,556
Exports extra-EU	1,003,193	845,708	804,164
Exports total	2,206,263	2,580,532	3,001,719
Extra-EU/intra-EU exports	83.4%	48.7%	36.6%
Extra-EU/intra-EU imports	42.4%	36.7%	29.7%
Trade balance	-327,348	-669,320	-844,595
Extra-EU trade balance	249,135	- 26,475	- 76,733

Table 62
Denmark
Trade in ICT Hardware
(Thousand ECU)

Denmark	1994	1995	1996
Imports intra-EU	1,034,533	1,542,801	1,618,698
Imports extra-EU	525,029	425,742	475,695
Imports total	1,559,562	1,968,543	2,094,393
Exports intra-EU	201,857	504,154	594,526
Exports extra-EU	447,047	269,445	249,393
Exports total	648,904	773,599	843,918
Extra-EU/intra-EU exports	221.5%	53.4%	41.9%
Extra-EU/intra-EU imports	50.8%	27.6%	29.4%
Trade balance	-910,658	-1,194,943	-1,250,474
Extra-EU trade balance	- 77,982	- 156,297	- 226,302

Finland	1994	1995	1996
Imports from EU	313,118	835,749	943,100
Imports from other countries	832,954	538,350	447,182
Imports total	1,146,072	1,374,099	1,390,282
Exports intra-EU	599,216	946,091	1,022,634
Exports extra-EU	657,178	681,463	870,949
Exports total	1,256,394	1,627,553	1,893,583
Extra-EU/intra-EU exports	109.7%	72.0%	85.2%
Extra-EU/intra-EU imports	266.0%	64.4%	47.4%
Trade balance	110,322	253,455	503,301
EU trade balance	286,098	110,342	79,535

Table 63
Finland
Trade in ICT Hardware
(Thousand ECU)

France	1994	1995	1996
Imports intra-EU	5,923,238	6,533,932	7,073,838
Imports extra-EU	4,014,284	4,585,949	5,038,439
Imports total	9,937,522	11,119,881	12,112,277
Exports intra-EU	4,734,635	6,024,790	6,907,383
Exports extra-EU	2,544,368	2,649,307	2,917,827
Exports total	7,279,003	8,674,096	9,825,210
Extra-EU/intra-EU exports	53.7%	44.0%	42.2%
Extra-EU/intra-EU imports	67.8%	70.2%	71.2%
Trade balance	-2,658,519	-2,445,785	-2,287,067
Extra-EU trade balance	-1,469,916	-1,936,642	-2,120,612

Table 64
France
Trade in ICT Hardware
(Thousand ECU)

Germany	1994	1995	1996
Imports intra-EU	6,815,048	8,307,693	7,883,661
Imports extra-EU	10,063,036	10,245,156	9,622,203
Imports total	16,878,084	18,552,849	17,505,864
Exports intra-EU	5,677,217	7,330,322	7,310,234
Exports extra-EU	5,623,051	5,171,753	5,276,665
Exports total	11,300,268	12,502,074	12,586,899
Extra-EU/intra-EU exports	99.0%	70.6%	72.2%
Extra-EU/intra-EU imports	147.7%	123.3%	122.1%
Trade balance	-5,577,816	-6,050,775	-4,918,965
Extra-EU trade balance	-4,439,985	-5,073,404	-4,345,539

Table 65
Germany
Trade in ICT Hardware
(Thousand ECU)

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'ade in ICT Hardware
Thousand ECU)

Greece	1994	1995	1996
Imports intra-EU	372,957	374,208	345,773
Imports extra-EU	135,413	105,415	108,561
Imports total	508,370	479,623	454,334
Exports intra-EU	40,055	35,078	19,963
Exports extra-EU	14,571	20,417	28,284
Exports total	54,626	55,495	48,247
Extra-EU/intra-EU exports	36.4%	58.2%	141.7%
Extra-EU/intra-EU imports	36.3%	28.2%	31.4%
Trade balance	-453,744	-424,128	-406,087
Extra-EU trade balance	-120,842	- 84,998	- 80,277

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'ade in ICT Hardware
Thousand ECU)

Ireland	1994	1995	1996
Imports intra-EU	773,728	1,201,035	1,436,944
Imports extra-EU	2,055,872	2,942,843	2,955,694
Imports total	2,829,600	4,143,878	4,392,639
Exports intra-EU	3,518,890	5,667,386	6,205,610
Exports extra-EU	1,782,637	1,797,309	2,309,150
Exports total	5,301,527	7,464,696	8,514,760
Extra-EU/intra-EU exports	50.7%	31.7%	37.2%
Extra-EU/intra-EU imports	265.7%	245.0%	205.7%
Trade balance	2,471,927	3,320,818	4,122,121
Extra-EU trade balance	-273,235	-1,145,534	-646,545

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'ade in ICT Hardware
Thousand ECU)

Italy	1994	1995	1996
Imports intra-EU	3,348,104	4,098,351	4,747,728
Imports extra-EU	1,726,871	1,743,065	1,990,737
Imports total	5,074,975	5,841,416	6,738,465
Exports intra-EU	2,844,340	3,191,337	3,428,687
Exports extra-EU	1,381,542	1,597,102	1,332,610
Exports total	4,225,882	4,788,438	4,761,296
Extra-EU/intra-EU exports	48.6%	50.0%	38.9%
Extra-EU/intra-EU imports	51.6%	42.5%	41.9%
Trade balance	-849,093	-1,052,978	-1,977,169
Extra-EU trade balance	-345,329	- 145,963	- 658,128

Netherlands	1994	1995	1996
Imports intra-EU	4,864,276	5,603,904	6,623,548
Imports extra-EU	5,800,501	6,552,897	8,006,341
Imports total	10,664,777	12,156,801	14,629,889
Exports intra-EU	8,485,912	10,526,760	11,695,537
Exports extra-EU	2,000,159	1,535,309	1,769,991
Exports total	10,486,071	12,062,068	13,465,528
Extra-EU/intra-EU exports	23.6%	14.6%	15.1%
Extra-EU/intra-EU imports	119.2%	116.9%	120.9%
Trade balance	- 178,706	- 94,733	-1,164,361
Extra-EU trade balance	-3,800,342	-5,017,588	-6,236,350

Table 69
Netherlands
Trade in ICT Hardware
(Thousand ECU)

Portugal	1994	1995	1996
Imports intra-EU	508,383	637,632	986,742
Imports extra-EU	142,712	114,153	170,063
Imports total	651,095	751,786	1,156,804
Exports intra-EU	55,956	61,548	63,270
Exports extra-EU	19,537	13,405	17,364
Exports total	75,493	74,954	80,635
Extra-EU/intra-EU exports	34.9%	21.8%	27.4%
Extra-EU/intra-EU imports	28.1%	17.9%	17.2%
Trade balance	-575,602	-676,832	-1,076,169
Extra-EU trade balance	-123,175	-100,748	- 152,699

Table 70
Portugal
Trade in ICT Hardware
(Thousand ECU)

Spain	1994	1995	1996
Imports intra-EU	1,973,748	2,278,626	2,804,449
Imports extra-EU	1,073,060	1,075,696	1,162,091
Imports total	3,046,808	3,354,322	3,966,539
Exports intra-EU	823,575	698,973	848,830
Exports extra-EU	753,848	822,873	923,732
Exports total	1,577,423	1,521,846	1,772,562
Extra-EU/intra-EU exports	91.5%	117.7%	108.8%
Extra-EU/intra-EU imports	54.4%	47.2%	41.4%
Trade balance	-1,469,385	-1,832,476	-2,193,977
Extra-EU trade balance	- 319,212	- 252,823	- 238,358

Table 71
Spain
Trade in ICT Hardware
(Thousand ECU)

ble 72
veden
ade in ICT Hardware
housand ECU)

Sweden	1994	1995	1996
Imports from EU	914,057	2,150,316	2,394,216
Imports from other countries	1,718,094	886,904	893,633
Imports total	2,632,151	3,037,221	3,287,849
Exports intra-EU	713,317	809,563	1,015,309
Exports extra-EU	1,266,051	1,327,672	1,489,389
Exports total	1,979,368	2,137,235	2,504,698
Extra-EU/intra-EU exports	177.5%	164.0%	146.7%
Extra-EU/intra-EU imports	188.0%	41.2%	37.3%
Trade balance	-652,783	- 899,986	- 783,151
EU trade balance	-200,740	-1,340,753	-1,378,907

ble 73
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ade in ICT Hardware
housand ECU)

UK	1994	1995	1996
Imports intra-EU	6,818,219	7,758,613	8,142,886
Imports extra-EU	8,575,893	9,069,755	10,350,017
Imports total	15,394,112	16,828,368	18,492,903
Exports intra-EU	7,998,328	10,426,364	11,423,052
Exports extra-EU	5,216,541	5,283,127	6,042,498
Exports total	13,214,869	15,709,491	17,465,549
Extra-EU/intra-EU exports	65.2%	50.7%	52.9%
Extra-EU/intra-EU imports	125.8%	116.9%	127.1%
Trade balance	-2,179,243	-1,118,877	-1,027,354
Extra-EU trade balance	-3,359,352	-3,786,629	-4,307,520

ble 74
J
ade in ICT Hardware
housand ECU)

EU	1994	1995	1996
Imports intra-EU	34,211,787	40,714,464	49,419,872
Imports extra-EU	34,866,729	37,732,855	42,551,539
Imports total	69,078,516	78,447,319	91,971,411
Exports intra-EU	35,583,835	46,201,535	53,006,832
Exports extra-EU	20,786,494	20,005,755	24,363,089
Exports total	56,370,329	66,207,290	77,369,921
Extra-EU/intra-EU exports	58.4%	43.3%	46.0%
Extra-EU/intra-EU imports	101.9%	92.7%	86.1%
Trade balance	-12,708,187	-12,240,029	-14,601,490
Extra-EU trade balance	-14,080,235	-17,727,101	-18,188,450

9. Market Structures and Penetration of ICT

The different markets in Europe certainly have features in common, but equally the degree of variation amongst the countries is also considerable. The tables which follow attempt to illustrate the degree to which Western European countries can be distinguished in terms of their competitive fabric, and overall use of IT and telecommunications.

