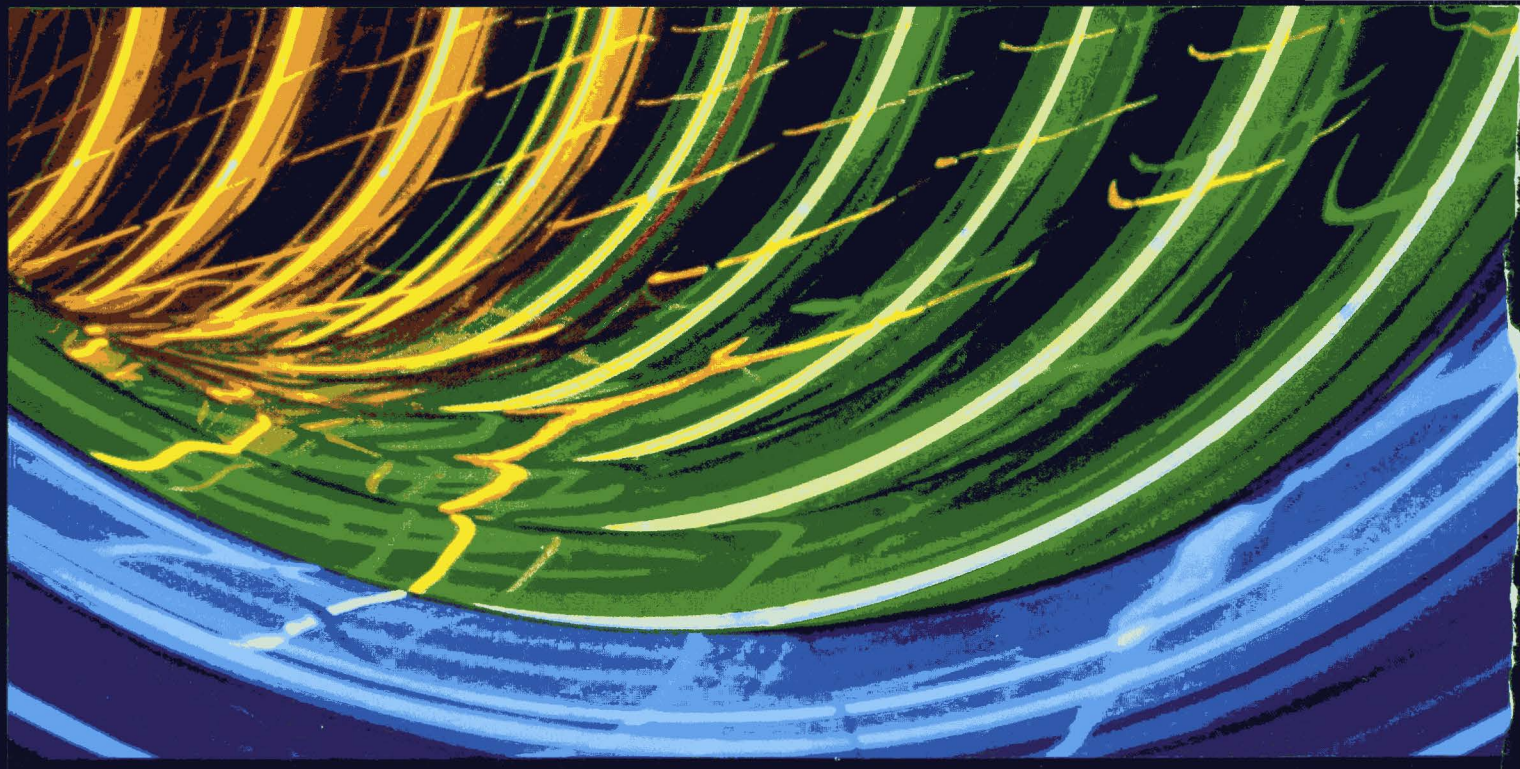


European Information Technology Observatory 96

European Information Technology Observatory – EITO

Members

eurobit

EUROBIT · European Association of Manufacturers
of Business Machines and Information Technology Industry
Lyoner Straße 18, D-60528 Frankfurt am Main
Tel. + 49-69-66 03 15 30, Fax + 49-69-66 03 15 10
Internet: http://www.fvit-eurobit.de/eurobit

ECTEL

The European Telecommunications and Professional
Electronics Industry · c/o ZVEI/FV K
Stresemannallee 19 · D-60596 Frankfurt am Main
Tel. + 49-69-63 02 21 3, Fax + 49-69-63 02 28 8

CeBIT HANNOVER

CeBIT · Welt-Centrum · Büro · Information · Telekommunikation
Deutsche Messe AG, Messegelände, D-30521 Hannover
Tel. + 49-5 11-8 90, Fax + 49-5 11-89 32 62 6
Internet: http://www.cebit.de

SIMO TCI
FERIA INTERNACIONAL DE INFORMATICA, MULTIMEDIA Y COMUNICACIONES

IFEMA - SIMO TCI
Parque Ferial Juan Carlos I · E-28067 Madrid
Tel. + 34-1-7 22 50 00, Fax + 34-1-7 22 58 07

smau

Esposizione internazionale dell'information
& communications technology
Corso Venezia 47/49, I-20121 Milano
Tel. + 39-2-76 06 71, Fax + 39-2-78 44 07
Internet: http://www.smau.it/magellano

Sponsors

SICOB

ASSOCIATION SICOB du Salon International d'Informatique,
Télématique, Communication, Organisation du Bureau et
Bureautique · 4 Place de Valois, F-75001 Paris
Tel. + 33-1-42 61 52 42, Fax + 33-1-42 61 21 27

KONTOR OG DATA

KONTOR OG DATA
Computers, Software,
Office Machines,
Office Furnitures
Post Box 25 68 Solli, N-0202 Oslo
Tel. + 47-22-55 82 20, Fax + 47-22-44 59 45
Internet: Per-Morten.Hoff@kdl.telepost.no

SYS SYSTEMS

Computers, Software, Communications
Messe München GmbH, Messegelände, D-80325 München
Tel. + 49-89-510 70, Fax + 49-89-510 75 06
Internet: http://www.messe-muenchen.de

With the Support of

European Commission
DG III · Industry
Rue de la Loi 200, B-1049 Brussels
Tel. + 32-2-2 99 11 11, Fax + 32-2-2 95 01 3 8

OECD OCDE PARIS

OECD
Directorate for Science, Technology and Industry
2 rue André-Pascal, F-75775 Paris Cedex 16
Tel. + 33-1-45 24-82 00, Fax + 33-1-45 24-85 00
Internet: http://www.cs1-hq.oecd.org/dsti

Preface

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

The EITO 96 presents the most comprehensive data currently available about the ICT market in Europe. It also provides special ICT studies e. g. on technological trends, standardization, the information society, new networks and applications, distribution channels, and specific markets like banking and financial services.

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 IT trade fairs CeBIT in Hanover, SIMO in Madrid, and SMAU in Milan.

The EITO 96 has been produced with the support of the EITO sponsors, the trade fairs Association SICOB in Paris, KONTOR OG DATA in Oslo, and SYSTEMS in Munich.

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 objective of the EITO is to provide an extensive overview of the European market for information and communications technology as a service to this industry, to users and to 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 96 has been produced in close cooperation between the EITO Task Force experts and leading market research companies in order to discuss and guarantee the quality of the statistics and data. The work of the EITO Task Force has also been supported by the Deutsche Telekom in Bonn.

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 three special contributions lies with EITO/GzF and Databank Consulting, Nomos Ricerca, and Romtec.

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 organizations and trade fair visitors, for market analysts, for politicians, members of the European Commission and national government representatives, for organizations involved in R&D, standardization 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

Imprint

European Information Technology Observatory 1996

Publisher
European Information Technology Observatory (EITO) - European Economic Interest Grouping (EEIG)
Lyoner Str. 18, D-60528 Frankfurt/Main

EITO Members
EUROBIT, Frankfurt/Main
ECTEL, Frankfurt/Main
CeBIT, Hanover
SIMO, Madrid
SMAU, Milan

EITO Sponsors
Association SICOB, Paris
Deutsche Telekom, Bonn
KONTOR OG DATA, Oslo
SYSTEMS, Munich

With the Support of
European Commission, DG III Industry, Brussels
OECD, Directorate for Science, Technology and Industry, Paris

Chairman
Bruno Lamborghini

Vice-Chairman
Enore Deotto

Managing Director
Günther E. W. Möller

Project Manager
Carola Peter

Chairman EITO Task Force
Egbert Dozekal

EITO Task Force
Johannes Adler
Michael Beckmann
Umberto Bena
Gaetano Bianchi
Marco Bozzetti
Giuseppe Dell'Osso
Alberto De Macchi
John Dryden
Catherine Orsini
Jorma Partinen
Luis-Alberto Petit Herrera
Eberhard Reik
Michael Rupf
Michael Towara

Copyright 1996
European Information Technology Observatory (EITO)/Gesellschaft zur Förderung des Maschinenbaus (GzF) *for all parts*
and
International Data Corporation (IDC) *for Part One: The ICT Market in Europe, Part Three: Statistical Outlook*
Marco Bozzetti and SMAU *for Part One: ICT: Key Technologial Trends and Standards*
Databank Consulting *for Part Two: Towards the Information Society: New Network Services and Applications*
NOMOS Ricerca *for Part Two: The ICT Market in Europe's Banking and Financial Services*
ROMTEC *for Part Two: The Evolution of ICT Distribution Channels in Europe*

Copyright Note
All data and tables used by third parties in agreement with the holders of the copyright must mention the source of the publication and the year of appearance.

For copies apply to
EITO Members
EITO Sponsors

Order Addresses
See inside front or back page

Price per copy
46,- ECU (plus VAT and mailing)

Price per copy plus CD-ROM
66,- ECU (plus VAT and mailing)
CD-ROM only available together with the book.

Design
HWL & Partner Design GmbH, Frankfurt/Main

Production
Eggebrecht-Presse KG, Mainz

ISSN
European Information Technology Observatory
ISSN 0947-4862

Contents

Part One

Information and Communications Technology in Europe: The European Commission's View

By Stefano Micossi, Director General Industry, European Commission 12

Information and Communications Technology in Europe: The Industry's View

By Bruno Lamborghini, President of the European Association of Manufacturers of Business Machines and Information Technology Industry, EUROBIT 17

The Information and Communications Technology (ICT) Market in Europe

1. Introduction 23
1.1. IT and ICT Market Size 24
1.2. IT and ICT Market and Current Economic Situation in Western Europe 25
1.3. Europe as a Consumption Area 46
1.4. Europe as a Production Area 53
1.5. Trade: EU and Other Worldwide Areas 58
1.6. Eastern Europe: Second Phase Development 61

2. Towards a New ICT Industry 64
2.1. The Internet Era 65
2.2. The IT Driving Forces 66
2.3 The TLC Driving Forces 72
2.4. New Jobs and New Suppliers for the Mass Connectivity Markets 75

3. IT and TLC European Market Perspectives 78
3.1. Growth Factors and Initiatives to Carry Europe Forward into the Information Society 78
3.2. Critical Factors and Impediments to Growth 82
3.3 Medium-to-long-term Scenario 84

Information and Communications Technology: Key Technological Trends and Standards

1. Evolution in ICT: A Global View 88

2. Microelectronic Components 89
2.1. Main Microprocessor Families 89
2.2. Memories 90
2.3. Signal Processing 91

3. EDP Systems 92
3.1. Computer Technology and Hardware Products 92
3.2. High Capacity Mass Storage Technology 94

4. Software Technologies 98
4.1. Systems Software and Utilities 98
4.2. Application Tools 101
4.3. Fuzzy Systems. 105

5. Telecommunication 108
5.1. CTI, Computer Telephony Integration 111
5.2. Digital TV and HDTV 114

6. Architectures 115

7. New Services and Applications 116
7.1. The Internet Phenomenon 117
7.2. CIM, CIE and CII. 127

8. Bibliography. 132

Part Two

Towards the Information Society: New Network Services and Applications

1. The Liberalization of Telecom Services and Infrastructures 134
1.1. Towards the Global Information Society 134
1.2. Economic and Social Factors Supporting a Liberalization Policy 135
1.3. Current Situation in Europe vis-à-vis the USA and Japan 137

2. Technological Innovation and Requirements for the Development of Advanced Networks and Applications 143
2.1. Technological Innovation Trends 143
2.2. Technological Requirements 143
2.3. Standardization Process 144

3. Outline of Basic Networks 144
3.1. PSTN and Intelligent Networks 144
3.2. Integrated Services Digital Networks (ISDN) 145
3.3. Mobile Telephone Networks 147
3.4. Public Data Networks X 25 147
3.5. Fast Packet Switching Networks 150
3.6. Cable TV 151
3.7. Integrated Broadband Digital Networks 152

4. Outline of Value-added Services 154
4.1. VAS for the Business Market 155
4.2. VAS for the Mass Market 158

5. Outline of Enhanced Interactive Services 160
5.1. Video-on-Demand 162
5.2. Interactive Home Shopping 165
5.3. Home Banking 166
5.4. Residential Information Services 168
5.5. Teleworking 169

6. Competitive Positioning: Europe Compared to the USA and Japan 171
6.1. EU Points of Strength in the Global Market 171
6.2. EU Points of Weakness in the Global Market 171
6.3. Synthesis of Europe Competitive Positioning 173

The ICT Market in Europe's Banking and Financial Services

1. Introduction 176

2. The Banking Sector in Europe 176
2.1. Contextual Analysis 176
2.2. European Regulations 177
2.3. Quantitative Data 177

3. The Banking Sector in Main European Countries 179
3.1. United Kingdom 179
3.2. France 181
3.3. Germany 183
3.4. Italy 185
3.5. Spain 187

4. The Structural Changes in Banking: Internal Efficiency and New Banking Offers . 187
4.1. General Issues 187
4.2. New Organizational Models 189
4.3. The Retail Banking and the New Market Approach 191

5. The Current State of Automation and Trends 196
5.1. The Key Role of ICT in Banking 196
5.2. Data Processing Outsourcing 197
5.3. Present Architectures and Trend 197
5.4. Hardware Equipment and Installed Base 198
5.5. Information Technology Expenditure 200
5.6. A New Role of Networking and Telecommunications 200

6. Traditional and Emerging Applications 206

7. New Banking Requirements 212

8. Methodology 217

The Evolution of ICT Distribution Channels in Europe

1. Emergence of a Channel Structure 220
1.1. The Evolution of Distribution Channels 220
1.2. Direct versus Indirect Channels 221
1.3. The EITO Standard for Channel Definition 222
1.4. Value-added versus Volume Indirect Channel Members 224
1.5. Indirect Channel Structure for the Mid 90s 225
1.6. The Direct Route to Market 227

2. Channel Players - How Many and What Kind? 227
2.1. Europe in Summary 227
2.2. Regional Variations 228

3. Channels, Indirect Channel Members and Markets Served 232
3.1. Direct and Indirect Supply Levels 232
3.2. Who Does Supply the Home and SOHO Market Segments? 235
3.3. Direct versus Indirect Supply 237

4. The Forces Driving Indirect Channel Changes 238
4.1. Price/Margin Pressure 238
4.2. Moderation of the Direct Route 238
4.3. Increasing Importance of the Volume Channel 238
4.4. Retail - Strengths and Weaknesses 240
4.5. Direct Response - What's the Pan-European Future? 241
4.6. The Outsourcing of Fulfilment and Logistics 244
4.7. Convergence 244
4.8. Electronic Distribution 245
4.9. Customers 247

5. The Channel Model of the Future 247
5.1. Areas for Manufacturer - Indirect Channel Member Mutual Action 247
5.2. Channel Conflict 248
5.3. Development of the Indirect Channel Member Business Model 249
5.4. Channel Model of the Future 249

Appendix A - Methodologies 252

Appendix B - Frequency Analysis Tables 253

Part Three

Statistical Outlook

1. Introduction 268
2. Methodology 268
3. European ICT Markets and Patterns of Trade 269
4. List of Tables 270
5. List of Figures 272
6. Economic Background 273
7. International ICT Markets 277
8. ICT Production and Trade Flows 318
9. Market Structures and Penetration of ICT 326
10. Price Dynamics 333
11. Definitions 337

Alphabetical Index 346

Part One

Information and Communications Technology in Europe: the European Commission's View

Towards the Information Society

1995 has been as important in consolidating the EU policy initiatives for the Information Society as 1994 was for starting the process and developing public awareness on the effects of the revolution taking place in the information and communications technology industry. Building on the momentum created by the Bangemann report, the European Commission carried out several initiatives in 1995 for promoting the Information Society and for progressing implementation of the action programme.

Stefano Micossi, Director General Industry, EC

A key event in 1995 was the G7 Ministerial Conference on the Information Society held in February in Brussels. The Information Society is a global phenomenon and the conference was an opportunity to initiate joint thinking towards common rules for the global Information Society. It was an important event in increasing public awareness of the extraordinary changes taking place in information and communications technologies, which were also demonstrated by the products and applications shown at the exhibition which complemented the conference. Both government and industry expressed a clear commitment to participate in the development of the global Information Society.

As the conference highlighted, the same priorities for action are on the agenda in the three major regions of the world: liberalization of telecommunications infrastructure and services within open and competitive markets, development of applications trials, efforts to deal with the difficult issues of standards, intellectual property protection, and the need to provide universal service. There are also important social and political issues, such as citizens' rights of access to information and the need to avoid creating an unbalanced Information Society.

The conference drew attention to the fact that the Information Society is already with us. It is not something for the future, something we can deal with when it comes along. Information technologies and information superhighways are already embedded in all aspects of our lives. The way we live and work is already changing radically.

Information and communications technologies are spreading to all industries, to the home and to public services. In many countries we are close to one PC installed per white collar worker. In 1995 ICT per capita expenditure exceeded one thousand ECU in Denmark, Germany and Sweden, as well as in Japan and USA. It is estimated that more than 40 million users in the world are linked to the Internet.

The Economic Dimension of the Information Society

As we move towards the Information Society we see traditional boundaries in industry, the economy and society being eroded. Companies across the industrial and service spectrum are increasingly becoming knowledge-based enterprises. What will be important in the Information Society is the increasing knowledge content in products and services.

IT and telecommunications are making it possible for all companies to redesign their processes and change their organizations. This creates new bases for competitiveness and these bases are increasingly common to all sectors and all countries. Empirical evidence and economic analyses support the view that the diffusion of information and communications technologies contributes positively to job creation in the long term, even if temporary job losses can result in the short-to-medium term from the restructuring process. The diffusion of ICTs contributes to the increase of both labour and total factor productivity as much as any previous technical wave has done. The impact on productivity at the macroeconomic level is all the more significant as these technologies are extremely pervasive.

Cross-countries comparative analyses show that the countries which witnessed the highest total rate of labour productivity growth in the long term also benefited from the highest growth rate in GDP and employment. There is a significant positive correlation between productivity growth on the one side, and the GDP growth and employment growth on the other.

From an economic point of view, ICTs are horizontal technologies, and their use produces important effects outside the original investment area. The results produced by ICT investment exceed simple individual advantages. They have effects on the competitiveness of the whole economic system.

The presence of externalities means that public authorities have an interest in promoting the use of ICT and create a favourable environment for their diffusion in all sectors of business and private activities. The conditions for access to information and to the communication infrastructure and services, the availability of these as well as their cost, performances and quality, are now key factors for EU industrial competitiveness.

A Key Role for Public Authorities

– *Liberalizing Telecom*

The prime source for investment in information technologies and infrastructure must be the private sector, while public authorities should provide stimulation and support, principally by creating a clear and transparent regulatory framework.

An open and flexible market environment must be established: open, because investment must be encouraged, and flexible, because it must accommodate developments that in large part are still not known. We must remove the barriers to entry while, at the same time, remaining vigilant that no new distortions are created.

This is why it is necessary to accelerate the present process of liberalization in the telecommunications sector by opening to competition the infrastructures and services which are still largely subject to monopoly and in making sure that equitable conditions are established for all operators and service providers. The combined effect of competition and technological progress will bring down telecommunication tariffs, still too high in Europe, in particular for advanced services.

Important results have been achieved in this area. During 1995 a number of new Commission initiatives followed the Telecommunication Council decision in December 1994 to set 1st January 1998 as the target date for full liberalization of infrastructures and services.

Mobile communications in the European Union are, de facto, already open. Alternative infrastructures and cable TV for supplying telecommunication services will be open from next year. Proposals covering the necessary regulatory safeguards such as licensing procedures, financing of the universal service, standards, interconnection and access agreements are being prepared.

– Easing the Standardization Process

Standardization is one of the key issues for the Information Society. The Information Society will only become a reality if the interconnection of networks and the interoperability of services and applications are guaranteed. In response to this challenge the European Commission has undertaken a thorough review of European ICT standardization. This is based on the results and recommendations of the Genval workshop in November 1994, where all players involved in European ICT standardization came together to discuss current practices and future policy options.

The timely availability of stable standards, well adapted to market requirements, has always been a powerful stimulus to the competitiveness of industry. The new approach recognizes that the principal interested parties in the standardization process are those who manufacture and those who buy the products. Standards should be more market-driven and more closely linked to business needs, involving end-users from the early stages of the standardization process.

The role of public authorities should be to intervene only exceptionally when imperfections or gaps appear or the general interest needs to be protected, and making sure that such action results in an "added value" which would not otherwise occur.

It should be a catalytic role, particularly important in the stimulation phase, followed by progressive hand-over to the parties serving market requirements in the experimental and deployment phases.

– Completing the Regulatory Framework

In order to create the conditions necessary for the private sector to invest and for the citizen to accept the Information Society, a wide range of regulatory and legal provisions should be reviewed and adapted. A Green Paper on copyright and related rights in the Information Society has been issued by the Commission, aiming at identifying the right balance between the conflicting interests of multimedia creators and authors on the one hand and the markets on the other. The current regulations regarding intellectual property rights will be adapted if necessary in such a way as to facilitate market development, by removing the barriers raised by existing gaps or inconsistencies in present regulations.

Important progress has also been made in the areas of legal protection of databases and privacy protection.

– Promoting the Contents Industry

The development of "content" markets is characterized by a high degree of uncertainty, by the complexity of mastering all the know-how necessary to develop new applications, and by critical mass phenomena which prevent markets from taking off below a minimal threshold of users. This requires that public authorities play a catalytic role aiming at promoting tests

and trials, in order to reduce uncertainty over future markets, or partnerships to gather complementary know-how to reach the critical mass.

Worth mentioning among the different initiatives taken recently by the Commission are INFO 2000, aiming at promoting development of a European multimedia content industry, and MEDIA, focused on the development and distribution of audio-visual products and the training of professionals for better use of technologies.

The Task Force on "Educational Multimedia Software" is currently pursuing, in close collaboration with industry and member-states representatives, its analyses of multimedia educational products and services.

The Social Challenge

As we progress in the Information Society, there remain many challenges ahead, not least to create an Information Society accessible to all European citizens. In Europe, particular emphasis is placed on the social dimension of the Information Society.

The emergence of the Information Society raises three types of threat in Europe: the risk of social exclusion, a threat to cultural diversity, and fears of job losses and displacement. The fears are real, but the answers to the fears are real too.

- The risk of social exclusion covers different issues. The knowledge-based society will generally require highly skilled IT-literate people. The main danger lies in the creation of a two-tier society where only a section of the population can fully enjoy the benefits of the information society and access to new multimedia services. Worse, new ways of delivering old services might prevent people from continuing to benefit from them.

  It is the responsibility of governments and social partners to tackle these issues. In reality, the Information Society has the potential to increase social integration, it can help bring governments closer to citizens and to provide access to information, current events, museums and libraries. The aged and the disabled will be less isolated. New ways of working and new forms of business can enable more individual responsibility.

- Europe is culturally and linguistically diverse. European citizens value that diversity. By the same token, they may have a real fear that the global Information Society will result in impoverishing European diversity.

  The fear that national and regional cultures may be submerged in a common culture must be seen in light of the fact that the information infrastructure creates opportunities for regional cultures and languages to flourish. Not only will access to cultural heritage be facilitated, but creating multimedia content is becoming comparatively cheaper and easier. Information highways also make the distribution of content cheaper and easier. Community policies are aimed at enhancing the richness of Europe's cultural identity, with its extraordinary diversity of content.

- Predictions that ICT will create unemployment, not only among manual workers but also among white-collar employees, give rise to growing fear. But it must be remembered that every technical revolution has thrown up job-creating sectors which received the overflow of employees and compensated for job losses in the shrinking sectors with a net positive result. In the case of the ICT revolution we should look to the new emerging sectors: the "contents" industry, the new services, the new direct and indirect opportunities generated by the overall effect of productivity gains on economic growth.

The developing Information Society will bring new jobs and fresh opportunities, as new markets and services develop. But these jobs will be different. So it is vital that efforts be made to train labour and the younger generation to be prepared for this transition.

What is essential, and the European Commission is strongly committed to this, is a deeper understanding of the social consequences of the Information Society in order to overcome the fears and to ensure a better social acceptability of the process.

With this in mind, an *Information Society Forum* was set up to address the challenges associated with the implementation of the Information Society, monitor its progress, and promote public awareness.

It is composed of representatives from all parties concerned: users, social groups, service providers, network operators, and equipment manufacturers.

A *Social Expert Group* was also created to examine the social and societal impact of the Information Society. It is preparing a series of reports covering eight priority areas – impact on employment, cohesion, work and corporate organization, opportunities for improved education, management of health care systems, impact on transportation, culture and democracy.

A Major Chance for the European ICT Industry

The momentum growing in the Information Society is reflected in the performance of the ICT market. As shown in this '96 edition of the EITO report, the European ICT market exceeded 300 billion ECU in 1995, growing by more than 8% over the previous year, at a rate which is the highest in the last five years.

The outlook for 1996 and following years is also positive, but of course this does not mean that conditions have become easier for ICT companies in Europe. Heightened global competition puts strong pressure on all companies, technological evolution forces continuous innovation in products and organizations, so that restructuring is still necessary to adjust the balance between revenue and costs.

The 1995 results provide a clear demonstration of the ability of companies to adapt successfully the products and services they offer, to enter into new businesses, to establish new alliances and to learn new skills. Similarly, and to an even greater extent, flexibility and the ability to be innovative will be needed in the coming years.

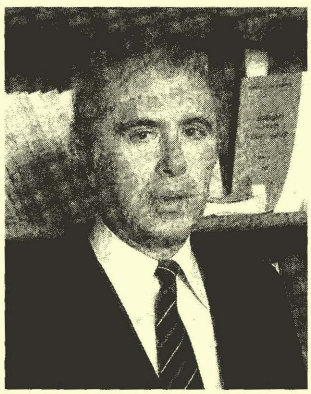
The European approach to the Information Society is a balanced one, socially progressive, fair and market driven. It is an approach designed to encourage entrepreneurship in an open and competitive environment. It is intended to ensure that the benefits of the Information Society are fairly and widely distributed, taking into account both public and private interests.

The demand and supply of information and communications technology will be the key competitive vectors of the 21st century. It is these industries and services that hold the strategic and economic keys to our future prosperity.

Information and Communications Technology in Europe: The Industry's View

Progress in the European Information Age

In my presentation to the last EITO Report, I noted that "1994 can be regarded as Year One of the European Information Age" for at least three reasons: the presentation of the Bangemann Report on "Europe and the Global Information Society"; the approval of a deadline - 1st January 1998 - for the full liberalization of telecom infrastructures and services; and the build-up of a new wave of agreements and partnerships stemming from the convergence of the "4 Cs".



Bruno Lamborghini, President of EUROBIT

In 1995, Europe has achieved further progress towards the construction of the Information Society, in terms of both concrete action and fruitful debate.

The G7 Conference on the Global Information Society held in Brussels in February and the documents subsequently drawn up by the G7 Business Roundtable for the Halifax Summit in June have played a key role in stimulating debate on regulatory harmonization and the opening up of the market to global competition.

Member countries have launched new initiatives to speed up the implementation of new infrastructures and services in a competitive environment.

The debate on the construction of the Information Society in Europe has highlighted the fact that this is not a process that involves one particular technology or sector or group of industries. Its significance is far wider: what we are dealing with is a radical transformation of the old industrial cycle and a parallel transition into an open, global market dimension.

Two major forces are driving the process: digitalization and globalization. They are spreading at exponential rates and are unstoppable. Their effects are clearly visible to everyone.

Given such sweeping change, we need to keep our feet firmly on the ground when assessing trends and prospects in the digital global scenario.

I want to emphasize three key trends:

I. The first is the new role of technology. Today, technology is no longer the key driving force of the ICT industry, but a secondary component of the main engine, which is the application of technology.

To a large degree, current progress in information and communications technology follows the paths and times set by the leading industry standards. This tends to accelerate the diffusion of information technology to the extent that many commentators now regard it as a commodity. Unfortunately, there is a lag between the level

reached by technology and the diffusion of innovative applications.

Conversely, the ICT industry is aware that development of innovative applications is the main entrepreneurial challenge today.

II. A second trend is that value-added is shifting from physical infrastructures (hardware and telecommunication networks) to non-physical infrastructures (services, applications and content). To borrow Nicholas Negroponte's terminology, value-added is shifting from atoms to bits, while the prices of "physical" products (including transportation of bits over telecommunication networks) are falling.

In line with this trend, the old monopolies are disappearing as traditional operators and new entrants turn their attention to new markets.

III. Demand has taken over the leadership role formerly played by the supply. Increasingly, development processes and the success of products and services will be market-driven, not just supply-driven. The Internet is a major example of a new development driven by spontaneous demand when certain basic conditions exist. This makes it more difficult for the industry to assess and forecast market trends (e. g., the great difficulty of identifying multimedia killer applications).

Together, these trends are changing the shape and the structure of the ICT industry.

Players are substituting their old market segmentation models with an integrated global approach based on new specializations, whose core product is "information": content, packaging, processing, distribution, end-user terminals/workstations.

As a result, operating boundaries are shifting and a new map of alliances and partnerships is being drawn up. Content creators (publishers, movie studios, entertainment providers, software developers) and content distributors (online services, broadcasters, cable operators, satellite operators, telecom operators) are now the primary focus for investment.

The extraordinary growth of the Internet demonstrates clearly the potential of new demand. But interactive multimedia applications are moving slowly, especially on the consumer market, because the market's real needs have not yet been clearly identified.

The question operators are asking today (and their main concern as regards medium/short-term returns on their huge investments) is: where's the beef? How will all this manoeuvring stimulate the growth of new markets and new consumer demand?

So the challenge facing the industry today is to identify new applications, develop new solutions and conquer new markets.

A Major Role for Europe

America clearly intends to make the maximum commitment to the Information Society in order to boost its technological leadership and improve the overall competitiveness of the US economic system. Internationally, US corporations – supported by an extremely favourable investment cycle and a strong recovery in corporate cash-flow – are taking the lead in forming new partnerships and alliances.

And Europe?

The European Union must be given credit for taking the idea of an Information Society out of the realms of utopia by encouraging users and operators to organize concrete initiatives and, above all, by promoting a more favourable competitive environment for the development of new markets (faster progress towards the liberalization of telecom markets).

Nevertheless, Europe continues to lag behind the USA in the construction of what, for the time being, I would still call a new multimedia environment rather than a true Information Society.

Faster progress in a clear direction is possible if Europe eliminates a number of weaknesses and capitalizes on its strengths. The list of weaknesses is long and familiar:

- national markets are still fragmented and relatively closed, despite 1992 and the Single Market;
- defence of telecom monopolies limits competitive innovation and keeps telecom costs high (only 25% of the European telecom market is fully liberalized, and only 5% excluding the UK and Scandinavia);
- prohibitive customs duties are still applied to strategic components like memories, while the new customs classification of multimedia products (LAN cards and CD-ROM drives) obstructs the diffusion of new technology;
- production of computer software and services is inadequate (US companies account for 80% of world production) and per capita IT expenditure is only half the US figure;
- European ICT investments account for between 20% and 30% of total fixed investments, compared with 50% in the US;
- computer literacy is still low in many countries;
- digital content development is weak and the number of global players in the new media industry is still small;
- the financial community is relatively insensitive to new high-tech entrepreneurial ventures.

Now the list of Europe's strong points:

- abundant technological resources and a huge potential for multimedia applications and networked solutions;
- an educated population and a strong socio-cultural base, including 80% of the world's art heritage, on which to build a knowledge society;
- a multilingual community in close contact with major developing areas in the East and the South;
- GSM, which has demonstrated the advantages of rapidly establishing uniform standards (in this case, the greater fragmentation in Europe as compared with the USA was a decisive stimulus to establish a common standard) and DECT;
- national diversities constituting a positive challenge for the development and use of multimedia;
- 100% EURO-ISDN coverage, leadership in ATM technologies.

As a multinational, multilingual area with an extensive social welfare system, Europe can exploit a number of specific advantages to accelerate the construction of an Information Society. But it is not likely to take the same route as America.

In the USA, business and entertainment are the areas offering the greatest potential for multimedia application development, and therefore the areas of greatest interest to the US industry.

A new wave of investments in pay-TV and set-top-boxes has been building up in Europe, too. But demand will also be fuelled by non-entertainment applications for the individual, the home and the local community, which will foster cultural and social growth and improve the quality of life.

Two Key Areas: the Home and the Local Community

In Europe, two application areas are of particular interest for the development of the new digital scenario: the home and the local community.

These areas are rapidly becoming key points of reference for new networks and interactive multimedia services. Even though the entertainment market will continue to account for the largest share of consumer spending, the home and the local community will provide a springboard for the development of new types of application that will give a decisive boost to the construction of the Information Society.

These applications cover education (distance learning), business (teleworking and the small office/home office segment) and retail (home banking, teleshopping, etc.), as well as what has been termed the digital city, a range of services and applications that create new kinds of interactive relationship among individuals and between the individual and the local community.

Current advances in mobile communications, which are creating, alongside the mobile office, what could be defined as the "mobile home", are a key factor in the development of the new roles of the home and the local community in the Information Society.

All this will have a profound impact on companies, public authorities, transportation systems and consumer habits, leading to the growth of new markets for multimedia technology.

Given its particular characteristics, Europe has significant competitive advantages in this area. More than other regions, it consists of a large number of socially and culturally integrated territorial areas (the Europe of towns and cities) with the potential to become telematics communities; that is, networked systems offering local citizens specific customized services.

The "global village" is an agglomeration of local telematics villages or territorial service networks linked to the home user. The greater the level of globalization, the greater the need for specific solutions at territorial and individual levels. In Europe at least, the Information Society will not be a uniform, standardized society.

A clarification as regards standardization: at the technological level, standardization can cut costs and promote widespread use; but at application level, standard technology is a platform on which to develop specific, customized solutions to meet the needs of individual users and local communities.

The home and the local community play an important role for another reason. Unlike interactive video, many home/community applications can be developed with existing transmission technologies, in particular Euro-ISDN. They can therefore be implemented immediately, without requiring homes to be cabled with optical fibres.

Europe, then, can turn its apparent constraints into opportunities and invest in the home, the local community and mobile communications as the main engines for the construction of the Information Society.

"Political" Conditions

At this point, a number of "political" conditions come into play.

First, all countries must agree to the rapid dismantling of all telecom monopolies, possibly before the January 1998 deadline.

Although much progress has already been made, the situation in Europe is still confused: some telecom operators tend to adopt an ambiguous, defensive attitude; some countries have yet to resolve such important issues as liberalization of alternative infrastructures, relations between telecoms and cable, satellites, the market entry of non-European operators.

The lack of a clear regulatory framework is the most serious obstacle to investment and new initiatives. New EU directives are ready or in the pipeline, so the ball is already rolling, but it must be made to move faster, in line with a clear timetable. Here, the Commission can play a key role in lowering telecom charges – long-distance tariffs and leased line costs in Europe are among the highest in the world – and creating a competitive environment.

The second political condition is the need for new global regulations, not just in communications but also in the areas of privacy, data security and protection of intellectual property rights.

Third, the new information and communications technologies must be introduced into our education systems. Computers and access to the Internet should be as common as pen and paper, but only a very small percentage of European schools provide these facilities today. Governments have not yet realized that development of a new education system is the key strategic investment for the future.

A fourth priority is modernization of state administrations and public services, which are fundamental to the creation of networks and services for the citizen and the improvement of the quality of life. State administrations can help to promote change even without investing public resources, for example by adopting innovative public-service outsourcing solutions.

The Contribution of EUROBIT

EUROBIT, the organization that represents the European IT industry and IT trade associations, is playing a major role in the construction of the Information Society in Europe through its action to promote a real Global Information Society environment.

In January 1995, EUROBIT met in Brussels with the two other main IT trade associations, ITI of the USA and JEIDA of Japan, to discuss and sign a Tripartite Agreement on a Global Information Infrastructure, with industry recommendations to the G7 Conference on six major issues: interoperability, privacy and trust in an Information Society, intellectual property rights, universal access, access to R&D and new applications and market access.

The paper was warmly received by President Santer and other heads of state and government and by international institutions. It made a constructive contribution to the discussion and conclusions of the G7 Conference.

The Tripartite (now Quadripartite) group of IT trade associations is currently drawing up new recommendations on specific issues.

In September 1995, a High Level Strategy Group was formed by EUROBIT (providing the group's chairman and secretariate), ECTEL (communications technology), ETNO (telecom network operators) and EACEM (consumer electronics). The Group's aim is to promote market-driven ICT standards in cooperation with the European Commission and the standardization bodies in order to lay the technical foundations on which to build a European/Global Information Infrastructure.

Europe and a New Socio-economic Order

Much work lies ahead. And what is needed now is concrete action, no more formal measures and declarations, but real initiatives to implement new applications, like the ten priorities listed in the Bangemann Report or the eleven projects announced at the G7 Conference in Brussels.

1996 and 1997 will be decisive for the development in Europe of a genuine Information Society providing real benefits for European citizens.

Another important point: Europe is perhaps more sensitive than other areas to the social impact of new multimedia technologies and applications; not only to their effects on employment, but also to the possibility that they could lead to greater social inequalities and growing divisions among the haves and the have-nots.

This greater awareness of social constraints could be used to create models for the less developed areas of the world, in order to eliminate differences in regional growth in the Information Society.

Thus Europe could be a major driving force behind the enormous changes taking place in the world socio-economic system.

Something more than the creation of new multimedia markets and new business opportunities is at stake.

This is not just an economic and technological challenge: by constructing an Information Society we shall be constructing Europe; a great market, an integrated and innovative continent.

The Information and Communications Technology (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 the end of November 1995.

1. Introduction

In 1995, ICT market growth has gained additional momentum on top of the recovery achieved in 1994. This strong performance is expected to continue in 1996.

The most striking story of 1995 has been growth in the network market: 1995 has been the year of the network.

There has been a general consensus and excitement about the new capabilities and the new competitive rules emerging with the expansion of the Internet as a vehicle of communication and electronic commerce. In 1995 Internet usage has started to take off. The Internet has jumped the quantum leap that separates the era of traditional – simply personal usage of Information Technology to a new era when everybody will use Information Technology in connection with a network.

Enthusiasm among ICT users and suppliers towards network-based computing is high as the implications for business and social life will be dramatic.

ICT demand among both business and consumer environments is driven by the increasing number of processes that can be placed on the network. Favourable economic conditions are encouraging this evolution. Networks are spanning both great distances and cultures, allowing the rapid exchange of vast and multiple sets of information among all types of individuals and professions. New lifestyles of work patterns will develop with the emergence of "nomads" and telecommuters of the network.

For ICT suppliers these important changes are generating new competitive rules. Alliances are as important as the ability to innovate in products and services.

Interlocking alliances are being developed as telecommunication companies and information technology suppliers join forces with each other as well as with cable TV system operators, multimedia content providers and a variety of other "new media" firms. The alliances promise to bring a spectrum of leading-edge communications solutions into both homes and businesses.

New jobs and new technological skills are emerging, partially compensating for the job losses in the traditional telecommunication and information technology businesses.

Reform in the liberalization of telecommunication services and infrastructure is proceeding according to the timescale and commitments undertaken by the member states of the European Union. The logic endorsed by the European Commission entails both the technological advances that are making borders obsolete and the economic imperative of improving competition. This move is supported by the major European players as they attempt to globalize their operations.

1.1. IT (Information Technology) and ICT (Information and Communications Technology) Market Size

The Western European ICT market reached 304 billion ECUs in 1995. Core information technology categories (including office equipment, electronic data processing equipment, software, professional services, processing services, network services, hardware maintenance and support) contributed 142 billion ECUs towards the ICT total telecommunication equipment and services accounted for the remaining 162 billion ECUs.

Growth in the Western European ICT market is now at its strongest for five years, with an 8.1% increase in 1995. The IT portion of the market alone grew by 7.5%, while the telecommunication portion increased by 8.7%.

Europe's proportion of the worldwide ICT market has remained similar to 1994 assisted by stable European economies and favourable exchange rate movements for European currencies. Europe (including Eastern Europe) accounted for 32% of worldwide total ICT consumption in 1995. IT consumption alone accounted for 30.4% of worldwide total.

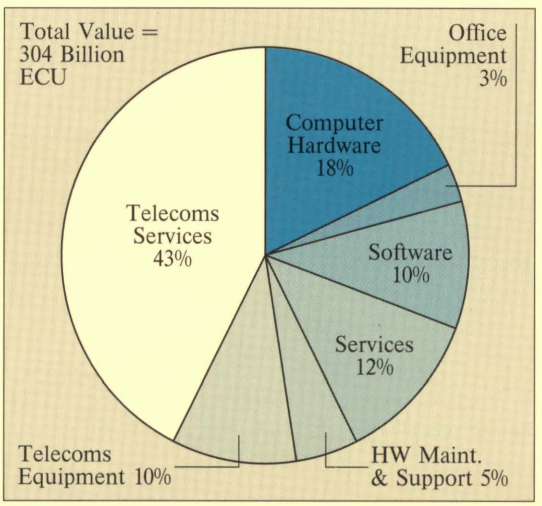
The sustained strength of the US ICT market continued to be a striking feature of the worldwide ICT industry in 1995. ICT market growth in the US improved to 7.3% in 1995, expansion of the IT sector contrasted with flat growth in communications. In 1995, the Japanese ICT market showed a second year of moderate growth, with a positive performance of 4.8%.

The ICT markets of the Four Tigers (South Korea, Taiwan, Hong Kong, and Singapore) continued to display fast growth, with a combined 1995 market growth of 29.7% in IT and 5.8% in telecommunications.

	1995	% of IT	% of ICT
Total IT	**142**	**100.0**	**46.7**
Computer hardware	54	38.2	17.8
Office Equipment	8	5.8	2.7
Software	29	20.6	9.6
Services	35	24.8	11.6
HW Maintenance and Support	15	10.6	5.0
Total Telecommunications	**162**		**53.3**
Telecommunication Equipment	31		10.1
Telecommunication Services	132		43.3
Total ICT	**304**		**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 ECUs at 1994 constant exchange rates. Total and percentages may not add up due to rounding

Table 1
*Western Europe Information and Communications Technology (ICT) Market. 1995 Billion ECU***



Source: EITO

Figure 1
Western Europe Information and Communications Technology (ICT) Market by Produ

ide IT Market on: ige Breakdown ted on Market 1994-96. ECU

	1995 Value	1994 %	1995 %	1996 %
Europe*	147	31.0	30.4	29.9
US	197	40.3	40.8	41.2
Japan	75	16.1	15.4	14.8
4 Tigers**	14	2.5	2.9	3.2
RoW***	50	10.2	10.4	10.9
Total	**483**	**100.0**	**100.0**	**100.0**

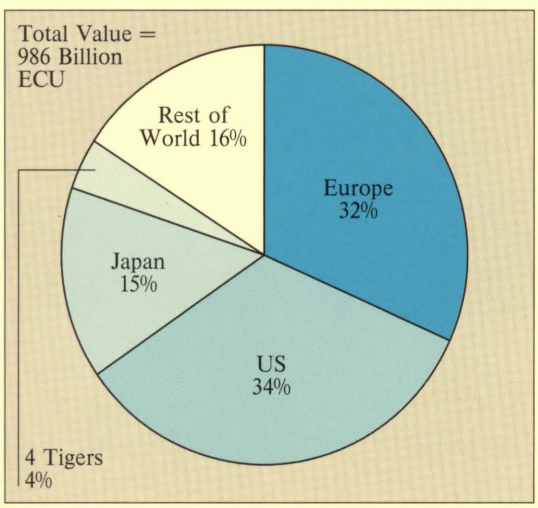
Note: * Europe includes Western and Eastern Europe
** 4 Tigers = Hong Kong, South Korea, Singapore, Taiwan
*** RoW = Rest of World

ide ICT Market on: ige Breakdown ted on Market 1994-96 ECU

	1995 Value	1994 %	1995 %	1996 %
Europe*	315	31.9	32.0	32.2
US	337	34.4	34.2	33.8
Japan	141	14.7	14.3	14.1
4 Tigers**	43	4.2	4.4	4.4
RoW***	149	14.8	15.1	15.5
Total	**986**	**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

ide ICT Market on. 1995



Source: EITO

1.2. IT and ICT Market and Current Economic Situation in Western Europe

Recovery in the Western European economy has been taking place for the past two years.

In a worldwide context, recovery has gained momentum in Western Europe and returned to a more manageable rate of expansion. Growth in Western Europe and in the US will be similar in 1996. If the performance of the Western European economy has been unspectacular in the first half of the decade, Japan has experienced a prolonged recession since 1992 after more than twenty years of exceptional expansion. A moderate recovery is forecast for 1996, but confidence remains fragile. This has not been helped by poor Japanese exports, which are now 15% more expensive than in the spring of 1995 following the appreciation of the yen against the dollar in the spring of 1995.