The market share of a leader in a particular market is, for the purposes of this study, a composite measure. For the hardware market it is obtained by considering the top leaders position in each of the hardware products segment to assess the degree to which the market leaders in various related sectors (from high-end servers to personal computers) dominate this market. The software and services markets are here defined in terms which stress their independent structures. For software the market share of a leader is obtained by considering the relative position of software suppliers for whom software revenue is identifiable. For services it is obtained on the basis of services revenue as identified and released by the players. Consequently the leader market share information is not sensitive to the balance of power between the traditional hardware suppliers and the independent specialists.

The figure on market concentration is based on the cumulative market share (measured on total IT revenue) of the top ten IT vendors, in each year, with the composition of the top ten varying each year.

ble 75
ıstria
ırket Structures
d Penetration of ICT

Austria		1994	1995	1996
Industry leader's share	Hardware	21.1%	15.5%	14.4%
	Software	6.0%	6.9%	7.9%
	Services	2.1%	1.8%	1.8%
Industry concentration (top 10 vendors)	Total IT	59.6%	66.3%	67.9%
Market comparisons	IT market versus GDP	1.82%	1.91%	1.96%
	Per capita IT expenditure (ECU)	386	418	438
	ICT market versus GDP	3.48%	3.64%	3.80%
	Per capita ICT expenditure (ECU)	738	796	848

ble 76
lgium/Luxembourg
ırket Structures
d Penetration of ICT

Belgium/Luxembourg		1994	1995	1996
Industry leader's share	Hardware	19.5%	16.4%	16.6%
	Software	3.1%	3.6%	3.9%
	Services	3.0%	4.3%	5.4%
Industry concentration (top 10 vendors)	Total IT	42.7%	40.0%	37.8%
Market comparisons	IT market versus GDP	2.15%	2.16%	2.23%
	Per capita IT expenditure (ECU)	416	435	462
	ICT market versus GDP	4.10%	4.22%	4.50%
	Per capita ICT expenditure (ECU)	794	851	932

ble 77
nmark
ırket Structures
d Penetration of ICT

Denmark		1994	1995	1996
Industry leader's share	Hardware	23.7%	18.2%	21.7%
	Software	7.4%	8.1%	7.8%
	Services	4.2%	5.0%	5.5%
Industry concentration (top 10 vendors)	Total IT	53.5%	61.2%	58.9%
Market comparisons	IT market versus GDP	2.60%	2.76%	2.87%
	Per capita IT expenditure (ECU)	635	699	751
	ICT market versus GDP	4.74%	4.97%	5.22%
	Per capita ICT expenditure (ECU)	1,158	1,258	1,366

Finland		1994	1995	1996
Industry leader's share	Hardware	13.9%	15.1%	17.7%
	Software	7.7%	8.3%	7.3%
	Services	9.5%	11.0%	13.9%
Industry concentration (top 10 vendors)	Total IT	62.9%	67.7%	76.8%
Market comparisons	IT market versus GDP	2.28%	2.37%	2.50%
	Per capita IT expenditure (ECU)	388	437	476
	ICT market versus GDP	4.62%	4.70%	4.96%
	Per capita ICT expenditure (ECU)	787	864	944

Table 78
Finland
Market Structures and Penetration of ICT

France		1994	1995	1996
Industry leader's share	Hardware	20.4%	19.6%	13.9%
	Software	7.4%	7.4%	7.4%
	Services	4.2%	4.7%	4.0%
Industry concentration (top 10 vendors)	Total IT	34.0%	32.5%	30.5%
Market comparisons	IT market versus GDP	2.28%	2.32%	2.41%
	Per capita IT expenditure (ECU)	447	470	499
	ICT market versus GDP	4.25%	4.37%	4.53%
	Per capita ICT expenditure (ECU)	833	884	937

Table 79
France
Market Structures and Penetration of ICT

Germany		1994	1995	1996
Industry leader's share	Hardware	17.1%	10.6%	11.0%
	Software	6.4%	6.5%	5.2%
	Services	3.3%	4.5%	4.4%
Industry concentration (top 10 vendors)	Total IT	42.6%	38.8%	38.0%
Market comparisons	IT market versus GDP	2.02%	2.10%	2.10%
	Per capita IT expenditure (ECU)	430	464	486
	ICT market versus GDP	4.14%	4.30%	4.23%
	Per capita ICT expenditure (ECU)	883	951	979

Table 80
Germany
Market Structures and Penetration of ICT

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ket Structures and
etration of ICT

Italy		1994	1995	1996
Industry leader's share	Hardware	33.7%	25.2%	16.9%
	Software	4.6%	5.0%	7.0%
	Services	8.1%	9.1%	10.0%
Industry concentration (top 10 vendors)	Total IT	48.9%	51.9%	49.5%
Market comparisons	IT market versus GDP	1.52%	1.49%	1.44%
	Per capita IT expenditure (ECU)	226	238	249
	ICT market versus GDP	3.76%	3.67%	3.70%
	Per capita ICT expenditure (ECU)	558	588	638

le 82
herlands
ket Structures and
etration of ICT

Netherlands		1994	1995	1996
Industry leader's share	Hardware	19.5%	20.8%	17.3%
	Software	2.9%	3.1%	3.0%
	Services	10.4%	12.5%	16.3%
Industry concentration (top 10 vendors)	Total IT	47.5%	49.1%	45.0%
Market comparisons	IT market versus GDP	2.56%	2.66%	2.79%
	Per capita IT expenditure (ECU)	474	510	548
	ICT market versus GDP	4.90%	5.12%	5.47%
	Per capita ICT expenditure (ECU)	905	980	1,072

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ket Structures and
etration of ICT

Norway		1994	1995	1996
Industry leader's share	Hardware	15.0%	14.5%	15.0%
	Software	11.1%	10.5%	10.1%
	Services	2.2%	3.0%	4.3%
Industry concentration (top 10 vendors)	Total IT	40.3%	58.1%	67.8%
Market comparisons	IT market versus GDP	2.41%	2.49%	2.53%
	Per capita IT expenditure (ECU)	587	643	695
	ICT market versus GDP	4.47%	4.65%	4.83%
	Per capita ICT expenditure (ECU)	1,089	1,202	1,327

Spain		1994	1995	1996
Industry leader's share	Hardware	19.1%	14.9%	13.9%
	Software	12.2%	16.9%	18.1%
	Services	9.0%	8.6%	7.0%
Industry concentration (top 10 vendors)	Total IT	45.7%	47.6%	44.2%
Market comparisons	IT market versus GDP	1.31%	1.31%	1.34%
	Per capita IT expenditure (ECU)	135	145	157
	ICT market versus GDP	3.34%	3.40%	3.68%
	Per capita ICT expenditure (ECU)	344	377	431

Table 84
Spain
Market Structures a
Penetration of ICT

Sweden		1994	1995	1996
Industry leader's share	Hardware	17.3%	20.9%	13.5%
	Software	9.9%	20.7%	23.7%
	Services	5.7%	7.5%	7.9%
Industry concentration (top 10 vendors)	Total IT	42.4%	46.0%	49.5%
Market comparisons	IT market versus GDP	3.16%	3.30%	3.36%
	Per capita IT expenditure (ECU)	639	714	745
	ICT market versus GDP	5.79%	5.90%	6.05%
	Per capita ICT expenditure (ECU)	1,170	1,277	1,342

Table 85
Sweden
Market Structures a
Penetration of ICT

Switzerland		1994	1995	1996
Industry leader's share	Hardware	21.7%	19.6%	16.2%
	Software	6.7%	6.7%	7.1%
	Services	1.6%	1.4%	1.4%
Industry concentration (top 10 vendors)	Total IT	43.5%	35.1%	35.9%
Market comparisons	IT market versus GDP	2.79%	2.90%	3.06%
	Per capita IT expenditure (ECU)	900	950	1,009
	ICT market versus GDP	5.34%	5.46%	5.74%
	Per capita ICT expenditure (ECU)	1,726	1,789	1,893

Table 86
Switzerland
Market Structures a
Penetration of ICT

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ited Kingdom
rket Structures and
netration of ICT

United Kingdom		1994	1995	1996
Industry leader's share	Hardware	13.8%	16.9%	13.3%
	Software	5.1%	4.8%	5.8%
	Services	4.4%	4.9%	5.7%
Industry concentration (top 10 vendors)	Total IT	32.5%	35.4%	36.4%
Market comparisons	IT market versus GDP	3.00%	3.13%	3.24%
	Per capita IT expenditure (ECU)	416	453	490
	ICT market versus GDP	5.46%	5.77%	6.09%
	Per capita ICT expenditure (ECU)	756	837	919

ble 88
Capita IT
penditure ECU
t)

	1994	1995	1996	1997
Austria	386	418	438	477
Belgium/Luxemb.	416	435	462	511
Denmark	635	699	751	819
Finland	388	437	476	525
France	447	470	499	538
Germany	430	464	486	511
Greece	64	71	76	85
Ireland	254	271	292	321
Italy	226	238	249	264
Netherlands	474	510	548	601
Norway	587	643	695	760
Portugal	99	107	117	130
Spain	135	145	157	173
Sweden	639	714	745	795
Switzerland	900	950	1,009	1,068
UK	416	453	490	536
Western Europe	368	395	421	455
US	691	782	870	956
Japan	595	648	713	748

ble 89
% GDP
ht)

	1994	1995	1996	1997
Austria	1.82	1.91	1.96	2.08
Belgium/Luxemb.	2.15	2.16	2.23	2.39
Denmark	2.60	2.76	2.87	2.98
Finland	2.28	2.37	2.50	2.65
France	2.28	2.32	2.41	2.52
Germany	2.02	2.10	2.10	2.15
Greece	0.88	0.88	0.86	0.88
Ireland	2.08	2.04	2.04	2.08
Italy	1.52	1.49	1.44	1.46
Netherlands	2.56	2.66	2.79	2.94
Norway	2.41	2.49	2.53	2.66
Portugal	1.32	1.32	1.36	1.42
Spain	1.31	1.31	1.34	1.42
Sweden	3.16	3.30	3.36	3.47
Switzerland	2.79	2.90	3.06	3.21
UK	3.00	3.13	3.24	3.38
Western Europe	2.16	2.21	2.26	2.40
US	3.47	3.80	4.08	4.29
Japan	2.13	2.32	2.51	2.57

	1994	1995	1996	1997
Austria	351	377	410	454
Belgium/Luxemb.	378	416	470	515
Denmark	523	558	615	663
Finland	398	428	469	504
France	386	414	438	475
Germany	452	488	493	518
Greece	196	229	269	311
Ireland	408	452	540	600
Italy	332	350	389	434
Netherlands	431	470	524	576
Norway	502	559	632	667
Portugal	217	248	283	317
Spain	210	232	274	292
Sweden	531	563	597	632
Switzerland	826	839	884	944
UK	340	383	429	457
Western Europe	373	405	439	474
US	530	551	581	609
Japan	528	553	575	593

Table 90
Per Capita Telecommunications Expenditure ECU (left)

	1994	1995	1996	1997
Austria	1.66	1.72	1.84	1.98
Belgium/Luxemb.	1.95	2.06	2.27	2.41
Denmark	2.14	2.21	2.35	2.41
Finland	2.34	2.32	2.46	2.54
France	1.97	2.05	2.12	2.23
Germany	2.12	2.21	2.13	2.18
Greece	2.71	2.84	3.05	3.23
Ireland	3.34	3.39	3.78	3.88
Italy	2.23	2.19	2.26	2.39
Netherlands	2.33	2.46	2.67	2.82
Norway	2.06	2.16	2.30	2.33
Portugal	2.90	3.07	3.29	3.46
Spain	2.04	2.10	2.34	2.38
Sweden	2.63	2.60	2.69	2.75
Switzerland	2.56	2.56	2.68	2.84
UK	2.45	2.64	2.84	2.88
Western Europe	2.19	2.27	2.35	2.51
US	2.66	2.67	2.72	2.73
Japan	1.89	1.98	2.03	2.04

Table 91
Telecommunications % GDP (right)

	1994	1995	1996	1997
Austria	738	796	848	931
Belgium/Luxemb.	794	851	932	1,026
Denmark	1,158	1,258	1,366	1,482
Finland	787	864	944	1,028
France	833	884	937	1,013
Germany	883	951	979	1,029
Greece	260	299	345	396
Ireland	661	723	831	920
Italy	558	588	638	698
Netherlands	905	980	1,072	1,177
Norway	1,089	1,202	1,327	1,427
Portugal	316	354	399	447
Spain	344	377	431	465
Sweden	1,170	1,277	1,342	1,427
Switzerland	1,726	1,789	1,893	2,012
UK	756	837	919	993
Western Europe	741	800	861	929
US	1,221	1,333	1,451	1,565
Japan	1,123	1,200	1,287	1,341

Table 92
Per Capita ICT Expenditure ECU (left)

	1994	1995	1996	1997
Austria	3.48	3.64	3.80	4.07
Belgium/Luxemb.	4.10	4.22	4.50	4.80
Denmark	4.74	4.97	5.22	5.39
Finland	4.62	4.70	4.96	5.19
France	4.25	4.37	4.53	4.75
Germany	4.14	4.30	4.23	4.33
Greece	3.59	3.72	3.92	4.11
Ireland	5.41	5.43	5.82	5.96
Italy	3.76	3.67	3.70	3.85
Netherlands	4.90	5.12	5.47	5.76
Norway	4.47	4.65	4.83	4.99
Portugal	4.22	4.40	4.64	4.88
Spain	3.34	3.40	3.68	3.80
Sweden	5.79	5.90	6.05	6.22
Switzerland	5.34	5.46	5.74	6.06
UK	5.46	5.77	6.09	6.26
Western Europe	4.35	4.48	4.61	4.91
US	6.13	6.47	6.81	7.02
Japan	4.02	4.30	4.54	4.60

Table 93
ICT % GDP (right)

10. Price Dynamics

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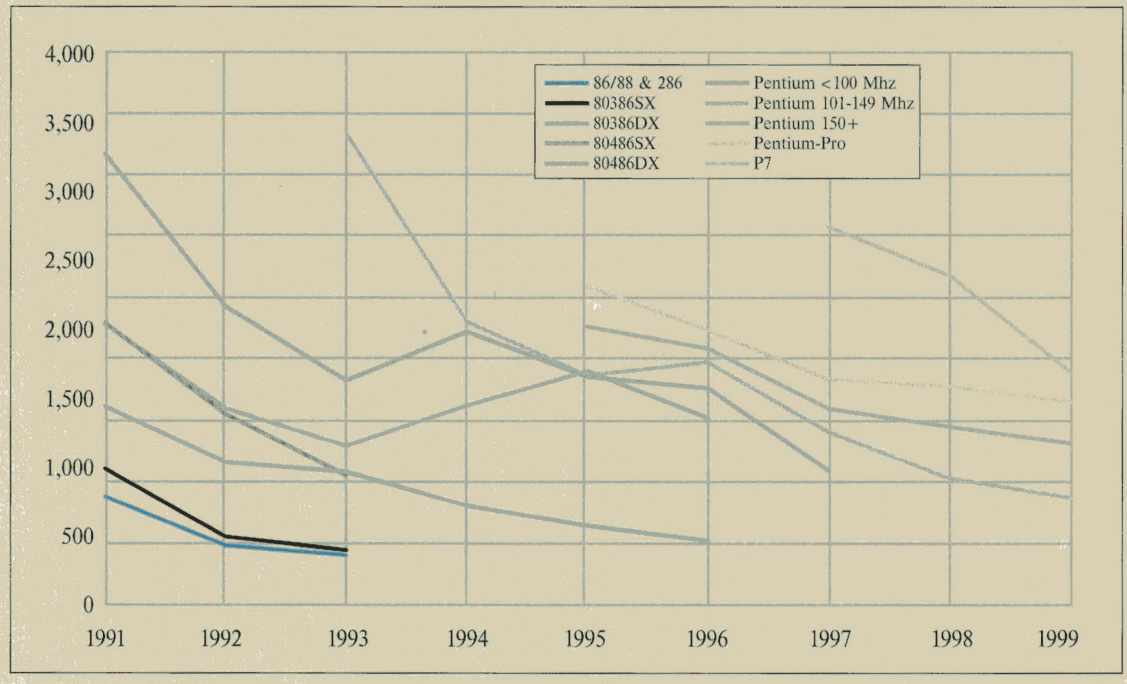
erage Selling Prices
PCs, US (ECU)
91–1999



le 94
olution of
rage Selling Prices
PCs, US (ECU
hange Rates 1996)
91–1999

	1991	1992	1993	1994	1995	1996	1997	1998	1999
86/88 & 286	883	484	406	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
80386SX	1,109	555	445	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
80386DX	1,617	1,164	1,086	812	648	523	n.a.	n.a.	n.a.
80486SX	2,289	1,555	1,055	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
80486DX	2,281	1,602	1,297	1,626	1,904	1,525	n.a.	n.a.	n.a.
Pentium <100 Mhz	3,664	2,422	1,828	2,221	1,858	1,766	1,094	n.a.	n.a.
Pentium 101-149 Mhz	n.a.	n.a.	3,836	2,305	1,871	1,978	1,411	1,034	872
Pentium 150+	n.a.	n.a.	n.a.	n.a.	2,261	2,086	1,600	1,452	1,318
Pentium-Pro	n.a.	n.a.	n.a.	n.a.	2,586	2,236	1,836	1,781	1,653
P7	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	3,067	2,674	1,900

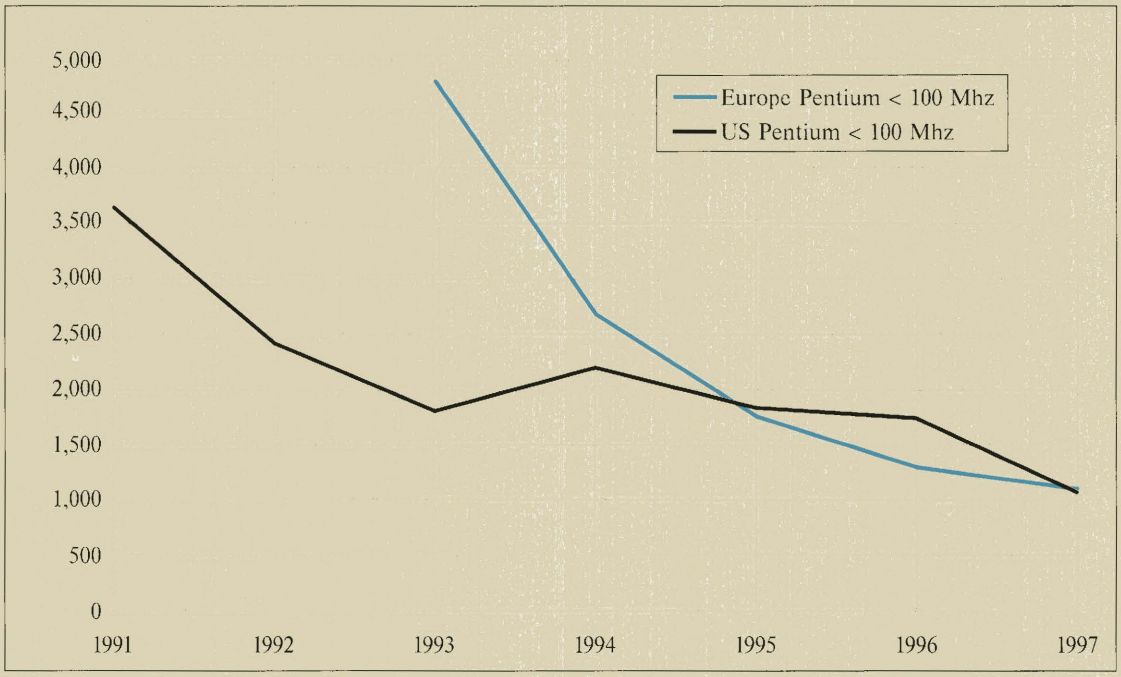


Figure 14
Convergence of Average Selling Prices for Pentium < 100 Mhz (US versus Europe), ECU, 1991–1997