European economic growth is benefiting from:

- low inflation;
- increasing investment;
- rising consumer and business confidence indicators;
- improving profit margins for Western European enterprises.

However, the strength of economic recovery varies widely between regions and countries within Western Europe.

In attempts to meet the requirements of the Maastricht Treaty, many governments have been compelled to operate fiscally prudent policies rather than policies based on political expediency. Maastricht requires government debt to be kept under control, low long-term interest rates, low inflation rates and a stable currency. The repercussions of poorly thought-out policies are almost immediately reflected in these variables.

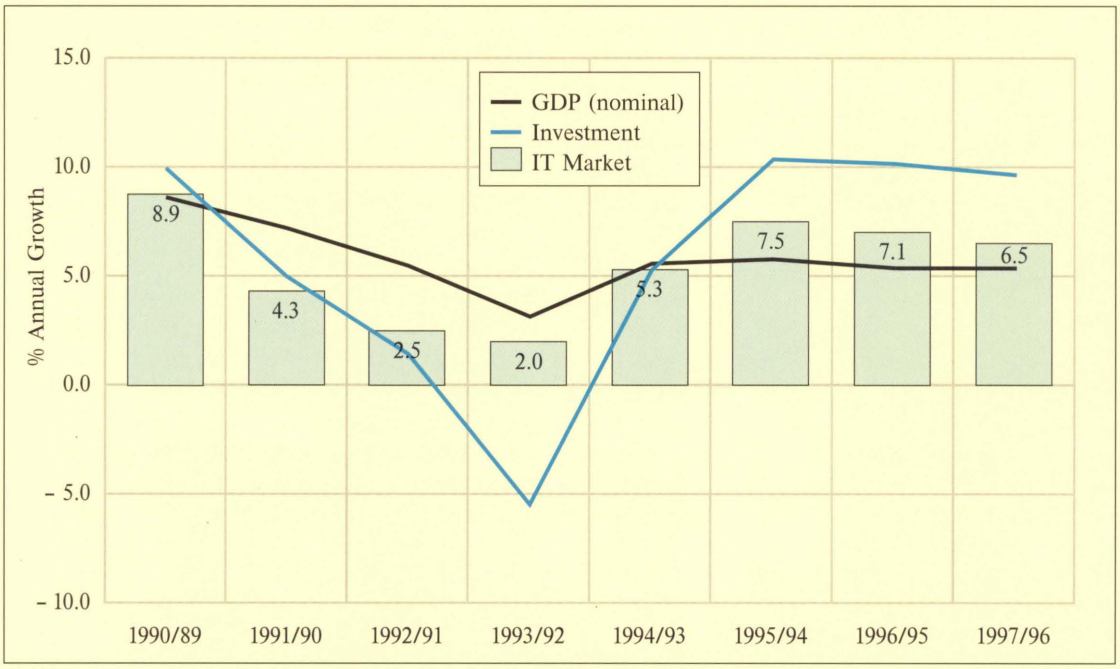


Figure 3
Western European Investment and IT Market Actual and Forecast. 199

Source: EITO

Improving profit margins for companies are being reflected in strong growth in investment in plant, machinery and IT. Real growth in gross private non-residential fixed capital formation almost tripled compared to 1994 real growth. Strong overseas demand for capital equipment has helped the German (and French) economies overcome the negative impact of currency fluctuations which took place in the spring of 1995.

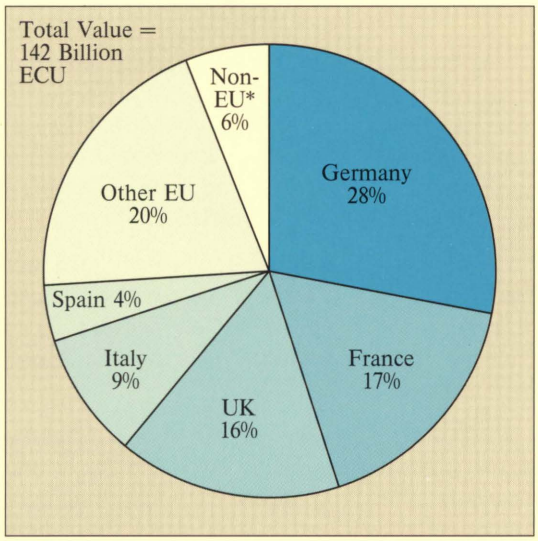
Investment has also been encouraged by low interest rates in most European economies. Rates fluctuated wildly between March and June 1995 as exchange rates went out of control. However in the second half of the year they appear to have settled at rates similar to the low rates which prevailed throughout most of 1994.

The European Commission's business confidence indicators have shown signs of stalling. However, this would appear to be a short hiatus rather than the beginning of a downturn. Manufacturing confidence has been particularly strong while consumer and retail indicators have reflected the still great uncertainty in the employment front (unemployment is creeping rather than tumbling down).

Inflation remains under control in most countries. In 1995, of the few major economies the Italian rate was more than 5%. In Germany, France and the UK inflation grew by a couple of percentage points in 1995.

Of the Scandinavian economies, Sweden continues to cause greatest concern. The country last experienced above-average real GDP growth in Western Europe in 1984. Despite this, IT investment continues to show one of the strongest growth rates of any European country

European
et by Country.



= Switzerland
ay

Source: EITO

European IT
by Country:
ge Breakdown
ed on Market
nd Growth.
97. Billion ECU

	1995 Value	1995 %	1995/94 %	1996/95 %	1997/96 %
EU	133	93.6	7.4	7.0	6.4
Germany	40	28.2	7.4	7.1	6.1
France	24	16.7	5.4	6.4	6.4
UK	23	16.2	8.9	7.4	6.3
Italy	12	8.6	5.0	6.5	7.4
Spain	5	3.6	7.4	8.7	8.5
Other EU	29	20.2	9.1	7.2	6.2
Non-EU*	9	6.4	8.7	8.0	7.0
W. Europe	**142**	**100.0**	**7.5**	**7.1**	**6.5**

Note: * Switzerland and Norway

boosted by strong export markets more than domestic demand. Finland, although experiencing strong real growth, is still undergoing a catch-up phase following the disastrous recession of the early 1990s. Norway and Denmark are flourishing both economically and in their economies' expenditure on IT.

Of other countries, Ireland is worth singling out. Despite an exceptionally strong real GDP growth rate (6.5% in 1995), investment in IT is rather lacklustre in comparison to increase in GDP. This disappointing picture should also be seen in light of the relatively backward state of IT in Ireland and the large number of companies which have major IT plants in the country.

1.2.1. IT Trends

The European IT market has benefited more than most from economic recovery. The lacklustre growth of the European IT market in the first half of the decade is beginning to benefit from developing technology drivers, which started to play an important role in driving the market in 1994.

i. Trends by country

Strong economic growth in most of northern Europe has been reflected in high growth rates in the IT markets of Scandinavia, the UK, Ireland, Germany and the Netherlands. There is, though, no clear-cut correlation between real GDP growth rates and the strength of the IT market. Sweden and Germany both have experienced below-average real GDP growth rates for 1995, yet the IT markets in both countries are showing exceptional expansion.

Germany: back to IT investments

The German IT market has benefited from an upturn in demand as companies began to make investments previously postponed during the recession.

Hardware market dynamics were driven by PC sales, which continued to show double digit growth in 1995. The major drivers of this growth were the shift towards the adoption of faster chip-based machines and a vendor price war enabling buyers to purchase top-of-the-range PCs at attractive prices. Because of falling prices and technology improvements, high quality PCs increasingly drew buyers from the home market.

Sales of client/server applications contributed to the strong growth of the packaged software market. Relational databases and packages catering for specific vertical markets were amongst the fastest growing software segments. Growth in professional services was also above the European average.

Overall the German IT market grew by 7.4% in 1995 and is expected to increase by 7.1% in 1996.

France: towards recovery

The French IT market started to come back to life in 1995. However, it scored a modest 5.4% growth and, for the third consecutive year, continued to be among the weakest in Europe. It is expected to build momentum in 1996, with a forecast growth of 6.4%, although the outlook is uncertain.

Even with strong PC growth, the French IT market could not count on a strong home PC market in contrast to many others. Growth of the consumer market only started to emerge at the end of 1995. Greater optimism exists for 1996.

Client/server and business process reengineering had a strong impact on organizations. Many large companies who wanted to change information systems also started to change their organizational set-up.

In the professional services market, France underperformed because of the on-going adjustment to a more packaged software-friendly environment among many organizations. A general decline in government expenditure also had a negative effect.

The one area of optimism is the relatively forward-thinking attitude of the French to the idea of outsourcing, resulting in double digit growth for 1996 and beyond.

United Kingdom: market driver

The UK IT market continued to support the total European market with a solid 8.9% expansion in 1995, performing far better than expectations at the beginning of the year. Growth is expected to moderate towards the European average in 1996, with an expected 7.4% increase.

As a result of strong UK growth, the gap between the comparable IT markets of UK and France narrowed, as the UK invested much more heavily in IT while France was experiencing unimpressive growth.

For the past three years, the UK has experienced strong economic growth in comparison to much of Europe and the IT sector has continued to benefit more than most. Growth in the hardware sector has been driven, primarily, by sales of PCs and printers.

The real rising star of the UK IT software and services sector continued to be outsourcing. The UK was one of the leading European countries to take to heart the concept of outsourcing. At present, it is still a relatively small part of the professional services market total, but high growth rates are expected in the next few years. The UK government has driven much of this growth as it pushes a policy of "market testing" to ensure that government departments achieve cost-effective provision of services.

Italy: ongoing recovery in technology adoption

Following a modest 2.1% expansion in 1994, the Italian IT market regained some of its vitality in 1995. IT market growth more than doubled with an increase of 5.0%. However this growth remains slightly below average European growth. Growth expectations are higher for 1996, with an anticipated 6.5% increase, and in 1997, at 7.4%. Growing faster than the European average, the Italian IT market is expected to catch up in its new technology adoption over the next two years.

In the PC market, 1995 growth performance was particularly strong. The reasons behind this good showing are primarily economic. Drivers, such as GDP and investment, are growing at a faster rate than previously expected. The minor rally of the lira on the currency markets has also helped the Italian PC market in the second half of 1995. The country is now starting to invest in top-of-the-range machines, but a considerable lag still exists between Italy and most of Northern Europe.

In the software and services sectors, IT consulting and outsourcing are forecast to expand at a fast rate. Following the trends of the UK and Nordic countries, the Italian services market is expected to benefit from the increasing shift of internal IT spending towards external suppliers.

Spain: a long delayed recovery

After three consecutive years of depression and stagnation (IT market growth of -1.2% in 1992, -5.2% in 1993, and 1.2% in 1994), Spain's IT market returned to a positive performance with an improvement of 7.4% in 1995. This still emphasizes that the Spanish IT recovery, like the Spanish economic recovery, is some 18 months or more behind most of Europe. A catch up is forecast for next year when above European average growth will take place (8.7%).

Despite political uncertainty and Western Europe's highest rate of unemployment, Spain is emerging from its recession. The country expects to receive ECU 3.8 billion from EU structural and agricultural funds in 1995 and 3% real GDP growth this year is expected to be in line with the European average.

Investment is now driving economic growth, underpinned by a recovery in services and the much healthier financial situation of Spanish companies following the 1992/93 corporate restructuring.

Bearing in mind Spain's 40 million population, the country should be one of the stronger IT markets. Despite this potentially large IT market, the Dutch (15 million population), Swiss (7 million) and Swedish (9 million) IT markets are all larger than that of Spain.

The fall in PC sales in 1994 gave way to almost double-digit growth in 1995 with a more substantial improvement anticipated for 1996 and 1997. Falling prices of top range PCs are driving the upturn. While the performance of the hardware and software markets is expected to improve in 1995 and 1996, professional service growth will be more difficult to achieve.

Other countries

In 1995, the Nordic IT markets continued to outperform the European market as a whole, with Finland and Sweden driving growth at double digit rates. PC and LAN hardware markets were particularly strong.

The Dutch IT market recorded impressive expansion in 1995. By contrast, the Belgian IT market was depressed. The Swiss market achieved average growth in 1995, which will be maintained in 1996. Continuing its catching up process, the Austrian market outperformed the European average in 1995, and the pace of growth is expected to be sustained in 1996.

The Irish IT market showed reasonable, if unspectacular, growth in 1995 and the same is anticipated for 1996.

In Southern Europe, growth in the Greek IT market was double digit. The Portuguese market was slightly below the European average with similar dynamics expected in 1996. In particular, EU-funded programmes are boosting the professional services market in the country.

ii. Trends by product segment

The lack of a clear-cut correlation between real GDP growth rates and the strength of IT markets across countries characterizes current trends in European IT developments. For example, the UK and Germany both had below average real GDP growth rates for 1995, yet the IT markets in both countries showed exceptional growth.

This was because two IT-related factors drove and are still driving IT market growth:

a) the broad acceptance of client/server computing;

b) the development of the consumer market.

Driven by these trends, the economics of the computer industry continues to change.

a) client/server computing

Client/server computing is taking hold on a global basis, across all countries, system types and industries. Europe has a distinctive position in this global trend as users here have a smaller system mentality, with a heavy Unix influence. This creates a strong positive attitude towards distributed computing.

Europe's users are moving to networked distributed architectures either by deploying client/servers or by downsizing corporate multi-user systems. They need a new combination of features for their advanced servers:

- robust application services;
- distributed computing services;
- simple to integrate components;
- ease of operations (installation, maintenance);
- a large cache of applications and tools.

b) the development of the consumer market

The second influence driving the market is the growth of the home market. The increasing availability of PCs at affordable prices, coupled with increased exposure in the mass media through television and newspaper advertising has helped immeasurably to increase the market. In addition, channels are expanding to accommodate this move. The consumer is now one of the most considered target audiences of the PC suppliers, after the phenomenal success of the vendors who first focused on this part of the market.

IT hardware: the revival of growth

IT Hardware revenues increased by 8.8% in 1995, up from 5.4% in 1994. A slightly lower performance of 7.6% is anticipated for 1996.

A progressive strengthening of the positive factors and the overcoming of some negative factors contributed to shape sustained dynamics for hardware products.

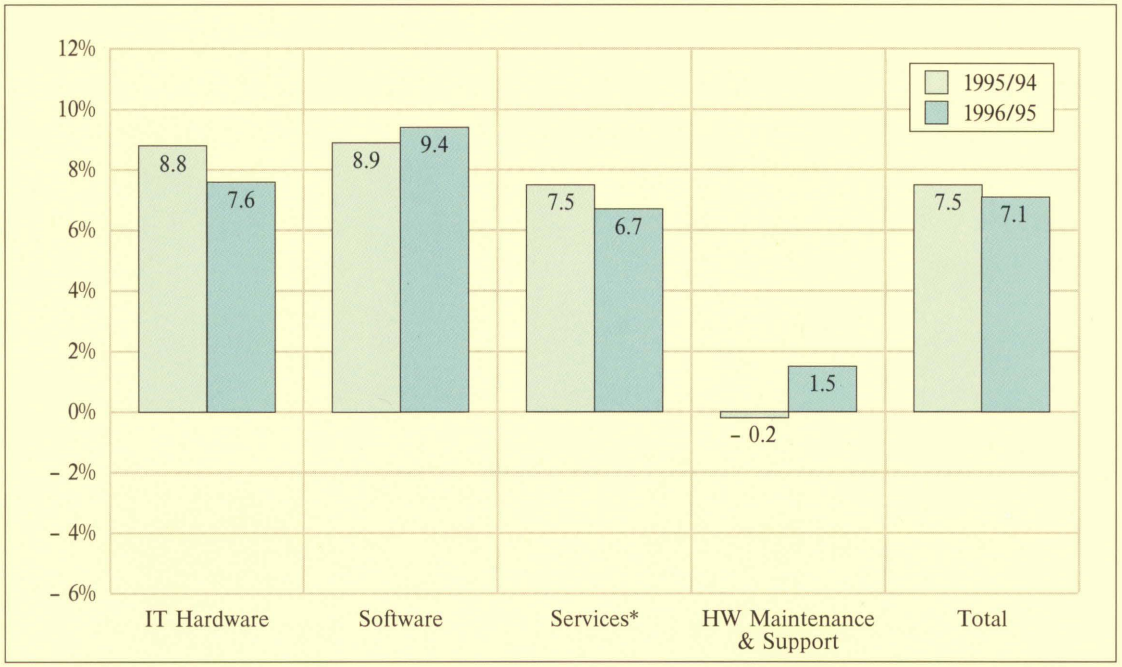
The main positive factors include:

- recovered business confidence driving new IT purchase plans;
- the Internet as a communication and electronic trade tool attracting new consumer and business users to purchase IT;
- continued price erosion in desktop and notebook personal computers supporting sustainable growth;
- continued improvements in integration capabilities of network and software products and solutions;
- increasing availability of new applications running in distributed computing environments.

The main inhibiting forces are:

- caution with respect to new chip and software announcements in the second half of 1995 which are holding back IT hardware investment plans;

Figure 5
Western European IT Market Value Growth by Product Segment. 1995-1996



Services include: Professional Services, Processing Services and Network Services

Source: EITO

- downward pressure on prices, exerted by heightened competition and shortened life cycles, especially for personal computer technology and Local Area Network hardware.

In the multi-user hardware systems market, the large-scale systems sector experienced another year of shrinking markets in 1995, though a new equilibrium is likely to be met after 1996 when falls are forecast to be far less steep. The flat performance in medium-scale systems was driven by the increasing size of databases held in this scale of machine, driving demand for more processing power, against falling prices. Small-scale systems also experienced a flat performance, despite falling prices, as client/server environments continued to proliferate.

The market for desktops bound for the home market continued to expand at high rates. Sales of PCs purchased out of consumer disposable income drove overall PC growth in Europe (as in the USA). However, the household segment developed much slower in some countries than others with no take-off expected in Spain, Italy and even France until 1997. Germany continued to experience an explosion in demand from the small business community and, particularly, for PCs to be used at home.

The market accelerators driving the high growth include:

- lower entry price points;
- declining cost of the total PC solution;
- affordability of solutions for small businesses;
- new high-end CPUs - Pentium, PowerPC and Pentium Pro;

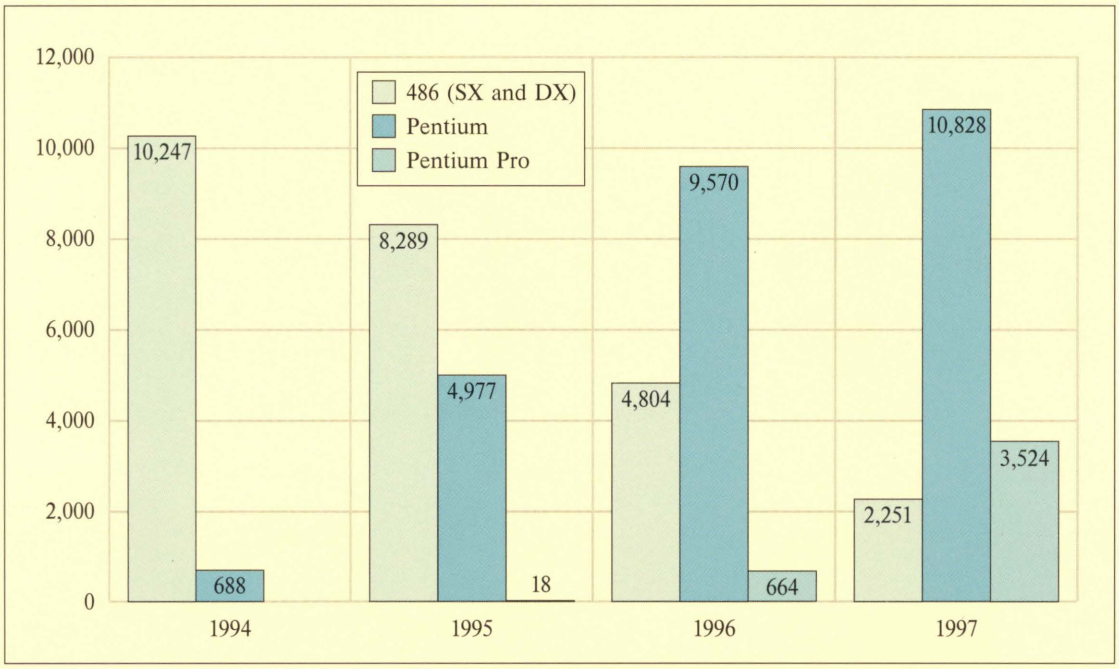


Figure 6
Western European Personal Computer Market. 486 Systems versus Pentium and Pentium Pro 1994-1997. Unit Shipments (Thousands)

- high performance notebooks;
- downsizing and client/server trends;
- workgroup applications;
- improved and streamlined logistics and structures;
- expansion of networks and on-line services;
- shrinking system lifecycles boosting upgrade demand;
- expanded multimedia capabilities;
- wider consumer acceptance of home computing.

Against this, some inhibitors held back sales in the PC market:

- a wait-and-see attitude towards new high-end hardware in some countries;
- shortages of TFT displays (high quality colour screens for portables);
- new high performance home game systems;
- limited multimedia applications in business;
- delay in the development of the information superhighway;
- inability to see PCs as a mainstream electronic consumer device.

In the portable market, the arrival of cost-effective, low-power portable Pentium PCs is pushing down the high price premium which has to be paid for the most up-to-date technology. Complemented by docking stations and port replicators, high growth rates are expected to be sustained in the medium-term.

The workstation market continued to expand with double digit growth in 1995. The high growth rates were driven by considerable activity amongst vendors with new products. This was further supported by the traditional workstations market which has still to reach saturation point.

In the printer market, growth in colour-capable ink jets was superseded by the growing market for colour non-impact printers. Just as there has been a switch from impact to non-impact printing, the printer market will shift from monochrome to colour output over the next few years.

The ink jet market boom coincided with strong PC growth and found a potent new market amongst small office and home office users. Meanwhile dynamism in the laser page printer market continued.

The bulk of growth in the LAN hardware market came from sales of internetworking equipment and smart hubs offering both local and wide area networking facilities. By contrast the network interface card market remained essentially static.

Meanwhile, sluggishness in the traditional office equipment market was countered by the emergence of new technologies such as image compression, optical character recognition, optical plastics and artificial intelligence. The integration of new features attracted new customers in demand for more sophisticated image processing capabilities, particularly in the reprographics market.

The shift towards digital, computer-connective, network-shared office equipment is poised in the next few years to accelerate true connectivity between networked computers and such digital office equipment as copiers, printers, scanners and facsimile machines will represent an excellent opportunity for long-term growth.

Software products: driving growth

Software products proved yet again to be strong drivers of IT market growth. Software sales rose 8.9% in 1995 and are set to increase by 9.4% in 1996.

Growth in the European packaged software market continued to be driven by application tools and application solutions. In contrast, the systems and utilities market showed less dynamism. The cost advantage of packaged software over custom solutions (a component of Professional Services) ensured higher growth in sales of packaged software than in sales of custom-based software options.

Distributed systems and Windows 95 are the factors most likely to boost the packaged software market in the near future.

Generally, buyers wish to minimize the cost of all software when building unique competitive advantage from "strategic software". They require application development tools and enterprise management software built for, and operating in, a distributed environment. Distributed applications are, by and large, client/server applications.

Windows 95 was finally launched in August 1995. It is expected to give a boost to the packaged software market over the next few years. The SOHO market is expected to be first off the mark amongst the target populations. Although this group will be early adopters through OEM channels, there will be low upgrade rates at the beginning of the product's life cycle. Power users are expected to have the highest upgrade rates whereas large corporate users are expected to wait for some time before buying in bulk.

Operating systems account for more than 40% of this market and will remain the dominant segment until the end of the decade. The second largest segment is middleware and utilities with performance management software accounting for a further 30% of the market. Operating systems and middleware are both showing healthy growth at present. These markets have been fuelled by the movement to Unix systems and the middleware need to support them.

In the area of tools, databases are the largest subsegment, followed by third-generation and fourth-generation languages. Application development tools are forecast to maintain a double digit average annual growth (in the region of 13%) over the 1995 to 2000 period. The fast adoption of new products with expected productivity or quality improvements will ensure high growth rates in the tools sector.

Some of the strongest growth rate projections are for object-oriented technology. The market for object-oriented software was particularly strong in 1994 with +25% growth forecasts for database management systems (OODMS), object-oriented CASE and object-oriented programming. However, these markets still constitute a relatively small part of the whole tools market. Database management systems (DBMS) are growing at a rate of between 15% and 20% and account for almost a third of the tools market.

In the applications market, accounting and word processing are the most important sectors of the market, followed closely by edutainment and infotainment consumer software. Growth in the 15-25% range was experienced by these markets in 1995.

Services: a European strength

Professional services

The professional services outperformed the overall IT market by growing 8.3% in 1995, and is forecast to increase by 6.7% in 1996.

However there were major differences in growth rates both within the segment and between countries.

Growth ranged between the record high achievements of the facilities management sector and the low growth rates of custom software. IT consulting, system and network implementation and education and training all outperforming the IT market average by a small margin.

Growth in custom software was particularly flat as companies increasingly demanded packaged solutions requiring slight customization rather than creating a one-off system.

IT consulting, systems and network implementation, and education and training performed well, although growth rates for each of these segments are not expected to maintain the same sustained dynamics over the next few years.

The market for professional services was, and is still, subject to continued downward pressure on prices. Under increasing price pressure, the performance of the custom software market is relatively poor.

Marked differences between country growth rates highlighted the strong uptake of outsourcing services in the UK and Scandinavia.

The IT consulting market will increasingly benefit from IT- and management-related issues. User corporations will focus more on improving business processes, not only on how to roll out the information technology in the department or enterprise. Business Process Reengineering services are already beginning to meet this need and will represent a growing share of the market.

IT consulting covers a broad range of consulting activities from detailed IT issues to what is effectively management consultancy. Buyers of such activities differ greatly: IT departments for technical issues whereas management consultancy/strategy issues are decided at board level. Consulting services are a leading indicator of intention to invest in IT. As a costly up-front planning investment, it suggests a serious commitment by the user towards change and long-term expansion.

Amongst individual countries, the UK professional services sector benefited from general economic growth and high productivity (following much rationalization during the recession). A fast take-up of outsourcing was driven by the present government's policy of "market testing" public services.

Growth in Europe's largest professional services market, Germany, was average. IT consulting performed well, driven by growth in the Eastern German economy. The French professional services market has always been disproportionately large for the size of the country's IT market. Growth last year was poor as custom software suffered from a lack of demand for external programming, companies preferring to employ internal IT professionals.

The Italian market was affected by reduced expenditure in several key vertical sectors. The manufacturing sector and central and local government all held back in their expenditure plans.

Amongst other countries, high growth rates in Sweden are solely the result of a small number of very large facilities management contracts while the Dutch market suffered as a result of competition from packaged solutions and a fierce price war among local service vendors.

Network services: towards a booming performance

Network services, which includes managed network services such as EDI and electronic mail services, grew 15.7% in 1995, and are forecast to expand 17.8% in 1996. Network services are expected to remain among the fastest growing segments of the entire IT market.

The growing requirements of managing enterprise networks are leading to increased demand in this segment. The increasing complexity of network technology has caused more large- and medium-sized businesses to consider using an external service provider to supplement their skill sets. Key factors in determining the level of usage of outside vendors for network services are the competitive environment, the level of internal networking expertise and the importance of the network to customer satisfaction.

As more business critical applications are transferred to the network, optimizing network performance is becoming crucial. In order to maintain a required level of performance, resource-constrained network managers are seeking to complement their capabilities and increase their effectiveness while maintaining control of key areas, such as strategic planning. Moreover, business units continue to make decisions independently and implement systems and practices that impact the overall network. As a consequence network managers must spend increasing amounts of time co-ordinating various demands being put on the network.

Support services: reflecting the diverse trends in the IT hardware market

Growth in the support services market was flat in 1995, recording a - 0.2% growth. In 1996 the market will increase by a slightly higher 1.5%.

The dynamics result from different trends in the software and hardware support markets. While the former is showing strong growth rates, the latter appears to be stabilizing after several years of decline.

On-site hardware maintenance still accounts for a large portion of the whole. But the needs of customers are changing: businesses are rapidly adopting the distributed computing model and shifting away from big-iron multi-user

systems. The new model is based heavily on client/server applications and complex PC-based networks. With this shift comes businesses' needs for multi-vendor expertise as well as systems management and operational types of services. Systems have generally become more reliable and new technologies such as RAID are designed to let customers perform a certain degree of self-maintenance.

Where growth exists in hardware support, it is less likely to occur in the traditional break/fix maintenance services. Instead, it will provide some form of systems and peripherals management (asset management, predictive maintenance and systems management), or let the end user or customer access support information more efficiently (on-line knowledge base and bulletin board services).

Software support has been driven by the strong and growing market for telephone support services. However, on-site software support and systems management are both substantial sectors of this market.

iii. IT user perspectives

From a user perspective, the uneven development pattern of the IT market is very much driven by two types of innovation: innovation aimed at improving efficiency of traditional processes and innovation aimed at enabling new core competencies and practices to emerge and consolidate. This latter kind of innovation is usually less influenced by economic cycles, as it is the result of the implementation of long-term strategies.

The propensity to use IT innovations differs greatly between different vertical markets (i. e. industry sectors). The major challenges for the following industry groupings are:

Manufacturing: Globalization, time to market, and optimistic forecasts on the pick up of domestic demand are expected to drive stronger business growth. The Commission of the European Union forecasts an average annual growth in production of 2.6% until the year 2000. With the bright exception of Germany and the Scandinavian countries, the manufacturing sector's investment in information technology continues to be at odds with the perception that it is a sector that lacks investment vision. Overall spending on IT does not reflect a fast-changing attitude towards IT from personal productivity tools to business-wide support systems. However, the investment profile is improving.

Transport, communication, utilities: This is a crucial sector for future economic developments. Increasingly, mergers and alliances will characterize a transport sector faced with increasing European integration-led demand, as well as, increasing competition. Huge investments in the transport infrastructure will lead to the expansion of various networks and to the emergence of new services, including value added services based on transport telematics. High business growth will be derived from privatization initiatives, liberalization of telecommunication services and infrastructure, in addition to the major benefits derived from the evolution towards the information superhighways era. Preparation for the information superhighways era involves complete rethinking of business models, and the role which IT investment will play.

Retail/wholesale: This sector is undergoing considerable restructuring. Changes include increasing concentration with a reduction in the number of traditional wholesalers. Transformations in the retail sector include the increased use of technology and a tendency towards vertical integration, diversification and internationalization. European Union actions in transport, competition, investment, structural fund and

Table 5
Implementation of Client/server Computing by Vertical Markets 1995
% of Sites Which Are Moving/Have Moved or Are Planning to Move Towards a Client/server Strategy

% sites	Germany %	France %	UK %	Italy %	Benelux %	Western Europe %
Manufacturing	47.8	25.9	44.6	36.8	43.7	41.0
Transport/Communication/Utilities	62.4	40.4	58.9	52.0	47.2	52.5
Retail/Wholesale	59.7	19.9	41.1	64.0	30.8	41.0
Finance	85.3	81.6	65.0	58.4	55.3	71.8
Government	84.0	44.3	75.0	40.5	51.0	67.6
Education	48.6	20.2	61.2	22.2	31.2	30.8
All Industries	**62.2**	**34.7**	**45.9**	**43.2**	**37.7**	**48.0**

enterprise policy are intended to exert positive growth effects. The opportunities created for logistics planning and management by the abolition of internal frontiers should contribute to expansion of physical distribution activities. The majority of organizations still maintain a traditional approach towards IT, focused on data accessibility priorities and supply chain management IT applications. For the minority of most advanced retail organizations, where business processes are being re-engineered, the focus of IT adoption is shifting to concentrate on how people in the organization interact with each other and the customer.

Finance: Deregulation and liberalization are stimulating the emergence of integrated financial services markets. Disintermediation, securitization, growth of the market for derivatives, mergers and alliances, electronic banking and electronic markets are among the important trends in the financial services market. Information and communications technology are a major force for change in the evolution of the financial services sector. In terms of IT strategy, banks and financial companies (the big spenders on IT) are committed to client/server and are pouring increasing amounts of money into buying client/server technology and downloading data from legacy systems into new architectures and applications. However, mainframes still remain a core technology on which the finance sector relies to run the central IT functions, such as customer databases.

The big challenge for banks and financial companies is to leverage the convergence of media, telecommunication and information technologies to broaden the range of services offered towards:

- new means to provide traditional services, such as multimedia kiosks, 24 hour direct banking services;
- new services, such as teleshopping, travel services and insurance services.

EDI, neural networks for risk analysis and Executive Information Systems will also be leading-edge technologies of great interest to financial institutions in the medium-term.

Government: Public expenditure cuts and eternally slow public purchase tendering procedures are still inhibiting the potential drive which national and European government bodies could generate. The dilemma for Europe is that public spending is still too biased towards

non-productive expenditure. Burdened by interest rate expense, it is unable to generate enough investment for the development of infrastructure and the improvement of public service to citizens. Nor does the outlook appear good, as higher unemployment and lower incomes have further narrowed the differential between public income and public expenditure that can be turned into productive public consumption and investment. The burden on local government is even greater. Defence and social security are among the most important sectors being targeted for public spending cuts, as well as being the largest contributors to government IT spending. The UK model of IT budget cuts is among the most interesting in Europe both for the impact on the IT industry's growth and the industry's competitive environment. The government is market testing public IT departments, agreeing to outsource staff and systems when the market offers more price-efficient solutions. This has started to generate higher growth in the UK IT services market.

Education: The decline in the total school population (some 68 million young people at the beginning of the '90s, against a peak of 73 million in 1977-78) is compensated for by the tendency to spend a longer period in education (27% of 19 year-olds were still being educated in Western Europe in the late '80s, against 19% in the early '70s). Despite governments reducing funds for school and university structures, the education market is rich in promise for the adoption of new technologies and educational methods, as the sector is crucial for long-term developments towards the information society.

Increasingly, primary schools are recognizing the benefits of multimedia, while the greater part of the IT budgets of secondary schools budgets is being spent on educational software.

Home market: Demand for IT in the consumer market is driven by multimedia PCs. A combination of favourable factors is driving a strong growth in PC purchase by households. Price wars among top vendors have precipitated sharp declines in hardware prices, lowering the cost and expanding the market for high-end PCs. Consumers are reaching deeper into their pockets, choosing to buy higher-performance PCs for a greater return on their investment and no longer fearing short-term obsolescence. Further enhancing consumer demand is the expanding universe of work-at-home households.

For total IT spending, sectors which will lead the growth in the next few years will be finance, business services, transport/communications/utilities, and health.

1.2.2. TLC Trends

The Western European telecommunication equipment and services market recorded 8.7% expansion in 1995, reaching a total value of ECUs 162 billion. The market is expected to grow by 9.8% in 1996.

User spending on communication products and services remained higher than expenditure on information technology, as major areas of opportunity emerged in mobile and data network equipment technology, and in wide area and local area network services. This trend will continue as services share of users' budgets is increasing at the expense of equipment.

The vast bulk of communications spending came from voice services, accounting for two-thirds of the market. However the emerging demand for connection and integration is driving up the share of new emerging segments.

Despite hostile reactions from some countries, the European Commission has maintained momentum towards liberalization. Initiatives in major areas include:

- the liberalization of cable television infrastructure;

Table 6
Western European Telecommunications Market by Region Percentage Breakdown and Growth Calculated on Market Values. 1995-1997. Billion ECU

	1995 Value	1995 %	1995/94 %	1996/95 %	1997/96 %
EU	152	93.8	8.9	9.9	11.2
Germany	43	26.5	9.0	9.4	8.9
France	27	16.5	10.0	13.6	17.7
UK	25	15.4	6.7	8.3	10.7
Italy	17	10.8	9.5	8.3	8.0
Spain	9	5.3	8.5	11.1	14.4
Other EU	31	19.1	9.3	9.2	10.1
Non-EU*	10	6.2	6.4	8.1	9.2
W. Europe	**162**	**100.0**	**8.7**	**9.8**	**11.1**

Note: * Switzerland and Norway

- the acceleration of the approval process for opening access to the telecommunication infrastructure of railways and utilities;
- clearer definitions of member state obligations concerning various components of telecom liberalization;
- strong monitoring and control of free competition.

Business developments will concentrate on the expected increase of the use of the telecommunication infrastructure for new services. Negative factors include the flattening investments in traditional equipment and lower revenue from liberalization in voice services. The positive counterpart will be increasing investment and service usage for wide area network traffic. This increase will be generated by businesses as they increase their use of emerging electronic commerce. The number of companies, as well as of customers, that will use some form of data communication will increase. In addition, much more traffic will be generated on existing networks by the use of new applications, such as multimedia information.

However, the economics, competitive rules and business dynamics of the major segments in both the telecommunication equipment and services markets are characterized by very different rules and trends. Also market drivers act in different ways across individual countries.

i. Trends by country

While the European Commission is pressing ahead with rules leading to the full liberalization of European telecom markets, the various country regulators and competitive environments are adapting slowly and at different paces to this process.

Germany: accelerating liberalization

The German telecommunication market is the largest in Western Europe, accounting for a 26.5% share of the total. In 1995 it grew by 9.0% and is expected to record growth of 9.4% in 1996.

To keep pace with the liberalization process heralded by the Commission, Germany will liberalize the network infrastructure market by July 1996, allowing utilities and cable television operators to sell line capacity to third parties. The privatization process of Deutsche Telekom has also been accelerated, with one-third of its shares being offered on worldwide stock markets by April 1996.

Telecoms investment continued to decrease in 1995. A positive performance in the mobile equipment and private datacom equipment markets has, to some extend, compensated for the pressures suffered in the public equipment segment.

Increase in the telecommunication services market was sustained by healthy growth in revenue from the public switched telephone network services, a booming mobile market, and continuous growth in the ISDN market (the largest in Europe).

France: clarifying the deregulation process

With the opening up of telecom networks run by the national railway company (SNCF), the French Administration progressively advanced its gradual approach towards liberalization and free competition. Further progress is expected in 1996. The French government plans to introduce new laws aimed at clarifying the regulatory and competitive landscape for all groups concerned, including France Telecom and its personnel.

The French telecommunication market continued to be characterized by the development of partnerships. The partnerships were not only among telecom operators, but also among utilities and value added service providers. This has resulted in the provision of advanced features and services, and and an early-adopter attitude to using new technologies.

Growth in the French telecom equipment market was more modest. However the outlook is more positive as revenue from new datacom technology equipment is expected to show strong growth. In the telecom services market, higher growth expectations are focused on the booming mobile market and the data network services market. These are fuelled by the French market for packet switched data network services which is the largest in Europe. The strong promotion of ISDN services is also paying off.

The French telecommunication market grew 10% in 1995 and is forecast to grow 13.6% in 1996.

United Kingdom: advanced competition

The UK telecommunication market continues to be a leading implementor of free competition. The UK market not only has the lowest telecommunication tariffs in Europe, but it also has advanced watchdog procedures on the pricing of phone services.

With 112 Internet service providers connecting about 800,000 people, the UK population are also very active users of the Internet. Important technology breakthroughs also characterized 1995 in the UK: one of the world's first TV-based Internet access services was launched and one of Europe's first ATM-based interactive TV trials took place. The more liberalized telecommunication regime continued to encourage foreign investors in the UK market.

Under pressure of competition, the telecommunication market in the UK is set to grow at a modest, though improving pace compared to the European average.

In the telecommunication equipment market, positive expectations are concentrated on public equipment, especially new technologies such as frame relay and ATM. In contrast, the actual performance of the teecommunication services segment is less impressive. A higher penetration of network services and competitive pressures are expected to hold back growth. However in 1996 the outlook is more positive, as ISDN and mobile services contribute a higher share of the network services business. More intense competition in the mobile service market has led the UK to lead Europe in revenue terms.

The UK telecommunication market grew by 6.7% in 1995 and is forecast to expand 8.3% in 1996.

Italy: the hard path towards liberalization

In 1995 the telecom market has continued to expand significantly in some areas, showing mixed results on the road leading to greater liberalization and competition.

In the last months of the year a second operator has started offering GSM telephone services. The Government has ratified, after years of delay, the European Commission directive on liberalization of data service. A proposed law is under consideration to introduce further liberalization in the telecom sector. The perspective of a complete liberalization of telecom infrastructure and services by the end of 1997 is attracting new operators.

Joint ventures created between foreign telecom operators and large Italian companies in the utilities, industrial and finance sectors, have started making new investments and offering telecom services in areas where national regulations already allow competition or will allow competition in the near future.

Higher competition in the data nework services is leading to lower prices, better quality of infrastructure and services, and stronger demand. ISDN services are expected to record better dynamics, as users switch from other services (particularly leased lines). However, the recovery is starting from low levels. The Italian data network services market is much less developed than in other European countries and a long time will be needed to fill the gap.

The implementation of liberalization in the telecom market is still suffering from delays and uncertainty both in the privatization process of the national PTT operator, and in the enforcement of fair open market conditions.

On the whole, the growth rate of the telecom market was a sound 9.5% in 1995, and is expected to be 8.3% in 1996. The positive trend is supported by the booming mobile services market (which is performing well above the European average) and solid infrastructure expenditure, as new operators enter the market and growing efforts are devoted to the wiring of metropolitan areas for the development of city networks and new services.

Spain: anticipating liberalization

Considerable progress has been made by the Spanish government to move towards liberalization: 12% of its equity in the national PTT was sold in 1995 and plans to sell more before 1998 have been disclosed. A second GSM licence was awarded in 1995 and a national broadcaster was allowed to sell capacity on its own network or the postal authority network. Spain also decided not to take up the 2003 option given by the Commission to open up voice services and is committed to fully liberalize the market by 1998.

International competition continued to hot up in the Spanish market with a number of overseas operators and value added network service providers active in the country.

The persisting low penetration rates coupled with improving economic conditions supported higher than average European growth. Mobile technology and ISDN markets scored record performances. The overall market is expected to exhibit strong growth over the next few years.

The market expanded 8.5% in 1995 and is forecast to increase by 11.1% in 1996.

Other countries

Among other European countries, the Netherlands and Benelux are characterized by a strong performance in the services segment, partially offset by a poorer-than-European-average performance in the equipment segment. However, the provision of new mobile communication infrastructures has recently boosted the equipment market following major investment in the past few years.

Portugal and Greece continue their efforts to modernize their telecommunication markets and have started to provide greater opportunities for market expansion.

While experiencing improving growth dynamics, Ireland decided to anticipate liberalization by 1998 (despite the option conceded by the Commission to fulfil liberalization requirements by 2003).

Actual and expected growth performance in the telecommunication market for the Nordic countries is among the least dynamic in Europe. The only exception is represented by the actual and expected performance of the Swedish market for data communication equipment. The boom has peaked in Scandinavia with the region's suppliers leading the field in less developed markets.

Switzerland is experiencing average growth in the telecommunication market, while Austria is showing the same poor performance as Scandinavian countries.

ii. Trends by product segment

The fastest growing segments of Western Europe's communications market remain wide area network services, and mobile equipment. Spending on ISDN services and mobile services are experiencing high growth rates. Mobile equipment expanded 14.6% last year.

Telecom equipment: investment pressure still strong

The public market for network equipment continued to be under pressure, after investment cuts carried out by the major public telecom operators. Mobile communications infrastructure recorded erratic growth rates in 1995. The expenditure pattern of infrastructure investment leads to spending in short bursts. Record growth in several countries equates to the launch of new mobile services while market decline in others shows networks which are "complete".

Overall the public telecom equipment market declined by -1.4%, to a total of ECU 14.6 billion in 1995, and is expected to slip another -4.8% in 1996.

In the private network equipment segment, growth in mobile terminals decelerated under higher price pressure, and despite the increasing impact of GSM and the adoption of flexible packaging options by mobile service providers to target a wider range of user types. The number of mobile connections per 1,000 inhabitants is expected to more than double across Europe over the next three years.

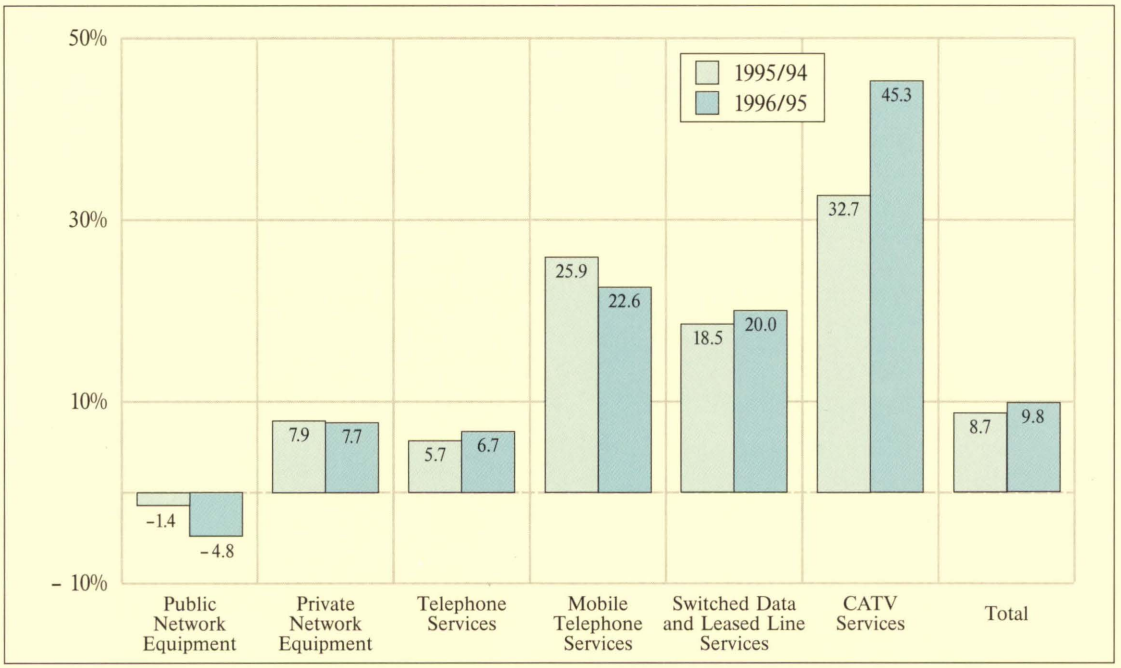
Increased demand for higher featured telephones was supported by the adoption of more sophisticated communication technologies which provide more services at the end-user level.