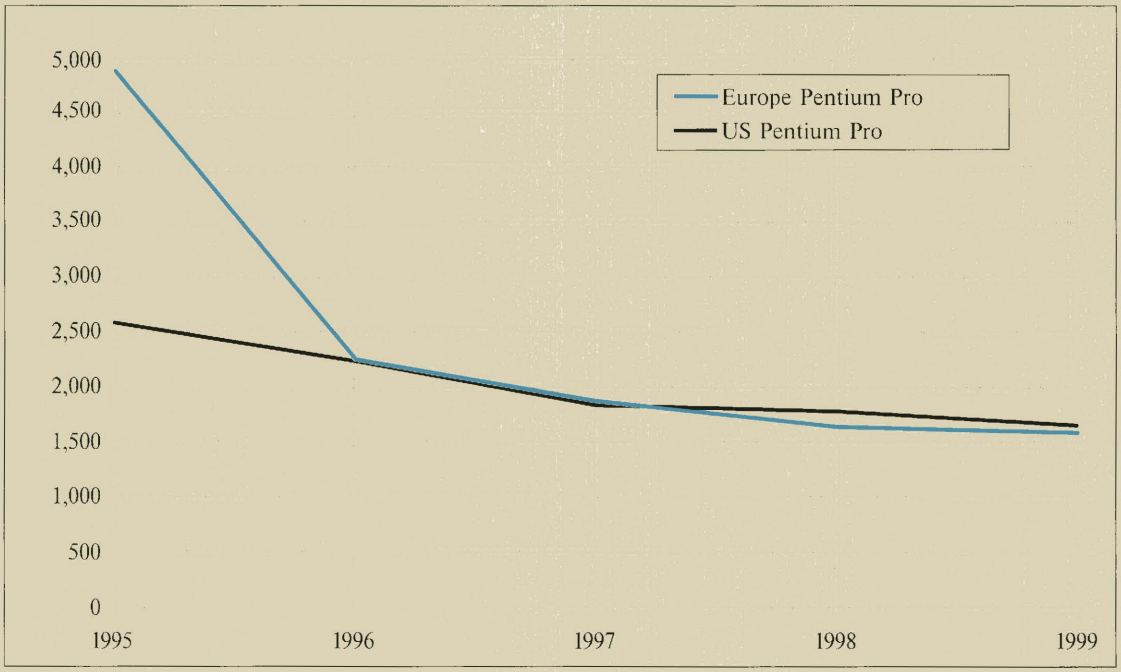


Figure 15
Convergence of Average Selling Prices for Pentium Pro (US versus Europe), ECU, 1995–1999

Figure 16
Evolution of Average Selling Prices for PCs, Europe (ECU), 1991–1999

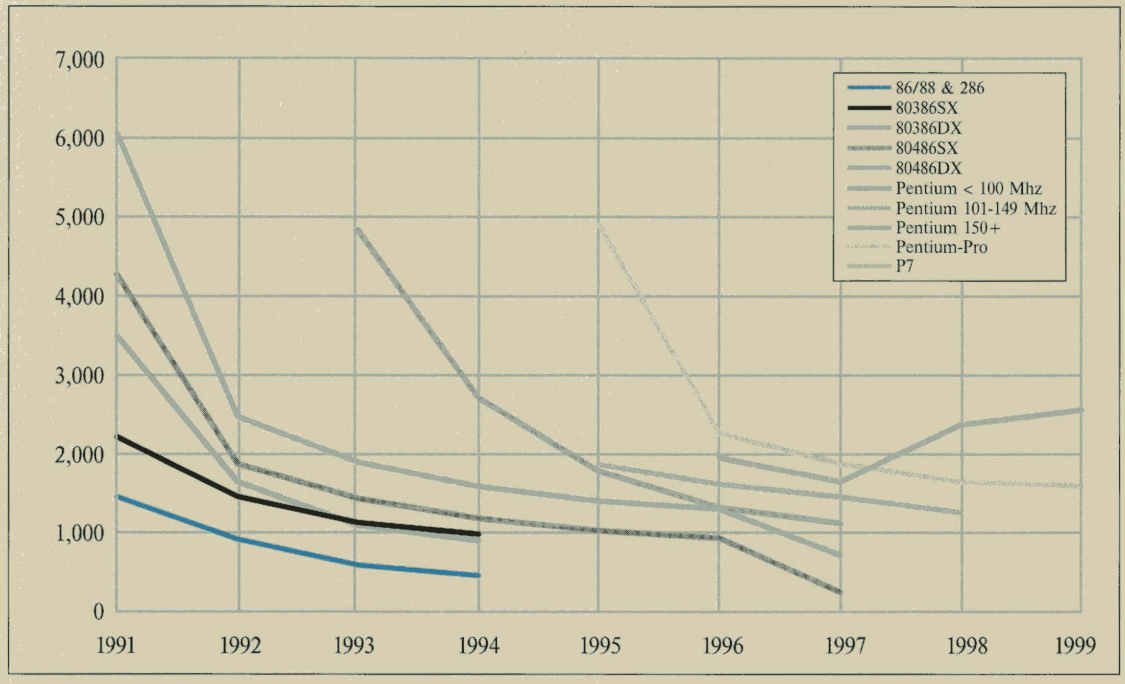


Table 95
Evolution of Average Selling Prices for PCs, Europe (ECU Exchange Rates 1996), 1991–1999

	1991	1992	1993	1994	1995	1996	1997	1998	1999
86/88 & 286	1,441	903	577	445	n.a.	n.a.	n.a.	n.a.	n.a.
80386SX	2,213	1,456	1,127	980	n.a.	n.a.	n.a.	n.a.	n.a.
80386DX	3,468	1,632	1,082	887	n.a.	n.a.	n.a.	n.a.	n.a.
80486SX	4,252	1,873	1,433	1,180	1,023	930	245	n.a.	n.a.
80486DX	6,008	2,454	1,884	1,576	1,391	1,291	706	n.a.	n.a.
Pentium <100 Mhz	n.a.	n.a.	4,805	2,702	1,779	1,318	1,119	n.a.	n.a.
Pentium 101-149 Mhz	n.a.	n.a.	n.a.	n.a.	1,857	1,606	1,446	1,247	n.a.
Pentium 150+	n.a.	n.a.	n.a.	n.a.	n/a	1,951	1,646	2,367	2,551
Pentium-Pro	n.a.	n.a.	n.a.	n.a.	4,876	2,251	1,873	1,638	1,584
P7	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	2,045

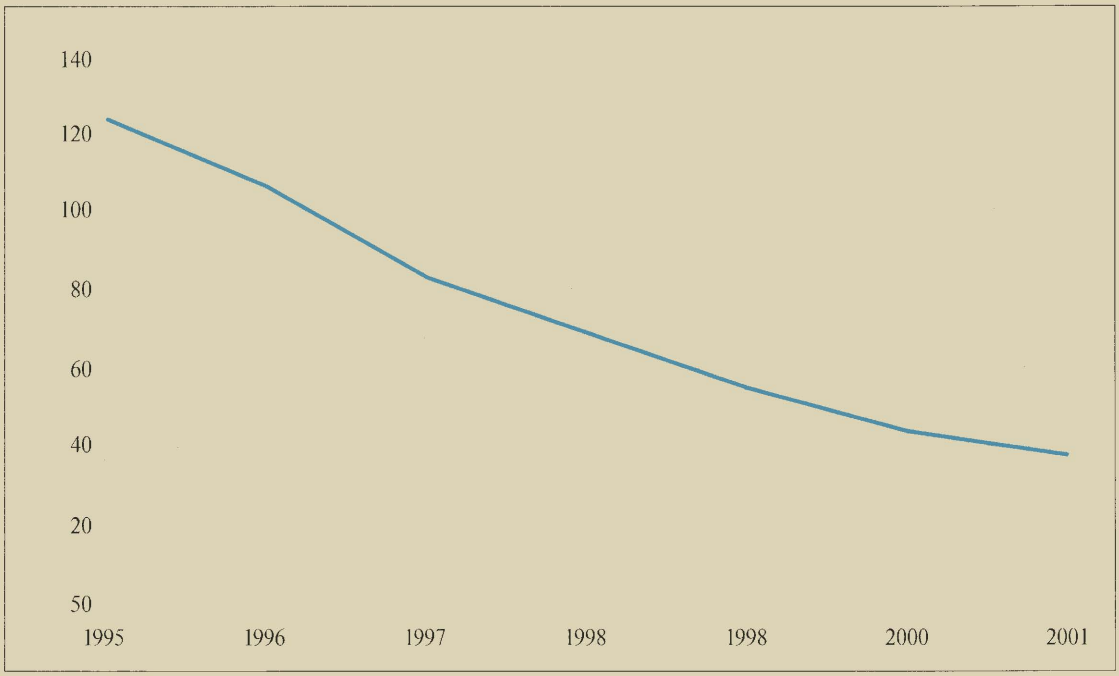


Figure 17
Evolution of Average Selling Price for PC Network Interface Card Western Europe (ECU), 1995–2001

Appendix

Table 96
Main Lines (Thousands)

Main Lines	1996	1997	1998	1999	2000	2001	CAGR in % 1996/2001
France	33,000	34,136	35,436	36,806	38,383	40,170	4.0
Germany	44,168	46,156	47,559	49,059	50,480	52,166	3.4
Italy	25,259	25,913	26,995	27,825	29,385	30,505	3.8
Spain	15,413	16,231	16,861	17,542	18,273	19,056	4.3
UK	30,720	31,597	32,585	33,500	34,343	35,018	2.7
Western Europe[1]	**210,731**	**218,313**	**226,424**	**234,428**	**243,075**	**251,647**	**3.6**
Eastern Europe	65,043	69,402	73,930	79,572	85,164	89,919	6.7
Total Europe	**275,774**	**287,715**	**300,354**	**314,000**	**328,239**	**341,566**	**4.4**
USA	165,537	171,382	177,136	182,493	188,016	193,711	3.2
Japan	62,229	64,017	66,330	68,350	70,320	72,377	3.1
Rest of World	234,789	272,417	312,709	352,564	393,257	433,727	13.1
World	**738,329**	**795,531**	**856,529**	**917,407**	**979,832**	**1,041,381**	**7.1**

[1] Incl. Turkey

Source: EITO Task Force

Table 97
Digital Main Lines (Thousands)

Digital Main Lines	1996	1997	1998	1999	2000	2001	CAGR in % 1996/2001
France	32,210	34,136	35,436	36,806	38,383	40,170	4.5
Germany	36,000	45,500	47,559	49,059	50,480	52,166	7.7
Italy	21,495	23,658	25,824	27,787	29,385	30,505	7.3
Spain	10,381	12,027	13,472	14,981	16,445	17,885	11.5
UK	28,670	30,649	32,422	33,500	34,343	35,018	4.1
Western Europe[1]	**176,155**	**199,273**	**213,595**	**225,661**	**236,440**	**246,563**	**7.0**
Eastern Europe	14,807	20,482	26,130	32,294	39,194	45,664	25.3
Total Europe	**190,962**	**219,755**	**239,725**	**257,955**	**275,634**	**292,227**	**8.9**
USA	138,223	150,131	162,434	174,281	184,444	191,774	6.8
Japan	60,611	64,017	66,330	68,350	70,320	72,377	3.6
Rest of World	193,512	236,304	283,009	328,524	374,077	416,856	16.6
World	**583,308**	**670,207**	**751,498**	**829,110**	**904,475**	**973,234**	**10.8**

[1] Incl. Turkey

Source: EITO Task Force

Total Mobile Telephone Subscribers	1996	1997	1998	1999	2000	2001	CAGR in % 1996/2001
France	2,501	4,400	6,800	9,500	12,500	15,400	43.8
Germany	5,504	8,000	11,000	14,800	19,000	22,900	33.0
Italy	6,418	11,000	14,800	18,100	21,000	23,500	29.6
Spain	2,996	4,800	6,500	8,100	9,600	11,000	29.7
UK	6,810	8,700	10,900	13,300	15,900	18,600	22.3
Western Europe[1]	**36,001**	**53,632**	**72,115**	**91,332**	**110,878**	**129,463**	**29.2**
Eastern Europe	1,509	3,600	6,258	9,223	12,369	15,649	59.6
Total Europe	**37,510**	**57,232**	**78,373**	**100,555**	**123,247**	**145,112**	**31.1**
USA	44,093	55,000	68,500	84,000	100,000	115,000	21.1
Japan	18,167	28,000	36,000	42,000	46,000	50,000	22.4
Rest of World	36,905	57,295	83,330	113,369	146,249	181,001	37.4
World	**136,675**	**197,527**	**266,203**	**339,924**	**415,496**	**491,113**	**29.2**

Table 98
Total Mobile Telephone Subscribers (Thousands)

[1] Incl. Turkey

Source: EITO Task Force

Analogue Mobile Telephone Subscribers	1996	1997	1998	1999	2000	2001	CAGR in % 1996/2001
France	279	100	30	0	0	0	-100.0
Germany	532	510	480	450	420	370	- 7.0
Italy	3,795	3,400	3,100	2,800	2,500	2,100	- 11.2
Spain	1,308	1,200	1,050	850	650	450	- 19.2
UK	3,377	2,800	2,300	1,800	1,300	800	- 25.0
Western Europe[1]	**12,816**	**11,298**	**9,907**	**8,412**	**6,893**	**5,284**	**- 16.2**
Eastern Europe	598	838	946	987	1,013	1,023	11.3
Total Europe	**13,414**	**12,136**	**10,853**	**9,399**	**7,906**	**6,307**	**- 14.0**
USA	41,393	47,000	51,500	53,000	50,000	46,000	2.1
Japan	4,247	3,300	2,200	1,100	0	0	-100.0
Rest of World	25,876	32,040	33,335	32,389	30,093	27,984	1.6
World	**84,930**	**94,476**	**97,888**	**95,888**	**87,999**	**80,291**	**- 1.1**

Table 99
Analogue Mobile Telephone Subscribers (Thousands)

[1] Incl. Turkey

Source: EITO Task Force

Table 100
Digital Mobile Telephone Subscribers (Thousands)

Digital Mobile Telephone Subscribers	1996	1997	1998	1999	2000	2001	CAGR in % 1996/2001
France	2,222	4,300	6,770	9,500	12,500	15,400	47.3
Germany	4,972	7,490	10,520	14,350	18,580	22,530	35.3
Italy	2,623	7,600	11,700	15,300	18,500	21,400	52.2
Spain	1,688	3,600	5,450	7,250	8,950	10,550	44.3
UK	3,433	5,900	8,600	11,500	14,600	17,800	39.0
Western Europe[1]	**23,185**	**42,334**	**62,208**	**82,920**	**103,985**	**124,179**	**39.9**
Eastern Europe	911	2,762	5,312	8,236	11,356	14,626	74.2
Total Europe	**24,096**	**45,096**	**67,520**	**91,156**	**115,341**	**138,805**	**41.9**
USA	2,700	8,000	17,000	31,000	50,000	69,000	91.2
Japan	13,920	24,700	33,800	40,900	46,000	50,000	29.1
Rest of World	11,029	25,255	49,995	80,980	116,156	153,017	69.2
World	**51,745**	**103,051**	**168,315**	**244,036**	**327,497**	**410,822**	**51.3**

[1] Incl. Turkey

Source: EITO Task Force

Table 101
Total Cable TV Subscribers (Thousands)

Total Cable TV Subscribers	1996	1997	1998	1999	2000	2001	CAGR in % 1996/2001
France	2,280	2,590	2,890	3,170	3,420	3,650	9.9
Germany	17,700	18,500	19,200	19,900	20,500	21,100	3.6
Italy	20	70	300	410	540	690	103.0
Spain	1,890	1,960	2,030	2,090	2,150	2,210	3.2
UK	1,700	2,000	2,300	2,600	2,900	3,200	13.5
Western Europe[1]	**42,733**	**44,925**	**47,004**	**49,003**	**50,827**	**52,631**	**4.3**
Eastern Europe	10,629	11,704	12,439	13,120	13,744	14,324	6.1
Total Europe	**53,362**	**56,629**	**59,443**	**62,123**	**64,571**	**66,955**	**4.6**
USA	64,000	64,640	64,963	65,288	65,614	65,680	0.5
Japan	3,220	4,290	5,910	8,000	10,200	12,290	30.7
Rest of World	74,330	85,119	97,013	108,613	119,741	130,592	11.9
World	**194,912**	**210,678**	**227,329**	**244,024**	**260,126**	**275,517**	**7.2**

[1] Incl. Turkey

Source: EITO Task Force

Table 102
Internet/Online Users
(Thousands)

Internet/Online Users	1996	1997	1998	1999	2000	2001	CAGR in % 1996/2001
France	6,800	7,000	7,500	8,175	10,118	12,491	12.9
Germany	2,783	4,461	6,695	9,426	12,621	16,299	42.4
Italy	723	1,315	2,043	2,956	4,139	5,616	50.7
Spain	1,106	1,412	1,780	2,528	3,426	4,466	32.2
UK	3,014	4,519	6,198	8,110	10,222	12,254	32.4
Western Europe[1]	**17,889**	**23,928**	**31,478**	**40,911**	**52,981**	**66,673**	**30.1**
Eastern Europe	491	894	1,535	2,432	3,581	5,008	59.1
Total Europe	**18,380**	**24,822**	**33,013**	**43,343**	**56,562**	**71,681**	**31.3**
USA	36,672	46,956	56,860	66,270	75,547	85,338	18.4
Japan	2,962	3,960	6,309	9,718	13,953	18,996	45.0
Rest of World	8,447	13,248	19,589	27,497	37,566	49,302	42.3
World	**66,461**	**88,986**	**115,771**	**146,828**	**183,628**	**225,317**	**27.7**

[1] Incl. Turkey

Source: EITO Task Force

Table 103
Penetration

Penetration 1996	Inhabitants (Inhab.) (000)	Households (HH) (000)	Main Lines (ML) (000)	ML per 100 Inh. (%)	Digital ML on ML (%)	CaTV Subscribers (000)	CaTV Subscribers/ HH (%)	Mobile Subscribers (000)	Mobile Subscribers/ Inhabitants (%)	Internet/ Online Users (000)	Internet/ Online Users/100 Inhab. (%)
Austria	8,070	3,081	3,902	**48.4**	**72.0**	870	**28.2**	599	**7.42**	109	**1.4**
Belgium	10,120	4,100	4,725	**46.7**	**72.3**	3,630	**88.5**	477	**4.71**	232	**2.3**
Denmark	5,230	2,389	3,301	**63.1**	**84.2**	980	**41.0**	1,387	**26.52**	120	**2.3**
Finland	5,130	2,121	2,860	**55.8**	**95.0**	822	**38.8**	1,491	**29.06**	521	**10.2**
France	58,270	22,385	33,000	**56.6**	**97.6**	2,280	**10.2**	2,501	**4.29**	6,800	**11.7**
Germany	82,140	37,264	44,168	**53.8**	**81.5**	17,700	**47.5**	5,504	**6.70**	2,783	**3.4**
Greece	10,500	3,614	5,329	**50.8**	**42.6**	3	**0.1**	513	**4.89**	134	**1.3**
Ireland	3,590	1,062	1,390	**38.7**	**83.0**	520	**49.0**	265	**7.38**	109	**3.0**
Italy	57,250	20,010	25,259	**44.1**	**85.1**	20	**0.1**	6,418	**11.21**	723	**1.3**
Luxembourg	410	151	244	**59.5**	**100.0**	134	**88.7**	45	**10.98**	22	**5.4**
Netherlands	15,600	6,450	8,431	**54.0**	**80.2**	5,900	**91.5**	1,014	**6.50**	664	**4.3**
Norway	4,390	1,811	2,500	**56.9**	**92.0**	714	**39.4**	1,258	**28.66**	158	**3.6**
Portugal	9,820	3,419	3,753	**38.2**	**78.6**	110	**3.2**	663	**6.75**	80	**0.8**
Spain	39,220	11,909	15,413	**39.3**	**67.4**	1,890	**15.9**	2,996	**7.64**	1,106	**2.8**
Sweden	8,870	4,171	6,032	**68.0**	**96.2**	1,770	**42.4**	2,492	**28.09**	672	**7.6**
Switzerland	7,060	3,330	4,547	**64.4**	**75.3**	2,510	**75.4**	663	**9.39**	322	**4.6**
UK	58,780	23,192	30,720	**52.3**	**93.3**	1,700	**7.3**	6,810	**11.59**	3,014	**5.1**
Western Europe[1]	**449,164**	**163,765**	**210,731**	**46.9**	**83.6**	**42,733**	**26.1**	**36,001**	**8.02**	**17,889**	**4.0**
Bulgaria	9,016	2,950	2,650	**29.4**	**6.8**	140	**4.7**	38	**0.42**	4	**0.0**
Czech Rep.	10,400	4,012	2,815	**27.1**	**33.0**	790	**19.7**	203	**1.95**	18	**0.2**
Hungary	10,239	4,015	2,680	**26.2**	**71.2**	1,130	**28.1**	467	**4.56**	84	**0.8**
Poland	38,646	12,668	6,425	**16.6**	**49.4**	3,040	**24.0**	244	**0.63**	164	**0.4**
Romania	22,703	7,903	3,170	**14.0**	**25.4**	2,350	**29.7**	19	**0.08**	12	**0.1**