Price erosion and discounts continued to have a negative impact on the PABX market to the extent that equipment sales are only relevant for their additional installation and maintenance revenue.

User spending on other terminal equipment (videoconferencing, faxes, etc.) will grow at a double digit rate, supported by continued product innovation and the increasing adoption of enhanced multimedia and video communication technologies. Frame relay and ATM equipment markets, although still representing a relatively small portion, started to show strong expansion.

The above trends in the market for private network equipment resulted in a 7.9% increase in 1995, to bring the total market value to ECU 16 billion. A similar performance of 7.7% growth is projected for 1996.

re 7
tern European
communications
ket Value Growth
roduct Segments.
5-1996



Telecom services: mobile driving growth

The market for telecom services totalled ECU 132 billion in 1995, making it by far the largest telecommunication market segment. The market grew 10.1% in 1995, and is expected to increase by a further 11.6% in 1996. A number of key trends supported the expansion of the telecom services market, such as: intense competition for international services; the migration to high speed technologies (i. e. ISDN, ATM); the swift adoption of mobile services and a shift towards managed data network services.

More than 70% of the overall telecom services business was contributed by telephone services. The segment grew steadily and will keep the same pattern of expansion until 1998, as a result of a combination of the following forces:

- the increasing average length of international calls encouraged by tariff reductions on international services;
- tariff increases on domestic services;
- increased use of the Internet and computer information services;
- increased use of freephone and premium rate services;
- growth in traffic outpacing growth in connections;
- introduction of flexible cost structures for users.

The above trends will lead to an increase in the average revenue per connection for telephone services.

On average, the installed base of PSTN main line connections in Western Europe grew by 3% per year in 1994 and 1995. Expansion is expected to increase over the next few years.

The market for mobile voice services continued to show rapid expansion. The positive effect on revenue from the enormous increase in the penetration rate of mobile connections will more than offset the high price declines driven by fierce competition. The introduction of flexible cost structures for users, and a slower growth in traffic compared to connections will also characterize the development of the market for mobile telephone services.

Western European subscribers to mobile services grew by almost 40% in 1995 and are expected to more than double by 1998.

The market for data network services also benefited from particularly high revenue growth, as a result of a rapid expansion in the number of connections.

The key drivers of the market are:

- a shift away from fixed point-to-point connections to high speed switched data services;
- a shift away from analogue services towards digital services;
- the increasing digitalization of the public infrastructure;
- the move towards higher speed (and more expensive) services such as public ATM and frame relay services;
- increased penetration of ISDN;
- the introduction of flexible cost structures for users.

Growth in data network traffic will be higher than growth in connections, as the use of data compression and the improvement of the quality of X.25 services will enable greater LAN interconnection traffic. Traffic growth from new connections will be coupled with strong growth in traffic volume by existing users.

A notable trend will also be the continued decline in prices of leased circuits and ISDN services.

Leased circuit prices will drop as national operators gear up to face the prospect of competition for the provision of domestic leased lines. Although the provision of leased line capacity on international cables remains the domain of the national operators, the race to become international network service providers is driving prices down. Indeed as national operators attempt to move onto the global stage, they are being forced to compete aggressively against each other in order to win the hub operations of multinational businesses.

The number of ISDN connections has increased as a result of the adoption of Euro-ISDN, common standards for, the launch of commercial Euro-ISDN as well as reduced tariffs. Increased penetration of ISDN will, in turn, ensure that tariffs continue to fall.

iii. Telecommunication users perspectives

Industrial and business sectors are showing more positive attitudes towards investments in telecommunication technology. This increasingly positive attitude is a direct result of the introduction of advanced technologies with enhanced information transport capabilities. In turn, this has allowed the development of new services and products.

Among the most interesting trends are:

Retail/wholesale: For the most advanced retail organizations, where business processes are being re-engineered, new technology adoption focus is shifting to concentrate on how people in the organization interact with each other and the customer. Telecommunication technology is playing a major part in this sense. Voice-mail messaging, "selling-through-screens" techniques and electronic interactive shopping are becoming the tools to enhance the competitive edge of distribution companies.

Finance: The big challenge for banks and financial companies to leverage the convergence of media, telecommunication and information technology is leading them to increase investment in communication technologies and services. Telecom investment is more dynamic, in the short-term, in the countries where the attitudes of banking systems and finance users (e. g. towards electronic money and teleshopping) are more advanced. Structural and psychological factors will inhibit potential growth in other countries where the payback on telecom investment is destined to be too long. By the year 2000, more than 90% of banks in Europe are expected to offer telephone banking services to their customers. However, "telebanking" technology is still more commonly seen as a means of identifying new sales prospects than as a means of giving attention and service to the customer.

Government: The big challenge for governments is now data communications. Putting public administration processes on-line and interconnecting government information systems will make several new applications affordable. Examples include: a 24-hour tax helpline, self-service job centres with computerized databases of available jobs, electronic processing of social security claims with payments through automated credit transfer, police information system agencies supervising fingerprint readers connected to the criminal records facilities. However, these opportunities will not be fully grasped until new policies on information access and management ensure a balance between the benefits of accessing information and services and the protection of the rights to privacy for citizens and employees. This is not likely to happen in the short term, although the issue is high on the agenda of most governments in Europe.

Health: Telecommunications, together with IT, are considered to be at the core of the evolutionary process towards health system privatization or health system reforms towards entrepreneurial trust-based organizations delivering quality and competitive services. The telecommunication investments in the health sector will be focused on improving internal organization effectiveness and the quality of services. In the short-term, among the most important technology issues which the sector must face are the areas of communications: LANs, WANs, EDI. The most challenging issues in the longer term are the application of imaging and voice telecommunication technology to enhance clinicians' practices and health service processes.

Education: Despite governments reducing funds for school and university structures, the education market is also rich in promise for the adoption of new telecommunication technologies and services to enhance educational methods via the implementation of the "virtual classroom". The big challenge will be to exploit networks, such as the Internet, which can offer the contents of libraries and research institutes from around the world. It is not by accident, after all, that the Internet was initially deployed in the education and university environment.

Home market: Growth of multimedia PCs in the home market is coupled with an increase in the number of homes that subscribe to online services. Access to online services becomes technologically easier for households because of the decline in the retail cost for modems and, more importantly, because of the integration of modems into most new PCs. An increasing number of PC households have the capability to receive information electronically, place product orders electronically, download product information, and communicate with vendors. Online service subscriptions are also growing steadily among PC/modem-owning homes. This increase is driven by declining online connection fees and monthly subscription charges.

Vertical market	Germany	France	UK	Italy	Benelux	Western Europe
Finance	4.3	2.4	3.0	2.1	2.3	2.9
Discrete manufacturing	3.3	1.7	2.4	1.4	1.6	2.3
Process manufacturing	3.0	1.8	2.3	1.7	1.8	2.4
Transport/communication/utilities	3.7	1.9	2.8	1.5	1.6	2.2
Retail	3.4	1.9	2.4	1.7	1.6	2.4
Wholesale	3.8	1.4	1.9	1.8	2.0	2.3
Healthcare	2.1	1.5	2.9	1.5	1.2	1.7
Education	2.7	1.2	3.0	1.2	1.7	1.6
Local Government	N/A	1.6	2.9	1.4	1.7	1.7
Central Government	4.2	2.1	3.5	1.3	1.8	3.7
Services	3.7	2.2	2.8	2.1	2.1	2.8
Other	N/A	2.0	2.1	N/A	1.4	1.9
Total	2.5	1.8	2.3	1.5	1.7	2.4
Scale of 1 to 5, where 1 is not important and 5 is very important						

Table 7
Usage of ISDN by Vertical Markets 1995

Source: Survey carried out by IDC among Large and Medium IT User Sites in Western Europe

An interesting way of studying the characteristics of communications expenditures by vertical markets is represented by the analysis of the level of usage of ISDN, as it is shown in *Table 7*. In 1995 the most intensive usage of ISDN was found in the finance sector, followed by discrete manufacturing and retail/wholesale businesses. The public sector (central and local government, health and education) is generally characterized by a less intensive usage of ISDN compared to the private sector.

1.3. Europe as a Consumption Area

1.3.1. IT Penetration

In terms of IT penetration, the gap between industrialized and recently-developed countries has further deepened during 1995.

i. Intensity of IT penetration

Intensity of IT penetration remains polarized between north and south as a result of the still two-tier performance of the market.

As far as the business market is concerned, growth was very high in the UK and the Scandinavian region, and close to average in Germany. In the home market, growth was very high in Germany, the Netherlands and about average in the UK and Scandinavia. In the Mediterranean region, growth both in business and home markets was affected by high unemployment, low business confidence and political instability. In France, low business confidence also had a negative effect on the pace of growth.

This resulted in very different growth patterns between the IT markets of individual countries compared to the growth patterns of the local economies.

able 8
T Penetration by
ountry. 1994. ECU

	IT/GDP %	IT Per Capita ECU	Number of PCs per 100 White Collar Workers
Western Europe	2.05	347	72
EU	2.01	335	72
Germany	2.18	457	76
France	2.02	388	62
UK	2.48	365	74
Italy	1.35	208	57
Spain	1.18	122	68
Austria	1.74	360	67
Belgium/Luxembourg	2.26	429	67
Denmark	2.65	624	79
Finland	2.23	358	62
Greece	0.76	47	42
Ireland	1.66	203	60
Netherlands	2.66	477	80
Norway	2.74	580	112
Portugal	1.11	82	43
Sweden	2.80	526	75
Switzerland	2.70	844	111
US	3.17	681	104
Japan	1.83	563	24

Source: EITO, IDC, OECD

Contrary to expectations, stronger growth has been taking place in the countries with the highest IT penetration. In the advanced markets a new approach to adopting IT is fast emerging among businesses and home consumers. Countries where IT penetration rates are lower have failed the market's expectations for a number of reasons: more negative business cycles with deeper and longer recessions, higher unemployment rates, less sophisticated IT usage patterns among businesses and much lower awareness of IT applications at home. As a result, the gaps between Northern and Southern Europe in terms of both intensity and quality of IT usage have continued to widen.

In terms of penetration of IT technologies in the economy, measured by IT spending as a percentage of total GDP, the Nordic countries, Switzerland, the UK, Benelux, Germany, France and the Netherlands have an about average penetration rate of around 2.2% or more. On the other hand Italy, Greece, Portugal, Spain and Ireland are well below average, with a level of less than 1.4%.

Several factors limit the level of IT penetration in the economy of each country. These factors include the predominance of small- and medium-sized enterprises, the level of dependency on agriculture and manufacturing compared to services, per capita income, and education rates.

However the gap in IT spending is too deep to be accounted for by structural factors alone. In any case it is still evident when some of those limitations are factored out, by considering, for example, the number of PCs installed per white collar worker. According to this ratio, Switzerland and Norway have the lead with 1 PC for every white collar worker. These countries are followed very closely by the Netherlands, Denmark, Germany, Sweden and the UK, with about 0.7 PC installed for every white collar worker. In Ireland, Portugal, Italy and Greece, the ratio is less than 0.6 PC installed for every white collar worker.

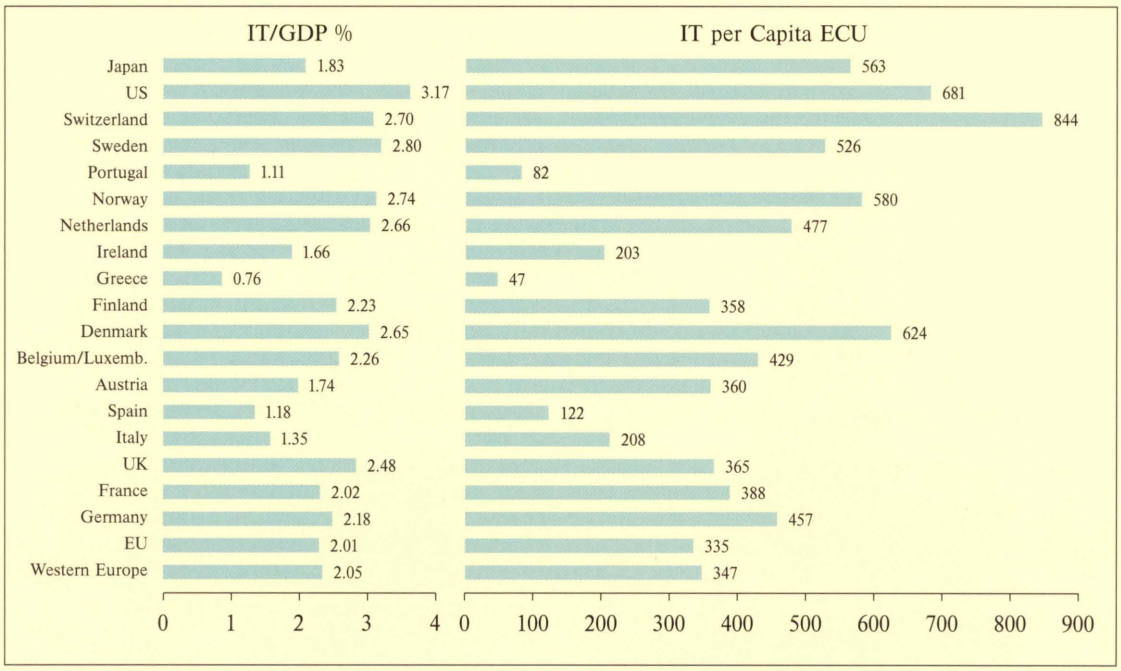


Figure 8
IT/GDP and IT per Capita in Western Europe, the U and Japan. 1994

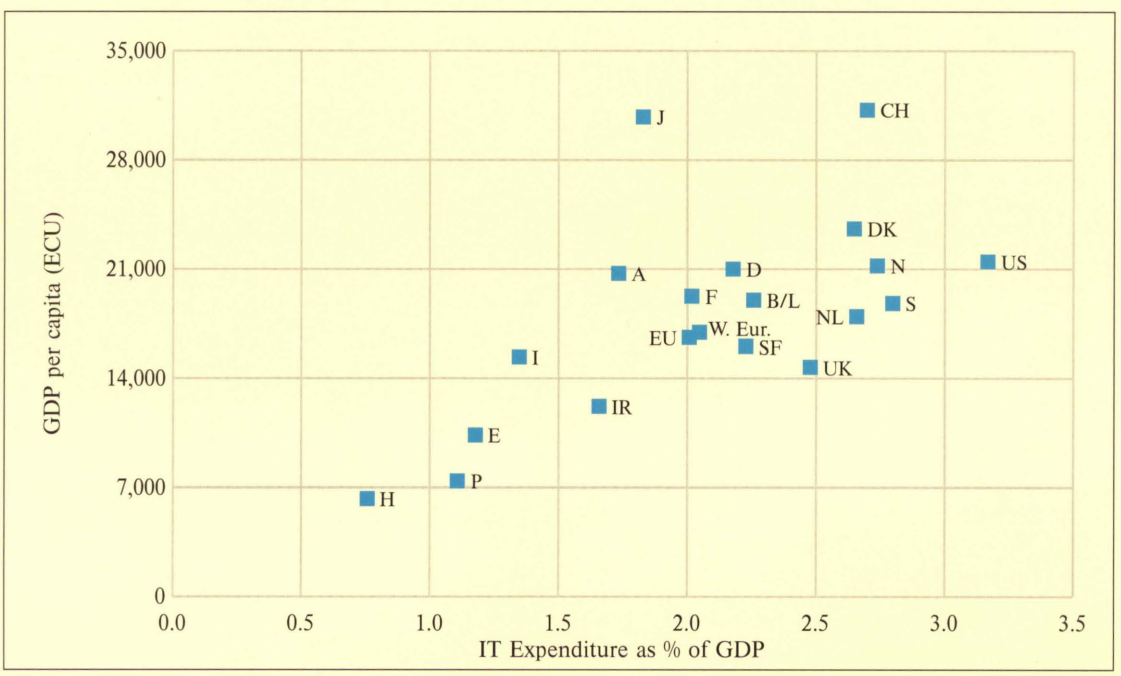


Figure 9
IT/GDP versus per Capita GDP in Western Europe, the and Japan. 1994

Rankings of IT expenditure on a per capita basis also continue to highlight the relative wealth of Switzerland and most of Scandinavia (although the deep recession in the Finnish economy took its toll). The low-lying position of Southern European countries emphasises the general backwardness of their economies with a larger presence of agricultural sectors and less-developed service sectors.

ii. Concentration in the IT market

In 1992 information technology vendors were fighting for survival as the recovery from the global recession got off to a slow start. In 1993, revenue began to rebound, but companies continued to restructure. In 1994, financial stabilization and growth were finally achieved. With the market expansion rolling in 1995, some of the weakest vendors were weeded out, and the healthier players initiated a highly spirited game of king of the hill. While the past few years have separated the successful vendors from the failures, the division in 1995 started to be defined by leaders and laggards.

The strong of the IT market are now getting stronger, and the vendors that are showing signs of weakness are in danger of slipping hopelessly into their competitors' maws or into oblivion. Meanwhile, the swift pace of merger and acquisition activity continues as solid revenue growth and financial stability are sustained for most vendors.

The combined market share of the top five European vendors further declined, from 36% in 1992 to 34% in 1993 to 31% in 1994. A dozen years ago, in 1982, these vendors held slightly more than 50% of the market. However, due to the different dynamics across countries and the different national markets penetration of the IT players, the number of companies whose combined market share accounts for some 40% of the European market demand for IT decreased from eight to seven.

Again, the overall European figure hides large national differences in concentration as different dynamics emerged, according to 1994 indicators (figures are for data-processing sector only, excluding office products):

Number of Companies with Combined Market Share of 40%

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

These variations stem from differences in the rate and structure of growth, plus different trends in the technology and services areas prevailing in the different countries.

The competitive environment of the computer systems market improved in 1995 as revenue and profitability were under greater control. The value of the dollar helped boost demand, although easing supply conditions rebuilt price pressures. In a steady growing market environment, computer system vendors have split into leaders, followers, and transients seeking to catch on to potential future industry standards.

Heightened competition characterized the commercial desktop market. Still, in contrast to other periods of price aggressiveness, competitive activity has not wrecked business models. Most vendors yielded offsetting benefits from investments in process and other cost reductions. The focus remained a profitable business model.

Merger mania took centre stage in the data communications market, stealing some of the spotlight away from excellent earnings reports that continue to define the performance of data communication vendors in 1995. Acquisition activity in the ISDN arena also reached a crescendo. From a revenue standpoint, leadership had its benefits. Top vendors in every data communications segment reported astounding growth.

The software segment continued to consolidate while increasing their market presence. Software vendors recording losses or low profitability were few, mostly as a result of the full integration of recently-merged companies and their product lines.

The vast opportunities for expansion in the professional services and systems integration market had most industry players struggling to keep pace with the market's potential. In this favourable environment, service vendors were battling for dominance by expanding both their geographic coverage and breadth of service. At the same time, flexible cost structures allowed most companies to deliver steady financial results, despite the added costs of acquisitions and restructuring. As a result concentration also increased.

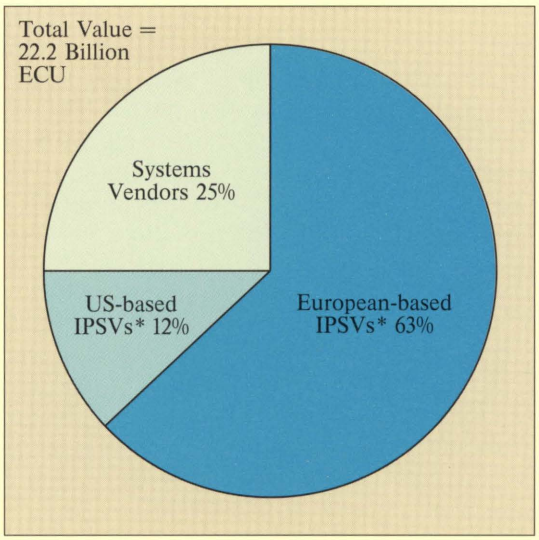


Figure 10
Western European Professional Services Market. 1994

* IPSVs = Independent Professional Services Ven

While the current industry expansion still supports the emergence of new players, existing vendors are developing various strategies to position themselves for long-term growth in a maturing market. Some are focusing on industry expertise; others are building a base of pre-engineered services packages, and still others are competing on implementation speed. As industry competition intensifies, all three trends are fostering the development of businesses that incorporate integrated services packages for enterprise wide implementation with build-on consulting services. The development of these business models will create a widening division of vendor margins, endangering those that do not quickly find ways to leverage established project expertise. The larger traditional players have a distinct advantage in benefiting from the packaging trend as the R&D requirements become a gating factor for smaller vendors that lack the necessary experience and resources.

able 9
eledensity by Country.
994

	Comm. Inv./ Revenue %	Main lines per 100 inhabitants	Mobile Conn./ per 1000 inhabitants	% of main lines connected to a digital switch	ISDN lines as % of main lines
Western Europe	29	49	38	65	0.51
Germany	36	48	31	46	1.41
France	27	55	14	95	0.69
UK	17	49	65	69	0.68
Italy	31	43	39	57	0.27
Spain	32	37	10	41	0.19
Austria	41	47	35	34	0.11
Belgium/Luxembourg	28	45	13	54	0.27
Denmark	14	60	97	46	0.16
Finland	31	55	128	62	0.11
Greece	26	48	16	25	0.00
Ireland	20	35	25	80	0.08
Netherlands	21	51	21	93	0.14
Norway	17	55	14	60	0.16
Portugal	24	35	18	59	0.03
Sweden	22	68	16	60	0.12
Switzerland	24	60	47	55	0.68

Although successful niche players will continue to emerge, they will quickly become acquisition targets for the larger vendors that will thrive.

1.3.2. TLC Penetration

The equipment infrastructure of the communications environment results from the different phases in the implementation of new technology investment plans carried out by the national PTTs in the various countries. As a consequence, telecommunication technology and services penetration is a variable that escapes, so far, the free competition rules of supply and demand, as it assumes a more controllable profile, depending on both monopolistic/oligopolistic pricing and supply conditions.

i. Intensity of communications penetration

Differences in the number of main telephone lines continue to be significant. Of the 17 West European countries, three (Spain, Portugal, Ireland) have fewer than 40 exchange lines per 100 people. Portugal and Ireland have the fewest, with 35 lines per 100 people. Sweden, Switzerland and Denmark top the European league with 68 (Sweden) and 60 lines per 100 inhabitants, respectively.

Between the two poles, France and the other Nordic countries have a teledensity of around 55 lines. Most other countries are close to the European average of 49 lines per 100 inhabitants. Among the top four countries, only the teledensity of Germany is slightly less than European average (48), while France has the highest (55).

Teledensity - which can be measured by lines per inhabitant - correlates closely with national wealth and the greater presence of telecom-intensive vertical industries. By contrast, the intensity of communications investment - measured as the ratio between communications investment and GDP - varies country by country. It has no correlation to teledensity or national wealth.

Penetration of mobile connections still contrasts sharply between countries within a region and between the most developed and less developed regions. This result derives from differences in level of liberalization, real income levels and pricing policies.

Sweden and the other Nordic countries have the highest penetration of mobile connections. Italy, despite being number three in market size, is just above the European average in this area, but still has an higher level than Germany and more than double the level of mobile penetration reached in France. The UK has four times the level of mobile penetration found in France.

Public network digitalization has progressed, but still shows significant differences. Among the biggest networks, France is in Europe the leader in public network digitalization, with a 95% rate. Closely following is the Netherlands. Among the smaller countries Ireland and the Nordic countries are also well advanced.

ii. Competition in telecommunications

The telecommunication market is actually in a state of flux as telecom operators and potential new entrants continue to establish their positions in preparation for the industry's dramatic structural changes expected to occur after full liberalization of the market in 1998.

Deregulation of telecommunication monopolies throughout Europe, privatization of the national operators, and increasing competition have all ensured a surge of network service providers operating in the deregulated services arena.

Although providers may differ in size and geographical presence, their aim is essentially the same: to capture a significant portion of network services revenues from the international business community. For the national telecommunications operators facing privatization, it is an opportunity to ensure continuing profitability in the face of eventual competition in basic telecommunication services including voice. For traditional IT systems vendors, it represents new market opportunities and diversification away from falling hardware revenue.

Telecommunication players' attention is centred on the debate over the telecommunication deregulation process pushed forward by the European Commission.The Commission's agenda calls for a more open market for cable and telephone services.

With respect to product offerings, such services as cellular, local, and long-distance telecommunications and cable will not only be offered by more vendors, but will be bundled as well. Creative pricing plans for packaged services will then become a greater competitive tool as more service providers enter the market.

Meanwhile, the licensing procedures for personal communication services are still ongoing across Europe, and the major winners are finding it hard work building their infrastructures. Further service launches are expected to begin in 1996.

1.4. Europe as a Production Area

1.4.1. Current Status in Employment

In 1994, employment in the IT industry declined to a level of some 940,000 people, or 1.1% of European employees. Some 255,000 people were employed in the data processing and office machinery segment, some 280,000 in the software and services segment, and the rest in the many companies operating in distribution. Overall the top 80 players in terms of European revenue employed 390,000 people in 1994, compared to 415,000 in 1993. Further job losses were suffered, owing to the streamlining of IT operating companies and the closure of some hardware manufacturing plants. Some 20,000 jobs were lost in 1993 in Europe, and 35,000 more losses have been estimated for 1994. In 1995 job cuts were approximately 15,000. Large enterprises suffered most.

Europe's telecommunications industry employs some 1,180,000 people, or 1.4% of European employees. Enterprises operating mainly as manufacturers of communications equipment number 4,390, of which 90 employ more than 200 employees.

Companies providing telecommunication services employ some 880,000 staff. They include national PTOs, managed data network service providers, and mobile services companies. The number of businesses is small due to Europe's regulated monopoly structures.

1.4.2. Outlook for Employment and Manufacturing

The outlook is, however, set to improve. Information creation, access and use are going to play a central role in the growth of manufacturing, R&D, investment and employment in Europe. Enormous potential is offered in the near future not only in the industry but also for employment in the economy overall. The heroes of this new growth will be new services springing from the advanced communications infrastructure, ranging from distance learning and telemedicine to teleshopping and video-on-demand.

Demand is set to increase in 1996, and over the following two years, in all the major high-tech development and manufacturing centres across Europe.

Analysis of recent company announcements shows that more than 21,000 jobs will be created between 1996 and 1998, after taking out some 6,000 jobs that will still be lost in the traditional commercial systems area. The fastest growing areas in terms of job creation will be:

- multimedia/audio visual: More than 10,000 jobs will be created in the UK and Ireland alone;
- mobile phone equipment and services;
- personal computers, storage and printers: More than 6,000 jobs are expected to be created over the next 3 years, as manufacturing plants expand or are newly built. These jobs will be mostly in Scotland and Ireland;
- semiconductors: More than 4,500 jobs will be created, plants being built in Ireland and the UK;
- software, services and support: More than 2,000 jobs are likely to be created across Europe.

In the telecommunication area big losses are expected in employment by national carriers. Almost all of the national carriers are planning job cuts between 1996 and 2000 in the range of some 25% of the current workforce. Overall national PTTs in Europe have announced more than 120,000 layoffs to be completed, through various schemes, by the year 2000. Also on the telecommunication equipment manufacturing side, the outlook is not bright, with more than

30,000 jobs to be cut. A positive trend will emerge in employment for the manufacture of mobile switching and end-user equipment, delivery of mobile services, and cable technology. Overall more than 10,000 jobs are expected to be generated in these segments.

Very positive expectations characterize the employment outlook in the audio-visual sector. This sector already employs some 900,000 people in the European Union, and the figure is expected to more than double by the year 2000. Pilot projects on the introduction of video-on-demand are already underway in some countries in Europe. New multimedia services will also include electronic access to libraries, art galleries and museums.

1.4.3. R&D Effort

Moves towards the Information Society are also gathering pace on the research front. Major projects funded by the three specific Research and Technology Development Programmes of the European Union, under the Fourth Framework Programme, have started. The three programmes, ESPRIT, ACTS and Telematics have worked together during the project selection process to an unprecedented degree.

In particular the Telematics programme budget has been almost doubled from 425.7 million ECUs for the years 1990-1994 to 843 million ECUs over 1994-1998. The 1990-1994 budget of this programme was allocated to seven areas: transport services 33%, health care 26%, flexible and distance learning 14%, administration 11%, linguistic research and engineering 6%, libraries 6%, and rural areas 4%. The new programme has a considerably wider scope and has shifted its focus from data to multimedia telematics, in line with technological advances and the development of new markets and user expectations.

Among the major initiatives in 1995, a particularly notable one is "Networking Europe's Brainpower". The project's objective is the interconnection of Europe's national research and university networks fast enough for multimedia network applications. This pilot initiative is being funded with 30 million ECUs drawn equally from ESPRIT and Telematics. Two merged consortia, involving all of Europe's PTTs and network provides are handling the project.

Other financial support for projects on the information society is being allocated through other programmes and bodies:

- the trans-European networks support mechanism, for which the Commission has earmarked an indicative amount of 450 million ECU for 1995-1999;
- the Structural funds and the Cohesion funds;
- the European Investment Bank and the European Investment Fund.

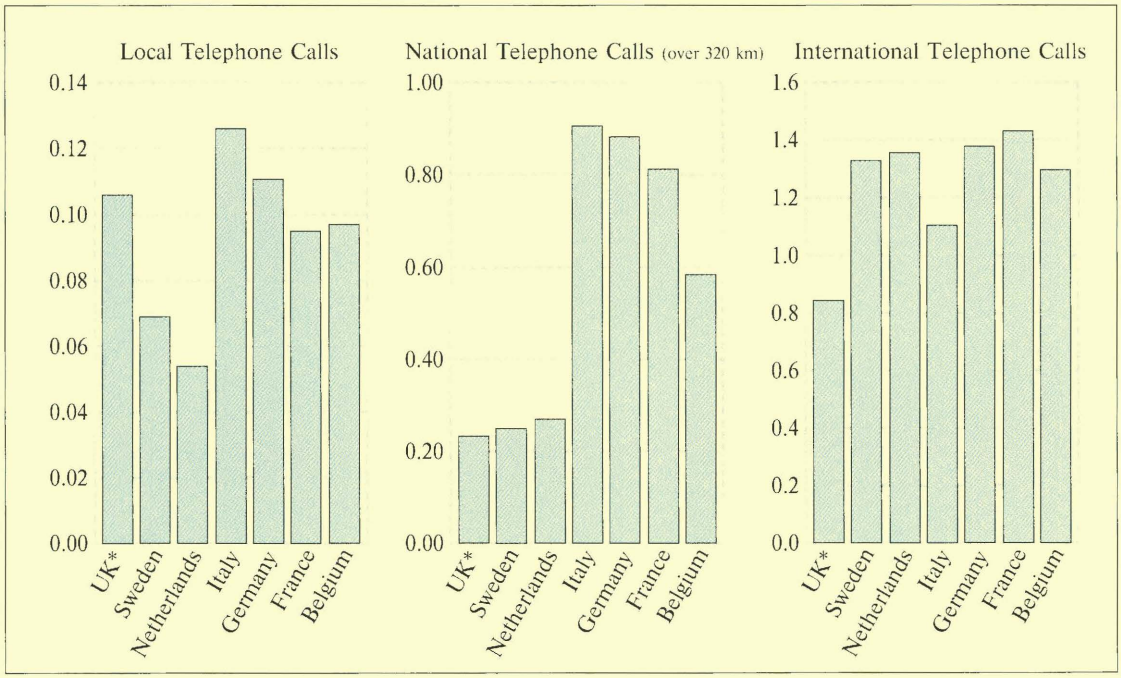
1.4.4. Information Infrastructure Liberalization Process and Investments

Much of the necessary legislation to fulfil liberalization of telecom services and infrastructure has been put in place by the European Commission. After the approval of the law liberalizing access to the infrastructure of non-telecom operators, the focus of the Commission is now on improving anti-trust policy to make sure that fair competition is maintained in the liberalized markets.

In particular, the Commission's agenda has the following three priorities:

- to formalize clearly the obligations for the member states concerning various components of liberalization so that possible moves to disfavour new entrants are discouraged and companies can anticipate opportunities on the basis of what the markets will actually be like;

gure 11
ɔcal and International
ıriffs in Europe:
Country Comparison
·ices in ECU
r a Three Minute Call



Source: EITO Task Force

* Discounts applied

- to ensure that reciprocity is guaranteed on opening the worldwide telecom markets so that European players have the same opportunity to enter non-European markets as their non-European competitors have to enter the European markets;
- to improve the policy on control of mergers and alliances in the IT, telecommunication, broadcasting and audiovisual sectors. In 1995 the Commission has taken several decisions, notably the prohibition of media mergers in Germany, Scandinavia and the Netherlands, to avoid discriminating behaviour and intersectoral cooperation initiatives among dominant players that foreclose the market to the smaller players, who would end up by accepting the conditions imposed by the big ones. A new merger-control regulation in the multimedia area will be developed soon on the basis of case law to define precisely where the line must be drawn.

After the successful experience of GSM mobile infrastructure, the Commission has also continued to promote the convergence of suppliers in the adoption of standard technologies, in order to help technology growth and new services adoption across national markets which are culturally and economically very different.

Efforts have been targeted on coordinating the European plans of telecom operators investing in the areas of E-ISDN (European Integrated Services Digital Network), ATM (Asynchronous Transfer Mode) infrastructure, and SDH (Synchronous Digital Hierarchy), i. e. the technology of the proposed 1995 pan-European broadband network envisaged by the national operators infrastructure.

Against the idea that liberalized markets inevitably lead to falling prices and an improvement in the availability and quality of services, it is important to understand that Europe is

characterized by segmented markets in which the existing tariff structure is absolutely artificial, in that it is not based on cost. As a result domestic tariffs have all been kept low, while international calls are very high (to subsidize the loss-making domestic communications). This means that, eventually, liberalization will lead to a temporary increase in domestic prices while international prices fall. At a later stage, when real competition is in place, tariffs on domestic lines will fall, too.

1.4.5. Mergers, Acquisitions and Cooperation in the ICT Industry

Positive acquisition and alliance trends that began in 1993 continued in 1994 and 1995. The increasingly consolidating IT market and the liberalization process in telecommunications, together with the blurring borders with the multimedia and information content industries, have made strategic acquisitions and allliances a must for both IT and telecom vendors.

Strategic acquisitions are a vehicle to gain market share and grasp the fastest growing opportunities in the fast changing ICT markets. With deals ranging in scope from casual business arrangements, to formal joint ventures, to full fledged corporate mergers and acquisitions, interlocking alliances are the name of the game.

Taken together, these acquisitions and investments will ultimately shape the unfolding interactive digital infrastructure. Generally speaking, players can be categorized into five industry groups:

- IT technology platforms and services providers;
- consumer electronics companies;
- network service providers - telephone, cable, broadcast, satellite, and online services;
- content providers - publishers, newspapers, movie studios, interactive programming developers;
- "personal" software - operating systems, tools, authoring systems.

As player alliances multiply, distinctions such as these will become less relevant and increasingly difficult to draw.

Strategic acquisitions and alliances can therefore be grouped into four main types, as a result of four corresponding, highly-interrelated, major drivers of industry change:

- competition in the user interface and access areas;
- the emergence of consumer multimedia technology;
- the expansion of the Internet and on-line services;
- the liberalization of telecommunications infrastructure and services.

i. User-interface and access-driven alliances

User-interface

Future competition in the user interface area will emerge over which tools users will employ to navigate and browse the following and other "landscapes", probably in descending chronological order:

- suites of applications and, later, components;
- LAN resources;
- WAN and corporate resources;
- home and consumer services;
- mobile systems interacting with all of the above;
- services provided across the information superhighway.

These issues have dramatic competitive implications for suppliers of applications and tools software, for hardware companies seeking to differentiate themselves, and for the distribution channels, resellers, and integrators that support them. Alliances and acquisitions help accelerate the development process and secure distribution channels.

User access

Integrated systems, applications and network device management require a distributed management infrastructure and mapping the data access tools model to the production data model. The strong interdependence of the application and information access markets drives the players concerned into active partnerships in the application and data warehouse areas to keep the cost of integrating the software low.

The combination of application software vendors, seeking added-value for their groupware of database software and vendors of complementary software, for information access, seeking channels, is likely to cause more alliances to be forged. Networks of alliances would increasingly become cost-effective alternatives to product investment.

ii. Consumer multimedia-driven alliances

A vast realignment in markets is occurring across all segments of the multimedia industry: multimedia personal computers, digital interactive consumer electronics, and network-based multimedia services. A steady stream of announcements trumpeting new alliances and industry crossover agreements have became the norm as players manoeuvre for a role in the emerging digital infrastructure.

For cable operators, forming ties with the telephone industry has become a matter of survival as the PTTs begin to stake claims in cable's still confusedly regulated territories. Further motivating cable operators into cross-industry alliances is competition stemming from direct broadcast satellite services, wireless cable services, broadcasters, and microwave transmitters.

The outcome of this consolidation in communication delivery systems is a blurring of the lines that once distinguished video from telecommunication services.

A similarly dynamic pace of acquisition and merger deals is occurring among owners and seekers of "content" or programming for the new networks. Pipeline companies are motivated by a desire to own content, thus ensuring a steady and perhaps exclusive flow of programming.

Considering the strategies being pursued by players that are driving the industry, the evidence suggests that:

- hardware companies have made a commitment to software and content publishing directly and indirectly;
- the telephone companies are developing a portfolio of companies through which they can independently control the content, hardware, software, and conduit necessary for delivering interactive network services.

Despite this flurry of deals each will be subject to regulatory and legislative review designed to ensure fair competition environment and practices.

iii. On-line service and Internet-driven acquisitions and alliances

The rise of the Internet as a potential vehicle for electronic commerce and public services has led network, hardware and software vendors to push the Internet as a foundation technology for products and services.

Multinational accords have mushroomed in 1995, among companies looking for ways to get in on the action, in differing ways:

- software companies making deals with international communication companies to make their own end-user interface and/or groupware software the preferred platform for conducting business on the Internet;
- software companies making deals with international communication companies to define standards for security, directory services, and high quality transmission of audio and video;
- computer technology providers allying or forming joint ventures with Internet access, content providers, and multimedia development firms;
- value-added network service providers, telecom operators and software companies joining forces in consortia to develop offerings of global multimedia network services;
- Internet service providers allying with consumer electronics vendors to provide Internet access via television;
- companies providing on-line access and tools allying with or acquiring content providers, computer technology manufacturers, multimedia development firms;
- cable operators forming ties with the telephone industry and with content companies to deliver interactive multimedia services.

iv. Liberalization-led alliances

PTTs do not have the confidence to explore the data transmission world alone, just as IT companies do not have experience in telephone lines. Both need to associate with the most successful content providers to lock more users into the usage of their information transport and access technologies.

Likewise, potential partners in the cable, multimedia and computer industries look to the PTTs' networking resources as a powerful new way of bringing their products and services to an eager public.

Telecommunication operators seeking alliances with or acquiring networking technology vendors to address the demand for state-of-the-art ISDN and ATM technology avoiding long-term and risky R&D investment.

The expansion in data network services justifies joint development efforts by hardware technology manufacturers and mobile terminal manufacturers to offer handheld devices combining laptop computers with mobile phone technologies.

1.5. Trade: EU and Other Worldwide Areas

Following several years where its ICT trade balance with the rest of the world has worsened, the EU showed a second year of improvement in 1994. Despite increasing imports, exports continued to show faster growth. Exports rose by ECU 10 billion in 1994 in comparison with the previous year. The larger part of this export growth was accounted for by increased exports to countries within the EU.

The USA continued to benefit from strong recovery in 1994 and this is reflected in a strong growth in imports both from the EU and, more significantly, Japan. Overall, the US maintains a trade deficit in ICT, primarily accounted for by Japan, but a very healthy trade surplus with the EU.

Japan has a ECU 26 billion surplus with the rest of the world, of which the EU accounts for more than thirty-one percent.

ble 10
orldwide Trade
Region.
ffice Machines and
DP Equipment, 1994.
illion ECU

		EU	EFTA	US	Japan	4 Tigers	RoW	Total
EU	Imports	31,231	1,191	10,953	6,431	7,859	3,268	60,934
	Exports	31,944	4,452	4,085	955	727	4,215	46,377
	Trade Balance	713	3,260	- 6,868	- 5,476	- 7,132	946	- 14,557
EFTA	Imports	4,026	268	2,071	864	1,043	276	8,548
	Exports	1,461	381	308	15	60	392	2,616
	Trade Balance	- 2,565	113	- 1,763	- 849	- 983	117	- 5,931
US	Imports	3,028	319	-	14,937	15,106	9,722	43,112
	Exports	10,295	809	-	3,168	3,134	12,084	29,489
	Trade Balance	7,267	489	-	- 11,769	- 11,972	2,362	- 13,622
Japan	Imports	855	17	3,303	-	2,208	1,440	7,822
	Exports	8,054	159	14,660	-	3,725	2,679	29,277
	Trade Balance	7,198	143	11,357	-	1,518	1,239	21,455

Source: Eurostat

ble 11
orldwide Trade
Region.
lecommunications
94.
illion ECU

		EU	EFTA	US	Japan	4 Tigers	RoW	Total
EU	Imports	2,837	1,026	1,173	54	533	1,589	7,211
	Exports	2,989	30	406	24	176	5,061	8,686
	Trade Balance	152	- 995	- 767	- 30	- 357	3,472	1,475
EFTA	Imports	576	285	103	138	253	- 47	1,308
	Exports	751	281	85	24	52	1,136	2,330
	Trade Balance	175	- 4	- 18	- 114	- 201	1,183	1,021
US	Imports	238	37	-	1,340	395	2,298	4,309
	Exports	844	96	-	398	491	2,213	4,043
	Trade Balance	606	60	-	- 942	96	- 85	- 266
Japan	Imports	18	110	51	-	86	298	562
	Exports	749	67	1,558	-	470	1,680	4,523
	Trade Balance	731	- 44	1,507	-	384	1,382	3,960

Source: Eurostat

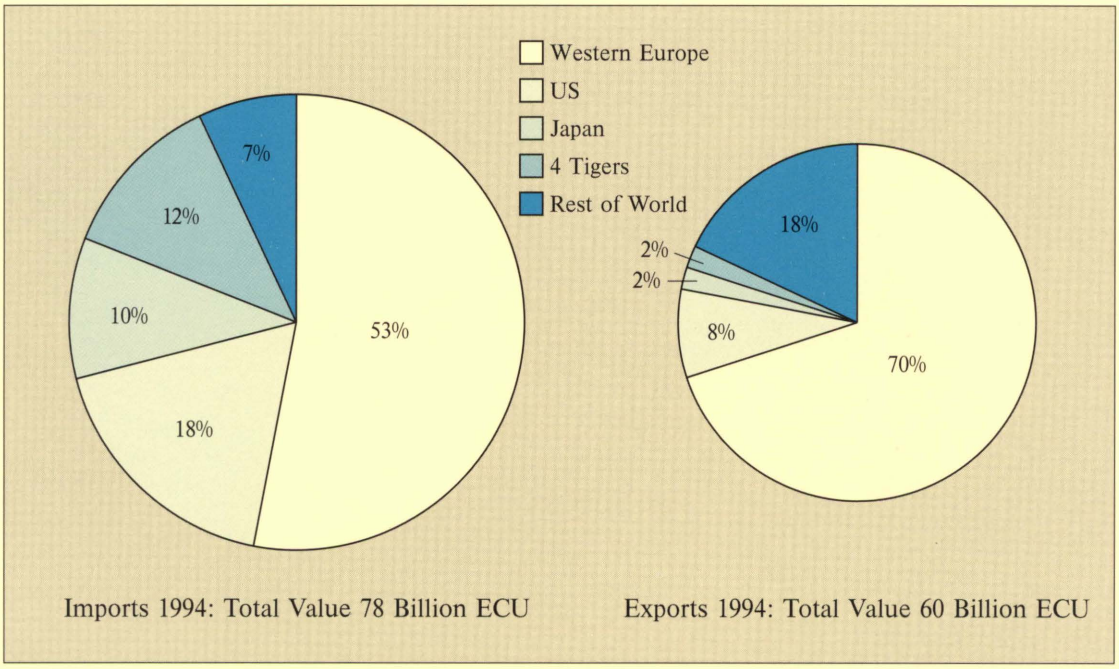


Figure 12
European Total
ICT Equipment Impor
Exports by Region. 19
Billion ECU

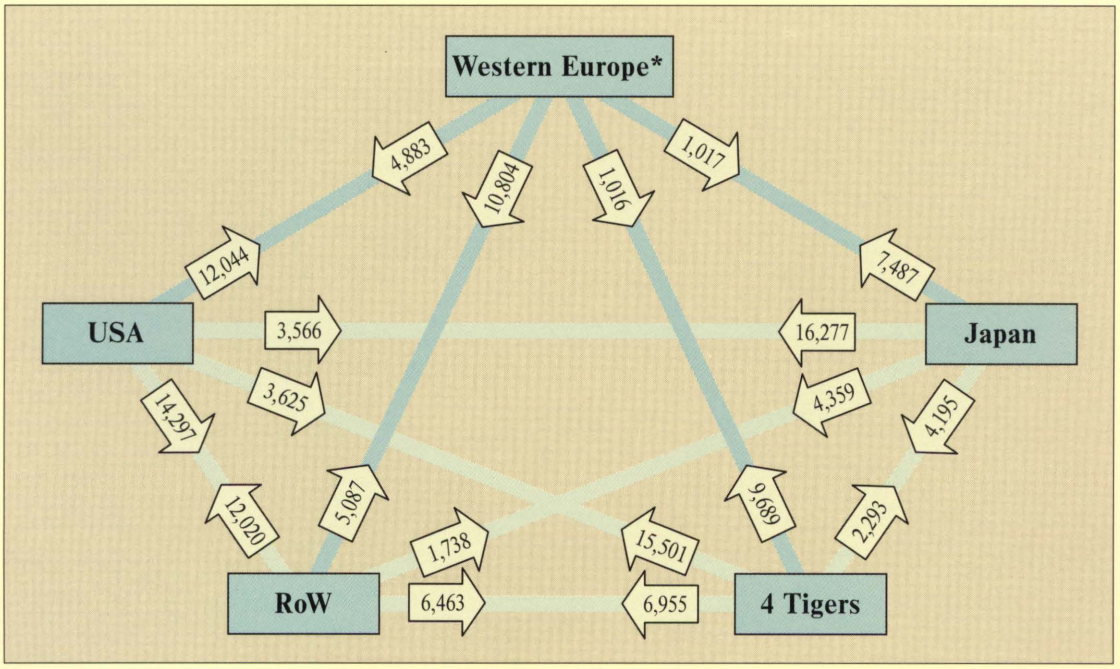


Figure 13
ICT Trade Worldwide.
1994
Million ECU

Source: Eurostat

* EU and EFTA

1.6. Eastern Europe: Second Phase Development

1.6.1. Poised for Rapid IT Market Growth

East/East Central Europe continues to represent one of the largest IT industry opportunities in the world, with overall IT spending reaching ECU 4.7 billion in 1995. Ongoing programmes to modernize a broad range of infrastructure and basic services, such as banking, insurance, manufacturing, retail and government administration, combined with the demands of an evolving private sector, will continue to drive strong IT growth throughout the region in the short term.

As the economies of East/East Central Europe move to stability, growth in the region's IT markets is increasingly focused on a second phase of market development, almost non-existent a few years ago, comprising packaged and custom software, services and networking. While demand for basic hardware remains strong, particularly in the markets of Russia, Poland and the Czech Republic, a growing amount of annual revenue in the region is now being generated from sales of software, professional services and maintenance/support services.

While spending on information technology has grown remarkably over the last five years, both the relationship of IT hardware expenditures to GDP and of white collar workers to PCs reveal that hardware spending is still considerably lower than that of the average country market of Western Europe. The potential of considerable pent-up demand for information technology is still high throughout the Eastern European economies.

1.6.2. IT Category Comparison

i. IT hardware

The country markets of Eastern Europe remain heavily oriented to personal computers and PC-related technologies, which accounted for the highest proportion of computer hardware spending in the 1994-95 period. Similarly, the low-end office equipment segment has experienced considerable market growth. While systems and server shipments have stagnated in several countries in terms of unit sales (Hungary, Poland), the overall value of the market continues to increase due to the more expensive equipment being sold. This development reflects the growing number of projects underway in the region to establish basic IT infrastructures in communications, financial services and public administration.

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 it has entered a more advanced level of computerization. Particularly strong growth is being seen in PC software and application tools for database development and management, and in the demand for IT consulting, contract programming and software design, IT education and training, systems and network implementation.

Most growth in the software and services sector is derived from large-scale projects in banking/financial services, government administration and industry/manufacturing.

Local firms have emerged to become important systems integrators, value-added resellers, support providers, software developers and training centres. They provide vital support to Western hardware vendors active in this marketplace.

1.6.3. Country Market Comparison

While substantial growth is being recorded in all markets of the East Central Europe region, important differences exist among the various country markets in terms of development and the demand for specific IT technologies. Indeed, while the markets of Russia and Poland offer the greatest potential, vendor activity is largely confined to sales of personal computers, printers, office equipment and related technologies. Smaller countries, such as Hungary and the Czech Republic, offer more sophisticated markets in terms of the type of systems and services required.

i. Czech and Slovak Republics

The Czech and Slovak Republics have evolved to become the most economically stable area in East Central Europe. GDP is expected to grow, exports are strong and inflation is low.

A two-tier growth pattern characterizes IT market trends. The Czech Republic currently presides over the largest information technology market among the countries of East Central Europe. This country continues to offer the most dynamic systems and server market in East/East Central Europe, with the exception of Russia, and fast growing PC and workstation markets. Significant revenue was also generated from sales of high-end mainframes into the banking and financial services sectors. By contrast, growth in the already small Slovakian IT market was hindered by falling business confidence and the government's decision to reinstate a 25 percent value-added tax (VAT) on both hardware and software, while undertaking few steps to facilitate trade with the Czech Republic.

A key feature of the software market is the fastest growth rate in the East Central European region of relational database management systems.

Several efforts are now underway in the Czech Republic to establish some guidelines and procedures for public sector IT procurement, as well as to determine IT standards for equipment and measurement. The country's banking and financial services sector is in the process of developing IT infrastructures to enhance its operations and competitiveness. A number of local companies in the industry and energy sectors have also sought to upgrade IT facilities with both used and new equipment in the last two years.

In Slovakia current IT business is driven by suppliers' efforts to address the requirements of infrastructure development in three areas: banking/financial services, government administration sectors and large state-run companies. Recently, the country's evolving private sector has become an important recipient of IT.

ii. Hungary

Hungary is now rebounding after several years of economic and political stagnation. The speed of implementation of the government's stabilization programme is reassuring for both foreign investors and the international lending community alike.

Large-scale infrastructure projects in banking/financial services and government administration facilitated ongoing dynamic growth in Hungary's information technology market. In terms of computer hardware, the systems and server market declined slightly, while the markets for technical workstations and personal computers exhibited moderate growth. Both the duty and the Hungarian government's 9 percent devaluation of the Forint in March 1995, along with the introduction of a monthly 1.9 percent crawling peg, have had the impact of raising PC prices and dampening demand.

Software and services recorded the highest level of growth in the market. Professional serv-

ices, in particular, have seen a flurry of activity, with most major international professional services setting up operations in this market.

The Hungarian government is positioning itself to become more active in overseeing IT developments in the public sector. It has set requirements for making public any major government IT procurement and has made open systems and Unix an integral part of its overall computerization strategy.

iii. Poland

After years of economic decline, Poland appears to have made the successful transition to a parliamentary democracy and market economy. Nonetheless, the country retains the image of being politically unstable.

Despite the size of its population and GDP, this country market is largely oriented towards personal computers, which accounted for almost two thirds of computer hardware spending in 1995. Despite fast-declining average system values, the PC business continued to exhibit significant growth. After several years of stagnation, shipments in Poland's systems and server market also showed high growth, on the basis of increased demand in several sectors, especially banking/financial services, government administration and manufacturing.

For four consecutive years, Poland's workstation/workstation server market has maintained considerable growth, exhibiting the fastest rates of expansion in the East Central European region.

The Polish government has become a major buyer of information technology, including hardware, software and professional services. It has also taken an active role in both the computerization of the public sector, with the establishment of several organizations to oversee IT procurement. Moreover, its monetary and fiscal policies and regulations have had a substantial impact on the evolution of the country's information technology market.

iv. Russia

The Russian Republic accounts for the highest proportion of computer hardware spending among the CIS states. Similar to other countries of East/East Central Europe, the Russian market is heavily oriented towards personal computers and related technologies.

The opening of the Russian market quickly transformed the local PC industry from one dominated by state-run manufacturers of outdated technology to a market largely served by assembly operations importing components from the Far East and limited sales by international vendors. Russia also presides over a substantial installed base of multiuser systems and workstations, offering IT vendors significant opportunities for replacement and upgrade sales.

The software and services market in Russia is largely a local one for reasons of price and local attitudes. While a number of Western software vendors have entered this market, their operations are limited in scope due to the extensive black market for pirated software and the large pool of local programmers.

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. With significant hard currency profits, banks are the only organizations which are procuring more expensive, sophisticated hardware and software solutions.

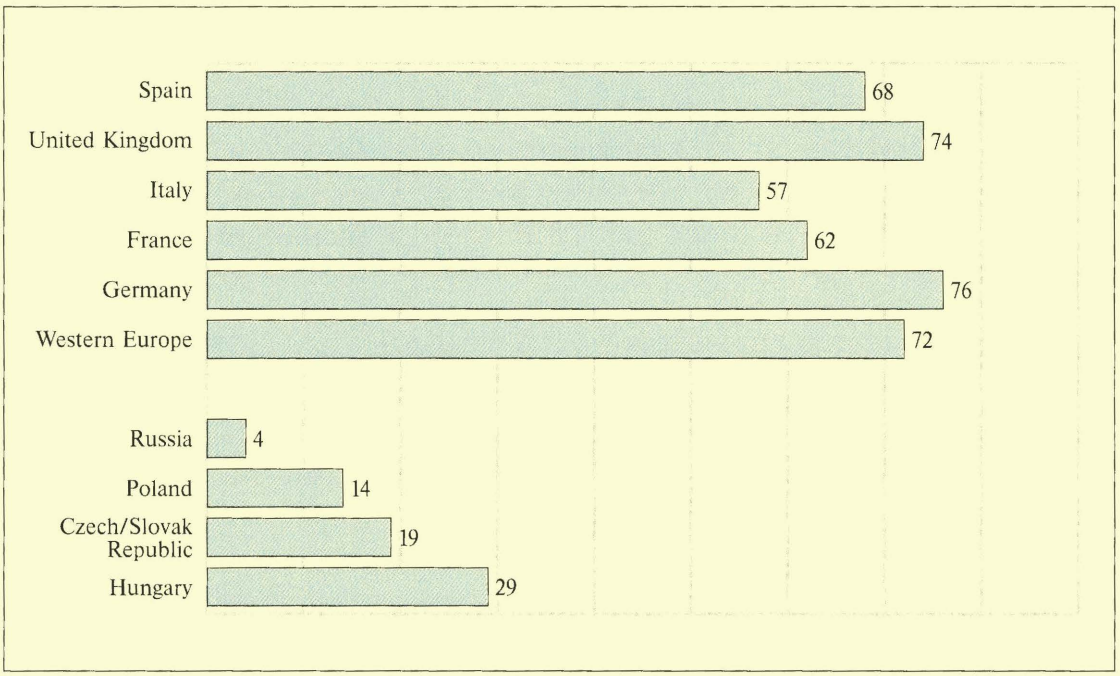


Figure 14
East vs. West: Number of PCs Insta per 100 White Collar Workers

2. Towards a New ICT Industry

The information technology industry is entering a major new phase of growth and expansion. Whether it is called the information superhighway, the I-way, the Infobahn, or simply our emerging national and global information infrastructure, the IT world is poised for a major shift with profound implications for business and society.

The forces behind this shift have been building over the past years at different speeds.

On the information technology front, for more than a decade:

- Computer hardware, particularly personal computers, have grown in number and power. There are now some 100 million personal computers used by businesses around the world and by more than 50 million consumers.

Country	1995	1997	CAGR 1995-97 %
Hungary	327	388	8.9
Czech/Slovak Republics	576	711	11.1
Poland	508	631	11.5
Russia	1,343	1,680	11.8
Western Europe	49,580	57,621	7.8
Germany	15,729	18,437	8.3
France	7,080	8,251	7.9
Italy	3,916	4,607	8.5
United Kingdom	8,046	9,285	7.4
Spain	2,016	2,438	10.0

Table 12
East vs. West: Overview of Comput Hardware Spending in Eastern Europe by Country 1995-19 Million ECU

able 13
ast vs. West:
atio of Computer
ardware Spending
GDP. 1994

Country	%
Hungary	0.58
Czech/Slovak Republics	0.54
Poland	0.26
Russia	0.14
Western Europe	0.70
Germany	0.83
France	0.60
Italy	0.43
United Kingdom	0.86
Spain	0.47

ble 14
st vs. West:
r Capita Spending
Computer Hardware
Country. 1994.
U

Country	1994
Hungary	38
Czech/Slovak Republics	42
Poland	14
Russia	5
Western Europe	118
Germany	174
France	115
Italy	66
United Kingdom	126
Spain	48

le 15
tern Europe:
nputer Hardware
ie Category
nparison. 1993-97.
lion ECU

Category	1993	1994	1995	1996	1997
Multiuser Systems	273	372	386	456	519
Workstations	41	57	78	107	129
Personal Computers	982	1,453	1,812	1,994	2,183
Printers	343	402	479	526	577
Total	1,639	2,286	2,754	3,083	3,409

- Communications software has made the connection of previously isolated PCs routine. In addition, current microprocessor technology has evolved to encompass not just PCs, but increasingly powerful families of easily-scalable systems and servers capable of storing and manipulating unprecedented quantities of real-time information.

On the telecommunications front, at increasing speed especially over the past few years:

- A global trend toward deregulation is leading to a new era of innovation and competition in what was once a slow-moving, nationally oriented sector.
- The pace of change in telecommunications, particularly data communications, is now driven by dramatic technological progress in both microelectronics and transmission media.
- Telecommunication advances should match, or even exceed, those of microprocessors over the coming decade.

2.1. The Internet Era

The most surprising driver however is the third one, both for its scale and the rapidity of its expansion: the Internet.

The Internet is a collection of over 30,000 computer networks and over 3 million computers that communicate using the TCP/IP communications protocol. These Internet-attached networks range from worldwide corporate networks, to university networks. Individual end-users are members of these separate networks and are dependent upon the owner of their specific network for access to information available across the Internet.

The Internet can trace its roots to the early 1970s, when the US Department of Defense wanted a secure computer-driven communications system. ARPANET emerged, allowing

electronic mail and communications between various universities and research sites involved in Department of Defense projects. In the 1980s, the US NSF (National Science Foundation) took responsibility for what became the Internet.

The creation of more advanced and standard methods for delivering linked text (hypertext to users) over the Internet has made the sharing of the information in all data types much easier and more intuitive.

Among these methods, the World Wide Web emerged in 1994 as an Internet-wide standard for addressing and linking hypertext documents. The system was invented in 1989 by British software engineer Tim Berners-Lee at the European Particle Physics Laboratory (CERN) in Geneva. The positive impact of the advanced World Wide Web versions launched in 1995, has led the Internet in a very short time to become today's magnet for development of the information superhighway.

At the right time, and in the right place, the Internet has tied private corporate networks and consumers together at limited cost.

Allowing infinite points of connection, the Internet has dramatically increased the value of the network infrastructure. This has generated a fast expanding win-win development characterized by:

- a demand-pull from information system organizations to bring the Internet within the corporate infrastructure;
- a supply-side push of the Internet as a foundation technology for products and services by network, hardware and software vendors.

Taken together, the combination of powerful low-cost computers, a technologically vigorous telecommunications environment, and the fast expanding connection of network nodes on the Internet are leading to the most fertile and exciting period in the history of the IT industry.

The changes at work are something both simple and grand: the next stage in the evolution of the information industry, one of pervasive, societal connectivity.

2.2. The IT Driving Forces

Today, about 40 million users in over 200 countries are linked to increasingly interconnected computer networks of all types. By the end of this decade, this number will swell to well over 100 million, providing a critical mass of telephone-like interconnectivity.

More importantly, this new era will change the way computers are used. For virtually all of the IT industry's history, computers have been used to improve internal business activity. In the future, they will increasingly be used to automate external links between customers and suppliers in a manner similar to, but far more powerful than, that of the telephone. It is these external applications that have the potential to transform businesses and improve productivity to an extent not possible during previous periods.

Prevailing societal trends are dramatically increasing business interest in harnessing computer network potential. In many economic sectors, maturing industries are encountering declining margins, increased global competition, and reduced customer loyalty. Similarly, many consumers, saturated with commercial messages, are becoming immune to traditional forms of mass media. Business leaders look forward to the emerging information highway as a new distribution channel that will offer direct, and potentially more profitable, relationships with customers.

Figure 15
Convergence of GDP and IT Market Nominal Growth Rates. 1988-1994*

* Convergence is measured by the difference between GDP nominal growth and IT market nominal growth in the same year

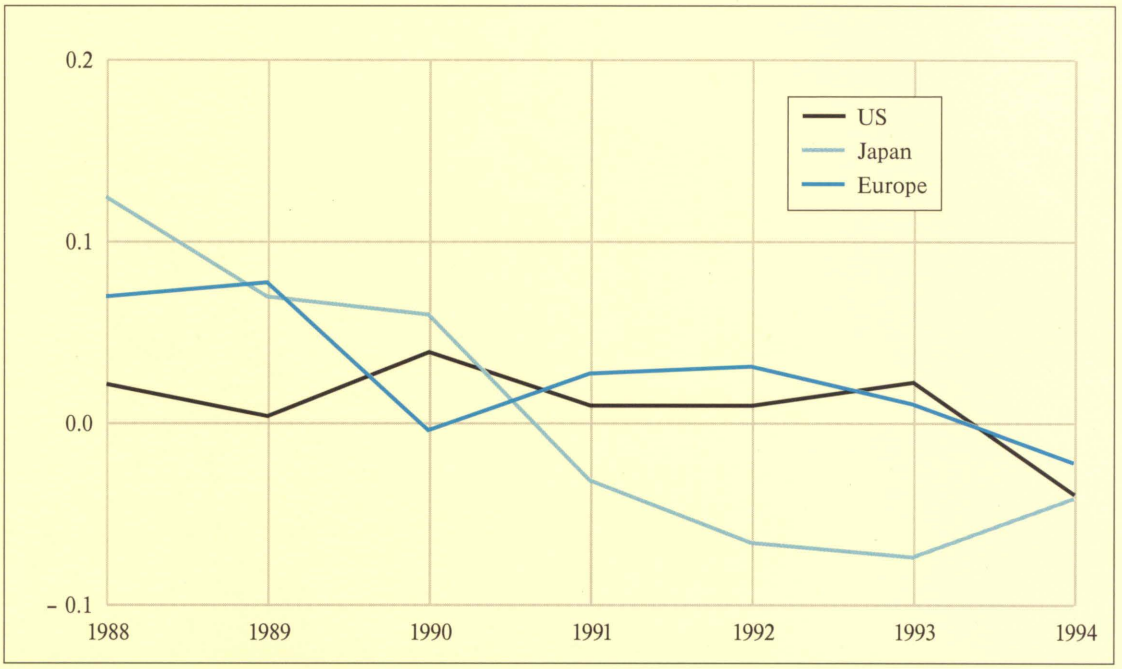
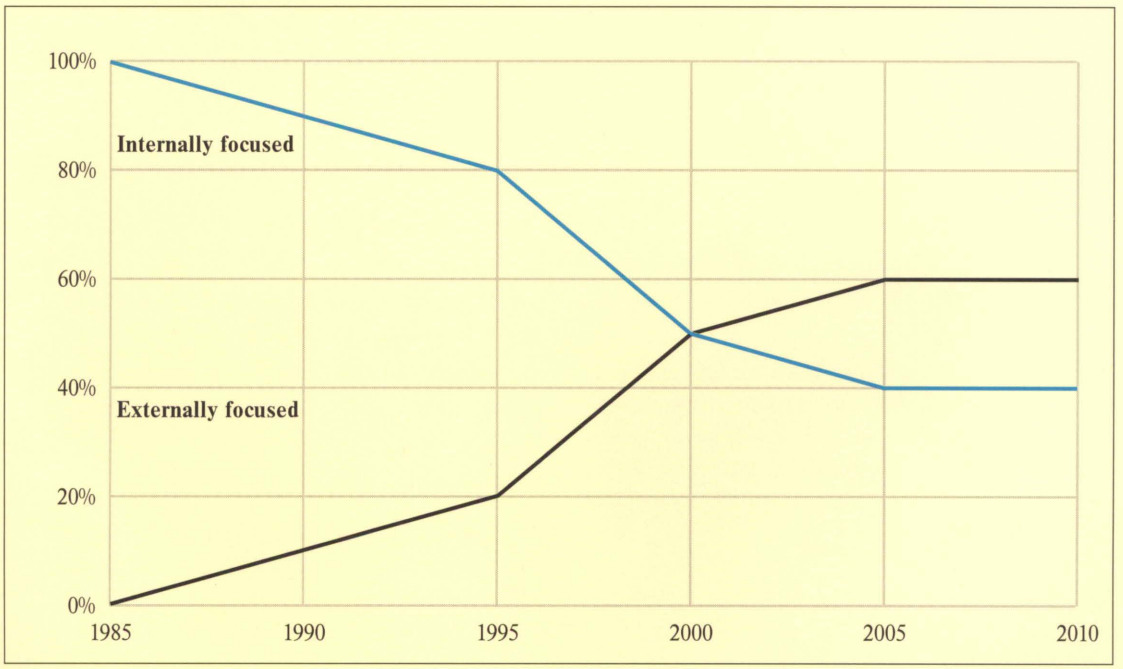


Figure 16
Changing Customer Priorities. 1985-2010



Within this evolution the most notable growth areas are to be found in the following segments:

i. Multimedia hardware technologies
ii. Multimedia software technologies
iii. Software and tools for the Internet
iv. Relational databases
v. Data warehouses
vi. Professional services
vii. Education and training services
viii. Integration, management and support services.

i. Multimedia hardware technologies

The markets for multimedia applications and technology are expanding as advances in hardware, software, and networking are reducing the costs of entry.

Growth across consumer and professional markets for multimedia applications and services can be attributed to a combination of:

- declining hardware prices and improvements in the compatibility and speeds of audio, video, and storage devices,
- suppliers push to adopt multimedia technologies in standard PC configurations,
- coalescing standards for video,
- an expansion in alternative PC distribution channels with a more far-reaching impact on consumer markets.

All major PC vendors have broadened their reach in the consumer market through expanded distribution channels, such as computer superstores, mass merchants/department stores, consumer electronics stores, direct mail-order consumer PC.

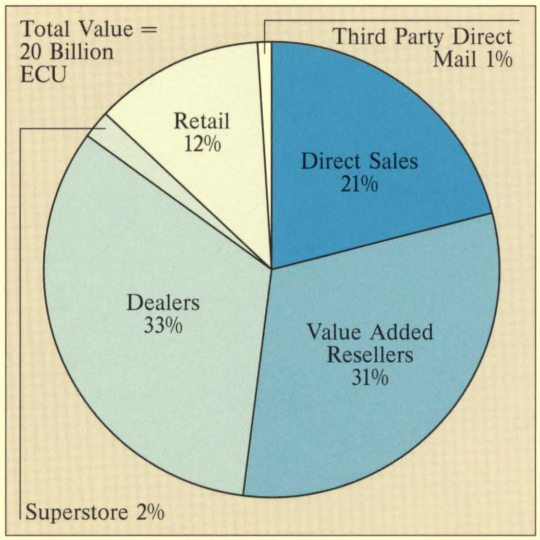


Figure 17
Western European Personal Computer Market.
Value Shipments by Channel. 1994

Technology innovations will continue to dictate the progression of multimedia markets. Some of the more important technologies influencing product development efforts are:

- video compression,
- video boards,
- CD-ROM,
- digital signal processors,
- audio cards.

ii. Multimedia software technologies

In the consumer market, multimedia software growth is shaped along four major content genres:

- edutainment,
- entertainment,
- reference,
- and productivity.

Entertainment is the largest category in terms of both revenues and title availability. The category comprises a broad variety of title types driving growth: action/battle, sports, role

playing/adventure, and adult games. Established game developers are being challenged by a new class of programmers with unique production skills. In particular, competition is emerging from large, vertically integrated entertainment companies using existing talent from TV and film sources for developing interactive multimedia content.

Edutainment is a relatively new multimedia content category that describes titles which combine learning with entertainment and/or game-like features. Four different programming types are predominant: reading/stories, skill games, visual/pictorial, music. Edutainment products for adults are also emerging. Edutainment is sizing up to be a strong second as developers see revenue opportunities for their products in the home and education markets.

CD-ROM-based reference titles, predominantly text-driven, have only recently taken on interactive multimedia qualities. Most of the development work to date in the consumer market is associated with encyclopedia-type applications. A growing segment includes titles that are more entertainment oriented and include animation, full-motion video, and sound effects.

Productivity applications are diversifying in the multimedia PC category. Productivity titles such as clip art, presentation tools, database collections, and information guides will drive growth in this programming segment.

iii. Software and tools for the Internet

Home consumers are mostly waiting for more practical benefits from network connection.

The strongest inhibitor is the lack of "agent" software technologies that enable users to peruse the network, collect information, filter it, and present it in some usable way. Such agents are just beginning to come into existence. As they do, corporations will be encouraged to build distributed applications and offer them on the World Wide Web. At this point, corporate-home feedback will become significant.

More people will do business and buy goods and services over the Internet, and there will be an increase in types of connection infrastructure. The result will be corporations connecting to the home in the same federated way that corporations are connecting to each other.

iv. Relational databases

The movement to open systems and client/server architectures continues to drive changes in the system-level software market.

The problems of scalability and heterogeneity of modern enterprises have driven demand for middleware to manage communications with highly replicated systems and to mediate between otherwise incompatible environments.

Traditional mainframe and minicomputer software vendors are under increasing price pressures as the hardware costs for the managed platforms are driven down. The sales cycle is also extending because the products are increasingly complex. The other side of this coin is that many software vendors are obtaining increasing fractions of their revenues from consulting and implementation services.

The strongest signs of evolution emerge in relational database management software (RDBMS). Consolidation is occurring as the larger RDBMS vendors leverage their economies of scale and depth in intellectual capital to establish an unassailable competitive advantage and dominate the database market.

Despite this, all the leading vendors are also aggressively seeking to diversify their products as a means to seek competitive advantage and enter new markets. This diversification is currently evident in areas such as data replication, support for complex datatypes, query optimiza-

Software Market/Description	1994 Worldwide Market Size (Billion ECU)
Consumer Applications Used in the home for recreation, education, and/or personal productivity enhancement	1.31
Cross-Industry Applications Address problems such as office automation and accounting	13.67
Vertical-Industry Applications Address problems that are unique to a particular industry, such as manufacturing and health care	15.88
Information Access Tools End-user oriented tools for ad hoc data access, analysis and reporting	4.41
Programmer Development Tools Supports the professional developer in the design, development, and implementation of a variety of software systems and solutions	15.53
Systems Management Software Used to manage the full range of computing resources	6.26
Operating Systems The machine-level instructions that operate the CPUs and networks	8.12
Utilities/Middleware Enabling application and user interoperation and communication, system utilities, and distributed object management	5.02
Software Market	70.20

Figure 18
IT Software Market Taxonomy

tion, RDBMS scalability, parallel processing, and automated operations. Efforts here move beyond issues of functionality to focus more on supporting usage and ease of testing.

v. Data warehouse

Although this market logically consists of hardware, software and service components, the most interesting trends are emerging in the software component.

From a software perspective, the data warehousing market encompasses the following software tools:

- tools for populating the data warehouse. Key functionality associated with these input tools includes the extraction of data from operational databases, the transformation of this data into a form suitable for management by a data warehouse, and the input of this data into the warehouse;
- the engines necessary to store and manage the data;
- tools designed for providing knowledge workers with access to the data contained in the warehouse.

A considerable amount of attention is focused on the market, as organizations realize that effective utilization of information is key to their competitive positioning. There is a number of reasons behind this:

- the explosion of information availability: automated and electronic data collection capabilities are generating tremendous quantities of discrete (transactional or cross-sectional) and continuous (time series) information;
- advancing technology: the availability of mass storage devices, cheaper MIPs, and dedicated tools for building and maintaining data warehouses allows users to rationalize the concept of the warehouse and move from experimentation into implementation;
- data replication: there is an overall resurgence in interest regarding near-real-time data replication as this technology (in one form or another) will be key in supporting suppliers' distributed database architectures.

The software data warehouse market is clearly poised for high growth as the technology necessary to rationalize the concept of data warehousing is now becoming available.

The data warehousing market has been constrained to date by two inhibitors:

- lack of appropriate enabling tools to extract, transform, or load operational data into a data warehouse;
- lack of cost effectiveness of alternative customized solutions, that are expensive to develop and to maintain.

Evolution of data warehousing tools will become faster than in the past, as the success of the market rests on the ability of suppliers to create specialized data warehouse development tools. The packaging of innovative technologies, especially in the area of data replication and data storage, combined with higher-performance engines for managing data would help remove many of the current barriers to customer adoption. As a result, data warehouses would appeal to a much broader audience and become a standard component of an organization's IT architecture.

vi. Professional services

The dynamics of the IT services market continues to change as purchaser priorities shift, technologies proliferate, and the supply of competent technical and industry expertise are constrained.

It is clear that an expansion of service capabilities is occurring. However the emphasis is on expanding consulting and industry expertise, not technology service offerings. This focus is creating new opportunities for differentiation that are only beginning to be exploited.

The increasing emphasis on applying technology to business problems is leading to:

- the evolution of offer segmentation into three main areas: product specialization, technology integration capability, and business process integration;
- increasing specialization of service companies in areas of strength. Fewer companies will be able to play the role of the general service provider.

vii. Education and training services

The business environment for selling IT training and education services is in a critical phase. Information technology is of increasing importance to business, and companies are finding that they are unable to maintain the necessary breadth and depth of skills necessary to implement technology investments. Even though internal training departments are stretched beyond capacity, there is still debate about whether companies should outsource training in order to reduce overheads or continue to expand their internal resources.

There will be a fundamental shift in the marketing of training services.

Three key strategies will serve to differentiate training organisations:

- the provision of performance integration services;
- speedier time to market of pre-product-release training,
- and development of truly global training operations.

Implicit in these strategies is the capability to provide customers with a variety of training options and flexibility in delivery of this training. The outlook for training and education organizations that offer this spectrum of flexible options is bright.

viii. Integration, management and support services

Client/server infrastructures have matured to the point at which the high cost of ownership and limited control of reliability are constraining continued deployment. Increasingly customers are demanding support that enables them to cut the cost of use of distributed systems while improving overall control and reliability in distributed environments.

The demands of users have been noted by a broad range of software, systems and network equipment vendors. The major typologies they can be grouped in are:

- a growing number of *legacy systems management vendors* deliver management products for distributed desktop systems;
- a class of *emerging systems management vendors* specifically target customers requiring enterprise-level systems management solutions;
- *network management platform vendors* are moving to integrate systems management with their existing network management products;
- *network operating system vendors* recognize the strategic role that integrated systems and network management capabilities play in their network software product lines;
- vendors of point administration solutions and system utility products, evolved into a class of PC-based *server and desktop management vendors.*

The continuum of vendors across the distributed systems management space offers a range of solutions at diverse price points, but each vendor remains focused on the three fundamental issues of cost of use, control and reliability. As products move up the price scale, however, control and reliability become more critical.

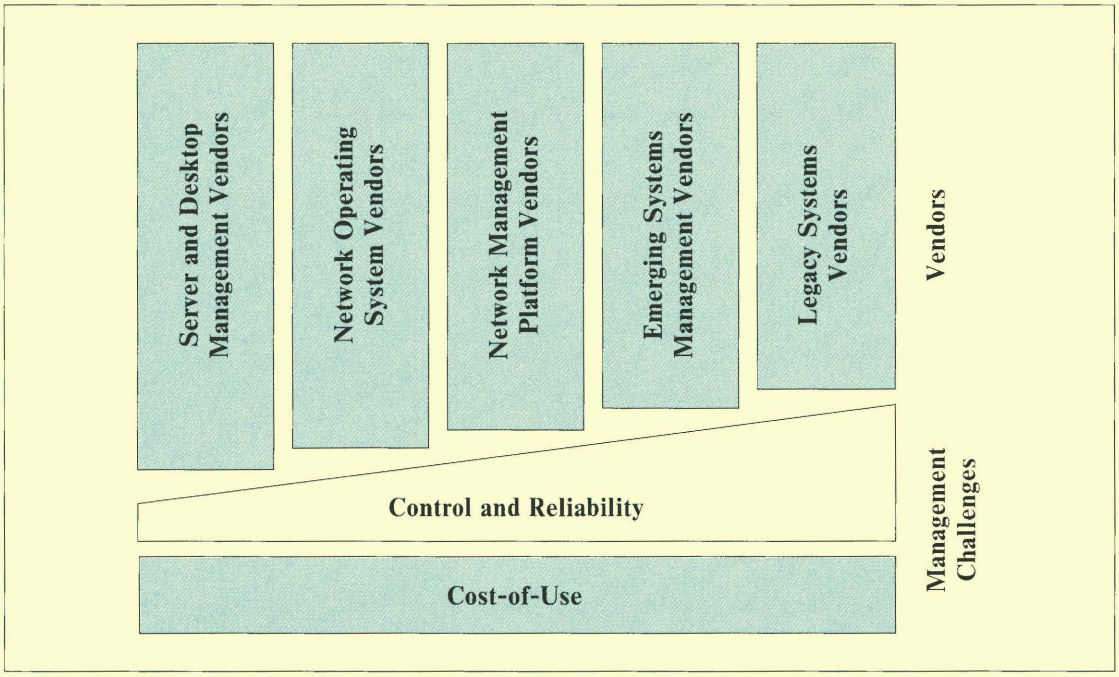
The market opportunity is clear: customers have already allocated a large share of their budgets for systems support and administration. Suppliers therefore need to deliver products that offer meaningful improvements in administrative staff productivity and deliver the control and reliability required for enterprise-level business applications.

2.3. The TLC Driving Forces

All industries have a need to communicate with other organizations. All businesses have customers or clients, and virtually all have significant relationships with suppliers and third parties, such as banks and insurance and legal firms.

Over the last decade, electronic forms of communication have replaced paper-based mail in many circumstances. Increasingly, paper-based systems have become too slow to keep pace with the needs of today's business activity. Business has come to rely on two main electronic technologies: the computer and the facsimile machine.

Figure 19
Systems Management Competitive Environment



During the 1980s, the facsimile machine emerged as a simple, reliable, ubiquitous, and inexpensive means of electronic communications, and it has thus become the dominant mode of inter-enterprise communication in all sectors. However, despite its many positive attributes, the fax machine can be viewed as almost a step backward in terms of stimulating electronic business communication. Often, facsimile messages involve taking a document out of its digital form, converting it first to paper and then to the analogue fax signal. During this process, the potential for the future processing available with an electronic messaging system is lost. For this reason, the transition from fax to true computer messaging will evolve rapidly, probably reversing the current positions over a three- to four-year period.

Especially in those organizations that are actively developing externally focused business, increasingly high priority is given to systems that link user organizations with existing or potential customers. Priority has also been given to applications that improve service, help organizations attempting to reach new customers or support sales and marketing to existing customers.

In order to build these applications, customers need a proven set of tools and solutions just as much of the choice among client/server suppliers has come down to which vendors have the best combinations of platforms, development and management tools, applications solutions, and customer service. The inter-enterprise era is starting to place new demands on suppliers in areas such as network gateways, wireless access, transaction security, applications engineering, overall management, and extended enterprise support.

In communication technologies it is clear among users that, unless security issues are successfully addressed, current usage levels are unlikely to move beyond today's messaging and file-transfer applications. However, interest in Internet transaction processing, intelligent networks, wireless technologies and ATM is increasing.

i. Intelligent networks

With increasing competition telecom companies are moving towards offering new voice services on the network as fast as possible. Intelligent networks open such voice services as voice mail, call forwarding, freephone numbers and caller identification to companies which cannot afford private telephone systems. Networked services are faster to install, easier to maintain, and more cost-effective to customize than the services once introduced switch by switch.

Among the best selling voice services in Europe are voice activated dialling, credit card verification, and national billing cards, together with the free phone number.

In the Scandinavian countries "virtual phone" services are already available. Virtual phone service is a sophisticated version of call forwarding, by which, with a universal number, a caller needs dial only one number to reach a party. The call will be automatically routed from office to car, to home telephone, and finally to voice mail if required.

Integrated voice response also represents a big step for organizations, such as banks, where every call may generate increased business or build customer loyalty. With this feature the caller is given a series of options using a voice recognition system. Selection is activated by numbers on a touch-tone phone.

Over the next ten years other voice services will become available. For example the capability to convert a fax to speech and convey it by telephone. Services such as caller identification can be integrated with a company's database to make telephone responses more targeted. The added value of these services will lie in how the customer will best exploit the basic modules.

ii. Cordless telephony

Organizations are starting to turn to radio-based cordless telephone systems. This system allows a business to operate its own internal wireless network with no air time charges, while external calls cost the same as a fixed telephone.

Cordless phones can benefit companies which operate a hot desking system whereby employees are not tied to a specific desk or workplace. Cordless systems can also be used where it would be too expensive to install a fixed-wire system, such as an airport, factory floor or exhibition arena.

Demand for this technology has been hindered by the lack of standardization. However, a new standard that will allow different makes of handsets to work together is under development.

iii. ATM

Another technology that is difficult to imagine not being pervasive in businesses with liberalized telecoms is ATM (Asynchronous Transfer Mode) broadband data network technology.

ATM is the networking of the future, as it will soon be sending information to and from computers faster, cleaner and with more flexibility and greater accuracy than today's technology. While today's networked computers based on local area network Ethernet technology can transfer 10 megabits of information per second,

an ATM-based network sends 155 megabits per second, with virtually limitless potential.

The new technology is suitable for multimedia applications, enabling all forms of transmitting and routing information flows – voice, image and video – over a single network. In those organizations with mobile workers and cross-functional teams, ATM will allow the creation of virtual groups of users and resources, independent of their network's physical set up. Similarly doctors can work in their practices while examining, by computer, patients in different hospitals.

The first ATM commercial service was offered in Finland, although across Europe development or first commercialization of this service is starting to spread.

iv. Interactive digital network technologies

Interactive TV is finally emerging as all major telephone and cable operators are taking action to build fibre into their networks and to support the combination of real-time two-way video and communication services. In the realm of consumer services, applications will be delivered through a set top converter box attached to a television and will consist largely of entertainment programming.

Factors promoting the development of these services and the deployment of fibre in the local cable and telephone loops are both market- and technology-driven. The major drivers are the following:

- the integration of fibre with coax-cable for transforming the television infrastructure into a system of high-capacity interactive networks. This combination will allow a distributed network configuration that is economical, incremental and that offers a high level of interactivity;
- the development of scalable video servers that utilize inexpensive storage technologies for managing and distributing programming, as well as processing consumer requests and transactions;
- the development of intelligent set top boxes that combine multitasking, multithreading operating systems with graphical user interfaces for distributing and administering the flow of video and communications both upstream and downstream;
- the deregulation of telephone and cable monopolies, which, at different paces across countries, has resulted in growing competition on delivery of entertainment programming and telephone services.

As more capital is allocated to these efforts, both the cable and telephone industries will need to assess several variables relevant to the scope and pace of network modernization, including the rate of return of infrastructure investment and factors that could accelerate or delay network modernization.

Over the next few years significant revenue could be generated from services such as downloading video games and near video-on-demand. The extent to which these services are a success will determine the pace of additional capital spending on hardware and electronics both in the home and in distribution systems.

2.4. New Jobs and New Suppliers for the Mass Connectivity Markets

New Information Systems (IS) challenges inevitably lead to changing human resources skills requirements. However retraining existing staff, adding additional personnel, using outside consultants, and outsourcing some functions must be accommodated within tight budget realities.

On the positive side the number of organizations that are adding staff outnumbers those reducing staff. In addition, the use of consultants and other third-party contractors is also on the rise. Information Systems organizations also indicate that they are in the process of changing their skills mix during 1995 to keep up with current demands.

Demand is greatest for qualified and talented Information Systems staff. Due to the shortage of experienced staff, up to 40% higher salaries are paid in emerging technologies than in more commonplace systems. In particular the need for relational database management systems or Internet-experienced staff translates into a huge new human resources opportunity.

Excitement and opportunity await new players and new IT staff. The most notable trends that are shaping the entrance of new players and demand for new job requirements are related to:

- the emergence of the Chief Information Officer (CIO)
- the usage of object technology in software development
- the adoption of client/server databases
- the need for network managers
- the need for Internet experts.

Chief information officers

The Information Systems architecture is changing to one where everyone has connectivity, everyone uses e-mail, and it is intended to bring huge improvements to the way people work, as well as reducing costs. Consequently the information systems department cannot remain a support function, but must become a business function, as a department that supplies vision, concepts and understanding of what information means to particular business functions.

As a result the role of the Information Systems Department Director is shifting towards a new profile. The IS Director is becoming the Chief Information Officer characterized by the shift toward a strategic focus rather than a service orientation. CIOs will also have to maintain a cross-enterprise perspective and act as internal consultants and infrastructure stewards.

The real challenge would come from increasing Information Systems' contribution to the business. By aligning IS strategy with the business, using Information Systems to achieve business objectives and ensuring an infrastructure that allows organizational flexibility.

The objectives driving CIOs' decisions and behaviour are more oriented towards analysing and learning from competitors' successful business decisions and strategies, ensuring and monitoring IS performance, focusing IS development on core areas and contributing to organization changes.

Object technology

The new model for successful software development is to establish a different balance between labour and assets by using object-oriented software technology.

Most software written today is hand crafted using a labour-intensive process. It is developed for unique situations and tailored to the dynamic, complex requirements of the organization it supports. Object-oriented software is a key enabling technology that brings flexibility into the application construction. It sets the stage for rapid gains in software development productivity as it facilitates reuse of software assets and applies to any computing environment.

Several systems integrators have developed capabilities in object technologies to offer enhanced capabilities of integration of business model and IT infrastructure. However the current market for professional services related to object-technology is associated primarily with early adopters.

From the developer viewpoint, a steep learning curve must be climbed. Going from procedural to object-oriented methodologies requires training and relearning. In designing objects for reuse, the level of demand placed on staff to think in abstract terms, identify patterns, and design solutions with generalized applications is very high.

The availability of experienced practitioners is among the major inhibitors of the adoption of object-oriented software. Demand for trained object technology professionals exceeds supply, leading to inflated salaries. One major concern for systems integrators is retaining talent. Given the demand, a turnover problem exists: personnel are likely to be recruited after being trained.

Software support

The software support marketplace continues to undergo significant change as it is now viewed as a major strategic initiative and as a key product differentiator. Software today is more complex to use. As users place increased emphasis on the use of software within the enterprise, getting support and training to overcome these complexities is vital for the success of their businesses.

Morever many users are not even sure whether the problems they are facing in IT usage lie in the network, the software application, the operating system or the hardware. Internet working complexities affect software support in the areas of database and workflow, scalability of environments, and control of software version.

Together with allying with software developers and independent support organizations, a constant commitment to training, hiring elusive expert staff and building up centres of excellence in the Information System department are the most viable initiatives for IS managers at present.

Network managers

The escalating demand for managing proliferating networks and network-based applications is driving new methods of involvement with outside providers in the area of network operations management.

Many network managers are seeking an organization that can complement and supplement their own resources, and act as a partner to them, most often in the areas of support/management, installation/configuration, strategy consulting, end-user training, and network design. In addition, as the sheer volume of network traffic and access demands increases, network managers are seeking assistance to keep up with the technologies. ATM migration is among the key issues for network managers. Similarly the implementation of frame relay and ISDN is creating opportunities for service providers in addressing wide area and remote access issues.

The emergence of this new demand spells opportunity for the service firm, but it also emphasizes the importance of partnering skills and customer education to influence expectations and awareness of the potential of the tools available.

Internet experts

Implementing company-wide Internet access or getting a World Wide Web site up and running involves specific sets of concentrated activities. Startup efforts involve planning and

installation skills, as well as specific analytical and programming abilities related to communications, addressing, and security issues. In the case of Web home page development, graphic design and database skills are also needed. Bringing these resources on board can represent a significant investment in an intense period of development. Moreover, managing Internet resources may not fit within the Information System department's core competency or overall strategic focus.

The concentration of investments required for the initial implementation of an Internet strategy, coupled with the unique combination of skills demanded, creates a situation ripe for the intervention of a knowledgeable, reputable team of technical and marketing experts. Outside service providers can play a key role in filling the need for specific expertise to planning, designing, implementing, supporting, and/or hosting both "inbound" and "outbound" Internet resources.

In response to the increasing demands of defining and implementing Internet strategies, several different types of vendors are offering Internet consulting and integration services:

- *Internet access providers* are putting varying degrees of emphasis on the consulting and integration portion of their services offerings;
- *major systems vendors* see Internet consulting as a key positioning for their network services offerings;
- *consulting and other services firms* are also incorporating Internet components into their broader projects.

3. IT and TLC European Market Perspectives

3.1. Growth Factors and Initiatives to Carry Europe Forward into the Information Society

The potential for stronger IT market growth in Europe is there. The challenge for Europe is a matter of pulling growth out as quickly and as extensively as possible. After all, the ground we are cultivating in Europe is much more fertile than anywhere else in the world. Europe has one-third more households, a greater population, higher GDP and overall number of employees than the most advanced ICT market, the USA.

There are several factors that can be considered in the effort of pulling out European ICT market growth.

3.1.1. Growth in the Economy

In the past few years no one more than Europeans has learnt by experience that economic expansion does not necessarily mean IT market expansion.

In general, we see that when economic growth is export-led, incremental short-term IT investment is likely to prevail, whereas when economic growth is driven by expansion in domestic demand, innovative long-term IT investment is more likely to emerge.

The present growth in the European economy is being driven by export expansion, generated by favourable movements in European currencies. The short-term scenario is likely to shift from exports to domestic demand, as national economies strengthen and business confidence improves.