Source: EITO Task Force

[1] Incl. Turkey

11. Definitions

The Statistical Section of the EITO is based upon a set of definitions and methodologies agreed between the EITO Task Force and IDC, and upon the European Union standards for trade statistics. To better reflect and measure the latest trends in the ICT industry the EITO has undergone some changes in the methodology and definitions of some segments compared to past editions. All definitions are outlined below.

Geographic coverage

The heading European Union (EU) refers to Austria, Belgium & Luxembourg, Denmark, Finland, France, Germany, Greece, Italy, the Republic of Ireland, the Netherlands, Portugal, Spain, Sweden and the UK. Non-EU is represented by data on Norway and Switzerland. Eurostat trade statistics to the end of 1994 refer to the twelve member EU. Western Europe includes both the European Union states and Norway and Switzerland.

Throughout the statistical section Eastern Europe is considered to refer to the Czech Republic, Hungary, Poland, Russia and Slovakia.

The Four Tigers refer to Hong Kong, Korea, Singapore and Taiwan.

Information technology (IT)

For the purposes of this study information technology refers to the combined industries of hardware for office machines, data processing equipment, data communications equipment and of software and services.

Information and communications technologies (ICT)

For the purposes of this study information and communications technologies refers to information technology plus telecommunications equipment and telecommunications services.

All market values are in constant 1996 ECU, therefore growth is expressed in local currencies (without the effects of changes in currency conversions). Trade data are reported in *current* ECU.

Domestic markets

Domestic market value reflects the revenues paid to primary vendors and the value-added across the distribution channels for sale to the final customer for office machines, DP systems, software and/or services. For product-specific definitions, see other terms below.

Unit shipments are the unit measure of hardware product sales by vendors to all distribution channels or to end-users. Units are counted as they leave suppliers and are not double-counted in the case of original equipment manufacturer (OEM) relationships.

IT user budgets are investigated in IT user surveys. As these measure purchase intentions and behaviours that vary according to different geographic and time parameters, growth rates of IT user budgets do not match with growth rates of market values.

11.1. Information Technology

11.1.1. IT Hardware

Computer hardware

Server systems include CPU(s) and basic peripherals (e.g., data storage devices, terminals, memory and peripherals), as well as revenue for new systems added to the installed base. Multiprocessor configurations are counted as single systems. In the 1998 edition of the EITO Server Systems value is reported in the two major components of server and add-ons.

Server systems is a classification used to group all computer systems except personal computers and workstations. "Servers" designates servers or hosts as sold in their initial configuration,

with frame or cabinet and all cables, processors (including replacement or upgrade processors), initial memory and memory embedded in replacement or upgrade processors, initial storage, bundled communications boards, and bundled operating systems software. The traditional classification by price bands into large (over $ 1,000,000), medium (between $ 100,001 and $ 1,000,000) and small (between $ 10,000 and $ 100,000) servers, has been replaced by the classification based on operating systems:

- *Unix Servers:* All servers running the Unix operating system or variant;
- *NT Servers:* All servers running Windows NT;
- *Other Servers*: All IBM S390 servers, AS/400 servers, Digital Open VMS, Netware servers, PC servers not running Unix or NT;
- *Server add-ons* include:

  Add-on storage representing any storage devices shipped for use on a high-end, mid-range, or low-end server subsequent to the acquisition and installation of the server.

  Printers: All printers primarily associated with hosts or exclusively with a server.

  Other server add-ons: Primarily terminals (interactive non-programmable display devices) and memory upgrades acquired separately from an initial system shipment or processor upgrade.

Workstations: Workstations include all traditional workstations. Personal workstations (based on Windows NT platforms) are included in the PC segment. Traditional single-user workstations have Unix or Open VMS operating system, usually bundled by the hardware manufacturer, with an emphasis on technical, graphics application segments and higher levels of functionality in many areas (graphics performance, floating point, memory, disk storage).

Personal computers (PCs) are general purpose, single-user, microprocessor based machines that are capable of supporting attached peripherals and can be programmed in a high level language. Board-level products are excluded. For microprocessor based systems that can support more than one user, the distinction between a small-scale system and a personal computer is based on the system's most common configuration. If a system is designed as a server or is multi-microprocessor based, it is classified as a small-scale system.

- *Portables:* Portable and transportable machines are included in this category, but electronic organisers (such as the Psion Organiser products) are not counted. Subcategories acknowledged include AC-portables, battery-operated laptops, notebooks and sub-notebooks. Small hand-held products such as high-end organisers and palmtops are excluded from the portable definition.
- *Desktops:* Desktop and tower machines are included in this category, but dedicated games machines (such as Nintendo) are not included. This category also includes personal workstations, combining Windows NT platforms, the economics of PCs, and emphasis on networked business/professional applications, with equivalent or slightly greater functionality than a PC's.

PC Printers include models designed to be attached to PCs, not sold with the systems. These include dot matrix printers, thermal/thermal transfer printers, non-impact page printers, ink-jet printers and colour printers.

Other PC add-ons represents expenditure on PC hardware products not normally acquired in a typical initial purchase and not included in other categories. It includes memory upgrades, replacement or upgrade monitors and keyboards, and various board-level enhancements for terminal emulation, facsimile transmission, graphics enhancement, sound production.

Office equipment

Office equipment includes:

Typewriters: Mechanical, electric and electronic typewriters;

Calculators: Professional desktop, pocket and hand-held models;

Copiers: Personal, digital, and colour copiers;

Other office equipment: Duplicating equipment (offsets, ink duplicators), cash-registers and point-of-sale systems, document filing (micro-film, WORM optical disks), other products (franking, addressing, labelling machines, mail handling systems, etc.).

Data communications hardware

Data communications hardware includes the LAN hardware and other data communications equipment markets.

LAN hardware is restricted to the equipment for multi-user systems, PCs, or workstations required to implement a local area network; it does not include software (e.g., specialised network operation systems) or servers, which are counted in their respective software and system categories. For this project, LAN connections that come bundled with a system and/or integrated on the mother board (e.g., Ethernet in workstations) are excluded to avoid double counting with the value of systems shipments.

The LAN hardware category includes LAN interfaces, LAN concentrators, terminal servers, internetwork equipment, repeaters.

- *LAN interfaces:* Three categories are tracked here: LAN cards, workstation network interfaces and multi-user interfaces. Value is normally assigned on a per-node basis and includes both new networks and nodes shipped into existing LANs.
- *Intelligent LAN concentrators:* For this project are hardware devices that act as central points for star wiring for the nodes attached to the LAN and additionally provide network management functionality over the physical layer.
- *Terminal servers* provide terminal connectivity to the LAN.
- *Lan Hubs*
- *Internetwork equipment* includes bridges and routers.

Other data communications hardware is for this project expressly limited to hardware and to the following categories, of which it is the sum: modems digital switching equipment, communications processors and channel extenders.

- *Modems* tracked are restricted to analogue and short haul modems, divided into dial-up and leased line segments and by speed (14.4, 16.8-19.2, 1200, 4800 and 9600 bps); not counted are fibre optic, satellite, pocket, or broad-band modems or digital-over-voice (DOV) products.
- *Multiplexers* are devices used to multiplex telecommunications circuits, using time-division and statistical time-division technology. Seven market segments are tracked: time-division multiplexers, point to point T-1 TDMs, networking T-1 TDMs, T-3 multiplexers (aggregates of 28 DS-1 circuits), and statistical TDMs; not addressed are coaxial or frequency division multiplexers or digital access cross-connect systems.
- *Packet switching equipment* includes all packet switch nodes to route data packets via the most efficient available path and PADS (Packet assemblers/disassemblers) to convert asynchronous and/or synchronous data to the relevant protocol format (e.g., X.25).

- *Digital switching equipment* includes matrix switches (designed to provide local and remote patching, switching and diagnostic functions, typically installed in data processing centres with two or more front-end processors) and data PBXs used to connect terminals to computer ports (increasingly obsolescent due to competition from front-end processors and local area networks).
- *Communications processors* are specialised and customised data communication devices that serve as nodal points for communications between IBM compatible hosts and other nodes on a network. The classical communications processor was a front-end processor configured to function solely as the interface between an SNA host and a cluster controller attached to 3270 terminals or PCs emulating terminals. Alternatives include remote processors configured as nodes in an SNA network and gateway processors configured to translate and/or route network protocols between SNA and non-SNA nodes.
- *Cluster controllers* are devices designed to control the I/O operations of a group of 3270-type devices, including displays and printers.
- *Channel extenders* are devices that extend the distance over which an I/O channel on a single IBM mainframe can communicate with an IBM-compatible peripheral or another IBM mainframe.

The above computer, office, and telecommunications equipment definitions refer to what the EITO Task Force classifies as general-purpose products. This equipment can be used for a variety of applications in a variety of industries.

In addition to these general purpose products, information technology is also used in a wide range of application-specific devices. These include, but are not limited to: retail point-of-sale systems, automatic teller machines, credit authorisation terminals, smart-card readers, factory data collection systems, numerical controllers for manufacturing equipment, cheque processing equipment, computer assisted publishing systems, and specialised systems for the military, aerospace and other industries. Taken together these markets are significant.

Readers should keep these definition issues in mind when working with this volume and other statistical sources. Figures from IT companies, industry research firms and institutions, trade associations, and governments may well include a mix of general purpose and application-specific equipment, complicating attempts to make direct comparisons with the published EITO figures.

11.1.2. Software Products

Software products are commercially available packaged programs for sale or lease from systems services and independent software vendors (ISVs). Value includes the packaged software fees plus related non-consulting revenue, such as fees for maintenance and/or support. This definition does not include consulting or system integration revenue or specially designed application software solutions added by turnkey systems houses (including VARs) to systems acquired from a hardware manufacturer or other third party. The primary categories are 1) systems software and utilities, 2) application tools, and 3) application solutions.

Also, for this project the software products category includes license fees partially earmarked for software maintenance, services, and/or support; other forms of software support are counted within the support services category.

Systems software includes system infrastructure software, as well as application tools.

- *System infrastructure software* is divided into four primary categories. System management software is used to manage the full range of computing resources for the enterprise. Middleware is defined as independent system software and services that distributed businesses use to share computing resources across heterogeneous technologies. Serverware delivers capabilities to coordinate resources between distributed servers or nodes on the network. System-level software is the foundation of system software products that collectively operate the hardware platforms and communications networks upon which business applications are built. System-level software includes operating systems and subsystems, networking software and services, and system utilities. *Application tools* include information access tools and programmer development tools. Programmer development tools are products that support the professional developer in the design, development and implementation of a variety of software systems and solutions. Examples include database engines. 4GL, AMD (analysis, modelling and design) and 3GLs.
- *Application solutions* software includes consumer, commercial and technical programs designed to provide packaged software solutions for specific problems inherent in the home, industry or in a business function. Such software can address consumer applications, "cross-industry" applications (e.g., accounting, human resource management, payroll, project management or word processing and other office activities) or specific industry applications for vertical markets (e.g., banking/financial, manufacturing, health care, oil and gas exploration, etc.).

11.1.3. Services

Consulting: Encompass a broad array of IT-related planning and design activities that assist clients in making IT-related decisions on business direction or information technology. IT-related business consulting includes corporate strategy assistance, process improvement, capacity planning, best practices, business process reengineering, and change-management services for business; not included are consulting involving tax, audit, benefits, financial, and/or engineering issues. IT consulting includes: information systems strategy assistance, information system and network planning architectural and supplier assessments, product consulting and technical designs for information technology, and maintenance planning.

Implementation: Comprise all activities directly involved with the creation of technical and business IT solutions, specifically with procuring, configuring, installing, developing, moving, testing and managing information technology. Implementation services also include all activities involved with custom application development and work performed on packaged applications. Training and education is also included in this segment. It includes activities required for the transmission of new behaviours, skills or actions that can be used to begin performing job-specific tasks or improved performance in IT-related functions.

Operations Management: Involves taking responsibility for managing components of a client's IT infrastructure. Specific activities include help-desk services, asset management services, systems management, network management, software update management, facilities management, back up and archiving and business recovery services. Processing services are also included under this category.

Support Services: Include all activities involved with ensuring that hardware, software and networking products are performing properly as a service to clients. Activities include all maintenance contracts for hardware, software and networking products, as well as services such as telephone support to resolve problems for clients and help with workarounds. Services in this category can come as a bundled package of other services or standalone.

11.2. Telecommunications

11.2.1. Telecommunications Equipment

The market is classified according to the nature of the user:

Public network equipment

This segment includes all equipment used by carriers to provide voice/data network services.

Switching: Local and junction switches, trunk switches, telex switches, data switches, cellular radio switches.

Transmission: Multiplexers, microwave, cross connects, line terminals.

Mobile communications infrastructure: All types of equipment and systems used by PTO's in the build-up of their mobile telecommunications networks.

Private network equipment

Includes all the equipment installed at telecommunications users premises.

PABXs and key systems: Private telecommunications switches used for switching incoming and outgoing calls.

Telephone sets includes domestic and business phones. Mobile terminal devices are not included in this category.

Mobile equipment (domestic and business): This segment includes mobile terminal devices: cordless phones and GSM hand-held devices, car phones, CTx and DECT systems, pagers. Equipment used in the running of a public wireless network is not included.

Other equipment includes domestic and business private equipment not otherwise counted above. This includes fax machines, answering machines, audio conferencing, video conferencing and automatic call distribution equipment.

11.2.2. Telecommunications Services

Telephone services: This segment includes carrier service revenues for residential, business, national and international voice services.

Mobile telephone services: This segment includes service revenues from analogue, digital and telepoint mobile networks (carphones and personal phones).

Switched data and leased-line services: This segment includes service revenues for the following categories:

- *Private line services*: A private line is a fixed connection between two points. Private lines are leased to a single customer, and only the traffic of that customer can travel through the circuit. Tariffs are based on fixed price per distance segment. No time or traffic related charges are made.
- *Switched data services*: This segment includes service revenues from packet switched data networks circuit switched networks, value-added networks and ISDN services.

CaTV: includes revenues from basic CaTV subscriber service providing transmission improvement and/or added broadcast channels, plus revenues from auxiliary CaTV services (such as pay-TV, security services, or shopping revenues) when provided via a separate CaTV network. This includes revenues from any operator, public or private.

11.3. Performance Measures

11.3.1. Trade Statistics

All trade statistics are presented in current ECU and are based upon official European Union data. All conventions common in the presentation of such statistics have been observed. For a full treatment of this complex area readers are referred to the publications of the Customs Co-operation Council and Eurostat. Data have been selected for standard sub-headings of the Combined Nomenclature as follows:

The reported areas (or groupings of countries) are: intra-EU (imports/exports occurring between a reporting country and a trading partner that are both within the EU), extra-EU (imports/exports occurring between a reporting/trading country in the European Union and a reporting/trading partner outside the EU).

Values of imports are generally stated at customs value or by reference to the concept of customs value (cif); exports are stated at the value of the goods at the place and time that they leave the statistical area of the exporting member state (fob). The focus of the analysis is on reporting countries in the European Union.

Please note: descriptions have been abbreviated. Product codes have been stated to indicate the level at which data were collected for this exercise. Thus, 84.69 should be considered to include all lower sub-headings below 84.69. readers interested in the full details of the trade classification are referred to the publications listed below.

References

1. Explanatory Notes to the Combined Nomenclature of the European Union, published by the Office for the Official Publications for the European Commission.

2. Explanatory Notes to the Harmonised System Nomenclature, published by the Customs Co-operation Council.

11.3.2. Production

Limited information is available for the correct evaluation of production, on the basis of the value-added contribution of each country.

An approximate relationship is therefore applied to compute production values:

production = market value + exports – imports

where market value is based upon EITO data, and trade data are based upon appropriately adjusted statistics.

For IT and telecommunications hardware this relationship is relatively straight forward to calculate, since data are readily available on both counts.

11.3.3. Industry Leader's Market Share

Market share statistics are based upon aggregations of IDC research, in order to illustrate structural issues within the market, whilst at the same time preserving confidentiality.

11.3.4. Industry Concentration

As for the industry leader's (sic.) market share (see above), industry concentration is an aggregate market share statistic.

11.3.5. Inflation

All forecasts and historical figures are expressed in nominal terms.

11.3.6. Exchange Rates

All market data and forecasts are presented in constant 1996 exchange rates. The exchange rates used for all except the East European markets are based upon the averages of daily rates for the individual currencies on the Paris money markets, as reported by the OECD.

Due to the characteristics of the local markets, Eastern European research has been carried out in a different fashion to that used for an established market. A different treatment is still necessary for Russia. In this case valuations continue to be made relative to a set of initial dollar values for equivalent Western machines. These reference values are then discounted by a variable amount which reflects the systems age. Finally, data are converted into ECU using the appropriate $/ECU exchange rate.

List of import/export codes used to value IT and telecommunications hardware trade

84.69	typewriters and word processing machines
84.70	calculators: calculating machines, accounting machines, cash registers, postage franking machines, ticket-issuing machines and similar machines, incorporating a calculating device
84.43.12	offset printing machinery, sheet fed, office type, sheet size = < 22 x 36 cm
84.71	DP equipment: Automatic data processing machines and units thereof; optical readers, machines for transcribing data onto data media in coded form, and machines for processing data.
84.72	"other" office equipment: printers, hectograph or stencil duplicating machines, addressing machines, automatic banknote dispensers, coin-sorting machines, coin-counting (or wrapping) machines, pencil sharpening machines, perforating or stapling machines
84.73	parts for use with the machines of sub-headings 84.69-84.72
90.09	photocopiers
85.17	equipment used for line telephony/telegraphy: telephone sets, apparatus for carrier-current line systems, telegraphy apparatus, faxes, weather map plotters.
85.20.20	telephone answering machines incorporating a sound device.