Improvements in the propensity to invest are not only related to healthy economic prospects but also to the interest in adopting

radically new business processes. This propensity emerges in those organizations which are finally prepared to shift their IT approach from the traditional focus on data accessibility towards the innovative focus on improving the way staff in the organization interact with each other and with customers. This new approach turns into the adoption of new techniques such as interactive "selling-through-screen" techniques, 24-hour telephone banking services, on-line advertising services, and "virtual classroom" education applications.

Long-term, radically-innovative IT investment is encouraged by increasing competition in traditional vertical markets. Increasingly companies are trying to differentiate their activities by seeking opportunities in other industries or in other national European Union markets. This is nurturing an increasing number of alliances especially in the retail and finance sectors. It will also lead to the adoption of new technologies to make the new emerging business models work effectively, both across borders and across industries. Moreover the opening of European borders is leading to an increasing number of European businesses attempting to increase their economies of scale by seeking business opportunities in other countries.

These favourable conditions to IT investment growth are already present in some European countries and are poised to emerge across the others. However they will act unevenly across the various countries.

When all of these forces are fully at work across Europe, one percentage point of overall economic growth will mean two to three points of IT growth. More than that, where these forces are at work a virtuous cycle will emerge by which growth in the economy and the IT market will also mean growth in employment, with an increasing share of newly-created IT-related jobs.

3.1.2. Internet Opportunities

The impact of the Internet will drive business opportunities today and wholly new business practices tomorrow.

The rate at which new Internet applications are being created and the speed with which the Internet is growing are encouraging. In Europe users of interactive Internet services grew from almost 3 million in 1994 to some 5 $^{1}/_{2}$ million in 1995. In the last quarter of 1995 almost 100,000 new hosts connected to the Internet each month (corresponding to some 300,000 Internet users). The number of people using the Internet only for e-mail purposes was even greater, reaching a level of almost 10 million by the end of 1995.

The Internet will drive growth across the entire IT value chain. At the commodity end of the spectrum a very small number of large carriers and cable TV companies will simply sell bandwidth. Meanwhile at the value-add end of the value chain a multitude of software companies, value-added resellers and publishers will sell applications and specific, vertically oriented business solutions.

On the other hand technological shifts driven by Internet opportunities will change the rules of the market to the extent that existing strengths are no longer relevant and the playing field is levelled.

Software companies releasing packages to mediate no-cost long distance telephone calls over the Internet will mean a real long-term threat to the telecommunications industry. Software vendors making new releases/updates available to their existing customers over the Internet will find in the network a long term alternative to the current distribution channels.

The race by many software and value-added network services companies to design the structure of electronic commerce on the Internet will drive new business practices in electronic transactions.

Potential enhancements in Internet usage are also very encouraging. Currently, the Internet is mostly used for e-mail and access to public information services, while access to vendors' online support services is viewed as a near-term developing application. Electronic commerce is perceived as a more long-term future application. However the rate at which these applications are being created indicate that next-generation Internet or information highways opportunities are not far off.

3.1.3 Application and Technology Push

The following are some developments in technologies and applications that will drive the emergence of next "information highway" era.

i. Computer telephony integration

The integration of personal computers and telephony will change the way small and large businesses operate, creating efficiencies and opportunities where none existed. At a very basic level Computer Telephony Integration (CTI) can be defined as a technology platform that merges voice and data services. This platform allows users to access to all forms of communication (e-mail, voice, fax, video-conferencing) through the use of icon-based interfaces on users' computer screens.

The primary benefits of CTI include:

- improved productivity,
- improved workflow automation,
- improved communications and communications management.

Currently available applications range from simple on-screen phone dialers to products that allow the PC to function as an answering machine/voice-mail system, remote retrieval of voice and fax messages. They also allow users to share a single line for simultaneous voice and data transmissions.

In the short term CTI will enhance such mass-market applications as interactive home shopping and distance learning, as well as information-on-demand types of services with a content-based fee structure.

The first generation of CTI applications will focus primarily on enhancing the productivity of people working at home, in remote offices, and in other small businesses. For example remote workers will be able to form ad hoc workgroups with each other through telephony-enabled groupware applications.

ii. Electronic marketing

The growing penetration of technologies in the home is challenging product marketers with the opportunity to develop marketing strategies that bridge media and demographic boundaries.

Current electronic direct marketing strategies utilize digital media to deliver advertisements, information, and products (as in the case of software) to specific audiences. The compelling aspect of this development is the opportunity to match promotions with the demographics of technology owners and the depth of technology usage within a specific home.

The primary vehicles for electronic product marketing are CD-ROM and on-line technology. These vehicles allow direct marketers to target multiple individuals through a single channel or combination of channels.

Electronic marketing portends a reshaping of how many people evaluate and purchase merchandise. The prevailing models in the short term will be based on the following vehicles:

- electronic catalogues,
- product distribution CDs,
- electronic magazines,
- informational CDs,
- multimedia CD-ROM titles.

Over time, media-specific strategies will dissolve in favour of more extensive hybrid approaches that take advantage of multiple delivery platforms - CD-ROM, online, and eventually cable. Differentiation will rely less on the distribution vehicle and more on the vertical or horizontal integration of the concept and audience. The application of 3-D environments will be used more extensively in order to create dynamic environments for shopping and social interaction for remote individuals.

3.1.4 Liberalization Push

Despite public opinion resistence nurtured by concerns over job losses, the European Commission is committed to maintain momentum towards liberalization with a series of directives to:

- ensure fair and effective competition
- and strengthen technology developments.

The European Commission's determination is driven by the evidence that liberalized markets do lead to lower prices, an improvement in the availability and quality of services and the opening of new opportunities. If well exploited, new jobs will increase. In the short term, particular attention will be devoted to antitrust rules. These will be aimed at monitoring alliances and mergers that might create discriminatory market conditions. In such an attempt, the Commission is determined to force European countries to accelerate the liberalization process.

Current European Agenda for Liberalization:

January 1996:

- use of cable television, utility and rail networks for telecom services;
- mobile operators allowed to build own networks, use alternative infrastructure and directly interconnect with other mobile operators.

January 1997:

- member states notify Commission of licensing conditions for new network operators, infrastructure providers, and public voice providers in 1998

January 1998:

- abolition of all special, exclusive rights to provide voice telephony and infrastructure in most member states.

In particular the following recent proposals and decisions will play an important role in driving growth opportunity:

- the proposal of a pan-European procedure for licensing low earth-orbiting satellites communication services is intended to eliminate differences in national licensing practices among the member states that represent major obstacles to the provision of these services;

- the conditions set on the approval of a venture between three major telecom operators to provide global communication services to corporate customers. These conditions include the liberalization of alternative communication infrastructures and of data communication services in France and Germany by July 1996. A nondiscriminatory and transparent access to the domestic public switched data networks for all suppliers offering X.25 data services in the same two countries have also been required.

With regard to empowering technology development, the European Union's budget which also covers research funding programmes in telecommunication and information technology, has been increased by 6.9%. This increase is meant to take into account the entry into the EU of Austria, Sweden and Finland. The total level of research funding has therefore been raised by ECU 800 million to reach ECU 13.1 billion over the next five years.

3.2. Critical Factors and Impediments to Growth

Evolution from a mass connectivity society towards an information highway society focus obstacles in a number of critical areas that affect international markets in general but might cause even more critical concerns in the European market environment. In the context of highly segmented national markets with different levels of liberalization so far achieved, inhibitors to growth might exert even stronger decelerating effects.

Major obstacles might arise from the following critical areas:

3.2.1. Infrastructure Harmonization and Security

Organizations' eagerness to take advantage of the information highways is tempered by deep concerns about security issues, and lack of infrastructure harmonization across European countries.

In many cases, the IS department becomes mostly or entirely responsible for addressing these concerns and finds itself at the vortex of a demanding yet resource-constrained situation with key corporate strategy and security issues at stake.

The majority of concerns fall on the European Internet Web market. Internet content and service suppliers are setting up strategic partnerships within and beyond European boundaries to develop culturally-relevant content and advertising. Still, a number of inhibitors compel full development of Internet usage in Europe. These inhibitors include:

- metered telephone lines pricing (unlike in the US) which can make people impatient with slow graphic-laden Web pages;
- lower and more unevenly distributed personal income in Europe than in the US;
- lower and more unevenly distributed information technology availability in European homes than in the US;
- low sophistication in customer service, marketing and technical support of European Internet service providers;
- less productive Internet publishers in Europe than in the US;
- lack of multilingual products.

3.2.2. Technology Integration

To meet the goal of integrated management, platforms must drive intelligence to the edge of the network through distributed agents capable of local collection, processing, and fault resolution for diverse network devices, systems, and applications.

Concurrent with efforts to create a more distributed management framework, vendors must address a variety of limitations present in existing platforms. They must:

- improve integration with management applications through improved application programming interfaces, shared data capabilities, and standard object definitions;
- develop the capability to manage more diverse networks through multiprotocol support:
- improve ease of use through simpler tools and greater automation.

The following two achievements are fundamental to successful platform vendor strategies:

- supporting interoperable distributed management platforms by addressing current platforms limitations;
- integrating device, systems, and application management into a single framework.

3.2.3 Pricing

In all sectors of the information and communication technology industry less competitive pricing is inhibiting the adoption of new technologies, especially the Internet-related ones.

The most notable limitations in the IT market are related to:

- leading multimedia technologies with price differentials of up to 30% between Europe and the US;
- lack of flexible software licensing conditions, that allow central purchase control and easy companywide distribution on all platforms at all locations.

In the telecom arena, different speeds of liberalization drive different price levels across Europe. Competitive markets have lower prices, while in the presence of local monopolies tariff structures are still artificial, and not related to cost. As a result, the UK and Sweden are consistently the cheapest in long distance and international calls. Germany and Italy are the most expensive charging three or four times the price of the cheapest markets for long-distance and international calls, while the price of local calls has been kept artificially low.

With liberalization local and long-distance or international call tariffs will have different dynamics across countries. The evolution from monopolies to free competition will drive price increases for local calls, and price decreases for long distance and international calls. In the most liberalized markets the price of local calls is starting to fall already. Businesses will suffer from different price conditions across Europe.

The lack of common regulations on cable TV and digital interactive services also risks creating obstacles and discriminatory competitive behaviour across European countries, delaying the emergence and adoption of interactive services.

3.2.4. European "Cassandra's Syndrome"

There is a widespread European fear that the information highway promoted in a fully liberalized environment will bring more competition from international technology and content providers, taking development opportunities away from local domestic suppliers.

As a result some suppliers and national governments tend to adopt very conservative and defensive attitudes towards the liberalization process and the development of new products and markets.

These fears are mostly attributable to a common under-evaluation of the benefits of the increased use of the Internet. Soon it will be possible to get on the Internet in the US and watch information and content produced in France or Italy. Overall there will be an over abundance of capacity and an over abundance of programming. Therefore it becomes very unlikely that one nation or one language will squeeze out everybody else.

The information highway will lower barriers to entry for everybody, as it will create untold new avenues to provide content for everybody, increasing exponentially content demand potential in all languages. In this perspective even the traditional European multiple language disadvantage will act favourably for local content developers who will be able to overcome low barriers to entry and achieve critical business mass. The evidence of the mushrooming of 110 local Internet service suppliers in the UK and 30 in Italy at the end of 1995, suggests that the expanding information highway is not crowding out local jobs and expertise.

The ability to pick out niche markets outside Europe will also nurture business growth to European content developers. European content is highly valued among international audiences. For example, although they might not appeal to 200 million Americans, European multimedia content products might be successfully targeted at niche audiences of up to 10 to 20 million Americans.

3.3. Medium-to-long-term Scenario

The long-term scenario is one of sustained innovation, business process reengineering and new life-styles. It promises to be an exciting future.

i. Business arena

On the business front, electronic commerce will blur organizational boundaries and create entirely new entities designed for and often operating exclusively in the emerging cyberspace.

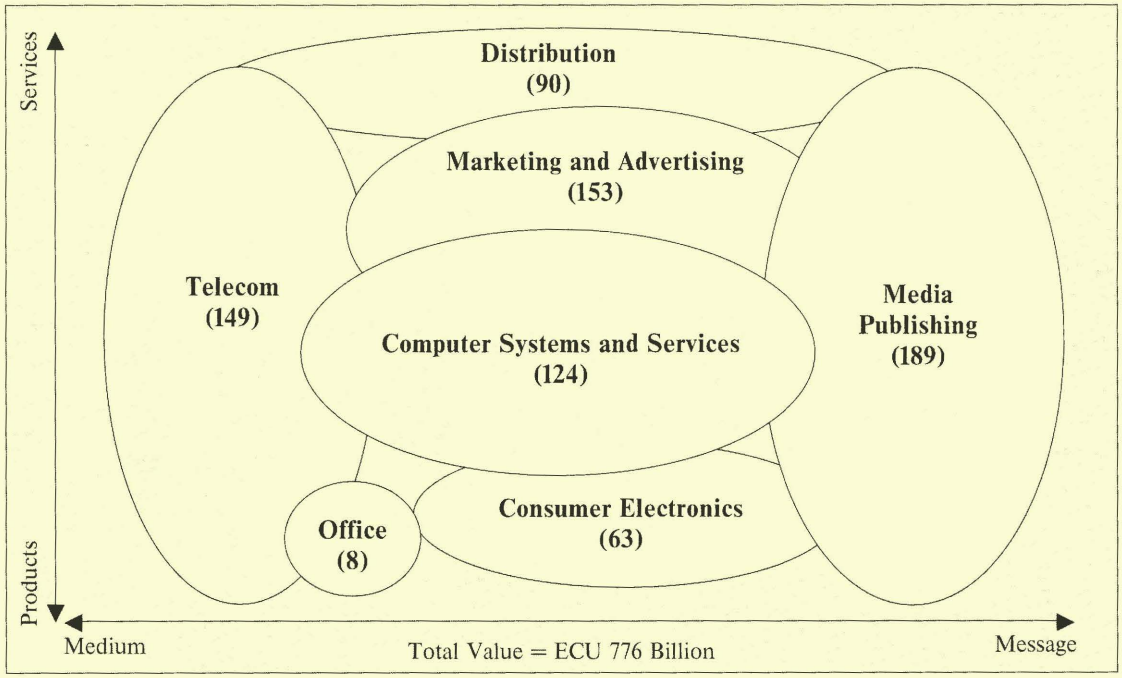
The impact would be comparable to the one that the shift from paper cheques to electronic funds transfer has had on the speed and efficiency of business transactions.

The results over a 15 to 20-year period of the transition to electronic commerce are likely to be so great as to be almost unimaginable today. At a minimum, the seamless flow of information between enterprises will give concrete meaning to the oft-cited "virtual corporation".

Despite the many unknowns, today's businesses view the future of electronic commerce with optimism and excitement. The industry patterns show that information-intensive industries tend to be taking the lead. Business services, banking, and insurance will move the fastest, followed closely by the retail and utilities sectors and then the manufacturing sector. Government and health care seem destined to continue to lag for at least the next few years.

Over the last decade, those businesses that have invested heavily in PCs, LANs, and intra-enterprise messaging networks have gained competitive advantages over those that have moved more slowly. However, competitive ramifications of this next great wave will be much

Figure 20
The European Information Business Arena. 1994
Billion ECU



Office:
typewriters, calculators, copiers, other office equipment;

Consumer Electronics:
TV Sets, VCRs, radio, tapedecks, watches, etc.;

Media and Publishing:
Film, TV programmes, videos, CDs, records and tapes;

Computer Systems and Services:
hardware, packaged software, services;

Marketing and Advertising:
on-line databases, on-line shopping, mail order catalogues, advertising, direct marketing, other business services;

Distribution:
broadcasting, telex/mailgram, mail, parcel, courier;

Telecom:
voice network services, data network services, customer premise equipment, service providing equipment, installation and maintenance.

more compelling. Because most of the external activity will be focused on serving existing customers better or finding new ones, those businesses that master the new technologies should be able to accumulate competitive advantages more rapidly than was possible in the era of intra-enterprise computing.

The ICT industry has spent three decades and literally trillions of dollars putting into place the resources, skills, and systems that will make the inter-enterprise era possible. As business begins to be conducted electronically, the potential for productivity improvements is great. For years, the industry has talked about marrying IT investments with business processes. Since the most important business processes are those that relate to customers and suppliers, the development of a highly interconnected business environment should prove to be an essential step in delivering on this industry's long-term promise.

ii. Consumer

On the consumer front the combination of real-time video and communication services will enhance dramatically the role of the "network" at home. No longer will networks be defined by the types of services they deliver - voice, video and data - but by the level of throughput and intelligence they will deliver.

Interactive TV marks just the beginning of the digital frontier, represented by the participation of multiple industries and players (cable operators, telephone companies, hardware manufacturers, software developers, publishers, network broadcasters, movie studios, etc.) in several technology segments (digital content, servers, network infrastructure, set-top boxes, electronic programming guides, end-user interfaces, etc.).

As a result of these trends, with a 200-300 ECUs purchase of a set-top box that distributes and administers the flow of video and communications, the home user can obtain a multiplicity of service options and points of interaction from multiple operators.

Consumer demand will drive the pace at which suppliers enter cooperative relationships to develop new services and technologies. Because deployment activity has focused on entertainment programming, consumer spending on entertainment services will provide the revenue test fields for non-entertainment-based interactive services.

Among the major services targeted for future broadband deployment are video-on-demand, shopping, storage-based/downloadable gameplay, and two-way gaming. Other services identified as potential revenue generators include home banking, video telephony, remote home security, and electronic newspapers. Early interactive TV deployments are likely to focus principally on perfecting the delivery of movies and gaming content.

iii. Conditions

The implications of these dynamics at business and at consumer level are far-reaching, but require a set of very important conditions to exert their benefits fully on the development of the European information society.

These conditions are:

- the re-evaluation of current network and service values, with a fundamental shift in pricing and competitive rules adopted by suppliers. From a market driven by cost-based pricing, the evolution will be towards a market driven by access-based value. Resistance to this shift from both suppliers and regulators will cause dramatic gaps in mass connectivity evolution across countries;
- a restructuring of business models to comply with the new ICT market rules and the new expertise requirements emerging from users as they deploy new information and communication technology;
- the dissolution of existing country regulations and the introduction of more effective and standard regulations governing cable and telecommunication services across Europe;
- a strong investment in preparing users for the most effective deployment of network technologies and training suppliers' technical staff to provide this support;
- more confidence from European suppliers and users in making the information society happen.

The opportunities over the next decade are greater than ever.

Information and Communications Technology: Key Technological Trends and Standards

This paper has been provided by M. Bozzetti on behalf of SMAU in close cooperation with the EITO Task Force.

1. Evolution in ICT: A Global View

The aim of this section is to indicate the most significant technological factors affecting Information and Communication Technology (ICT) that are of decisive importance for the market now, and will continue to be so in the near future. As in previous reports, we shall consider the following as the basic ICT technologies:

- microelectronics;
- computer hardware;
- software;
- telecommunications.

These technologies cooperate and interoperate by means of architectures. The evolution of technical architectures plays a key role in ICT, both affecting and being affected by the developments taking place in the technologies themselves.

Viewed as a whole, ICT also influences and is deeply influenced by a market which this EITO report has subdivided into office products, EDP systems and telecommunications.

The technology trends in the 1990s can be summarized as follows:

- the continuing miniaturization of electronic components, with a parallel cost (and therefore price) reduction 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.

All technologies are contributing to the evolution of ICT, but the "hottest" over the next decade will be those listed in the following *Table 1,* which also briefly describes the foreseen improvements.

International "de jure" standardization 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. Successful "de jure" standards are increasingly derived from "de facto" standards, because users have already endorsed the products on which these standards are based. Consequently, the distinction between de jure and de facto standards is less significant for users and in any case, standards cannot be (and must not be) seen as static influences or constraints on the introduction of innovations.

The International Organization for Standardization, (ISO), the International Electrotechnical Commission, (IEC) and the International Telecommunication Union (ITU), with its

Table 1
Main Foreseen Technological Improvements

Key technology	Foreseen improvement over the next decade
Wireless systems	capacity up 1,000x
Fibre optic systems	capacity up 100-300x
Very and ultra large system integration (integrated chip technologies)	density up 100-1,000x
General and special purpose processors	capacity up 1,000x
Storage technologies	capacity up 100-1,000x
Speech processing • recognition • synthesis • speaker verification	 • towards continuous speech, and a natural language with more than 20,000 words • from highly intelligible synthesis to the transfer of personal characteristics across languages • from limited vocabulary to arbitrary input/speaker
Image processing • ad hoc processors • recognition • synthesis	 • capacity up 1,000x • free text and handwriting • photo realistic
Display technologies • resolution • size	 • pixels up 10-200 x • up to 60″
Battery technologies	average duration of charge for laptops up to 36 hours with a weight of 1 lb
Software	productivity up 3-5x

Consultative Committees CCITT and CCIR are the worldwide "de jure" standardization bodies operating in the interdisciplinary ICT sector. They have their counterparts in the European Standards Organizations: the Comité Européen de Normalisation (CEN), the Comité Européen de Normalisation Electrotechnique (CENELEC) and the European Telecommunications Standards Institute (ETSI).

Both at world and European level, these bodies have organized and coordinated their activities in order to be able to cooperate in a fruitful manner.

2. Microelectronic Components

2.1. Main Microprocessor Families

The difference between CISC (Complex Instruction Set Computing) and RISC (Reduced Instruction Set Computing) architectures is becoming more subtle, because each tends to steal the best concepts of the other. For example, Intel's new Pentium Pro translates x86 CISC instructions into simple micro-operations executed by what is essentially a RISC processor. On the other hand, Sun Microsystems' UltraSparc-II will implement special graphics instructions to speed up MPEG (Motion Picture Expert Group) decoding that are very similar to CISC instructions.

Producer	Model	Official introduction date	Target clock speed	Estimated performance	Fabrication process/ feature size
AMD/NexGen	K6 (Nx686)	Unknown	180 MHz	Unknown	Five-layer-metal CMOS/0.3-micron
Cyrix	M1rx	Fourth quarter of 1995	120 MHz	176 to 203 SPECint92	Five-layer-metal CMOS/0.6-micron
DEC	Alpha 21164A	During 1996	Over 300 MHz	500 SPECint92; 700SPECfp92	CMOS/0.35-micron
HP	PA-8000	First quarter of 1996	200 MHz	> 360 SPECint92; > 550 SPECfp92	CMOS/0.5-micron
Intel	PentiumPro (P6)	Fourth quarter of 1995	150 MHz	276 SPECint92; 220 SPECfp92	BiCMOS/0.6-micron
MIPS/SGI	R10000	Fourth quarter of 1995	200 MHz	300 SPECint92; 600 SPECfp92	CMOS/0.35-micron
PowerPC Consortium	620	Fourth quarter of 1995	133 MHz	225 SPECint92; 300 SPECfp92	CMOS/0.5-micron
Sun	Ultra Sparc-II	Second quarter of 1996	250 to 300 MHz	350 to 420 SPECint92; 550 to 660 SPECfp92	Five-layer-metal CMOS/0.3-micron

Table 2
Main Microprocessor Families

The current state-of-the-art technology is 0.35 micron CMOS (Complementary Symmetry Metaloxide Semiconductor) and forecasts talk about a step-up to 0.25 micron CMOS clocked up to 400 MHz in 1997.

2.2. Memories

2.2.1. Main Memories

In the main memory design arena, a number of system board manufacturers are introducing support for EDORAM (Extended Data Out Random Access Memory) memories.

The technology behind EDORAM is a simple extension of the trend that made FPM (Fast Page Mode) RAM the standard available form of DRAM (Dynamic RAM). When you read an element in a DRAM array, you charge electrical lines to first select a row and then a column; however, the lines do not stabilize immediately and it is this delay which prevents the RAM location from being read instantaneously.

FPM RAM returns data faster because it assumes that the next data requested will be in the next column of the same row. In many cases this happens, and there is no need to wait for the row delay. However, this process stops working reliably if the CPU (Central Processing Unit) demands data too quickly, because the lines do not stay stable long enough for the CPU to read off the answer. This usually begins to happen in CPUs running at speeds of more than 33 MHz.

To solve this problem, EDORAM adds a set of latches (or secondary memory cells) at the output, which sense the data being fed for output, store it and keep it available long enough for the signals to reach the CPU reliably. These chips should be stable at system bus speeds of up to 50 MHz.

Even more circuitry can be added to let EDORAM offer information at still higher speeds. An approach known as burst EDORAM assumes that the CPU wants, say, the next

four addresses and begins fetching them automatically; this technique can easily and reliably supply systems with a bus clock speed of up to 66 MHz.

Memory designers are working on two other solutions to increasing CPU speeds: synchronous RAM, in which the CPU and RAM are locked together by the same clock; and cache RAM, which gains speed by adding a small amount of fast Static RAM (SRAM) to the chip that acts as a cache for the DRAM.

The synchronous solution is a cleaner replacement for the old interfaces between chips. Normally, memory chips answer requests; SDRAM (synchronous DRAM) feeds off the same clock cycle as the CPU and can keep in step by anticipating the CPU's demands. Some devices even have a pipelined architecture, in which one stage can fetch an address while others present the data for output.

Another way to speed up memory access is by adding an on-chip cache. Called CDRAM (cached DRAM) or EDRAM (enhanced DRAM), this solution uses an SRAM cache on the same chip as the DRAM. These memories can respond to CPU requests at SRAM speed if the right information is already in the cache. They also gain speed because the cache can fetch data from the DRAM in large blocks using the internal buses. The cache and bus width sizes currently vary from a 16-Kb cache with a 128-bit line bus to an 8-Kb cache with a 2,048-bit line bus.

2.2.2. Video Memories

Although the system main memory market is subject to the constraint of standard packages (now 72-pin SIMM - Single In-line Memory Module), graphic board manufacturers are free to experiment with different kinds of approach. The most common, but still expensive alternative to DRAM is VRAM (Video RAM). VRAM has two ports and can therefore serve two simultaneous requests to access data: one to maintain and change the image, the other to collect the information for the video monitor. This approach works best only at higher resolutions (1,024x768 or more) with 24-bit or more colours, but it is the starting point for the next generation of video RAM designs, which will make use of the same solution as that adopted for main memories (e. g. cache and synchronous VRAM). Some manufacturers are adding extra intelligence to RAM chips in order to optimize performance in full-motion or 3-D operation; examples of this kind of evolution are WRAM (Window RAM) and 3D RAM.

2.2.3. Non Volatile Memories

The need for low power consumption in some areas (particularly for portable and handheld PCs) is driving research into new kinds of non-volatile memories. Chip makers are working in two main directions: flash and ferroelectric memories. The first technology is similar to that of Electrically Eraseable Programmable ROMs (EEPROM): that is, the chips retain data until they are erased by means of a relatively large voltage. The second uses iron in the production process and is capable of maintaining data even in the absence of power. Although flash RAMs tend to wear out, ferroelectric RAMs (FRAM) do not seem to degrade even after a number of write operations, which means that, providing producers succeed in building good-capacity chips, FRAMs could also replace DRAMs in the future.

2.3. Signal Processing

Existing PCs handle audio, video and telephony signal-processing tasks by using general purpose Digital Signal Processors (DSPs), but there is now a new trend being pushed by Intel, Apple and some system vendors (such as Compaq): instead of passing them on to dedicated chips and special hardware, Intel's Native Signal Processing (NSP) uses the CPU to perform audio and video tasks.

However, although NSP may be a cost-effective technology for delivering speech, audio and other multimedia functions to the business market, it needs some extra hardware for purposes of backward compatibility and, as a result, the question is still open and we could see both solutions being adopted in future commercial systems.

Some manufacturers are working on a new generation of specialized chips that mix CISC, RISC and DSP architectures in order to obtain a sort of hybrid CPU/DSP; others, such as Intel and Cyrix, are introducing multimedia capabilities into their normal CPUs. These are clear signs that a new generation of PCs is coming, which will have a native inclination to handle video and sound in the same way that yesterday's and today's PCs were structured to run word processors and spreadsheets.

3. EDP Systems

3.1. Computer Technology and Hardware Products

The evolution of computer architectures has confused terms such as "mainframe", "minicomputer" and "microcomputer", but technologies such as CMOS and RAID, and languages such as C, C++ and so on, fall into the classical mainframe world.

Mainframes use a model in which applications run at the main site and are accessed via dumb terminals, which seems to be nonsense now that the terminals are themselves powerful PCs with considerable interfacing capabilities and the ability to run applications.

The currently preferred model is a hybrid three/four-layer architecture consisting of a mainframe at the centre, a middle layer of database and application servers (on the same or different platforms), and desktop PCs connected with a NOS (Network Operating System) running GUI (Graphic User Interface) client environments, EUC (End-User Computing) tools and applications. The key to this model is that it uses each platform for what it does best.

These considerations are pushing mainframe makers towards redefining the role of mainframes in terms of both hardware (more cost-oriented) and software (more open), as we shall see in the next paragraph.

3.1.1. Large-scale Systems

IBM is arguing that the Emitter Coupled Logic (ECL) bipolar technology used in mainframes over the past 15 years has had its day. It is too expensive to make and has limited development potential. As a result, all future IBM mainframes will be made using CMOS chips.

The leading IBM plug-compatible mainframe supplier, Amdahl, has reached the same conclusion. Together with its Japanese stakeholder, Fujitsu, it is also preparing parallel CMOS-based mainframes, although its development programme is thought to be two years behind that of IBM.

The only supplier still developing bipolar machines is Hitachi, although it will also supply machines based on IBM's parallel CMOS technology as a back-up.

On the other hand, CMOS is currently a lot less powerful than bipolar technology. A single engine CMOS system is rated at 12 MIPS (Mega Instructions per Second), whereas a single-engine bipolar system clocks up 60 MIPS. When the degradation of performance caused by coupling is taken into account, a six-way CMOS system is only as powerful as a uniprocessor bipolar system. However, the average increase in bipolar performance over the last few years has been 15–20% a year, whereas the speed of CMOS is doubling every 12–18 months.

For users in the right power bracket, CMOS systems offer clear advantages – far better price/performance, increased reliability (due to redundancy built into the design), and improved environmental factors (systems are about half the size and use 90% less electricity).

The traditional approaches to parallel processing are Massively Parallel Processing (MPP) and Symmetric Multi Processing (SMP). With MPP designs, each processor has its own memory and storage – no resources are shared – giving complete scalability. However, all applications have to be rewritten because there is no single system image. With SMP designs, the processors share memory to create a single system image that allows applications to run unchanged, although there is a performance penalty each time a new processor is added.

IBM's approach to parallel computing is a cross between the two. It centres on groups of S/390 CMOS processors (ten being the largest today) closely linked under one operating system image, sharing memory. On top of this is another layer of memory – essentially a combination of microcode and hardware housed in a separate box – called the coupling facility.

This coupling facility is the system manager and operates as an extra level of cache memory that can be linked to the memory of the other processors by means of a high-speed bus. This enables the software subsystems to view the parallel processors as a single system, and allows the existing application software to run unchanged.

On the software side, IBM will replace the MVS/ESA operating system and its 30 related software products with a single, integrated mainframe operating system, almost certainly to be called OS/390.

The bundled components will include Posix extensions, TCP/IP (Transmission Control Protocol/Internet Protocol), Distributed Computing Environment, Distributed File System, Network File System, and LAN Server, plus Systems Object Model run-time and application class libraries.

The new operating system will also have optional functions such as an application development environment for mainframes supporting C and C++.

3.1.2. Medium-/Small-size Systems

The main components of the medium-scale area are relatively stable: Unix-like systems on one side and IBM AS/400 on the other. The difference in relation to large-scale systems is more subtle in terms of power and capacity, and also in terms of role.

But the differences are also blurring in the lower segment of workstations, LAN servers and PCs: the trend is to make a distinction on the basis of functions rather than hardware architecture, and so Unix can run on PC, or Windows NT on Digital Alpha, depending on the needs.

3.1.3. PCs

PC hardware architecture is evolving relatively slowly (in order to permit backward compatibility) but at a constant rate (in order to be able to keep up with the rapid evolution of other components, such as disks, CPUs, communication and multimedia devices, and so on). The key technological trends in this area are discussed below.

3.1.3.1. Plug and Play

All of the signs point to the widespread adoption of PnP (Plug and Play) throughout the industry in 1996. PnP is a specification that allows system self-configuration involving BIOS (Basic Input/Output System), operating system and device. A similar concept has been in use on Mac systems since 1980s. With the availability of Windows 95, almost all hardware manufacturers in the PC area are upgrading their products to support it.

3.1.3.2. USB, Universal Serial Bus

This is an external I/O interface expected to appear in some commercial systems in 1996. It offers a maximum band-width of 12 Mbps, enough to handle all kinds of device, from mouse or keyboard to video monitors, printers and so on. USB is both asynchronous and isochronous; isochronous transfers get top priority, assuring that time-sensitive data streams are not interrupted. USB can handle 127 devices connected in a tiered-star topology, and each device can house a USB hub to which additional devices can be connected. Cable segments can be up to 5 metres long. It supports hot-plugging, and so it is possible to add or remove devices without powering down the computer. In PnP-ready systems, the appropriate device drivers can automatically load and unload. USB logic will soon be integrated in a Peripheral Component Interconnect (PCI) chip set, so the only additional cost of USB implementation will be for the external connector (four wire).

3.1.3.3. SCSI, Small Computer System Interface

Since 1986, when Apple standardized on SCSI, this cross-platform interface has grown in popularity thanks to the possibility it provides of connecting a large variety of devices (hard disks, optical disks, CD-ROM, scanners, printers, etc.). But SCSIs have some well-known problems: they support only eight devices per chain and need terminations at both chain ends (the main cause of malfunctions), the connectors are large and expensive, each device requires a unique ID number, and no hot-plugging is allowed.

The proposed SCSI-3 standard allows more than eight devices per chain, automatic ID assignment, and faster throughput. So SCSI will continue to be a valid alternative to the emerging new bases over the next few years.

3.1.3.4. UMA, Unified Memory Architecture

Since the beginning of the PC era, the frame buffer (the memory in which the screen image is mapped) has been separate from the main memory. But the early PCs had monochrome and character mapped videos as against today's "true colour" and high resolution GUI and so, as the frame buffer has grown from 2 KB to 2.25 MB (24-bit 1,024x768), there is a waste of memory if a lower resolution/colour depth is used. UMA unites the frame buffer and the main memory, allocating the amount of memory required to handle the current screen mode and leaving all of the remaining RAM free for use as main memory. UMA-compliant chip sets from some major producers are expected to be on commercial PCs in early 1996. Although this solution should decrease the cost of systems by about $ 50, there will be a 5% drop in the performance level of a 16 MB system. For this reason, the solution will initially be applied to cheaper PCs.

3.1.3.5. Peripheral Devices

There are no significant new developments in video display or printer techniques: prices continue to fall at the same time as there is an increase in the number of functions, colours and resolutions available.

Of interest is the growing spread of the use of scanners (and consequently of OCR - Optical Character Recognition - software), due to the fact that their prices are low enough to make them a normal office accessory, especially in the black and white version.

3.2 High Capacity Mass Storage Technology

The development of new information storage systems and devices is a key factor for the overall evolution of information systems.

Table 3
Key Characteristics of Storage Media

This is driven by two parallel trends:

- the continuous development of new storage devices and technologies;
- the development of new logics for storage management.

The main development aspects of the former are the use of magnetic and optical techniques, the reduced size (particularly encouraged by mobile computing) and increased capacity of the devices, and their lower cost.

The main aspects of the second concern distributed storage logic and *Hierarchical Storage Management (HSM).*

Many scenarios can be proposed:

- after their real take-off as a replacement for *Floppy Disk Drives (FDDs),* optical disks undergo further study and a real increase in density may be achieved on both read only and erasable disks;
- applications may be sold on *CD-ROMs (Compact Disks with a Read Only Memory);*
- tape (even of the non-removable type) may offer in-board archiving memory.

In any case, access time will become less important as computation requires less assistance from mechanical memories; the key point will be the transfer rate and the time needed to load an application (and unload the result before switching off).

Table 3 and *Table 4* show the key characteristics of the most innovative storage media and products available on the market.

3.2.1. Magnetic Media and Devices

Magnetism has been to mass storage what silicon is to computing. Its strong points are that it is a low-cost, high-quality medium offering infinite cycling possibilities, and that it is a low-cost light transducer.

Medium	Price/MByte	Access time
Solid-state	$ 60-100	less than 3 ms
RAID	$ 2-10	9-20 ms
Hard drive	$ 0.8	9-20 ms
Optical (single)	$ 1-4	50-100 ms
Optical (jukebox)	$ 0.4-1	15-30 seconds
Tape (single)	$ 0.4-2	30 seconds to 3 minutes
Tape (robot)	$ 0.05-1	1-5 minutes
Tape (archived, off-site)	$ 0.05	Hours

Reduced DSP costs, and the complex operations that a magnetic disk driver has to perform when archiving large amounts of information (particularly in the case of multimedia information), are driving the implementation of intelligent drivers with their own specific operating systems.

PRML (Partial-Response Maximum-Likelihood) is a digital signalling technique that allows more information to be packed into each track of a drive, filtering out the noise associated with densely packed data. This increase is up to 50 percent on conventional heads and magnetic media, but can reach 100 percent if it is coupled with digital techniques for aligning the drive head over the correct track, thus allowing more tracks to be packed on each platter and, of course, halving hard disk storage costs.

3.2.2. Optical Media

The challenge facing optical storage is not so much access time but data rate. Today's data rate for a reasonable loading time of ten

Product	Description	Availability
Low-cost CD-recordable	drives under $ 1,000	1995
Rewritable CD-ROM	Phase-change technology	1996
Mini-disk MO	$2^1/_2$ inch 140 MB	1995
High density $3^1/_2$ inch MO	650 MB	1996
$5^1/_4$ inch 4X MO	5.2 GB faster access	1996
100 GB digital linear tape	Half-inch DLT cartridge	1996
Tape mini-loaders	4 mm DAT robot	1995
New technology prototype tape	IBM 3490 half inch cartridge	1995
Non-tracking tape	1.2 GB	1995
1-inch hard drive	1 GB	1998
$2^1/_2$-inch hard drive	Up to 5 GB multidrive	1995
Compact flash solid-state	32 MB EEPROM	1995
Cached actuator storage device	Solid state cache at actuator level	1995
Network storage appliances	Devices with 16MB RAM Cache, 2 GB disk cache and 60GB optical juke-box	1995

Table 4
Key Characteristics of Innovative Products for Data Storage

Source: Strategic Research Corp.

seconds is 10 Mbits/s; in the year 2000, the required data rate will be 1 Gbit/s or, at 50 Kbpi, a cumulative head to media speed of 500 ms which can only be obtained by taking advantage of the ability of optical techniques to read dozens of tracks simultaneously.

CD-ROM is playing a key role, particularly in multimedia applications. *WORM, Write Once Read Many,* is no longer application-specific, but is still finding it difficult to become accepted as a data exchange medium, and *Rewritable Magneto Optic (MO)* disks are still trying hard to gain recognition as standard data exchange media.

Optical pick-ups can be distinguished by their function, or rather by the type of disk to which they are dedicated: read only, write once, phase change or magneto-optic.

CD-ROM performances are still far behind those of hard and magneto-optical disks.

Various magneto-optical disk formats are now available on the market: the smallest is a 2.5 inch disk, but they also go up to 5.25 inches. Maximum storage ranges from 140 MBytes to 1.3 GBytes.

3.2.3. Storage Management

Storage management is no longer only concerned with technology and the device itself, but also with the set of different media that can (and must) be used smartly in order to satisfy the need for very fast access and retrieval, and the availability, reliability, flexibility and low cost per item of stored information.

The *Redundant Array of Inexpensive Disks (RAID)* is the first significant attempt to reach the goals described above. It provides various ways of improving reliability, availability and/or performance at a lower cost per MB than that of the classical single disk. There are six different levels of RAID (from level 0 to level 5), each of which has a different logical approach towards attempting to address a particular need, and may be hardware or software-based. The hardware implementation of RAID is more expensive than that based on software, but it offers better overall performance.

Here is a brief description of the six levels:

- Level 0 - Disk striping: the data is divided into blocks and spread throughout all of the disks in the array - Best performance but not fault tolerant.
- Level 1 - Disk mirroring: provides a redundant, identical copy of a selected disk - Space consuming.
- Level 2 - Implements redundancy with error correcting codes requiring more than one disk - Little used because it is not very efficient.
- Level 3 - The same as level 2, but the error-correction method requires only one disk for parity data - Good overall performance and fault tolerance.
- Level 4 - Similar to levels 2 and 3, but separates data from error-correction data - Little used because it is not very effficient.
- Level 5 - Striping with parity: The same as level 4, but the parity data are written on all of the disks - Best compromise between performance and fault tolerance.

A different approach is followed by *Hierarchical Storage Management (HSM)* which, at any given time, tries to use the most suitable storage medium for different types of information (depending on the frequency of access, the speed required and the storage layers available).

The main goals of HSM include:

- support for an unlimited number of layers in the media hierarchy;
- media independence;
- a rules engine that supports capacity and time thresholds, exceptions by file type and forced migration;
- optimized migration to create a minimal need for recall;
- the ability to recall files quickly and automatically;
- support for data typing when it exists in operating systems;
- fast data recall.

HSM is a technology that is well known to the mainframe community: inactive data are automatically transported from expensive hard disk drives to less expensive optical or tape storage devices, often in compressed form. HSM technology is now also available in the non-mainframe arena: most of the demand for HSM software is in UNIX and NOS environments.

HSM means that the data are always available to users, and that users do not have to change their normal procedures: they are simply moved to a cheaper and slower medium when not used for a given time, but remain addressable. HSM is an automated process that satisfies the never-ending demand for disk storage.

The classical HSM approach (normally used on mainframes) is to move the data from a non compressed form on fast media (high speed disks or RAID) to an intermediate compressed form on a cheaper direct access device (a magnetic or optical disk), and then to a robot tape cartridge from which they are finally archived off-line. A simpler two-level solution is to move the data from a hard disk or RAID directly to an automated robot tape.

HSM is totally different from backup-restore procedures and does not replace them: off-line storage is still considered a unique and addressable extension of the primary on-line storage, whereas backup only involves the periodical copying of data.

4. Software Technologies

The software context continuously provides an unending stream of innovation, with each new development generating others in its wake.

Three strictly related and interdependent paradigms represent the kernel of the new developments:

- object-oriented software technologies;
- WEB and hypertextual logics;
- rapid development applications and visual-oriented development environments.

Two further areas of innovation are the evolution of both warehouse/multidimensional and object-oriented databases (OODBMS).

The consolidation of the Internet (for details see section 7.1.) and the reusability of software components are going to activate a new „paradigm shift" in software development. Although a number of problems, such as real availability, correctness and security still have to be resolved, the ability to develop application programmes by assembling modules selected from among the billions available worldwide (and in some cases running in their locations and linked together in the form of hypertextual programmes) should revolutionize software development methods, logic, times and costs.

A great deal is also being done in all fields of software technology standards, particularly in relation to software total quality and control metrics.

4.1. Systems Software and Utilities

These primarily include the strictly related software governing operating systems, system utilities and system management. The products on the market often include all of these functions in a single package; others support only one of these functions but are "portable" and "scalable" on various platforms, from PCs to mainframes.

The megatrends in this segment are:

- the very wide acceptance and diffusion of the concepts of "openness" and "client/servers";
- increased functional power, with some mainframe functions now being available on servers;
- a very high degree of cross-platform scalability;
- ease of use;
- low price/performance ratio.

Two key technical innovations are being driven by the forthcoming market opportunities: "consumer-oriented" and "enterprise-oriented" systems.

The key elements of the first include very friendly "visual" interfaces with multimedial functions, their very low cost, the simplification of all operations, and the fact that they are very easy but sure and reliable to use; for the second, all these features are necessary, but there is also a need for high level security, availability and reliability as well as a high degree of scalability and portability on different platforms.

4.1.1. Operating Systems

PCs and workstations play a central role, both as driving forces in IT marketing and as key elements in the development of information system architectures (now based on client/server, distributed, open logics). It is therefore in this area that the greatest efforts in terms of

innovation are being made and it is here that the battle for market dominance is being fought. But enhancements and innovations are also blooming in the area of small/medium-sized and large computers.

The present rapid evolution of operating systems is based on:

- the microkernel approach;
- the widespread use of object technology;
- greater independence from hardware platforms;
- plug and play logic;
- the adoption of new security mechanisms built into the OS kernel;
- the logic of "openness" with the availability of different protocol piles that allow the interoperability of different environments on different communication networks;
- the conversion to a new generation of CPUs (in the different areas, from 16 to 32 and from 32 to 64 bit CPUs).

Microkernels are the essential core of almost all operating systems. The microkernel isolates all hardware-dependent characteristics and is therefore portable to the different nodes of a multiprocessor or distributed system. Conceptually, with the exception of the microkernel itself, the largest part of an operating system runs as a highly flexible application, with the microkernel substituting horizontal for the traditionally vertical stratification of functions. Microkernel logic has already been adopted by the latest advanced operating systems; furthermore, the use of objects (which fit very well with microkernel logic) provides operating systems with inheritance and polymorphic features and allows the "dynamic binding" of the required functions at any specific run time.

Figure 1 shows the foreseen scenario of the dominant operating systems over the short and medium term: the most significant elements are the big increase in the use of Windows NT, the substantial maintenance of the position of Unix and the drastic reduction in IBM mainframe operating systems. This last fact confirms the changing role of the "classical" mainframes, which will survive as specific database servers and/or mission critical holding hosts.

4.1.1.1. PC and NOS

In the OS battle for PC and NOS (Network Operating Systems), the technological reference point is Microsoft, whose Windows environments now also condition the Unix world, which is the key pillar dominating medium-scale systems: the main competitors include IBM, Apple, Novell and Sun.

By definition, 1995 was the year of Windows 95, the Microsoft OS that acts as a bridge between the old DOS (the 16-bit world) and the "new" 32-bit NT environment.

Microsoft's NT Server is going to attack Novell's market leadership in NOS, particularly because of its multiplatform hardware support, its ability to be an applications server, its common interface with the client side, and the very rich set of functions built into the basic product.

4.1.1.2. Unix world

The evolution of Unix is mainly oriented towards covering all of the new platforms, and, on the market, it is taking on the role of database server thanks to the good support it provides for all of the most used DBMS.

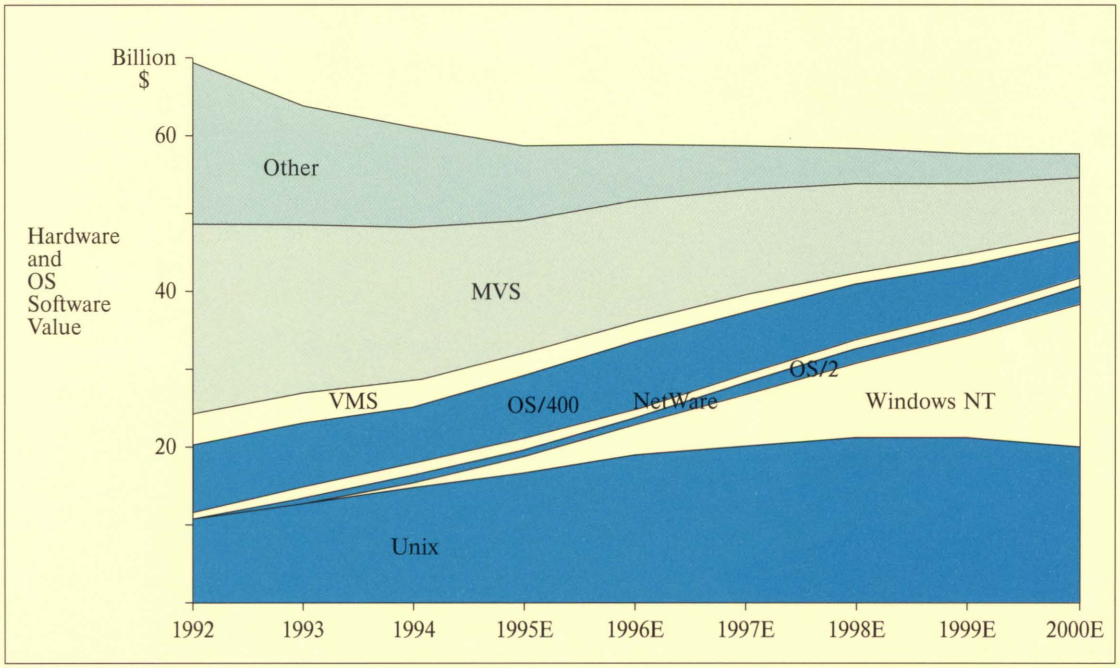


Figure 1
Worldwide Server/Host Spending by Operating System

Source: Gartner Group

Unix can now be used on almost all of the small/medium platforms, and it is penetrating further into the "traditional" mainframe world mainly for the purposes of networking and DBMS support.

Some Unix "products" are also consolidating their position in the PC/WS range, and are now also supporting and compatible with Windows OLE (Object Linking and Embedding).

In November 1995, Novell, SCO and HP signed an agreement in order to focus on a single Unix version for PC, WS and LAN Servers. This agreement could be a fundamental step in the evolution and consolidation of a real "de facto" standard for Unix, enhancing the R.4.2 with graphic interfaces and being compatible with the winning MS-Windows environment.

4.1.1.3. Operating systems for medium/large systems

The evolution of „proprietary" operating systems for medium/large systems is mainly based on:

- the support of the new RISC multiprocessor architectures;
- multi-thread and object logic;
- compliance with DCE (Distributed Computing Environment) architecture [DCE];
- scalability and the portability on different platforms.

Almost all of the main medium/large system manufacturers are providing both proprietary and Unix OS for the same hardware platforms.

4.1.2 System Management

The growing complexity of each single system, and the the rapid penetration of distributed computing by means of LANs and WANs, require efficient, flexible and powerful tools for the control and management of the increasingly "network-centric" global system.

As described in previous EITO reports (see [EITO 93], [EITO 94]), the ISO NMS (Network Management System) for the OSI (Open System Interconnection) reference model and the TCP/IP SNMP (Simple Network Management Protocol) are the "de jure" and "de facto" standards, even if the majority of the products on the market are "proprietary". For the distributed environment, the OSF DME (Distributed Management Environment) within DCE (see [EITO 95], [DCE], [DME]) is still the main reference point.

From a functional point of view, the key areas for improvement are configuration and change management, operations and problem management, performance management and, last but not least, security management.

The innovations in this area are mainly related to the widespread use of:

- graphic interfaces and high quality geographic maps;
- "intelligent logic", such as expert systems and fuzzy logic, for problem determination and problem solving;
- the logical and functional integration of network and systems management;
- the key role of centralized or distributed directories that allow end-users to search for the required information on remote users and resources: the reference standard is the X.500 Recommendation;
- powerful and increasingly automated help desks, whose role will become a vital component of the greater pervasiveness of information centres and the growing shift to outsourcing.

Security is becoming an increasingly more significant aspect of distributed environments, and the growing user acceptance of electronic commerce, EDI, public administration services, etc., requires secure transactions. Both OSI and DCE refer to security, with OSI detailing the "architectural" services and mechanisms and including security management as one of the five NMS System-Management functional areas: configuration, fault, performance, accounting and security management.

Clear authentication of the interlocutors and the exchanged messages is one of the key needs that can be solved by means of techniques and mechanisms such as digital signs, symmetric and asymmetric (public key) cryptography, chip/smart cards and biometric controls for user identification.

4.2. Application Tools

Innovation is being driven by object-orientation, visual programming, the use of client/server architectures and relational databases, increased levels of tool integration, interoperation, reuse, and maintainability. "Faster and cheaper" is the peremptory demand of developers and the objective of the new efforts being made in the direction of *RAD, Rapid Application Development:* object technology, the reuse of software components and worldwide access to an enormous number of component warehouses (see section 7.1. for the Internet phenomenon) are already allowing, and preparing for the near future, a real paradigm shift in software development and significant CASE enhancements.

RAD tools provide developers with everything they need to build a prototype and transfer it to "production": i. e. into a fully functional and operational application and environment.

Design starts from the interface, assembling windows, menus, buttons, etc. in a visual fashion. All of the "elements" are graphic, self-explanatory visual icons, and the developer simply "assembles" the available components (normally objects): only a few high level programming statements need to be written, and this obviously leads to an enormous reduction in programming and debugging times. The design process for software development is also changing, moving from the traditional, rigidly top-down approach (request analysis and goal definition, detailed functional specification and system design, programming, testing and debugging, and then the move to production) to a less sequential approach: interface design at client level and "engine" design at both client and server levels can be done in parallel and independently, using a prototype-like approach, and when everything has been fed back to and approved by the end-user, these macro-elements can be integrated, tuned and then passed into production.

One interesting aspect is that the "development and test environment" is always at a PC or LAN level, even if the final software is to be run on a different system with a different size and a different OS (for instance, a mainframe). A second aspect is that this development environment works at a higher level of abstraction, using visual aids built on top of both "traditional" (such as Cobol or Pascal, object-oriented or not) and new languages such as C++ or Java.

4.2.1. The Consolidation of Object Technologies

EITO 95 contained a detailed analysis of object-oriented technology and made a technical comparison of the different approaches of manufacturers such as IBM, Microsoft, Apple, Next and HP.

One year later, the situation has not radically changed, and more or less all the actors are still playing on the stage: there is still no single winner, although, thanks to the general acceptance of the OLE interface, Microsoft is broadening its use for Windows and client/server applications.

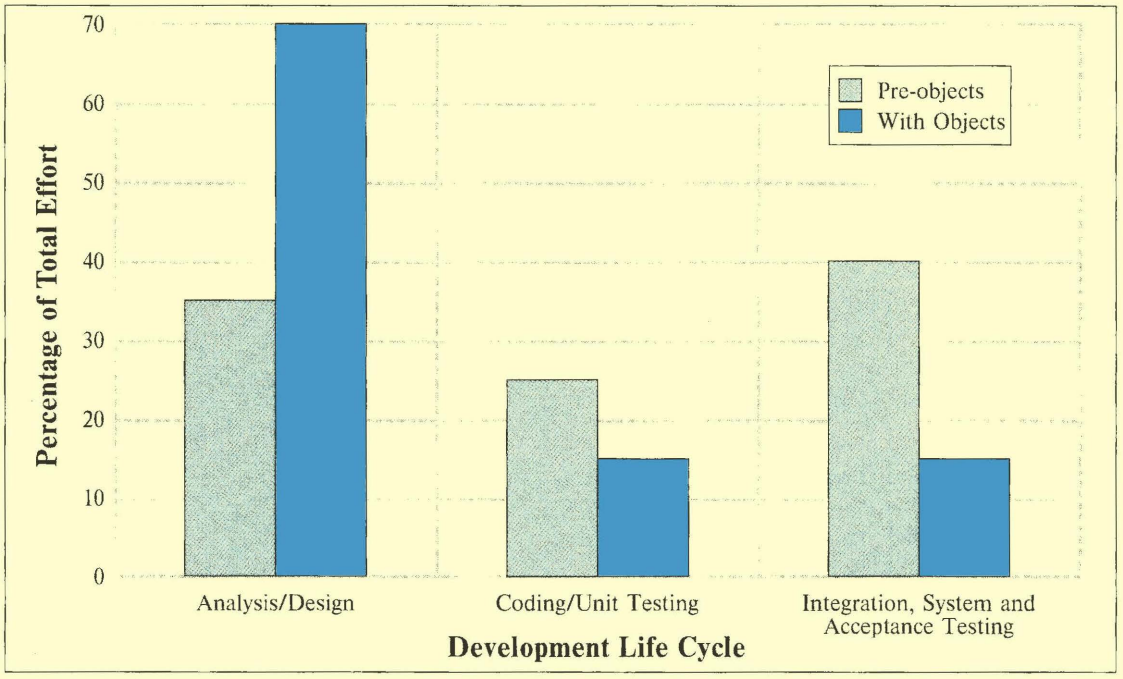
What is sure is that object technologies are not just the latest transient fashion, but a real "revolution", which represents a paradigm shift that all the ICTs have to deal with. *Figure 2* shows a comparison between "traditional" software project and development and OOA and OOP (Object-Oriented Analysis and Programming).

It is significant that Cobol will also soon have its OO release: ANSI released its first draft proposal for OO Cobol (X3.J4.1) in 1993, and it is expected to be standardized in 1997. In the meantime, some compilers of OO Cobol appeared on the market in 1995.

4.2.2. Databases, Data Warehouses, Multidimension Databases and OLAP

Relational database vendors have added some features to their products to compete with ODBMSs (e. g. the ability to store the Binary Large Objects, BLOBs, necessary for multimedia applications). The basic difference between relational and object databases will remain: relational databases handle large amounts of data well, but not complex relationships; and object databases do well with complex relationships, but do not yet scale up sufficiently well to handle large volumes of data.

Figure 2
Effort Shifts to Analysis and Design



Source: Gartner Group

The definition of "data warehouse" was first introduced in 1981, but the concept has only recently actually been implemented in business contexts.

A *data warehouse* contains "historical" data relating to the global business and life of a company, which can be searched in a friendly manner and is useful for decision making. Inmon characterized a data warehouse as a collection of data strictly related to subjects and not to applications (i. e. for an insurance company, data structured by customer, premium and claims instead of products such as car or life insurance policies), which is integrated, non volatile, chronology-dependent and structured in order to support current management needs.

As the data are rarely updated (any new data normally being added to what is already stored), they are therefore only "read" (thus giving them their "non-volatile" characteristic). The data are normally collected from different "current" databases that are frequently updated on-line, which means that their content (often coded in different ways) has to be made homogeneous in order to guarantee the integrity of the information stored in the data warehouse.

Typical data warehouses are "corporate databases" concerning sales, marketing, finance, manufacturing and human resources.

For decision makers, simple information on monthly revenues or invoicing is no longer meaningful: they need to be able to break down turnover by geographical regions, industrial areas, direct and indirect channels, individual products and salesmen, etc. The user of such databases needs to be able to make very complex inquiries that are very often different from one another in a simple manner and with very good response times. As a result, these

archives are now implemented by means of "multi-dimension" databases and some of the searches are made by means of On-line Analytical Processing (OLAP).

The very large amounts of data typically stored in data warehouses are also supported by specific "data base servers" based on massive parallel processing.

Multi-dimension databases are a specific evolution of "traditional" relational databases that are capable of providing the functions and performances described above.

A multi-dimension database is based on a set of relational structures that build up a complex matrix of multiple discrete dimensions, with the data required being found at the crossings of the dimensions. In the case of a business application, the dimensions might be time, locations, vendors, products, advertising tools, and so on, with the values being budgets, forecasts, invoices, revenues, etc.

As each dimension might be an elementary item (for instance, a specific vendor) or a composite item (such as a location identified by country, region, province and municipality), the number of crossings can be very high, thus making it necessary to be able to manage them in an intelligent way, perhaps by eliminating those that are not meaningful: a vendor can be active only in some areas, some products are sold only by some channels, etc.

A multi-dimension database organizes data by means of quantitative and measurable values (such as numeric values) and descriptive items (such as the colour of a product). This structure can be logically seen as a "cube" (or "hypercube"), with each face representing a "classification category". "Data pivoting", or the ability to rotate the (hyper)cube, allows users to select rapidly different views of the required information: for instance, year-by-year comparisons of results, the classification of the "top ten" considered items, the ranking of best/worst performances, etc.

The main goal of a multi-dimension data base, which operates mainly on historical data and uses very large amounts of memory (much more than a relational data base), is to provide an immediate answer to any request within the considered variables and dimensions.

On-line Analytical Processing (OLAP) includes all of the techniques oriented towards the querying and analysis of historical data, thus making it very different from On-line Transaction Processing (OLTP), which is strictly oriented towards the continuous updating of transactional data.

OLAP is normally based on multi-dimension databases that constitute a data warehouse supplied by a number of "traditional" databases. OLAP ensures that end-users can analyse the data without the need for special developments.

Multi-dimension databases and OLAP are therefore strictly interrelated concepts characterizing a data warehouse. At present there are no "de jure" standards and all of the marketed products are "proprietary", the most important deriving from large traditional relational DBMS.

Some of the products are software based and can be transported to different platforms and used in a client/server or "distributed" context; others are "ad hoc" server systems based on specialized and highly reliable high-performance computers and often based on multiprocessor architectures.

4.3. Fuzzy Systems

Although introduced by L.A. Zadeh as long ago as 1965 [ZADEH65], fuzzy logic is only now beginning to be widely used, often together with neuronal networks (see EITO 93) and probability theory, for the development of fuzzy systems: i. e. very intelligent systems capable of exploiting their tolerance of imprecision and uncertainty, learning from experience and adapting to changes in course.

Fuzzy systems are good for solving complex problems that involve intuitive thinking.

Fuzzy systems, which include fuzzy sets, logic, algorithms, models, software, processes and controls, provide concepts and techniques that minimize the precision needed to perform a given task. They try to follow the human ability to use approximate rather than exact methods of reasoning, and their development is now increasing in a large number of different application areas, from robotics to consumer electronics, from the automotive to the aerospace industry, and from medicine to economics.

In a broad sense, fuzzy logic is almost synonymous with fuzzy set theory insofar as it is based on classes with imprecise boundaries. Any crisp theory can be fuzzified by generalizing the concept of any set within that theory to the concept of a fuzzy set.

The kernel of a fuzzy system is that *the "values" are in the range [0.0, 1.0],* where 0.0 represents absolute falseness and 1.0 absolute truth: e. g. the statement: "Alex is young" can be assigned a truth value of 0.90 if Alex age is 6 years old. And this leads us to the concept of a *fuzzy set,* which is a generalization of an ordinary set by allowing a degree of membership for each of its elements. In the example of the age of a set of people, the following *Table 5* associates a degree of "youngness" to each element:

Table 5
Fuzzy Set

Name	Age	Degree
Mark	45	0.1
Alex	6	0.9
Andrea	2	1

The membership functions of a set map each element to its degree between 1.0 and 0.0, and the statement „Alex is a member of the set of young people" can be rendered symbolically as:

$$m\ YOUNG\ (Alex) = 0.9$$

where m is the membership function operating in this example on the fuzzy set of young people. In a set of objects (X), each element can be described as x: $X = \{x\}$.

A fuzzy set A in X is characterized by a membership function mA(x) that maps each element to its degree in the real interval 0.0-1.0. As mA(x) moves closer to 1.0, the degree of membership of x in A increases.

Starting from this basic concept, it is possible to derive various operations and properties, many of which have their counterparts in ordinary sets, relations and logic.

Fuzzy logic is an extension of ordinary logic, just as a fuzzy set is an extension of an ordinary set. Like ordinary logic, fuzzy logic introduces the concepts of union (OR), intersection (AND), and complement (NOT). The degree of an element in a fuzzy set may correspond to the truth value of a proposition in fuzzy logic. Fuzzy logic defines fuzzy implications such as "if A then B" ($A \rightarrow B$), that are viewed as a relationship between two fuzzy sets (A and B are fuzzy sets). It is therefore possible to set the following formal definitions:

A is EMPTY if and only if (iff) for all x: mA(x) = 0

A=B iff for all x: MA(x) = MB(x)
(for simplicity mA = mB)

COMPLEMENT mA = 1 - mA

A is CONTAINED in B iff mA → mB

C = A UNION B, where mC(x) = MAX (mA(x), mB(x))

C = A INTERSECTION B, where mC(x) = MIN (mA(x), mB(x))

At this point, it is important to understand the difference between fuzzy systems and probability: both use the same numeric range and both seem to have the same values; but there is a big difference from a semantic point of view.

With the above example, probability logic refers to a 90% chance that Alex is young: vice-versa with fuzzy logic "Alex is a member of the set of young people" means that Alex is "more or less" young or some other qualifier whose value corresponds to 0.90.

UNION (OR) and the INTERSECTION (AND) represent an even clearer divergence from probability theory, where the OR operation is a sum and the AND operation a multiplication.

Another important element in fuzzy logic is the concept of *linguistic variables*. Returning to our previous example, "age" can be considered as a linguistic variable whose values of "young", "middle aged", "old", are defined by membership functions. A linguistic variable may be viewed as a form of data compression; it is referred to as "granulation" and is an instance of a fuzzy set with its *"hedge"*.

Some examples of linguistic hedges and their meanings are described in the following *Table 6* (from [COX92]).

Such "hedges" modify the fuzzy values while maintaining close ties to natural language through mathematical calculation.

about, around, near, roughly	approximate a scalar
above	broaden a fuzzy region
almost, definitely, positively	contrast intensification
rather, somewhat, quite	fuzzy region dilution
very, extremely	fuzzy region intensification

Table 6
Examples of Hedges

A simple example is to consider the statement, "Alex is very young". How can we calculate m"very" YOUNG(Alex)? The hedge "very" is normally defined as mA(x) ^2. Therefore, if m YOUNG (Alex) = 0.9, then m "very" YOUNG (Alex) = 0.81. Other examples are "more or less" or "about" and so on, that are normally calculated as SQRT(mA(x)).

Fuzzy control is a technique based on fuzzy inference which, given suitable inputs (typically, measurements from the system itself), is capable of determining the outputs for controlling a system.

A *fuzzy model* is an approximation of a fuzzy region in an ~M x N cartesian space, in which M is the number of fuzzy control variables and N the compatible domain.

In order to give an idea of a fuzzy system and the use of the above logic, we can look at a price-estimation model: the example (from [COX92]) considers a simple fuzzy model for establishing a price in a retail firm for a product with a manufacturing cost of about $ 12 and a competition price of $ 20.

Different and even mutually contradictory rules are required by the marketing, finance and manufacturing people: "Our price must be high", "Our price must be low", "Our price must be around 2 * costs", "If the competition.price is not very high, then our price should be near the competition.price".

Figure 3
Example of Fuzzy System

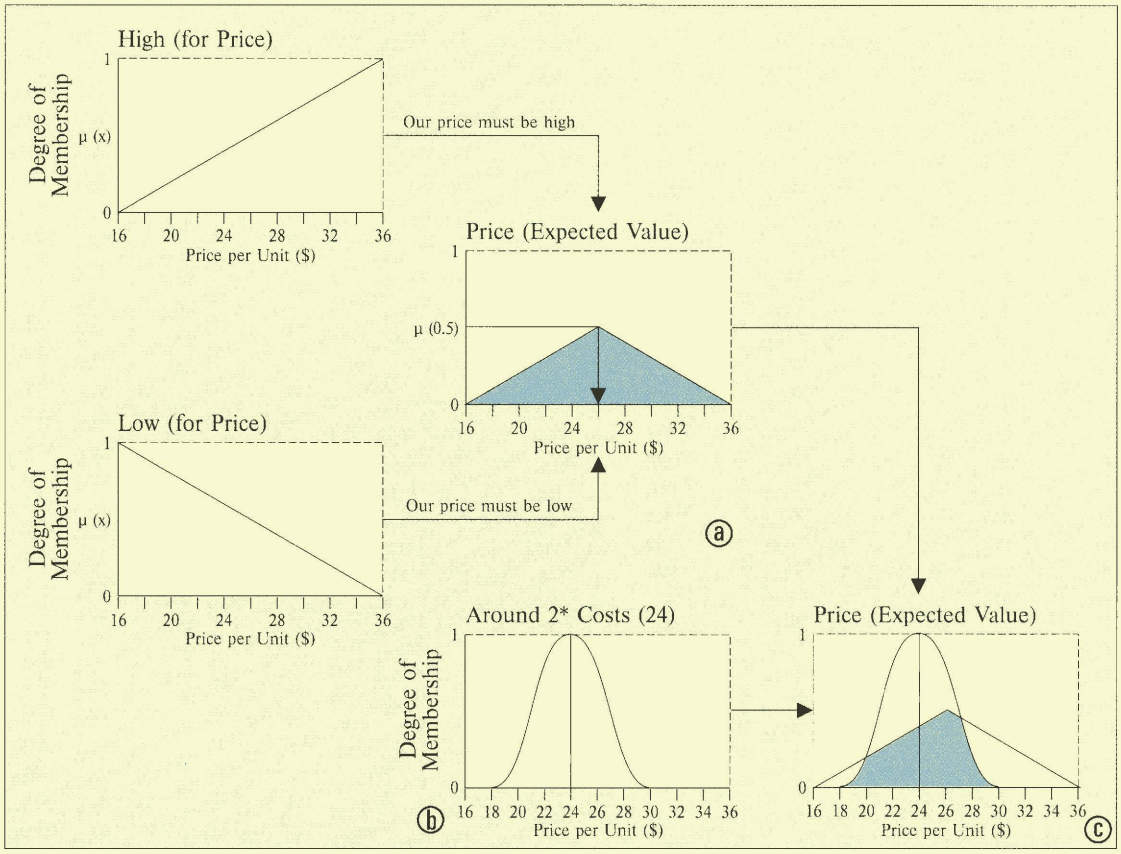


Figure 3ⓐ shows a temporary fuzzy region for "price" considering the first two contradictory rules. *Figure 3ⓑ* shows the application of the third rule, with a bell-shaped area centered around the scalar value (2 * 12): in *Figure 3ⓒ*, the minimum truth value at each corresponding point along the common domain is selected, restricting the possible solution area. *Figure 4* shows the application of the last rule. Some transformational operations are applied to satisfy the "hedge" of the conditional proposition, (i. e. "not very high"): for "very high", the membership function at each point in the set is squared *(Figure 4ⓐ),* for „not" it is complemented *(Figure 4ⓑ):* in the "not very high" degree of membership, the competitive price has a value of 0.48. The "near competition.price" hedge develops a bell curve centered around the competitive price of $ 20, as shown in *Figure 4ⓒ*. The shaded area in *Figure 4ⓒ* represents the final fuzzy space for the "price" variable. But in order to know the final value; it is necessary to *defuzzify* the fuzzy region. This can be done in various ways, and *Figure 4ⓓ* shows the two most commonly used: the "composite maximum" (see in *Figure 4ⓓ*) selects the maximum value in the region; the "centroid" (see in *Figure 4ⓓ*) selects a point representing the centre of gravity of the region.

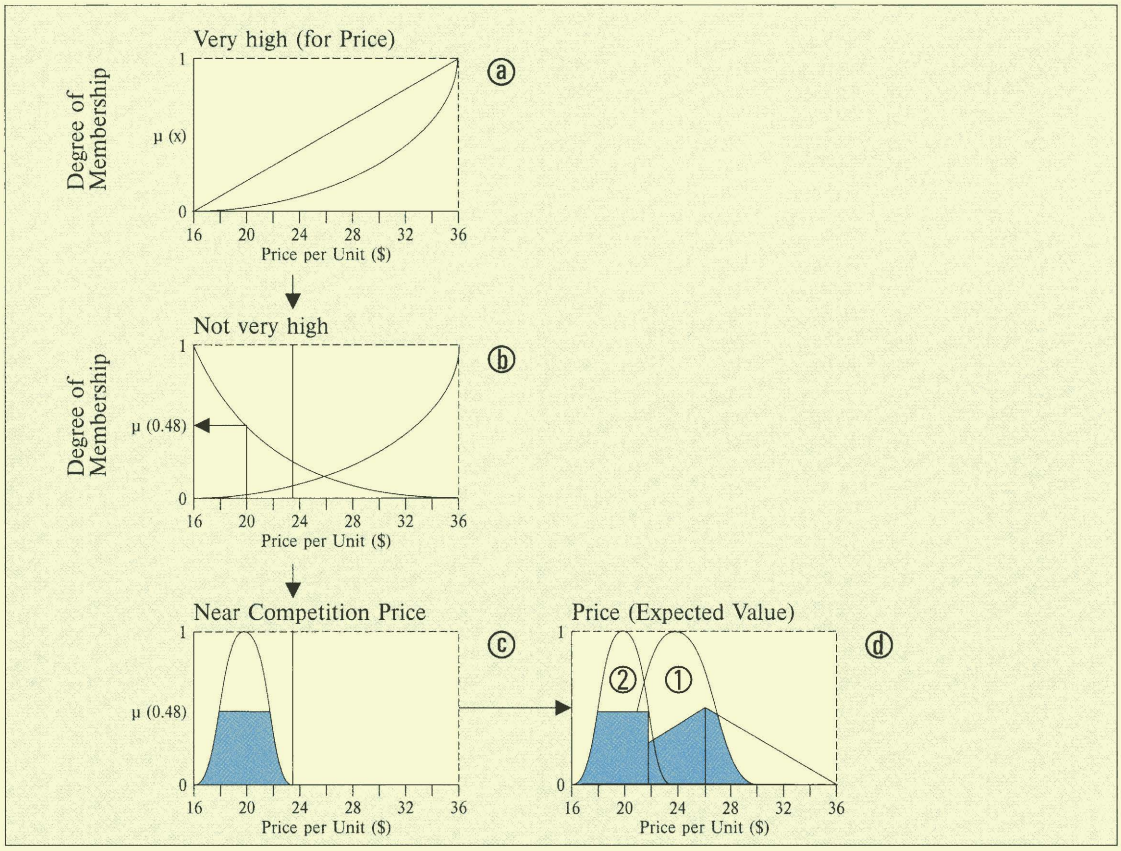


Figure 4
Example of Fuzzy System

As previously pointed out, the application of fuzzy systems is concrete and already used in many areas. The first real applications were introduced into the "decision support system" for operations requiring the dynamic management of several rules of thumb in chemical production control. Fuzzy systems are implemented by software, and often strictly related to expert systems and neuronal networks.

5. Telecommunication

In the present network-centred, mobile and multimedia context, TLC plays a core role and its related innovations have had a great impact on ICT environments.

The last EITO report provided a technical overview of high-speed communication techniques and protocols (see *Figure 5*), indicating the three main directions being taken in the evolution of TLC:

- *greater speed:* ATM and SHD have been confirmed as the leading technologies for WAN/GAN backbones and broad-band ISDN, and are also entering high speed LANs; narrow-

band ISDN is consolidating its position as the cheaper, basic communication service for personal televideoconferencing, CTI, data and voice integration, etc.; Frame Relay is the interface between LANs and long-haul nets; the use of coding and compressing techniques, such as MPEG-x, JPEG and some H-series CCITT Recommendations, is being broadened in the multimedia area;

- increasing *intelligence in the network:* the "information system" for network management and control is going to be the integrated net "core" bringing together different "commuting" technologies, and will allow an increasingly wide range of services: band-on demand, dynamic real-time end-user configurations, security, directory services, etc.;
- *greater ubiquity and mobility:* mobile communication and computing are changing both business and "consumer" ICT architectures, as well as the reference media, in relation to the present band allocation: ether for the interactive and short exchange of messages (GSM, PCNs, DECT, satellite); cables for all of the other services, including TV and movies. The Internet phenomena (see section 7.1.) and "superhighways" are paradigm-shifts for reaching the current goal of a TLC infrastructure capable of delivering all types of information anywhere by means of a friendly and cheap interface.

As discussed in section 7.1, the surprising evolution and spread of Internet is establishing a number of new logics and de facto standards (such as WEB and HTML), and is therefore leading the technical innovations in this field.

The "network-centred" evolution raises some key issues for distributed multimedia ICT: network management and security, and their relationship with system management, as also described in section 4.1.2.

Internet logics are profoundly affecting this world that, at the very least, has to deal with and be connected to the "net": a typical example is the firewall.

As the name suggests, a firewall is a hardware and software gateway system that provides suitable security for the traffic flying in both directions between the network/systems to be protected and the external world (typically the Internet). The USA National Institute of Standards and Technology (NIST) defines a firewall as "a collection of systems, routers, and policy placed at a site's central connection to a network" [NIST-SP]. Various types of firewall can also be implemented, by using a number of specific products now on the market: the simplest and most economic is a "packet filter" that selects the IP packet arriving at or leaving an external node by means of a predefined software-updated table. A more complex, but also more secure solution is the "application gateway", which only allows communication with predefined local and remote applications. Such a gateway acts as the "boundary" node for both the internal and external net, often with two different interfaces betweeen the two different worlds. The most sophisticated solution is to "duplicate" the gateway by creating a "subnet" that forms a "demilitarized zone" between the two nets.

Another significant trend is the mobile "client/server": highly mobile workers with suitable lap tops are the dominant sophisticated users of the new integrated services and distributed computing.

In the LAN area, the push for long-haul groupware and knowledge exchange is driving the development of "virtual" rather than "high speed" LANs (in *Figure 6* the set of IEEE 802 recommendations).

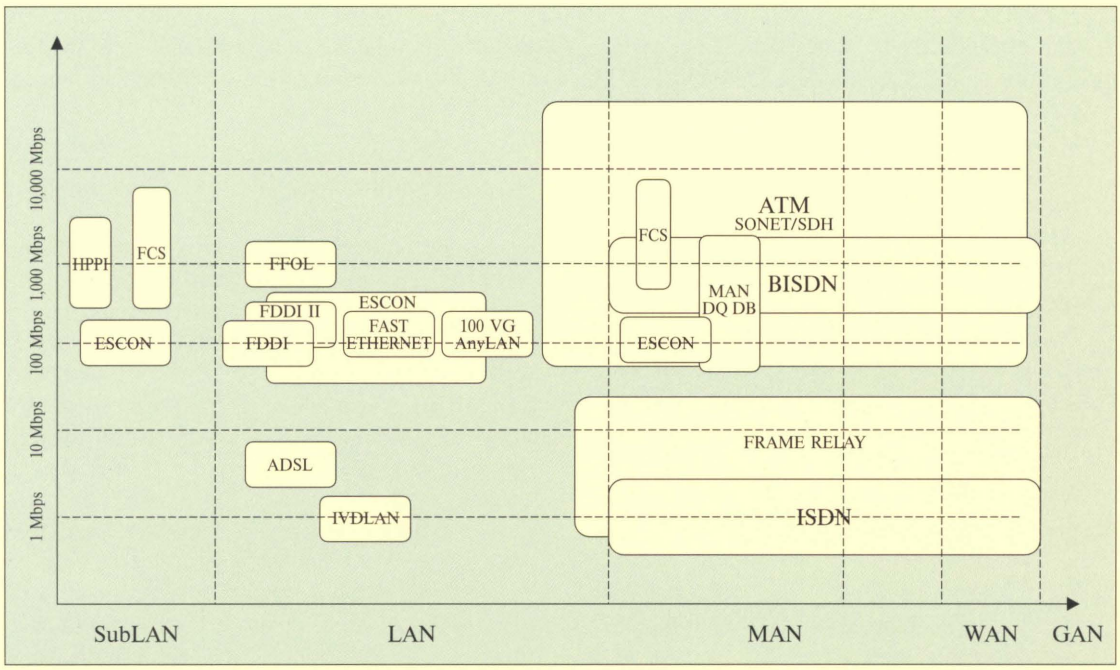


Figure 5
High Speed Communication Techniques

Source: SMAU

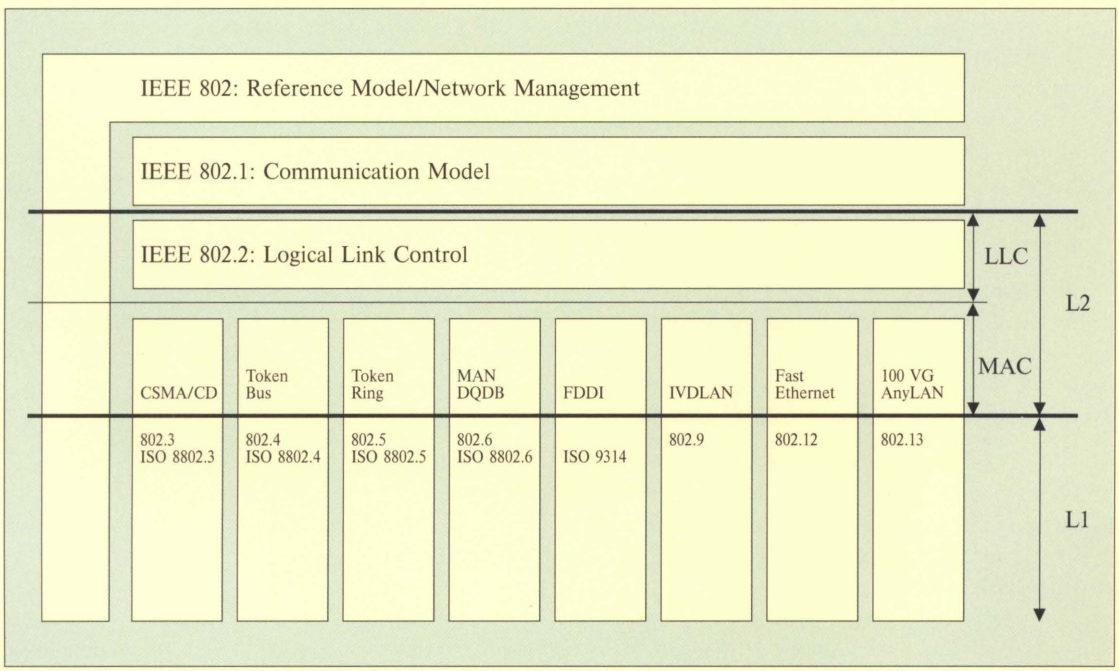


Figure 6
IEEE 802 Series

The concept behind *"virtual LANs"* is the possibility of interconnecting some remote LANs and workstations or personal computers over one or more WANs in order to create a single "logic" LAN capable of sharing information resources and providing real interoperability by means of software, without any drastic physical reconfiguration or changes in wiring closets.

A number of currently marketed products (in particular, intelligent hubs and routers) are now offering such a facility, even if each manufacturer has its own proprietary solution.

ATM Forum (the Association of ATM vendors and users) is also working on a specification for ATM LAN emulation that will be capable of defining virtual LANs over ATM nets.

5.1. CTI, Computer Telephony Integration

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.

CTI applications must not be confused with voice/data integration, even if they can also deal with such features: they normally use a PC to deal with input or output calls.

The PC is connected to the telephone socket and can provide interoperability, usually in one of the following configurations/architectures:

- Phone-centric *(Figure 7):* an external adapter links the PC and telephone set to the telephone line;
- Server-centric *(Figure 8):* a LAN communication server links PCs to a PABX/switch and is responsible for routing calls (third-party call control); it is mainly used for call centres and workgroups;
- Voice server *(Figure 9):* the dual version of the server centric configuration in which the LAN communication server deals with some telephone lines and it receives the voice or data calls but not the control and state links (just the opposite of the previous architecture);
- PC-centric *(Figure 10):* each PC has an add-in board that directly connects the telephone set and the line and is capable of emulating the telephone to the switch.

A key element of CTI is the API, Application Programme Interface: at present, there are no "de jure standards" and each manufacturer offers its own specific solution. Two solutions are currently emerging as de facto standards:

- TAPI, Telephone API: developed by Intel and Microsoft, it allows Windows applications to access voice services;
- TSAPI, Telephone Service API: developed by AT&T and Novell, it allows both PC to telephone equipment and PABX to Netware server connections.

ECMA, the European Computer Manufacturers Association, has defined the CSTA, Computer Supported Telephony Application, recommendation, which is a protocol for connecting a switch with a computer.

Voice/Data integration is an increasingly requested feature, that allows enormous reductions in communication costs.

Besides ISDN and broad-band ISDN-based equipment, there are now several products on the market capable of combining data and voice such as "integrated" multiplexers, routers and concentrators.

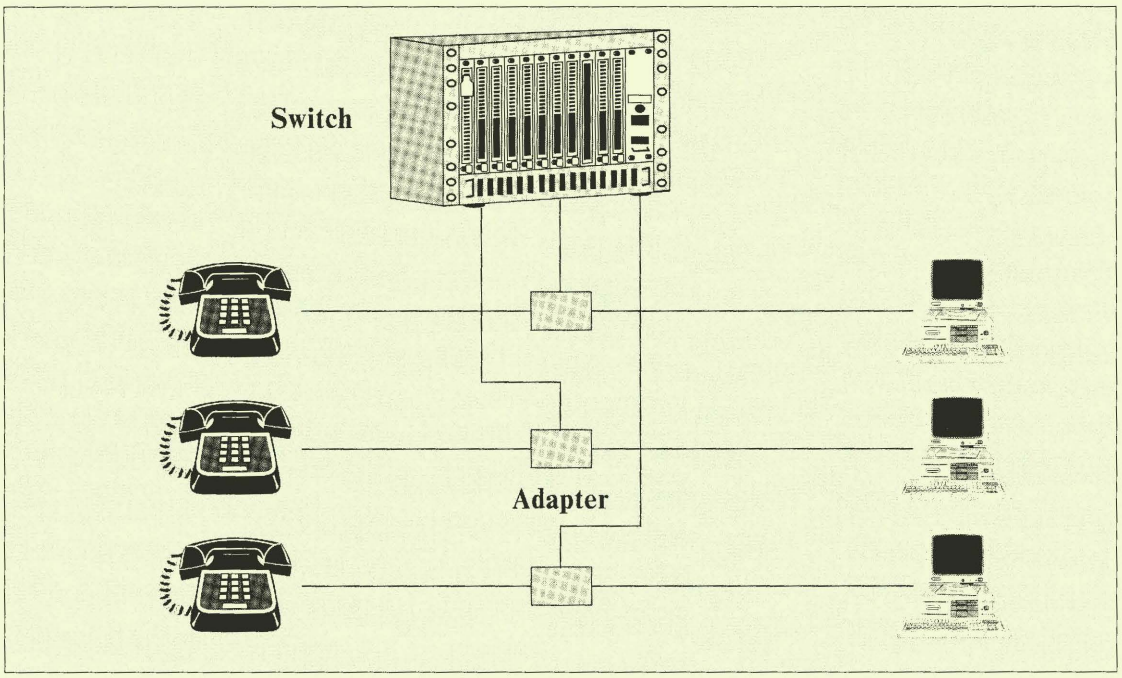


Figure 7
CTI
Phone-centric

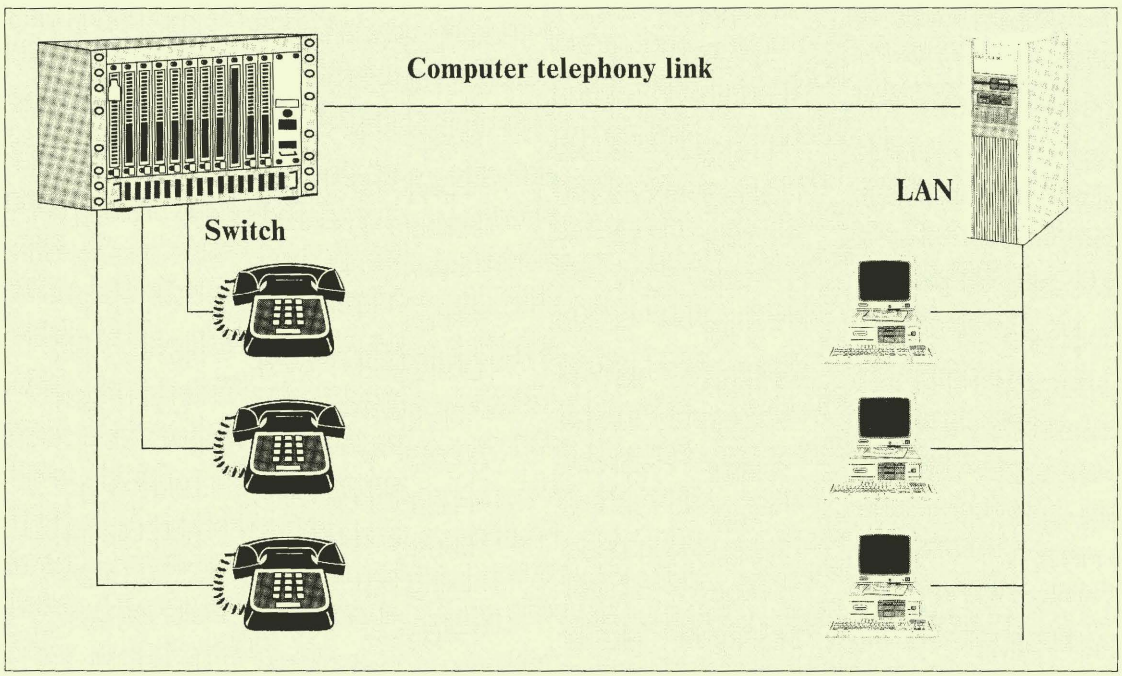


Figure 8
CTI
Server-centric

Figure 9
CTI
Voice Server

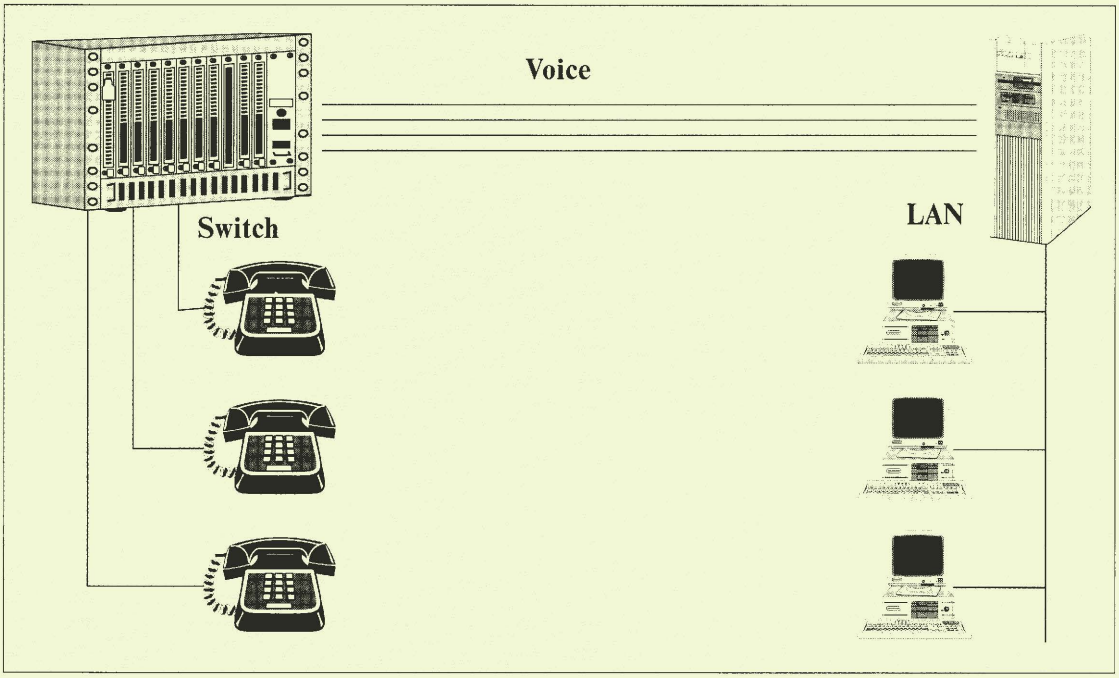
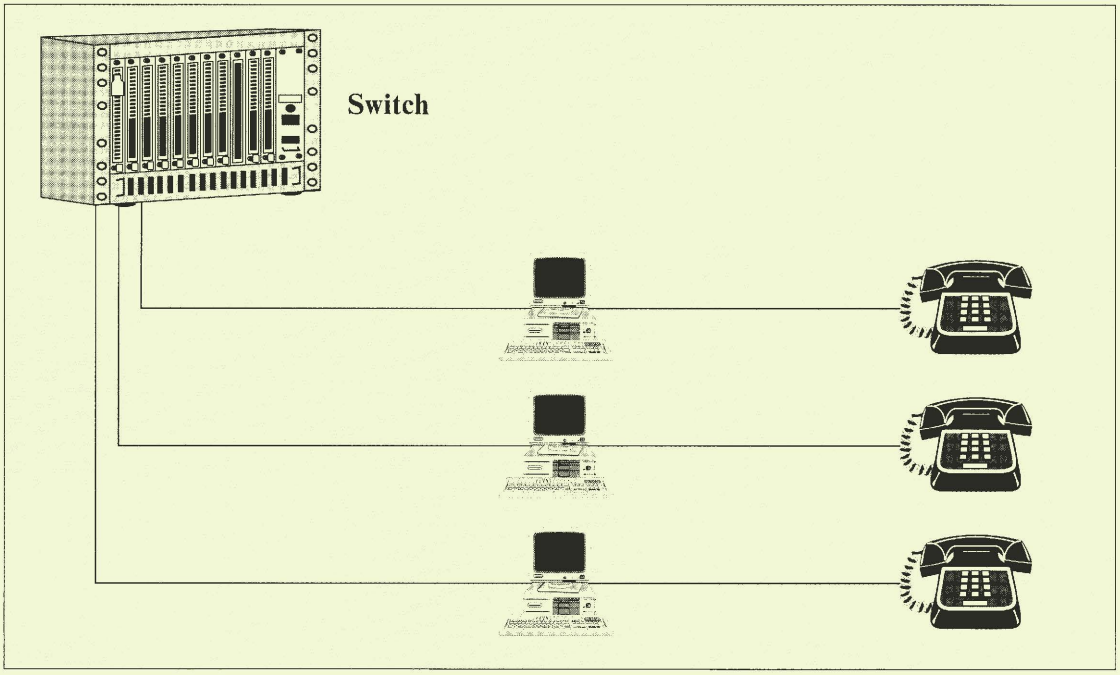


Figure 10
CTI
PC-centric



5.2. Digital TV and HDTV

Television is being revolutionized by what is widely known as High Definition Television (HDTV), whose key characteristics are:

- an image definition that is five times greater than that of traditional television;
- an image format of 16:9 (like that used for films) instead of the present format of 4:3;
- a viewing angle of 30 rather than 10 degrees, which allows the full immersion of the audience but requires flat and very large screens (wall-screens) that are still expensive;
- audio stereophony of CD quality;
- the elimination of existing defects, such as cross-luminance.