ECU Exchange Rates

(Units per ECU)

	1994	1995	1996
Austria	13.60	13.18	13.43
Belgium	39.83	38.56	39.32
Denmark	7.57	7.32	7.36
Finland	6.21	5.71	5.83
France	6.61	6.52	6.49
Germany	1.93	1.87	1.91
Greece	288.33	302.75	305.48
Ireland	0.80	0.82	0.79
Italy	1920.24	2129.41	1958.68
Netherlands	2.17	2.09	2.14
Norway	8.40	8.29	8.20
Portugal	197.62	195.95	195.75
Spain	159.52	163.01	150.82
Sweden	9.19	9.32	8.51
Switzerland	1.63	1.54	1.57
UK	0.77	0.82	0.81
US	1.19	1.31	1.27
Japan	121.20	123.01	136.71
Source: OECD			
Local commercial rates			
Czech Republic (Crowns)	33.6	33.4	34.4
Hungary (Forints)	126.1	193.7	185.4
Poland (Zloties)	2.7	3.5	3.5
Russia* (Roubles)	2,929.5	6,834.0	6,248.0
Slovak Republic (Crowns)	37.1	39.0	38.6

* Russia: research is carried out using US Dollars rather than Roubles. The Russian currency's steep devaluation makes local currency research impossible (e.g., in December 1995, the rouble to ECU exchange rate was 7,140 roubles to the ECU).

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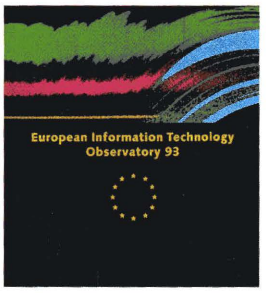

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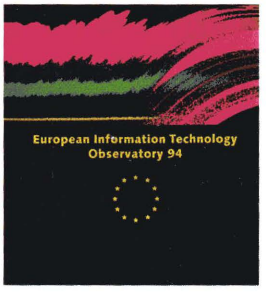

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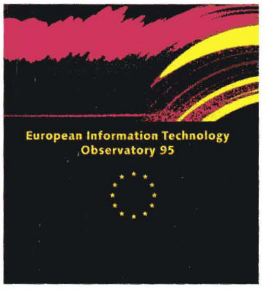

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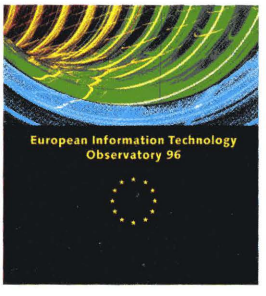

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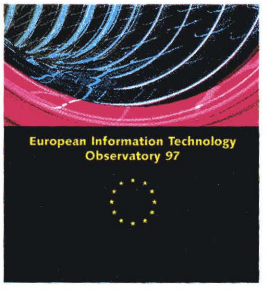

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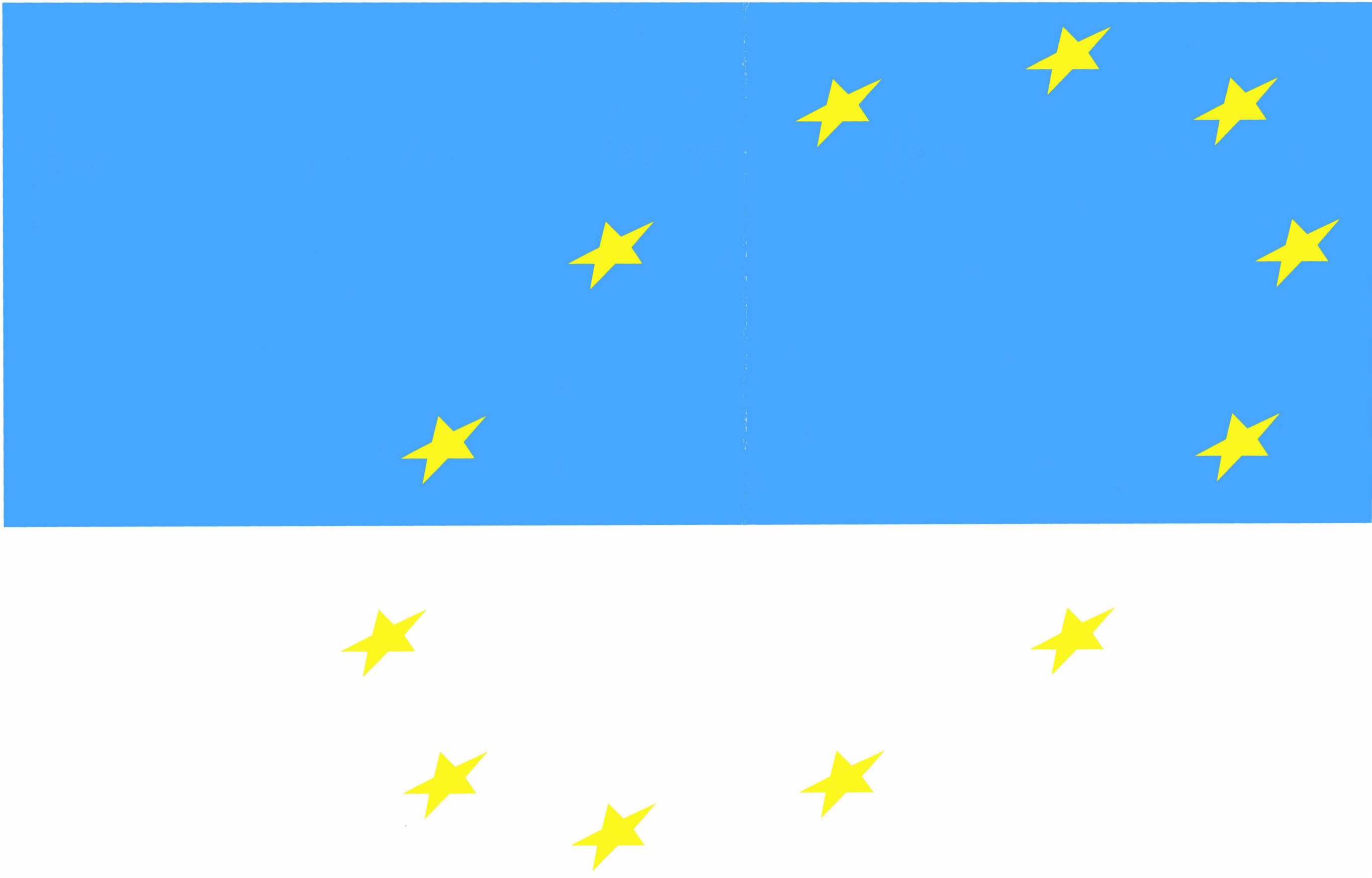

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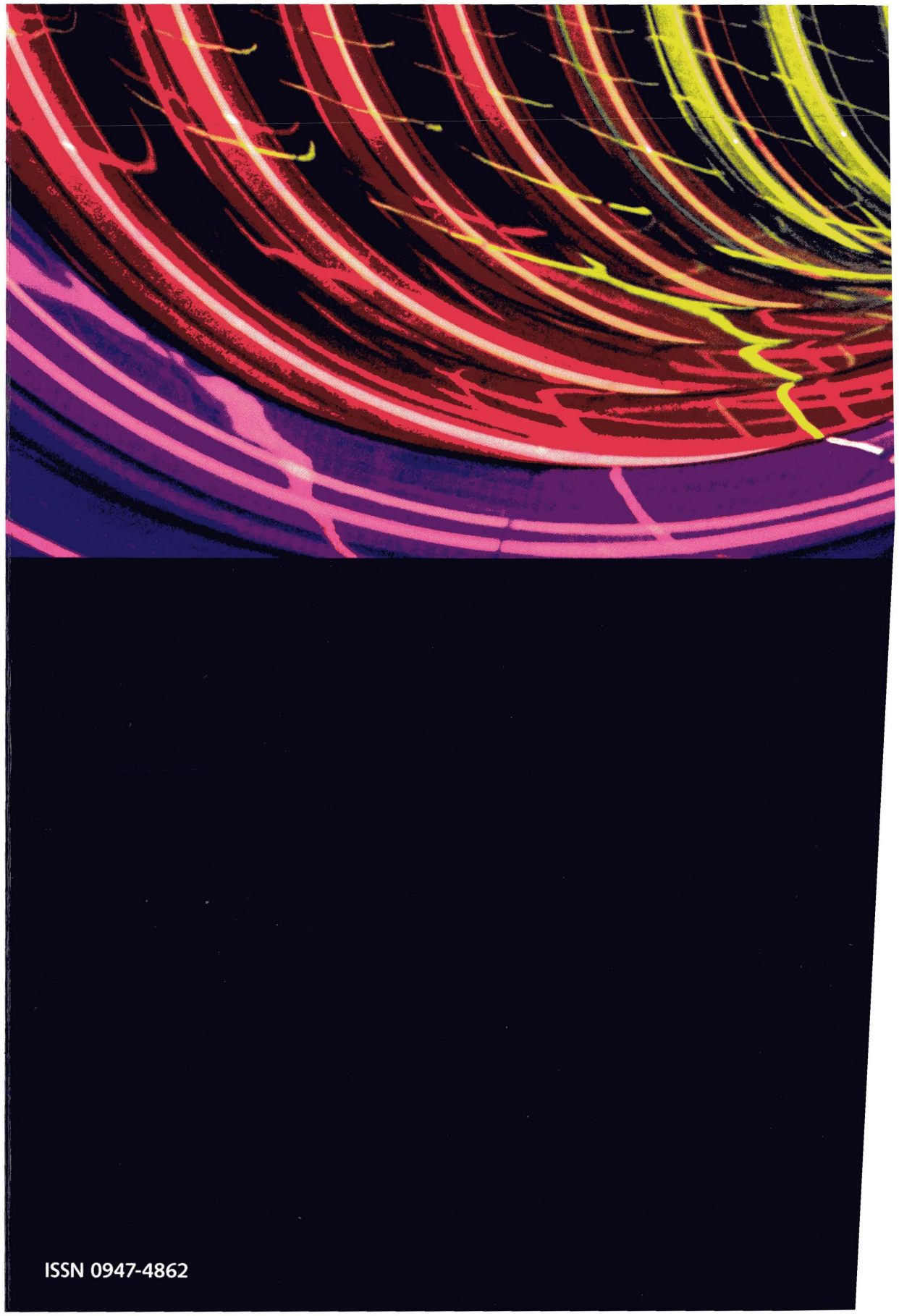

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