At the beginning of the 1980s, the HDTV proposed by the Japanese NHK was based on analogue technologies, which were also adopted by European countries and manufacturers. However, this approach failed and the real revolution has been the introduction of digital coding and related compression techniques.

Table 7 shows the main steps of this digital revolution in Europe, which involves not only HDTV but also all of the lower level standards.

The global framework can be summarized as follows:

- Digital Terrestrial Television Broadcasting (DTTB);
- Direct To Home (DTH) satellites, allowing 100-200 TV channels with digital standards;
- Video On Demand (VOD) and Near Video On Demand (NVOD) cable TV;
- twisted pair VOD;
- Fibre To The Home (FTTH).

VOD implies interaction between user and TV provider.

Table 7
HDTV Evolution

1980	The Japanese NHK proposed MUSE system HDTV based on analogue standard 1125/60, which was initially introduced in 1968.
1986	A MAC standard for direct broadcasting satellites proposed by UER
1987	Eureka Project No. 147 for digital audio broadcasting (DAB) with orthogonal frequency division multiplexing (OFDM) modulation
1988	Eureka Project No. 256 for digital compression techniques
1990	Eureka Project No. 625 for MPEG 2 standardization of high quality audio-video signal compression
1991-92	Start up of the Race 813 Project for HDTV using digital terrestrial television broadcasting (DTTB) and other media

NVOD repeats the same programmes every 10 minutes on various TV channels, statistically allowing the beginning of the selected programme to be seen with an average maximum wait of five minutes.

The key standards for digital TV are:

- MPEG-2 for image compression, that allows HDTV digital images to be compressed in less than 30 Mbps;
- OFDM modulation (except for satellites, which will use 4 PK and/or 16 QAM modulation techniques).

The system guidelines include:

- the digital TV signal hierarchy: "low" definition (LDTV) at 1.5 Mbps, "standard" definition (SDTV) at 5.5 Mbps, "enhanced" definition (EDTV) at 11 Mbps, and finally HDTV at 30 Mbps;
- multilayer (or embedded) signals: depending on the prime time and the type of programme, it is possible to transmit two or more lower level signals instead of the higher one;

- signal scalability: signal reception gradually decreases from the primary to secondary geographical areas.

For DTH satellites, two bandwiths are considered:

- the Fixed Satellite Service (FSS) at 10.7-11.7 and 12.5-12.75 GHz;
- the Broadcast Satellite Service (BSS) at 11.7-12.5 GHz: planned by WARC '77, this bandwidth requires the use of high-power satellites with an equivalent isotropic radiated power (EIRP of about 63 dBW). Use of the 12 GHz service has not been as much as expected because of the limited number of channels (five in Pal or Secam) and high costs.

Today, the majority of programmes and channels use medium-power satellites (with an EIRP of 49-51 dBW) in the FSS bandwith.

The first result of the EU's Digital Video Broadcasting (DVB) projects has been the technical specification of the European system for satellite DTH services (DVB-S) also capable of delivering digital TV signals to CATV and "jointly-owned" buildings (SMATV, or Satellite Master Antenna TV). ETSI is now working on standard recommendations for DVB-C (CATV distribution) and DVB-T (digital terrestrial TV distribution).

6. Architectures

As previous EITO reports have underlined, ICT architectures have followed the rapid evolution of ICT environments over the last few years: the separate evolution of the IT and TLC worlds, and then their confluence and integration, and the evolution from "batch" to mobile and "network" computing passing through time-sharing and the use of desk-tops. The functional structured layer approach was first used for ICT infrastructures (in particular for network layers see OSI and TCP/IP as typical architectural reference models), and then for application services and system management and control.

The great efforts made towards standardization (namely the OSI, Open System Interconnection and DCE, Distributed Computing Environment reference models) have led to their widespread acceptance and the concepts of "interoperability", "portability" and "scalability" now drive the market and part of the process of technical development. But the speed of innovation is greater than that of de jure standardization. In the multimedia context, the very concepts of, for example, "client/servers" and "open systems" are changing.

"Open systems" were initially introduced by OSI as generic "systems" that support the complete range of the OSI protocol pile, and which can therefore be interconnected to and interoperate with other "open" systems. Subsequently, the open concept was also used in the mid-range and operating system areas for Unix-based systems capable of providing software portability. The inclusion of a large number of sublayers, protocols and interfaces in the OSI model, as well as the growing spread of TCP/IP architectures with both LANs and Internet, led to the concept of open being extended to systems with various protocol piles, both de jure and de facto standards.

The concept now covers a wide range of systems that incorporate de jure and de facto standards from multiple vendors, and provide interoperability, portability and scalability in terms of the choice of hardware platforms, add-on hardware and peripherals, software applications and middleware. A key aim is to enable the smooth transition to new technologies and innovations.

The need to reshape the whole information system (in its broadest sense and in all contexts of use), while balancing this against asset, invest-

ment and organizational aspects, emphasizes the need for a robust ICT enterprise architecture that will provide a "personalized" reference model capable of economically and effectively dealing with today's continuous and highly dynamic evolution of products, services, distribution channels, prices, competences, skills and user needs.

"Network", "mobile" and "multimedia" computing are the cornerstones of the definition and objectives of new architectures which have to encompass the infrastructures, applications, end-user services, information (data) models, as well as the management and control of the global and integrated systems supporting business objectives and processes. The first objective for the "new generation" architectures is to provide a framework for enabling infrastructures capable of supporting "personalized" solutions and integrated services for end-users. These architectures will become increasingly based on the business drivers identified by the "process owners" within the business value chain of the enterprise.

The liaison between ICT architectures, business processes and the organization of enterprises is becoming increasingly closer. The deployment of distributed information systems, and the integration of legacy systems into a new IT environment, requires the definition of a common technical architecture strategy for the enterprise, that defines mission, technologies, building blocks and processes for the deployment of systems.

There will be no master platform in the short-to-medium-term, and the dynamic ICT market will continue to offer new solutions and open value-added niches. "Enterprise architecture" must therefore be sufficiently flexible to keep pace with change, and adopt "disposable technologies" in an intelligent way, in order to provide "competitive effectiveness".

7. New Services and Applications

The end of the life cycle of recent production applications has generated the need for new applications/services design and development based on new technological opportunities, in particular intelligent networks and client/server architectures.

Two big areas are now following different logics and rationales for innovation: applications/services for domestic markets and consumers, and applications and services for businesses and enterprises.

In the first area, the information age is continuing with CD-ROM, cable and satellite TV (video on demand, pay TV, pay per view, etc.), entertainments, edutainments, citizen services from central and local public administrations, information to improve the quality of life, and, at the same time, to do business. Many technologies are available, but the high level of investment required and the correspondingly high risks are delaying the "new" age. The "new" consumer exists, but still represents only a niche; consequently, the new services will probably be offered step-by-step, depending on their market acceptability (still more or less unknown).

In the second area, change is increasingly rapid and immediate. The companies need to compete in a dynamic global context, and the "old", mainly centralized and mainframe-based applications and services are now obsolete and have to be redesigned on the basis of Business Process Redesign (BPR).

BPR is driving the market to both "outsourcing" and the redesign of ICT (architectures, middleware, applications and services) in the form of distributed and mobile computing.

The most innovative applications and services of enterprise information systems include:

- office automation, workflow and groupware;
- personal agent: it finds, selects and filters information according to criteria defined by the end-user or learned by the agent itself during previous sessions;
- factory automation, CAD, CAM, CIM etc.;
- education and training, for which CD-ROMs are already playing a key role, also in stand-alone PCs, and on-line access to Internet, Compuserve and other on-line services represents an unpredictable phenomenon, and is opening up significant opportunities in the field of "remote" learning;
- electronic commerce and EDI: tied to the growing use of credit/debit/fidelity cards and their related services, EDI solutions are going to be given a big boost with Internet and similar on-line mail services;
- decision support systems.

Most of these items have been analysed in previous EITO reports and are also analysed in other sections of the present report: here, we will focus on the Internet, due to its worldwide diffusion and impacts, and on all the innovations for process and factory automation.

7.1. The Internet Phenomenon

The Internet refers to a specific collection of networks around the world linked together using the TCP/IP protocol suite. The Internet has become so ubiquitous that sometimes it is simply named "the Net".

The Internet began in 1970 (with the name ARPANET) as a research project sponsored by the U.S. Government through DARPA, the Defense Advanced Research Projects Agency. The initial protocol was NCP; the current TCP/IP protocol being introduced on 01/01/1983. Today, the Internet has grown to more than 6 million hosts (connected computers) all over the world *(Figure 11)*.

7.1.1. Internet Architecture and Standards

The Internet layered architecture is shown in *Figure 12:* the main structure is based on the TCP/IP protocol suite. The main objective of such a model was the interoperability of application processes running on different hosts, connected via one or more transmission networks.

The main layers are:

- *link/network access,* which provides the coding and transmission of data over the transmission media or network;
- *the network/internetwork layer,* which provides the routing and addressing of data among net nodes;
- *the transport layer,* which provides transparent, reliable, host-to-host data transport, regulated by suitable flow controls governed by two different protocols: the connection-oriented TCP, Transmission Control Protocol, and the connectionless UDP, User Datagram Protocol;
- *the process/application layer,* which provides network application services to the end-users of the architecture.

In comparison with the OSI model (the de jure standard designed to be a big improvement over the "old" TCP/IP, but which was not capable of being so massive, pervasive and accepted as to become a "de facto" standard such as the Internet), the key difference lies not only in the number of layers, but above all in the TCP/IP logic which passes to the higher layer the duty of correct delivery management, including possible data retransmission. Such an

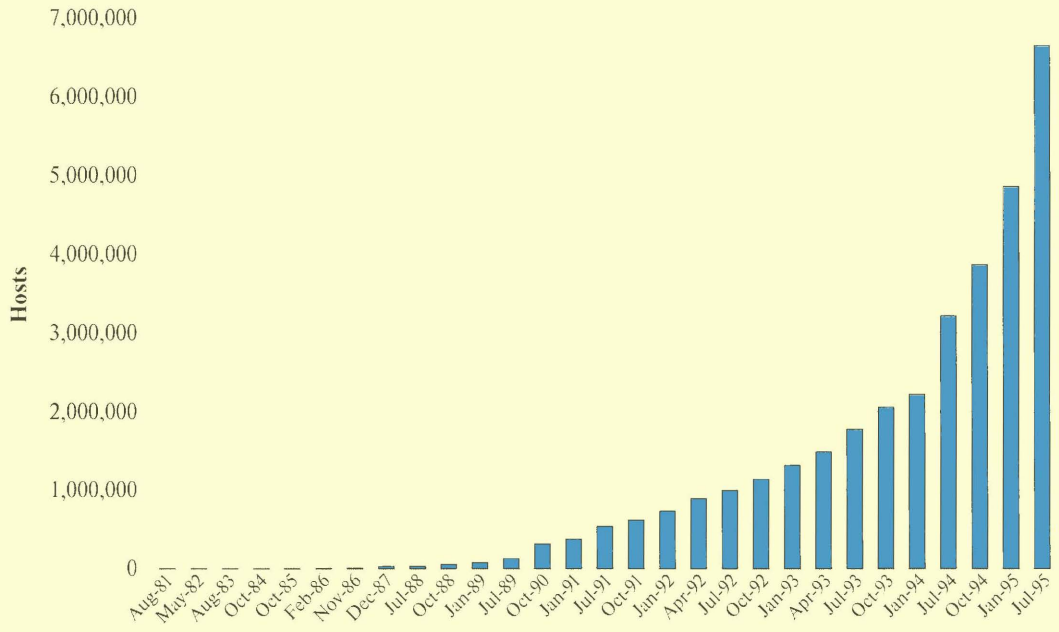


Figure 11
Worldwide Internet Growth (Millions)

approach speeds up the lower layer protocols and reduces service/retransmission traffic, even if it cannot always guarantee a safe and reliable communication path.

Within these layers, a large number of services and protocols have been developed, several of which are "standard" not only for the Internet world but also for "de jure" standard organizations such as ISO and ITU.

ISOC (Internet Society) is the organism that has officially in charge the Internet. It is structured in two groups: IAB (Internet Architecture Board) that deals mainly with the definition of standards for interconnection, and IETF (Internet Engineering Task Force), concerned with the evolution of the Internet architecture and the smooth operation of the Internet itself.

There are two types of Internet documents: Internet-Drafts and Requests for Comments (RFCs):

- Internet-Drafts have absolutely no formal status and can be changed or deleted at any time.
- RFCs are the official document series of the IAB and are archived permanently (i. e., they are never deleted and, once an RFC is published, it will never change); however, it is important to note that not all RFCs are standards. Generally, an RFC is a description of a protocol, procedure or service; a status report; or a summary of research. Most of the standard protocols on the Internet started as RFCs. With a few exceptions, they are considered public domain documents and are available on-line from various repositories. RFCs are numbered sequentially, and the number is never revised; new versions of the documents are issued instead. More information on RFCs and the Internet protocol standards process can be found in RFC 1310.

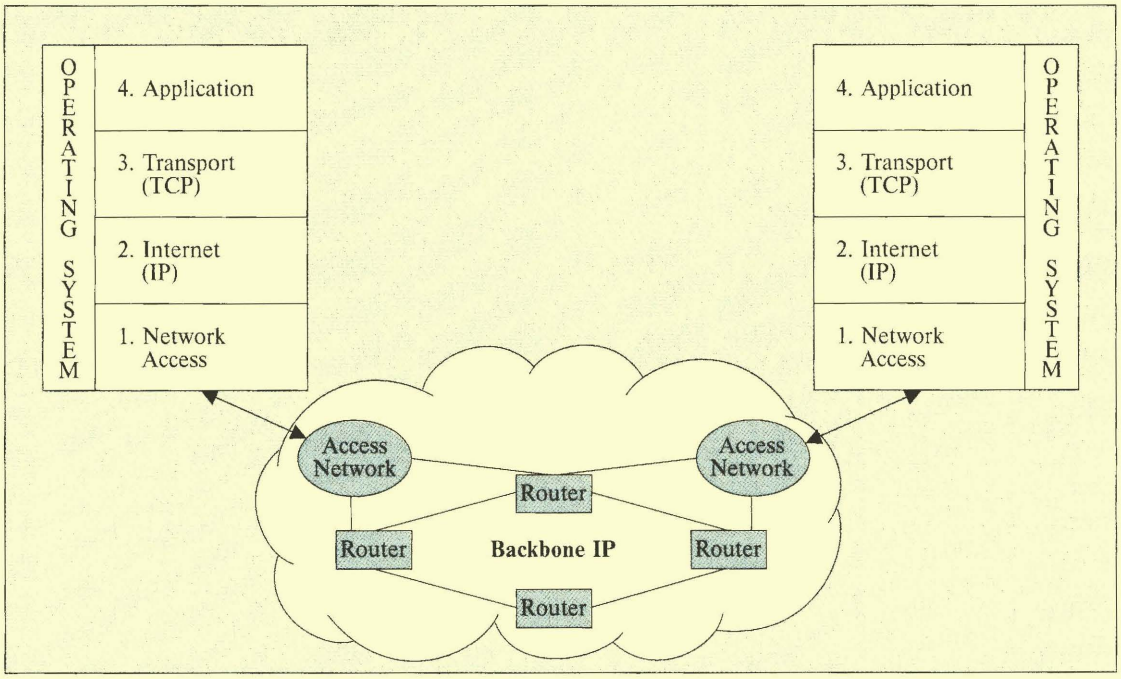


Figure 12
TCP/IP (Internet) Architecture

7.1.2. Internet Addresses

Every host interface, or node, on a TCP/IP network is identified by a unique IP address. This address is used to identify a host on a network; it also specifies routing information in an internetwork. The IP address identifies a computer as a 32-bit address that is unique across the TCP/IP network. An address is usually represented in dotted-decimal notation, which depicts each octet (eight bits, or one byte, range: 0 . . . 255) of an IP address as its decimal value and separates each octet with a period. An IP address looks like this: **192.168.0.1**

Because IP addresses identify nodes on an interconnected network, each host on the internetwork must be assigned a unique IP address valid for its particular network.

Although an IP address is a single value, it contains two pieces of information: the network ID and the host (or system) ID for the computer:

- The network ID identifies a group of computers and other devices that are all located on the same logical network, and are separated or interconnected by routers. In internetworks (networks made up of a collection of local area networks), there is a unique network ID for each network.
- The host ID identifies the computer within a particular network ID, (a host is any device that is attached to the network and uses TCP/IP protocols).

Networks that connect to the public Internet must obtain an official network ID from the InterNIC*) to guarantee IP network ID unique-

*) InterNIC: The organization responsible for registering new Internet names and network numbers. They also maintain an extensive information and directory service.

Class	W values[1,2]	Network ID	Host ID	Available networks	Available hosts per net
A	1–126	w	x.y.z	126	16,777,214
B	128–191	w.x	y.z	16,384	65,534
C	192–223	w.x.y	z	2,097,151	254

[1] Inclusive range for the first octet in the IP address.

[2] The address 127 is reserved for loopback testing and interprocess communication on the local computer; it is not a valid network address. Addresses 224 and above are reserved for special protocols (IGMP multicast and others), and cannot be used as host addresses.

Table 8
IP Address Classes

ness. After receiving a network ID, the local network administrator must assign unique host IDs for the computers within the local network. Although private networks not connected to the Internet can choose to use their own network identifier, obtaining a valid network ID from InterNIC will allow a private network to connect to the Internet in the future without reassigning addresses.

The Internet community has defined address classes to accommodate networks of varying sizes. Each network class can be discerned from the first octet of its IP address. The following table summarizes the relationship between the first octet of a given address and its network ID and host ID fields. It also identifies the total number of network IDs and host IDs for each address class participating in the Internet addressing scheme. This sample uses w.x.y.z to designate the bytes of the IP address.

7.1.3. Network Access

Depending on the type of transmission media and transmission protocol interface, or the type of network accessed, various interfaces and protocols are used. The following specific protocols are used for connections via switched or dedicated telephone lines, PPP and SLIP.

7.1.3.1. PPP

The Point-to-Point Protocol (PPP) is an industry-standard suite of control protocols that allow multiple network protocols to be carried on a point-to-point link. Windows NT supports IP, IPX, and NBF connections using PPP. This allows the use of applications that write to a network specific interface, connections to third-party PPP servers, and remote access to the Internet. [RFC 1661]

7.1.3.2. SLIP

SLIP, Serial Line IP, is a currently de facto standard commonly used for point-to-point serial connections running TCP/IP. It is not an Internet standard. [RFC 1055]

7.1.4. Internetwork

7.1.4.1. IP

The Internet Protocol (IP) is designed for use in interconnected systems of packet-switched computer communication networks. Such a system has been called a "catenet". The Internet protocol provides for transmitting blocks of data called datagrams from sources to destinations, where sources and destinations are hosts identified by fixed length addresses. If necessary, the Internet protocol also provides for the fragmentation and reassembly of long datagrams for transmission through "small packet" networks.

The Internet protocol is specifically limited in scope to provide the functions necessary to deliver a package of bits (an Internet datagram) from a source to a destination over an interconnected system of networks. There are no mechanisms to augment end-to-end data reliability, flow control, sequencing or the other services commonly found in host-to-host protocols. The Internet protocol can capitalize on the services of its supporting networks to provide various types and qualities of service.

This protocol is called on by host-to-host protocols in an Internet environment, and calls on local network protocols to carry the Internet datagram to the next gateway or destination host.

For example, a TCP module would call on the Internet module to take a TCP segment (including the TCP header and user data) as the data portion of an Internet datagram. The TCP module would provide the addresses and other parameters in the Internet header to the Internet module as arguments of the call. The Internet module would then create an Internet datagram and call on the local network interface to transmit the Internet datagram.

In the ARPANET case, for example, the Internet module would call on a local net module which would add the 1822 header to the Internet datagram creating an ARPANET message to transmit to the ICMP. The ARPANET address would be derived from the Internet address by the local network interface and would be the address of a host in the ARPANET; that host might be a gateway to other networks. [RFC 791]

7.1.4.2. ICMP

The Internet Control Message Protocol (ICMP) is used when a gateway or destination host needs to communicate with a source host, (for example, to report an error in datagram processing). ICMP uses the basic support of IP as if it were a higher level protocol, although it is actually an integral part of IP and must be implemented by every IP module.

ICMP messages are sent in several situations: for example, when a datagram cannot reach its destination, when the gateway does not have the buffering capacity to forward a datagram, and when the gateway can direct the host to send traffic on a shorter route.

The Internet protocol is not designed to be absolutely reliable. The purpose of these control messages is to provide feedback about problems in the communication environment not to make IP reliable. There are still no guarantees that a datagram will be delivered or a control message will be returned. Some datagrams may still be undelivered without any report of their loss. The higher level protocols that use IP must implement their own reliability procedures if reliable communication is required. [RFC 792]

7.1.4.3. ARP

The purpose of the Address Resolution Protocol (ARP) is to define a method of converting protocol addresses (e. g., IP addresses) to local network addresses (e. g., Ethernet addresses). [RFC 826]

7.1.5. Transport Layer

7.1.5.1. TCP

The Transmission Control Protocol (TCP) is a connection-oriented, end-to-end reliable protocol designed to fit into a layered hierarchy of protocols which support multi-network applications. The TCP provides for reliable inter-process communication between pairs of processes in host computers attached to distinct but interconnected computer communication networks.

Very few assumptions are made as to the reliability of the communication protocols below the TCP layer. TCP assumes it can obtain a simple, potentially unreliable datagram service from the lower level protocols. In principle, the TCP should be able to operate above a wide spectrum of communication systems ranging from hard-wired connections to packet-switched or circuit-switched networks.

The TCP fits into a layered protocol architecture just above a basic Internet protocol which provides a way for the TCP to send and receive variable-length segments of information enclosed in Internet datagram "envelopes". The Internet datagram provides a means for addressing source and destination TCPs in different networks. The Internet protocol also deals with any fragmentation or reassembly of the TCP segments required to achieve transport and delivery through multiple networks and interconnecting gateways. The Internet protocol also carries information on the precedence, security classification and compartmentation of the TCP segments, so that this information can be communicated end-to-end across multiple networks. [RFC 793]

7.1.5.2. UDP

The User Datagram Protocol (UDP) is defined to make available a datagram mode of packet switched computer communication in the environment of an interconnected set of computer networks. This protocol assumes that the Internet Protocol (IP) is used as the underlying protocol.

This protocol provides a procedure for application programmes to send messages to other programmes with a minimum of protocol mechanism. The protocol is transaction-oriented, and delivery and duplicate protection are not guaranteed. Applications requiring the ordered and reliable delivery of streams of data should use the Transmission Control Protocol (TCP). [RFC 768]

7.1.6. Process/Application Layer Protocols

A large number of protocol services have been defined and implemented: the most widely-used will be described below, with a particular attention being paid to the WEB that is the real key element of the spread of the present Internet.

7.1.6.1. BOOTP

The Bootstrap Protocol (BOOTP) is a UDP/IP-based protocol which allows a booting host to configure itself dynamically and without user supervision. BOOTP provides a means of notifying a host of its assigned IP address, the IP address of a boot server host and the name of a file to be loaded into the memory and executed. Other configuration information such as the local subnet mask, the local time offset, the addresses of default routers, and the addresses of various Internet servers can also be communicated to a host using BOOTP. [RFC 1542]

7.1.6.2. DHCP

The Dynamic Host Configuration Protocol (DHCP) provides a framework for passing configuration information to hosts on a TCP/IP network. DHCP is based on the Bootstrap Protocol (BOOTP), adding the capability of automatic allocation of reusable network addresses and additional configuration options. DHCP captures the behaviour of BOOTP relay agents, and DHCP participants can interoperate. [RFC 1541]

7.1.6.3. DNS

The Domain Name System (DNS) provides a dynamic conversion between network names and addresses, meaning that we can refer to an easy to remember explicit name instead of a "cryptic" four octet number. [RFC 1034, 1035]

7.1.6.4. Finger

This is a simple protocol which provides an interface to the Name and Finger programmes at several network sites. These programmes return a friendly, human-oriented status report on either the system at the moment or a particular person in depth. [RFC 1288]

7.1.6.5. FTP

The File Transfer Protocol (FTP) is the most widely-used TCP/IP application protocol in terms of traffic. This protocol can copy files from one machine to another. This is not the same as being able to remotely access a file, which is provided by another application layer service. FTP is analogous to an application like Kermit or XModem, although it also includes some navigational functions. Nearly every commercial TCP/IP offering includes some form of FTP support. [RFC 959]

7.1.6.6. Gopher

The FTP protocol has worked well for quite some time, yet it is still a rather limited application. Even with the best GUI front-end, FTP is fairly cumbersome to navigate, and filenames are often cryptic. In order to simplify the process of locating documents distributed over geographically dispersed hosts, the University of Minnesota Microcomputer Center developed the Gopher protocol. Gopher is an application layer client/server protocol for distributed document search and retrieval. [RFC 1436]

7.1.6.7. IRC

The IRC (Internet Relay Chat) protocol has developed over the last four years since it was first implemented as a means for users on a BBS to chat among themselves. It now supports a world-wide network of servers and clients, and is stringing to cope with growth. Over the past two years, the average number of users connected to the main IRC network has grown by a factor of 10.

The IRC protocol is a text-based protocol, with the simplest client being any socket programme capable of connecting to the server. [RFC 1459]

7.1.6.8. NFS

The Sun Network File System (NFS) protocol provides transparent remote access to shared files across networks. The NFS protocol is designed to be portable across different machines, operating systems, network architectures and transport protocols. This portability is achieved through the use of Remote Procedure Call (RPC) primitives built on top of an External Data Representation (XDR). Implementations already exist for a variety of machines, from personal to supercomputers. [RFC 1094]

7.1.6.9. NNTP

NNTP (Network News Transfer Protocol) specifies a protocol for the distribution, inquiry, retrieval, and posting of news articles using a reliable stream-based transmission of news among the ARPA-Internet community. NNTP is designed so that news articles are stored in a central database allowing a subscriber to select only those items he wishes to read. Indexing, cross-referencing and the expiration of aged messages are also provided. This RFC suggests a proposed protocol for the ARPA-Internet community, and requests discussion and suggestions for improvements. [RFC 977]

7.1.6.10. POP2 and POP3

The intent of the Post Office Protocol (POP) is to allow a user's workstation to access mail from a mailbox server. It is expected that mail will be posted from the workstation to the mailbox server via the Simple Mail Transfer Protocol (SMTP). [RFC 918, 1081, 1082]

7.1.6.11. SMTP

Simple Mail Transfer Protocol (SMTP) is designed for reliable and efficient mail transfer. It is widely used in government and education facilities and is also the standard used by the Internet for mail transfer.

The Simple Mail Transfer Protocol would be an „application layer" protocol when slotted into the OSI model. It is an open protocol because the only assumption it makes of the transport mechanism below it is that it will provide a reliable service.

In most cases, SMTP is used in conjunction with the Transmission Control Protocol (TCP) service, which provides the reliable transport layer (Service). Other transport mechanisms that are mentioned as being supported in the specifications are the Network Control Program (NCP) service, the Network Independent Transport Service (NITS) and the X.25 service. [RFC 821, 822]

7.1.6.12. SNMP

Implicit in the SNMP (Simple Network Management Protocol) architectural model is a collection of network management stations and network elements. Network management stations execute management applications which monitor and control network elements. Network elements are devices such as hosts, gateways, terminal servers, and the like, which have management agents responsible for performing the network management functions requested by the network management stations. SNMP is used to communicate management information between the network management stations and the agents in the network elements.

The SNMP architecture articulates a solution to the network management problem in terms of:

1. the scope of the management information communicated by the protocol;
2. the representation of the management information communicated by the protocol;
3. operations on management information supported by the protocol;
4. the form and meaning of exchanges among management entities;
5. the definition of administrative relationships among management entities, and
6. the form and meaning of references to management information.

Using SNMP a network administrator can send commands and inquiries to the network nodes. He/she can monitor the network status and performance, change configuration parameters and analyse errors. [RFC 1157]

7.1.6.13. TELNET

The purpose of the TELNET Protocol is to provide a fairly general, bi-directional, eight-bit byte-oriented communications facility. Its primary goal is to allow a standard method of interfacing terminal devices and terminal-oriented processes with each other. It is envisaged that the protocol may also be used for terminal-terminal communication ("linking") and process-process communication (distributed computation). [RFC 854]

7.1.6.14. WAIS

The network publishing system, Wide Area Information Servers (WAIS), is designed to help users find information over a computer network. [RFC 1625]

7.1.6.15. WHOIS

The NICNAME/WHOIS Server is a TCP transaction-based query/response server running on the SRI-NIC machine (26.0.0.73 or 10.0.0.51) that provides netwide directory service to Internet users. It is one of a series of Internet name services maintained by the DDN Network Information Center (NIC) at SRI International on behalf of the Defense Communications Agency (DCA). The server is accessible across the Internet from user programmes running on local hosts, and delivers the full name, U.S. mailing address, telephone number and network mailbox for DDN users registered in the NIC database. [RFC 954]

7.1.6.16. WWW

The World Wide Web (WWW or simply Web) project started at CERN (the European Laboratory for Particle Physics) research labs in Switzerland. The Web is a wide-area hypermedia information retrieval initiative aiming to give universal access to a large universe of documents. What characterizes the Web most is that its protocols are a superset of many of the most common Internet application services, and that there has been tremendous growth in the diversity of information published in the Web format. Web servers exist for libraries, corporations research scientists, and so forth.

The creators of the Web developed several application-layer protocols and a document-publishing standard. The three key concepts are URLs, the HyperText Markup Language (HTML), and the HyperText Transport Protocol (HTTP). Descriptions of these concepts and of the next ongoing innovations follow.

URL

In a hypertext environment, the key requirement is being able to represent any item of information or resource globally. For the Internet this is an especially hard problem since the universe potentially consists of all Internet hosts. The Web effort led to the first stab at a formalized syntax, called URL, Uniform Resource Locators, used to refer to globally available information.

URLs are essentially an extension of a full pathname. URLs add a prefix that indicates the type of retrieval method to use, along with a host domain name indicating the physical location of the information. The remainder of the URL is the pathname to a document (usually), along with any retrieval options that might be allowed (most often an account name and password).

URLs are quickly becoming the standard for representing locations on the Internet. *Table 9* lists some of the most commonly used URL retrieval schemes. Note that the URL convention does not define how a client operating system transforms a URL reference into an object, as this is left to the implementer. As will be seen later, Web front-ends make extensive use of URLs.

HTML

The creators of the Web defined HTML to represent hyperlinked documents on the Web. An HTML document can contain graphics, rich text, sound, video, and links to other HTML documents all around the world. HTML is implemented as a Document Type Definition (DTD) in Standard Generalized Markup Language (SGML), which is a language for specifying grammars in a document.

SGML does not define any formatting conventions, but rather lets you tag text structurally; you use it only in concert with a DTD, which essentially defines a style sheet or set of allowable structure elements in a document. Generally, SGML text resembles an offline formatting language such as RTF (Rich Text Format) or troff (for UNIX), where the user

Retrieval Scheme	Description
FTP	Following the domain name is a full path used to retrieve the document or directory using the FTP protocol.
HTTP	Following the domain name is a full path to an HTML document to be retrieved using the HTTP protocol.
Gopher	Following the domain name is a valid Gopher selector to be used to retrieve a document or directory from a Gopher server.
WAIS	Following a domain name is a path to a WAIS server along with fields used to retrieve a document from a WAIS full-text index.
TELNET	Following the domain name is an optional user name and password to use when establishing an interactive session using TELNET.
MAILTO	Instead of a domain name, the string includes a full Internet mail address. The client should spawn a user's mail application and send mail to the address given.

Table 9
Common URL Retrieval Schemes

edits a standard text file and later processes it to actually display the formatting.

In order to publish rich hypertext information on the Web, you set up a Web server in a manner similar to setting up a gopher server and then populate the server with HTML documents linked together.

HTTP

The Hypertext Transfer Protocol (HTTP) has been in use by the World Wide Web global information initiative since 1990. HTTP is an application-level protocol with the lightness and speed necessary for distributed, collaborative, hyper-media information systems. It is a generic, stateless, object-oriented protocol which can be used for many similar tasks, such as name servers and distributed object-oriented management systems, by extending the commands (or "methods") used.

One feature of HTTP is the typing and negotiation of data representation, allowing systems to be built independently of the data being transferred.

VRML

The Virtual Reality Modelling Language (VRML) is a language for describing multi-participant interactive simulations, virtual worlds networked via the global Internet and hyperlinked with the World Wide Web. All aspects of virtual world display, interaction and internetworking can be specified using VRML. It is the intention of its designers that VRML become the standard language for interactive simulation within the World Wide Web.

The first version of VRML (1.0) allows for the creation of virtual worlds with limited interactive behaviour; future versions (1.1 and 2.03) will allow for richer behaviors, including animations, motion physics and real-time multi-user interaction. Several companies and organizations have already announced their support for VRML-based 3D graphics on the World Wide Web.

Java

Java is a programming language from Sun, very similar to C++, whose programmes can be run on any type of computer provided that the computer has the appropriate software to interpret the programme.

The application of Java to the WWW might not be immediately obvious. Java allows people to embed programmes into an HTML document. There are some astounding consequences of this capability. Most notably, Java makes it possible for a browser to be totally extensible; in other words, a Web browser that would normally have a limited set of features and capabilities will be able to be enhanced on the basis of the goals of the designer of the web document.

SSL

The Secure Sockets Layer (SSL) Protocol has been submitted by Netscape Communications Corp. to the IETF as an Internet Draft. SSL is designed to provide privacy between two communicating applications (a client and a server). Secondly, the protocol is designed to authenticate the server, and optionally the client. SSL requires a reliable transport protocol (e. g. TCP) for data transmission and reception.

The SSL protocol provides a "channel security" which has three basic properties:

- The channel is private. Encryption is used for all messages after a simple handshake is used to define a secret key. Symmetric cryptography is used for data encryption (e. g. DES, RC4, etc.).
- The channel is authenticated. The server endpoint of the conversation is always authenticated, whereas the client endpoint is optionally authenticated. Asymmetric cryptography is used for authentication (e. g. Public Key Cryptography).
- The channel is reliable. The message transport includes a message integrity check (using a MAC). Secure hash functions (e. g. MD2, MD5) are used for MAC computations.

STT

Secure Transaction Technology (STT) is a protocol provided by Microsoft and Visa International to handle secure payment with bank cards over insecure data transports like the Internet. The protocol requires only reliable message transport, such as TCP. It features strong, export approved DES encryption of financial information, direct RSA encryption of bank card account numbers, and the mandatory authentication of all participants, including clients, for reduced financial risk.

7.2. CIM, CIE and CII

The levels of use, market penetration and integration of ICT in the manufacturing and process industries have always been higher than in other economic sectors, and ICT is now playing an increasingly significant and strategic role in aligning IT with the business of enterprises and the new paradigms derived from complete "Business Process Re-design" (BPR). The present competitive, turbulent and uncertain scene means that companies have to become increasingly "changeable".

The rethinking of industrial processes and the redesign/reengineering of ICT systems are strictly correlated, and the results are put together with new, more streamlined and flexible organizational structures.

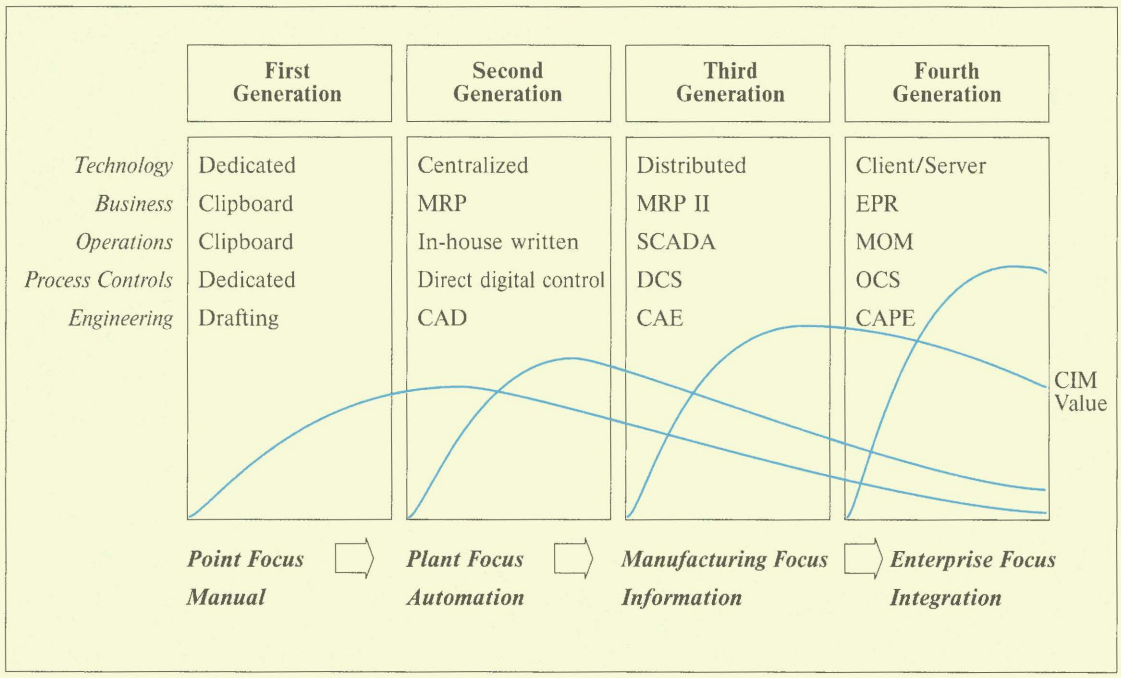


Figure 13
CIM Evolution

Source: Gartner Group

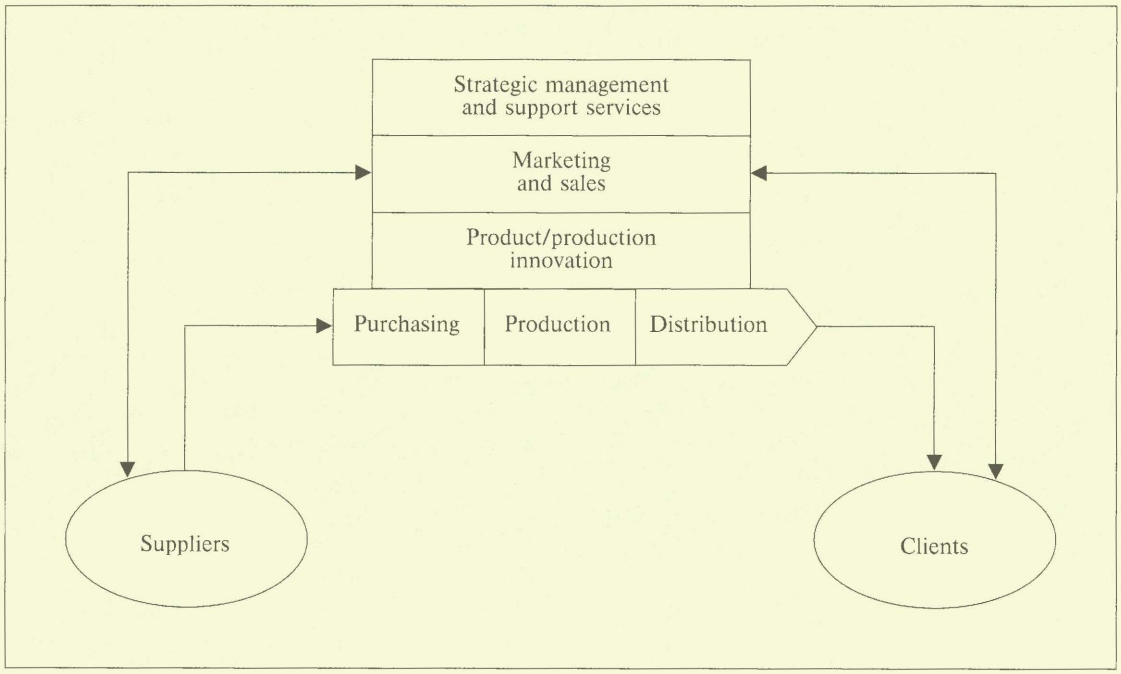


Figure 14
Environment and Competitive Forces

Table 10
Relationship between IT Applications and Processes

IT Application Processes	Management and support services	Market and sales	Innovation	Purchasing	Production	Distribution
Administrative management	●					
OA and EUC	●	●	●	●	●	●
Market and sales		●				
Logistics				●		
Production					●	
Production/Process Control/automation				●	●	●
Innovation support Applications			●			

Source: CATN

Figure 13 shows the main steps of the evolution of ICT in the automation of the process and manufacturing industries, from its beginnings with the automation of the first devices in the '70s up to the present global integration of manufacturing and process automation with the business activities of enterprises, including:

- MRP: Material Requirement Planning
- MRP II: Manufacturing Resource Planning
- SCAD: Supervisory Control and Data Acquisition
- CAD: Computer Aided Design
- CAE: Computer Aided Engineering
- DCS: Distributed Control Systems
- OCS: Open Control Systems
- EPR: Enterprise Process Re-engineering
- MOM: Mechanics of Materials
- CAPE: Concurrent Art-to-Product Environment.

Backed by the European Union, the PRIMA (Process Industries Manufacturing Advantage) Consortium brings together the largest European firms and has recently defined a conceptual reference model for industrial processes.

The model derives from an understanding of the specific differences of the individual vertical segments of the industry, in particular their critical success factors (costs, times, value and presented image) and the effects of business drivers, such as socioeconomic, market and technological factors.

A similar model was introduced by CATN, the Computer Aided Technologies Network, for the described process industry. PRIMA and CATN are now cooperating to integrate and innovate their models.

CATN's model *(Figure 14)* identifies three main physical transformation processes (purchasing, production and distribution) and three main control and management processes (strategic management and support services, marketing and sales, and innovation), correlating them with clients and suppliers and, more generally with the competitive environment. The model is market-driven and independent of the specific sector to which an enterprise belongs or its specific organizational structure. The relationships between IT applications and the processes of the enterprise are highlighted in the following *Table 10,* in which OA = Office Automation, EUC = End-user Computing.

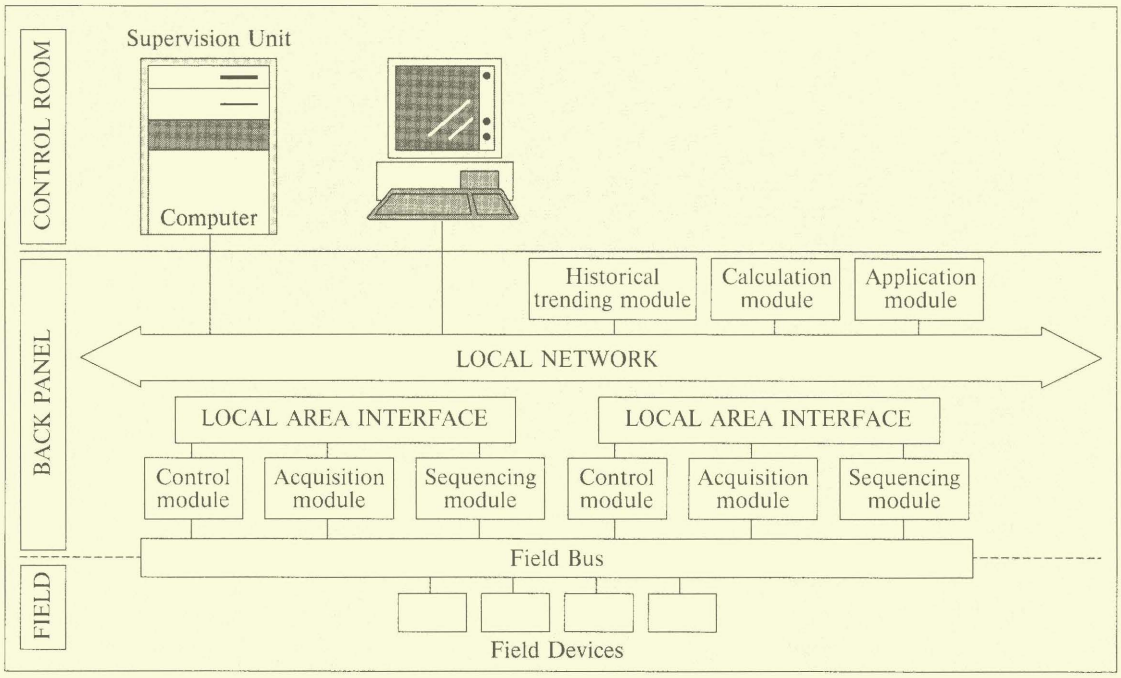


Figure 15
DCS, Distributed Control System, Architecture

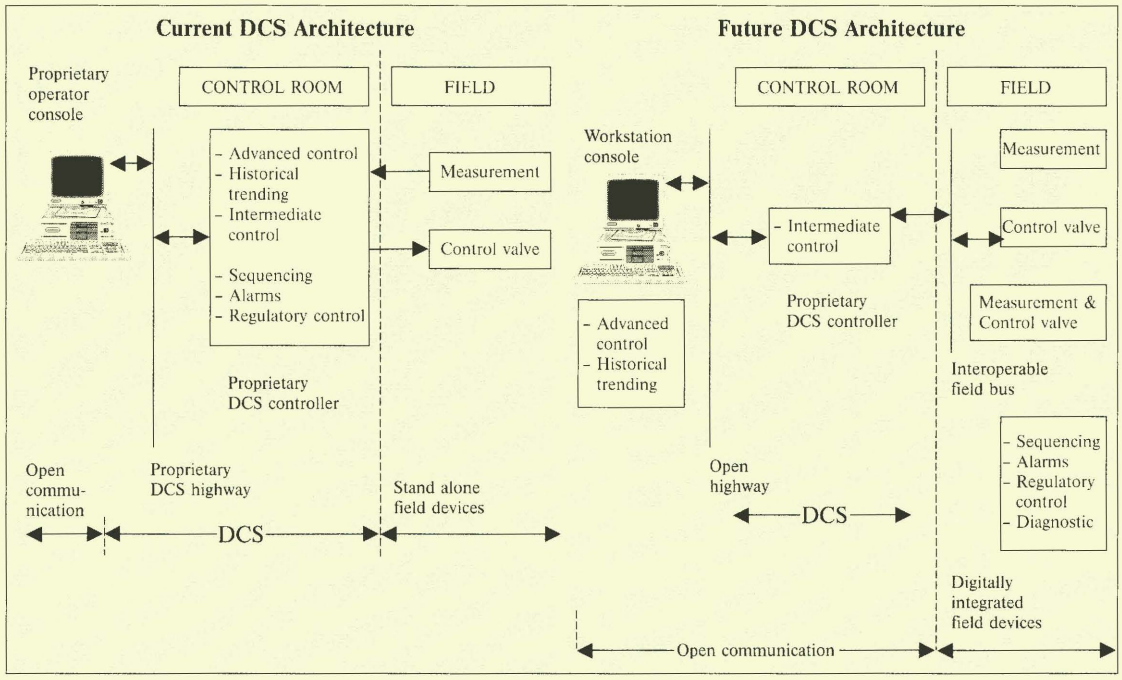
At present, three levels of application integration have been proposed and are under development:

- *CIM:* Computer Integrated Manufacturing, for the integration of all logistic and production technical applications;
- *CIE:* Computer Integrated Enterprise, for the integration of these CIM applications with administration and management applications;
- *CII:* Computer Integrated Industry, for global integration extended outside the company to suppliers, customers, distributors and so on.

The traditional meaning of CIM was the integration of all factory automation systems at a higher level (CAD, product management, production automation, movement and warehousing), by setting up communication networks and common databases.

The crisis in the CIM market and the collapse in expectations, which occurred at the end of the 1980s was due to both an overestimate of the maturity and availability of ICT equipment, and an underestimate of the real needs of process "owners". These problems are now being overcome as CIM, CIE, CII are reconsidered in the light of profound BPR. New ICT techniques become available (such as low cost digital equipment, object-oriented tools and development environments, further developments of client/server architectures, high-speed networks, and multimedia and virtual techniques) in the context of a global integration of organizational processes rather than the "old" integration of just some applications, systems and technologies.

Figure 16
The Evolution of DCS Architecture



From a technological point of view, the evolution of DCS, Distributed Control Systems, represents a significant step forward (see *Figure 15*).

These systems consist of the following main elements:

Control units: allow the digital and analogue acquisition of data from measurement equipment and provide information to the other units of the control system;

system management units: allow human operators to control the DCS itself and the processes under control, by providing fault, configuration, report, and tuning functions;

interface units: allow interaction between the different components of the system;

communication networks: allow inter- and intra-system interoperability.

The present evolution is driven by the spread of Open Control Systems (OCS): that is, systems based on "open" platforms that are in conformity with the "de jure" or "de facto" (widely accepted by the market) standards concerning operating systems, application interfaces and protocols. *Figure 16* shows this DCS evolution.

The IT standards are the widely known and used "general" standards, such as Unix, Windows, OSI, TCP/IP, X/Windows, SQL and Motif; the control-specific standards include FIP, Profibus and SP50.

The Manufacturing Automation Protocol (MAP) and Technical and Office Protocol (TOP) are the reference protocol piles based on the OSI model which are constantly enhanced by the MAP/TOP User Group and the Computer and Automated System Association of the Society of Manufacturing Engineers (CASE/SME).

Significant improvements are also being made in relation to PID (Proportional, Integrator, Derivator) and PLC (Programmable Logic Control) devices with the new DPSs, which allow full digital management of the signals.

By means of these new technologies, control logic is also moving towards new approaches, commonly called APC (Advanced Process Control): in a broad sense, an APC is something more than a single loop control and, as it is based on multivariable systems, it is capable of managing various outputs deriving from different input data/signals.

The new systems based on OCS structures require an increasing use of complex logic for the correct manipulation of a very large number of factors, and this means an increasing use of fuzzy and expert systems.

8. Bibliography

EITO93 EITO: "European Information Technology Observatory 93", March 1993

EITO94 EITO: "European Information Technology Observatory 94", March 1994

EITO95 EITO: "European Information Technology Observatory 95", March 1995

SMAU95 SMAU: "Information Technology in industrial processes" in "SMAU Observatory on Information & Communications Technology", June 1995, p. 221-246

DCE http://www.osf.org:80/comm/lit/OSF-DCE-PD-1090-4.html

DME http://www.osf.org:80/comm/lit/OSF-DME-PD-0394-2.html

RFCxxx http://www.cis.ohio-state.edu/htbin/rfc/rfc-index.html

PER95 G. Perrone: "Informatica ed automazione nell'industria di processo", FTI Annual Report, April 1995 p. 864-889

NIST-SP NIST, National Institute of Standard and Technology: "Keeping Your Site Comfortably Secure", NIST Special Publication 800-10, http://www.nist.gov

DGIII-1 DG III-1: EC DG III - Cell of Analysis of Industrial and Technological Evolutions: "High capacity storage - mass storage technology", 22/11/92

ZADEH65 L. A. Zadeh: "Fuzzy sets", Info. & Ctl, Vol. 8, 1965, p. 338-353

ZADEH68 L. A. Zadeh: "Fuzzy algorithms", Info. & Ctl, Vol. 12, 1968, p. 94-102

ZADEH84 L. A. Zadeh: "Making computers think like people", IEEE Spectrum, 8/1984, p. 26-32

COX92 E. Cox: "Solving Problems with Fuzzy Logic", AI Expert, march 1992, p. 28-37

MUNA94 T. Munakata, Y. Jani: "Fuzzy systems: an overview", Communications of the ACM, March 1994, vol. 37, n. 3, p. 69-76

Reference magazines: Byte

PC Magazines

Datamation (International Edition)

Data Communications (International)

Enterprise System Journal

Software Development

Part Two

Towards the Information Society: New Network Services and Applications

This paper has been provided by Databank Consulting in close cooperation with the EITO Task Force.

1. The Liberalization of Telecom Services and Infrastructures

1.1 Towards the Global Information Society

Europe – as all modern economies – is shifting towards an information-based economy, where networks and network infrastructure play as significant a role as did the rail networks in transforming the European economies in the last century. The society emerging from this transition is defined as the Global Information Society and the infrastructure supporting this transition as the Global Information Infrastructure (GII).

Fast, high-capacity communication facilities – information infrastructures – are being built to handle the ever increasing tide of multimedia (voice, data, image, text and video) traffic, in the expectation that a huge market will develop for tradeable electronic information. The info-communications industry, including telecommunications, computing, consumer electronics and audio-visual sectors, is growing at almost twice the rate of the rest of the economy and accelerating.

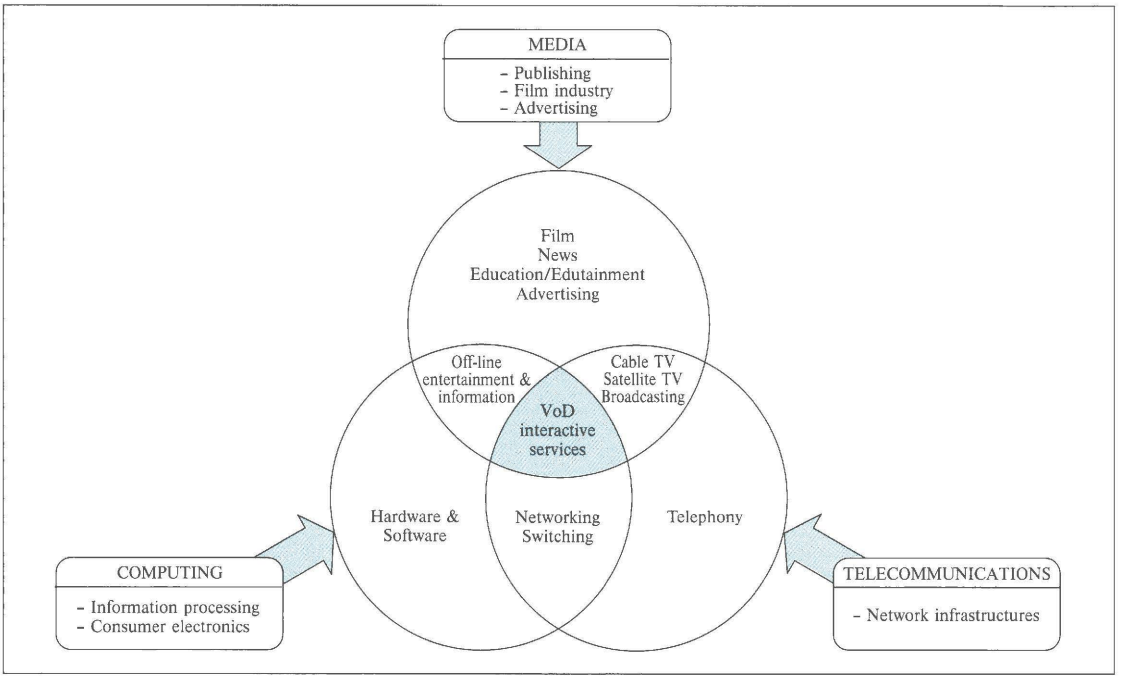
This revolution has been recognized at the highest political level. In their conclusions on the Bangemann Group Report, the European Heads of State and Government meeting in Corfu in June 1994 considered *"that the current unprecedented technological revolution in the area of the Information Society opens up vast possibilities for economic progress, employment and the quality of life"*. Similar statements have been issued by the G7 summit on the Global Information Society in February 1995.

For Europe to meet the challenges presented by this Information Society, it is vital to ensure that business, industry and Europe's citizens can access modern, affordable and efficient communications infrastructures over which a rich and diverse range of traditional and new multimedia services will be offered. To achieve this, the Bangemann report, the G7 summit and more recently the Council of Telecommunication Ministries of the European Community have agreed that a key priority is to pursue the liberalization of telecommunications services and infrastructures in Europe.

The liberalization of telecommunication services and infrastructures is led by:

- technological developments;
- the impact of a world economy geared towards free trade;
- the need to encourage competitiveness within Europe, and of Europe versus the rest of the world;
- the resulting benefits that industry and users alike can expect, including reduced prices, larger consumer choice, swifter innovation.

Figure 1 Convergence Between Media, Telecommunications and Computing



1.2. Economic and Social Factors Supporting a Liberalization Policy

1.2.1. Productivity, Economic Growth and Employment

Several OECD and European Commission studies have shown that productivity growth related to the use and diffusion of advanced technologies, in particular ICT, is a driving force to competitiveness, through reduced costs and increased market shares. Liberalization leading to faster development of the telecom and media sector can support economic growth in Europe by:

- supporting a faster integration of the European economy through trans-European communication networks overcoming distance and language barriers;
- supporting the emergence of even larger new-technology-based industries, such as knowledge-intensive services, and of new ICT-based commercial services and multimedia applications;
- supporting the evolution of the educational and training system;
- enhancing innovation and productivity in existing industries;
- leading to new jobs creation, even if the new wave of innovation will also cancel many traditional jobs and change profoundly the mix of skills required by labour markets.

In the telecom sector, rationalization leading to job losses in the traditional operators is partially overcome by new entrants and growth in mobile communications, satellite services and value-added services.

Studies promoted by the French Government estimate that Minitel directly and indirectly created 300-350,000 jobs over the last ten years. It is also expected that by the year 2000, more than 15% of publishing and information services will be electronically based in Europe, creating new opportunities in the information and education market place.

Two recent French studies confirm the positive effects of information networks on economic growth. According to the Théry report "Les autoroutes de l'information", one French franc of turnover in the telecommunications sector could generate about three francs in the related services. The report to the French Ministry of Industry on "Les teleservices en France: quel marché pour les autoroutes de l'information" estimated that the number of jobs directly and indirectly created by all new services could rise to between 170,000 and 370,000 according to the scenarios, though many jobs will replace traditional ones.

Finally, the removal of regulatory barriers between the media and telecom sector will allow European industries to pursue economies of scale crucial to offer profitably multimedia and integrated communication services (voice telephony, broadcasting, interactive TV services; mobile and wired communications; local and long distance communications), as their American and rest of the world counterparts are starting to do.

1.2.2. Social and Cultural Impacts

The diffusion of new communication services in the evolution towards the Global Information Society will profoundly influence the way we live, work and socialize, opening new opportunities but also creating new risks. The main issues to be considered are:

- consumers will benefit from lower prices as well as increased quality and efficiency of supply and new services;
- in public services, such as education, healthcare, assistance to the elderly and special care groups, information infrastructures and ICT services will provide an opportunity to release the increasing financial burden imposed on State budgets while guaranteeing quality and effectiveness;
- new ways of working (teleworking, home working, cooperative working) will increase flexibility and help individuals to shape their working life to their needs;
- communication on the information networks will overcome barriers of distance and nationality, creating new patterns of socialization (for example the emerging virtual communities on the Internet);
- the ever increasing circulation of information will allow cultural enrichment and communication between different cultures and populations.

On the other hand, there are risks to be considered and problems to solve, such as:

- the risk of creating a society of haves and have-nots, divided by the ability to have access and use information and knowledge;
- the problem of protecting privacy and personal data, while allowing the free circulation of information;
- the problem of protecting and rewarding creativity and content provision, in a world where information can be effortlessly copied and manipulated;
- the problem of encouraging fair and open competition, while avoiding excessive concentration of power in ownership and control of new media.

1.2.3. The Emerging Issues: Universal Access, Privacy Protection, Copyright Protection, Network Security

How to guarantee universal access is a critical issue in the re-regulation debate. There are four factors that can support it in the new competitive environment:

- reduction in the cost of services;
- changing definition of essential services;
- shared responsibility in contributing to universal services support mechanisms;
- possible public subsidy of less affluent citizens' use of services.

The protection of privacy and personal data is also a basic principle for the building of the Information Society. On-line transaction registration can provide sensitive information about habits, attitudes and beliefs of the consumers, which could be used for non-authorized purposes. Protection against computer crime and network security are also crucial issues widely discussed in the re-regulation debate.

In all forms of electronic publishing, the protection of copyright is also a problem. The European Commission advocates for reinforcing international copyright laws which can assure a fair remuneration for creativity and invention as well as investment by the rightful owners or those who put together material from other sources to create new products.

1.3. Current Situation in Europe vis-à-vis the USA and Japan

1.3.1. The Regulatory Framework and Trends in Europe

All European countries in principle have accepted the need to liberalize the telecommunications sector, following the lead of the European Commission. However the regulatory framework for telecommunications in Europe still varies widely: only the UK, Sweden and Finland already allow full competition, while most countries still retain monopolies for basic services and infrastructures. Data transmission, value-added services, satellite and mobile communications, Closed Users Group telephony, are already open to competition in almost all European countries.

The use of cable TV networks for the provision of telecommunications services is (with the exception of the UK, where it is allowed) usually forbidden or not done because of the absence of express regulations. In the UK BT is expressly prohibited from supplying broadcasting services on its telecommunications network. In France, since 1990 the regulatory framework has permitted CATV networks to apply for licences to offer telecommunication services other than voice telephony, but take-up has been limited.

The drive towards liberalization is accelerating, as confirmed by the decision by the European Telecommunications Council on 17/11/94 on infrastructure liberalization, which calls for abolition of all binding provisions on the choice of infrastructure for providing telecom services, including voice telephony, from January 1, 1998. Countries granted delays, such as Spain, Luxembourg and Portugal, are anticipating their plans to liberalize. The Netherlands and Spain both have plans to licence a second national infrastructure provider shortly, while the further relaxation of restrictions on the use of alternative infrastructure is under consideration in France.

However, there is still a strong debate on the timing and implementation measures for liberalization, with, on the one hand, the European Commission, users associations, cable TV operators, potential and present newcomers in the telecom markets pushing for the acceleration of liberalization even before 1998 and, on the other hand, some governments and public operators opposed to it.

Two directives allowing cable TV networks to offer liberalized telecom services and allow mobile telephony suppliers to use alternative infrastructures from 1996, in advance of the 1998 liberalization date, are being promoted by the Commission under article 90 of the Treaty of Rome, (which allows the Commission to adopt measures autonomously). A common position was reached on the extension of the ONP directive (Open Access Network Provision) to voice telephony, which dictates rules to guarantee equal and open access to public infrastructures and interconnection. The Commission is also starting to address the issue of the

	Voice Telephony			X 25	Leased Lines	Mobile telephony		
	Local	Trunk	International			Analog	Digital	Paging
Australia	D	D	D	D	D	D	C	C
Austria	M (1998)	M (1998)	M (1998)	M	M (1998)	M	D (1996)	C
Belgium	M (1998)	M (1998)	M (1998)	C	M (1998)	M	M(1996)	M
Canada	M	C	M[1)]	C	C	RD	D	C
Denmark	M (1998)	M (1998)	m (1998)	C	M (1998)	M	D	M
Finland	C	C	C	C	C	D	D	D
France	M (1998)	M (1998)	M (1998)	C	M (1998)	D	C	D
Germany	M (1998)	M (1998)	M (1998)	C	M (1998)	M	C	C
Greece	M (2003)	M (1998)	M (2003)	1997	M (2003)	-	D	M
Iceland	M	M	M	M	M	M	M	M
Ireland	M (2003)	M (2003)	M (2003)	C	M (2003)	M	M(1996)	M
Italy	m (1998)	M (1998)	M (1998)	C	M (1998)	M	D	M
Japan	C	C	C	C	C	RD	C	C
Luxembourg	M (1998)	M (1998)	M (1998)	C	M (1998)	M	M	M
Netherlands	M (1998)	M (1998)	M (1998)	C	M (1998)	M	D	C
New Zealand	C	C	C	C	C	C	C	C
Norway	M (1998)	M (1998)	M (1998)	C	M (1998)	M	D	C
Portugal	M (2000)[2)]	M (2000)	M (2000)[2)]	C	M (2000)[2)]	M	D	C
Spain	M (1998)	M (1998)	M (1998)	C	M (1998)	M	D	C
Sweden	C	C	C	C	C	C	C	C
Switzerland	M (2000)	M (2000)	M (2000)	M (2000)	M (2000)	M	M (2000)	C
Turkey	M	M	M	M	M	M	C	M
UK	C	C	C	C	C	D	C	C
US	PC	C	C	C	C	RD	C	C

Table 1
Where is Infrastructure Competition Allowed? Status of Facilities Competition in the OECD Area, December 1995

Key: C Competition
PC Partial Competition
D Duopoly
RD Regional Duopoly
199X Competition expected to be introduced this year
M Monopoly

1) Intercontinental. Canada - US traffic, which constitutes 70 per cent of Canada originated international traffic is handled by Stentor regional telcos, Unitel and resellers on a competitive basis. Intercontinental (non-Canada-US) facilities based traffic is carried by Teleglobe; international resale has been allowed in Canada since 1991.

2) Exclusive rights of PTOs according to their respective concessions. For local and regional service Telecom Portugal and Telefones de Lisboa. For international Telecom Portugal and Comphania Portuguesa Radio Marconi.

Source: Based on OECD Communications Outlook 1994

convergence of telecommunications and broadcasting, to harmonize differences in legislation between European Union countries and within them.

The privatization of national operators, the creation of national independent regulatory authorities (as for example Oftel and the FCC), and tariffs reform (no longer established by the Ministry of Post and Telecommunications but determined according to flexible mechanisms, such as price-capping) are the other key changes underway on the European regulatory scene. Within two to three years all the European public telephone operators will be privatized, even if gradually or with different procedures (total or partial privatization with the maintaining of a "Golden Share" by the state or not, etc.).

Table 2
Regulatory and Legal Framework for Liberalization in Europe – Status December 1995

MEASURES	STATUS	NEXT STEPS	CONTENT
Green Paper on Infrastructure liberalization: principles and timetable (Part I)	Resolution by EU Telecommunications Council – 17/11/94	To be adopted in national legislation	Full liberalization of voice telephony and telecom infrastructures by 1/1/98
Green Paper on Infrastructure liberalization: implementation measures (Part II)	Approved by EU Telecommunications Council June 1995	Legal measures to be proposed in January 1996 for adoption in telecoms legislation	Regulation on interconnection, licensing and universal service aspects
Directive on liberalization of alternative telecom and cable TV infrastructures (under art. 90)	Adopted by the Commission October 1995	Integration in national legislation	Cable television networks allowed to carry liberalized telecom services by 1996
Directive on Mobile and Personal Communications (under art. 90)	Draft, in public consultation until December 1995	To be adopted by the Commission early 1996	Full liberalization of mobile services and infrastructures by 1/1/96
Proposal for a EP and Council directive for application of ONP to voice telephony	Approved by Telecommunications Council, June 1995	To be voted upon by European Parliament by end 1995	Fair and equal access to infrastructures for competitive service providers
Proposal for a EP and Council Directive updating the ONP framework	work ongoing	To be adopted by end 1995	Measures to adapt ONP to new competitive environment after 1998
Proposal for a European Parliament and Council decision on Trans-European Networks	presented to Telecommunications Council, June 1995	Detailed measures to be presented during 1996	Series of guidelines for the realization of TENs
Directive on liberalization of satellite services (art. 90)	Adopted end 1994	Integration in national legislation	End of restrictions on satellite earth stations – excluding public voice telephony services

1.3.2 The Regulatory Framework and Trends in the USA

The main thrust of telecommunications regulation in the United States over the last 10 years has been the increase of competition. By the mid-1980s competition had been established in the provision of equipment, in services, and in long distance infrastructures. In the long distance market, there are now hundreds of carriers in the US, the largest of which are AT&T, MCI and Sprint with a combined market share of about 90%. The RBOCs (Regional Bell Operating companies, spun-off in 1984 from AT&T) providing local telephony services were in turn restricted from manufacturing or providing long distance telecommunications.

The whole legislative framework is now under revision both at the state and federal level, towards allowing full competition and removing barriers between TV and telecom markets. The RBOCs are eager to enter the

long-distance and TV markets: at present they are not allowed to provide information services, cable television and video programming in their own service area, even if they can construct and operate cable services in other areas. Some exemptions have been granted for experimenting with so called "video-dialtone services" (such as Video on Demand).

On the other hand, long distance and CATV (Cable TV) companies are keen on entering the local telecommunications market. Of the 97 million households in the United States almost 60 million (or about 60%) subscribe to cable television, the networks of which pass 97% of all households.

At the state level, the local exchange business is being liberalized, with a general trend towards price-based rates (as opposed to rate-of-return) for telephone services and, to a lesser extent, cost-based fees among competitors for interconnection and local access services, while providing for some safeguards especially concerning universal service obligations. There are at present over 1,300 local exchange carriers, owned by the RBOCs or independents.

At the federal level, political debate is raging on the timing and rules of liberalization. Both the House and the Senate have passed partially conflicting bills in 1995, which should be reconciled by a House-Senate Conference Committee by the beginning of 1996. The Clinton administration, though it has complained publicly that the bills will allow too much media concentration, is expected to sign it. The main principles of the expected reform will be:

- full liberalization of service and infrastructure competition for the provision of cable and telecom services (both local and long-distance), with safeguards to guarantee interconnection by competitors;
- harmonization of the separate antitrust and regulatory regimes in the telecom, media and publishing markets, relaxing (but not eliminating) barriers against cross-ownership by area, cable-telco mergers, caps on TV stations ownership;
- creation of a federal-state board to ensure universal service at just and reasonable rates;
- retainment of the 25% cap on foreign ownership of TV stations, but permission of unlimited foreign ownership of telcos, provided that US companies have reciprocal treatment in the country of origin;
- some provisions on control of content, with new TV sets sold in the US required to carry a computer chip that allow parents to block violent or objectionable content and implement sanctions for sending obscene or indecent material on the Internet and on-line services.

1.3.3. The Regulatory Framework and Trends in Japan

With the adoption of new legislation in 1985, competition was introduced in Japan to the existing carriers NTT (for domestic telecommunications) and KDD (for international telecommunications) in both services and infrastructures. Now there are 84 Type 1 carriers in Japan, allowed to have their own infrastructure, and hundreds of Type 2 operators allowed to offer their services on those networks. Licensing, fair competition and tariffs in the Type 1 market sector are controlled by the Ministry of Post and Telecommunications (the level of foreign investment in the stock of Type 1 carriers is limited to 30%); the Type 2 service providers, on the contrary, are not submitted to any control, with regard, for instance, to service charges.

Potential new entrants are the CATV network operators. About 20% of Japanese households are connected to a CATV network. In December 1993 the Ministry of Post and Tele-

communications decided to relax the rules on the usage of CATV networks and to allow the provision of telecommunications over CATV networks. So far, only two CATV operators have decided to introduce voice telephony over their networks.

In spite of this legislation favourable to competition, the national operator, NTT, where the state has the largest stake, controls about 95% of the national communications market. Though today NTT, the national operator, is not allowed to offer TV services, complete liberalization between TV and telecom markets is under discussion as well as splitting of NTT as was done in the US to AT&T. As far as opening the market to foreign operators is concerned, Japan seems very cautious and reacts separately to the requests of foreign operators and governments, as they are made.

1.3.4. Information Infrastructures Plans

The process towards the definition of strategic guidelines for the Global Information Society culminated with the G7 Ministerial Conference of February 1995. In Europe, several countries are developing national visions for the development of information infrastructures (e. g. superhighways government studies in France and the UK) and plans for broadband networks development (see also part. 3.7). At the European Union level, on 19 July 1994, following the Corfu Council approval of the Bangemann report, the European Community presented an Action Plan entitled "Europe's way to the Information Society". The plan proposed four lines of action:

1. adaptation of the regulatory and legal framework for telecommunications, mainly through liberalization;
2. encouragement of initiatives on trans-European networks, services and applications;
3. making the most of social and cultural dimensions, including the linguistic and cultural aspects of the Information Society;
4. promoting the Information Society, to increase European citizens awareness of the issues, opportunities and risks which it brings.

The action plan led to the establishment of several workgroups on the issues mentioned and the promotion of ten pilot applications to test the commercial environments, create demand and promote awareness. Applications include teleworking, healthcare, distance learning, electronic tendering, public administration networks and several of these have been adopted in the 11 pilot projects launched by the G7 summit (summarized in the following table).

Regarding the promotion of trans-European telecommunications networks, the Commission has earmarked an indicative amount of ECU 450 million for the period 1995-99, just under 300 millions of which is to support projects of common interest.

The USA Administration, led by President Clinton and Vice President Gore, was the first to launch a plan for the development of a National Information Infrastructure and to promote in international fora the vision of a Global Information Infrastructure, largely assumed by the G7 resolution. The US Agenda includes comprehensive regulatory reform of the telecom and media sector and led to the establishment of several workgroups (the Information Infrastructure Task Force, the Information Infrastructure Standards Panel, the Advisory Council with representatives from industry, universities and local governments) to support private initiatives in creating the Infrastructure. A key goal is to connect every school, hospital, clinic and library by the year 2000. Actual funding is limited, and tied to specific projects such as the development of the High-Performance Computer and Communications Program.

Table 3
G7 Projects Description

G7 PROJECTS	DESCRIPTION	TIMING	COMMENTS
Global Inventory	To create and provide an electronically accessible multimedia inventory of information regarding the major national and international projects on the global information society	1995-96	Agreement has been reached on the technical approach to be used. An electronic discussion group list has been set up for the country representatives
Global Interoperability for Broadband networks	To facilitate the establishment of international links between the various high speed networks and testbeds	1995-97	Work is underway to identify early candidate applications ready to exploit existing testbeds. Deployment and testing of new international links is planned for June 1996
Cross-cultural education and training	To provide innovative approaches to language learning, for students preparing for jobs in an international environment and for SMEs	1995-97	A "virtual G7 server for education and training" will be built to connect centres of excellence in the participating countries
Electronic libraries	To promote the global electronic library network perspective coordinating existing digitalization programs of libraries	1995-on	The development of search and retrieval multilingual tools has started and a WWW server site on the project has been created
Electronic Museums and Galleries	To accelerate the multimedia digitalization of collections and their accessibility to the public and to experts	1995-on	Three working groups have been created to develop the technical system for the pilot project
Environment and Natural resources management	To increase the electronic linkage and integration of distributed databases of information relevant to the environment	1995-97	The implementation plan has been refined, including initial target issue (climate change), information digitalization to start in early 1996
Global emergency management	To foster the implementation of national emergency management systems and their linkage in a global network	1995-98	A report on 17 sub-project proposals has been drafted and goals have been defined: a prototype network is planned for 1996
Global Healthcare applications	To demonstrate the potential of telematics technologies in telemedicine and to promote joint approaches to key issues	1995-on	Sub-projects are launching feasibility studies: participating countries must find budgets
Government on line	To exchange experience and best practice on the use of on line information technology by administrations	1995-2000	Initial demos are planned for mid 1996: the goal is to deliver measurable results by the year 2000
Global marketplace for SME's	To facilitate increased industrial efficiency and participation in global trade for SMEs promoting a global electronic environment suited to their needs	1995-98	A nucleus of an inventory on relevant on-going activities in each country and at EU level has been established and preliminary list of SMEs requirements established
Maritime Information systems	To integrate and enhance environmental protection and industrial competitiveness for all maritime activities by means of global information maritime systems	1995-98	Subprojects have been defined for improving the integration of information systems for navigation and vessel management, logistics and multimodal transport, fisheries, intelligent manufacturing in the shipbuilding industry

In Japan the concept of Information Society and the supporting infrastructures has been the focus of considerable government attention over the last two years. Japan government bodies, such as MITI and the Ministry of Post and Telecommunications, are driving a very ambitious policy aimed at connecting all national households by 2010 to broadband network. NTT has already budgeted 82.2 billion ECU for building up the optical infrastructure: the first stage aims to cover 20% of population by 2000. Extension to all major cities - covering 60% of the population - should be achieved by 2005. However the large public deficit and recent events such as the Kobe earthquake have been slowing down ambitious funding plans for the National Information Infrastructure.

2. Technological Innovation and Requirements for the Development of Advanced Networks and Applications

2.1. Technological Innovation Trends

The technological innovations, enabling the implementation of new high-speed networks and offering new services especially concern:

- the "informatization" of the networks and the creation of new "software-driven" Intelligent Networks (IN) - integrated by a signalling network (CCSS No7) and including customer databases and service centres to supply VAS. INs make it possible to offer new enhanced telephone services, like personal telephone number, caller identification, Virtual Private Networks (VPN) and others;
- the compression of digital images. This enables the reduction of the bit rate necessary to transmit an image by a factor of 10 to 100 and therefore to multiply the capacity of air, satellite, cable, optical fibre and even telephone lines for video transmission. Moreover, the compression makes it easier also to offer high-definition TV services;
- optical fibres and optoelectronic systems. These enable the achievement of cheap high-speed networks, not only for the network backbone but also at local loop, in proximity to the households (fibre to the curb or to the building), or even in the user's house (fibre to the home);
- ATM (Asynchronous Transfer Mode) switches. These enable the high-speed switching of voice, data and images. The ATM systems represent the core of the broadband networks required for high-speed data communications between remote LAN (Local Area Networks), and for multimedia services, such as interactive TV.

All these technologies are already available, although at different stages of standardization and implementation.

2.2. Technological Requirements

The main common technological requirements for the development of advanced networks and services operating at different levels are as follows:

- Interworking concerns the connection of applications to applications, in practice usually solved by application architecture provided by the major software vendors.
- Interoperability concerns the connection of generic services, such as E-mail and file transfer.
- Interconnectivity concerns the connection of different infrastructures, as in the Euro-ISDN case, enabling ISDN networks of the different countries to communicate in a transparent way.

- Security is also a general, multifaceted requirement. At the network level, security applies to the exchange of data (communication security) and includes access control, communication integrity, communication confidentiality. Reliability means the guaranteed functioning of networks and the defence of the integrity of networks. At the services level, security is connected with privacy protection and concerns data confidentiality, protection against piracy and illegal manipulation of information, and possibly non-repudiation, meaning maintaining evidence concerning a certain event (i. e. a payment transaction) to solve disputes about its occurrence. The European Commission High Level Advisory Group recommended international cooperation for establishing standardized encryption systems to develop new secure services, such as, for instance, on-line payments. A controversial aspect is that governments want to maintain the right to decipher encrypted messages for security reasons and for investigating computer crime.

2.3. Standardization Process

The standardization process is essential to interconnect Information Highways in Europe and the world. The present process is very much criticized as too slow and bureaucratic, especially at the European level, and is under pressure from the fast and efficient informal de facto standards creation characteristic of the Internet world. On the other hand, de facto standards may overlook important requirements. The three European standards organizations CEN, CENELEC and ETSI, for example have proposed the creation of an ICT standards requirement forum, with the role of planning and defining priority requirements for creation of standards.

3. Outline of Basic Networks

3.1. PSTN and Intelligent Networks

In Europe, demand for basic telephone services is maturing: from 1995 to 2000 the telephone main lines on PSTN (Public Service Telephony Networks) will grow by only 3.7%. The market will increase mainly because of the growth of local and long distance (national and international) phone traffic and of new telephone-based information and communications services (such as audiotex and enhanced fax) and intelligent/personalized services targeted both to the consumer and business markets.

No other value-added services market has been as successful in Europe as audiotex, by which private service suppliers deliver by telephone every kind of interactive (or non-interactive) information and entertainment service. In 1995 audiotex was worth more than 2 billion ECU. Currently all European telephone operators have implemented kiosk systems in combination with audiotex offering powerful publishing tools for the benefit both of the information providers and end-users: Premium rate services and billing facilities. Market growth is also facilitated by the increasing availability of Dual Tone Multifrequency (DTMF) telephone sets, making it easy to access interactive services. National regulations differ largely. Broadly speaking, in Europe audiotex is still an uncoordinated market and has developed above all at national level.

The enhanced fax services market (such as multiaddressing, detailed billing, transmission security offered to business customers) is also increasing rapidly. In 1995 fax store and forward services were worth about 330 million ECU in Western Europe. Enhanced fax is offered mainly in the UK and in Italy.

Table 4
Telephone Main Lines (in Thousands), Installed Base

	1994	1995	1996	1997	1998	1999	2000	CAGR '95-2000 %
France	31,600	32,434	33,149	33,785	34,416	36,072	37,028	2.7
Germany	40,869	42,655	44,622	46,444	47,488	48,135	48,533	2.6
Italy	24,678	25,326	26,141	27,125	28,277	29,427	30,437	3.7
Spain	14,734	15,236	15,768	16,330	16,922	17,546	18,107	3.5
UK	28,284	29,073	29,842	30,591	31,319	32,026	32,671	2.4
Rest of Western Europe	57,083	59,376	61,675	63,898	66,154	68,412	70,617	3.5
Western Europe	**197,248**	**204,100**	**211,197**	**218,173**	**224,576**	**231,618**	**237,393**	**3.1**
Eastern Europe	58,974	62,450	66,064	69,936	74,045	78,377	82,889	5.8
Total Europe	**256,222**	**266,550**	**277,261**	**288,109**	**298,621**	**309,995**	**320,282**	**3.7**
USA	152,978	158,124	163,672	169,507	176,289	184,593	192,961	4.1
Japan	60,832	62,439	64,114	65,951	67,706	69,312	70,760	2.5
Rest of World	186,693	213,872	242,072	275,372	299,239	328,408	357,604	10.8
World	**656,725**	**700,985**	**747,119**	**798,939**	**841,855**	**892,308**	**941,607**	**6.1**

Intelligent networks software is providing and will increasingly provide the platform to supply intelligent services targeted both to business and consumer users, such as call waiting, call forwarding, call identification, audio-conference, personal number, voice-mail, Centrex, virtual private network (VPN), universal number. Telephone operators are increasing their capacity to advertise and promote the new services.

The business sector will increasingly enjoy the diffusion of the new sophisticated services. The fastest emerging one is probably virtual private network. This is a logical closed user group implemented on public switched networks, giving corporate users the functionality of a private network without the burden of managing one, at a lower cost than dial up services (tariffs are not based on traffic). VPNs reduce equipment and personnel costs, improve flexibility and provide a common set of features such as: global digital desk to desk dialling plan; abbreviated dialling; integrated billing; billing by cost centres; logging call details. The most important benefit for a corporate user is probably the ability to focus on one's own core business without worrying about running a network.

3.2. Integrated Services Digital Networks (ISDN)

Euro-ISDN, adopted as a common set of standards for full interoperability of all the European ISDN networks, provides a pan-European digital and switched communications platform for voice, data and images, widely identified as the building block of the European telecommunications infrastructure. By January 1997 Euro-ISDN will be fully available in 13 European countries. There are two types of ISDN

	1994	1995	1996	1997	1998	1999	2000	CAGR '95-2000 %
France	840	1,180	1,680	2,440	3,230	3,720	4,140	28.5
Germany	1,669	2,750	4,600	6,376	8,048	9,676	11,126	32.3
Italy	53	148	290	535	880	1,225	1,455	58.0
Spain	113	240	420	570	720	855	970	32.2
UK	755	1,250	1,600	2,290	2,750	3,210	3,670	24.0
Rest of Western Europe	155	339	641	968	1,331	1,670	1,998	42.6
Western Europe	**3,585**	**5,907**	**9,231**	**13,179**	**16,959**	**20,356**	**23,359**	**31.6**
Eastern Europe	0	5	7	10	15	23	34	46.7
Total Europe	**3,585**	**5,912**	**9,238**	**13,189**	**16,974**	**20,379**	**23,393**	**31.7**
USA	1,144	2,080	3,440	4,280	5,472	6,488	7,280	28.5
Japan	984	1,068	1,420	1,888	2,580	3,440	4,320	32.2
Rest of World	152	286	777	1,322	2,096	2,898	3,733	67.2
World	**5,865**	**9,346**	**14,875**	**20,679**	**27,122**	**33,205**	**38,726**	**32.9**

Table 5
ISDN Equivalent Lines (in Thousands), Installed Base

access: basic and primary access. In ISDN basic rate access the user is presented with two 64 Kbit/s B channels, while in primary-rate access, the user is presented with 30 B channels of 64 Kbit/s. The user needs 2 equivalent lines for one basic access and 30 equivalent lines for one primary access. Primary-rate access is particularly suitable for transmitting large volume of traffic and for videocommunication.

Most European operators promote ISDN with particularly favourable tariffs (in comparison with basic telephony rates). The range of applications is very wide, from telephony, videoconferencing, videotelephony, file transfer, to LAN interconnection, back up for leased lines and group 4 facsimile. ISDN offers many supplementary services like calling-line identification presentation and restriction, direct dialling, multiple subscriber number, terminal portability, and closed user groups.

Commercial ISDN services began to be introduced in the 1980s, but so far ISDN has developed mainly in Germany, France and UK, while it is still in its infancy in countries like Italy and Spain. Equivalent ISDN lines in Europe were almost 6 million in 1995. In the business sector ISDN is already increasingly replacing the basic telephone network, but in practice it seems that the full potential of this network has yet to be realized. Possibly ISDN connections will take off only with the full deployment of interrelated trends, such as the diffusion of client/server architecture and desk top videoconferencing, teleworking and high-speed Internet services. Forecast growth rates, however, are good.

3.3. Mobile Telephone Networks

Mobile communications has been one of the major growth industries in the last decade, satisfying an unexpected widespread demand for communicating anywhere, at any time.

Total mobile telephone subscribers were about 23 million in 1995 in Western Europe and over 85 million in the world, and are expected to reach over 71 million in Western Europe and over 267 million in the world by the year 2000.

The industry is characterized by fast innovation with new systems substituting previous ones every few years. Analogue systems are now being replaced by digital ones, while worldwide cellular radio systems based on satellites (LEO - Low Earth Orbiting satellites systems) are forecast for the year 2000. Three operators - Globalstar, Odyssey and Iridium - have already been licensed by the US Federal Communication Commission (FCC).

The main analogue systems available in Europe are NMT (Nordic Mobile Telephone) and ETACS (Extended Total Access Communication System). Their diffusion is expected to peak in most countries in 1995-96, while the digital systems based on the pan-European GSM (Global System for Mobile Communications) standard are taking off. GSM is a success story and has given a global lead to the European telecom industries and operators also against the US competitors, which are hampered by the fact they do not agree on only one continental standard. At the same time digital systems based on the PCN (Personal Communication Network) standard are being launched. PCN operates at a higher frequency (1800 MHz vs 900 MHz of GSM) with a smaller range of transmission, allowing multiplication of transmission channels and dramatic price reduction. Compared to analogue systems, digital systems allow a more efficient use of frequencies, higher security, better transmission quality, and the provision of value-added services such as enhanced voice mail, call identification, itemised billing, specialized pricing, mobile data transmission and fax services.

Competition in mobile communications has been introduced in most European countries on a duopoly basis with the advent of GSM systems, and is evolving into a real multisupplier environment with the launch of PCN systems, already licensed in France, Germany and the UK. The diffusion of PCN, and to a lesser extent, of GSM, in the next few years will increase differentiation and competition in tariffs, and between fixed-link and mobile tariffs, creating a real mass market before the year 2000. The digital mobile communications network will increasingly compete and replace fixed-link voice services.

3.4. Public Data Networks X 25

The European data-network services market is a rather mature market. National telephone operators are the main suppliers, though competition from other private carriers is increasing because of liberalization. X 25 networks are the basic platform to offer value-added services like E-mail, EDI, EFT-POS. France and Spain have the highest rate of connections, followed by Germany and Italy.

Increasing demand for speedier services needed for connecting LANs (X 25 networks usually reach only 9.6 Kbit/s) and for transmitting traffic of short, high volume bursts characteristic of LAN connection, and the need of the public operators to revitalize the mature X 25 market, is boosting the Frame Relay (FR) market. FR is a standard protocol specifically designed for LAN interconnection at 64 kbit/s up to 2 Mbit/s. The main limitations of FR are that it does not offer error checking, flow control, or disaster recovery and it is actually a mainly point-to-point offering.

	1994	1995	1996	1997	1998	1999	2000	CAGR '95-2000 %
France	883	1,350	2,200	3,500	5,000	6,800	8,500	44.5
Germany	2,476	3,900	5,400	7,200	9,100	11,100	13,000	27.2
Italy	2,240	3,850	5,350	6,850	8,300	9,700	11,000	23.4
Spain	412	950	1,600	2,300	3,100	4,000	5,000	39.4
UK	3,524	5,400	7,200	8,900	10,500	11,900	13,100	19.4
Rest of Western Europe	4,865	7,600	10,500	13,300	16,000	18,400	20,600	22.1
Western Europe	**14,400**	**23,050**	**32,250**	**42,050**	**52,000**	**61,900**	**71,200**	**25.3**
Eastern Europe	326	650	1,000	1,700	2,700	3,800	5,000	50.4
Total Europe	**14,726**	**23,700**	**33,250**	**43,750**	**54,700**	**65,700**	**76,200**	**26.3**
USA	24,134	33,000	41,000	49,000	57,000	64,000	71,000	16.6
Japan	3,451	8,050	12,000	15,500	18,500	20,500	22,000	22.3
Rest of World	12,384	21,200	33,000	47,000	63,000	80,500	98,000	35.8
World	**54,695**	**85,950**	**119,250**	**155,250**	**193,200**	**230,700**	**267,200**	**25.5**

Table 6
Total Mobile Telephone Subscribers (in Thousands), Installed Base

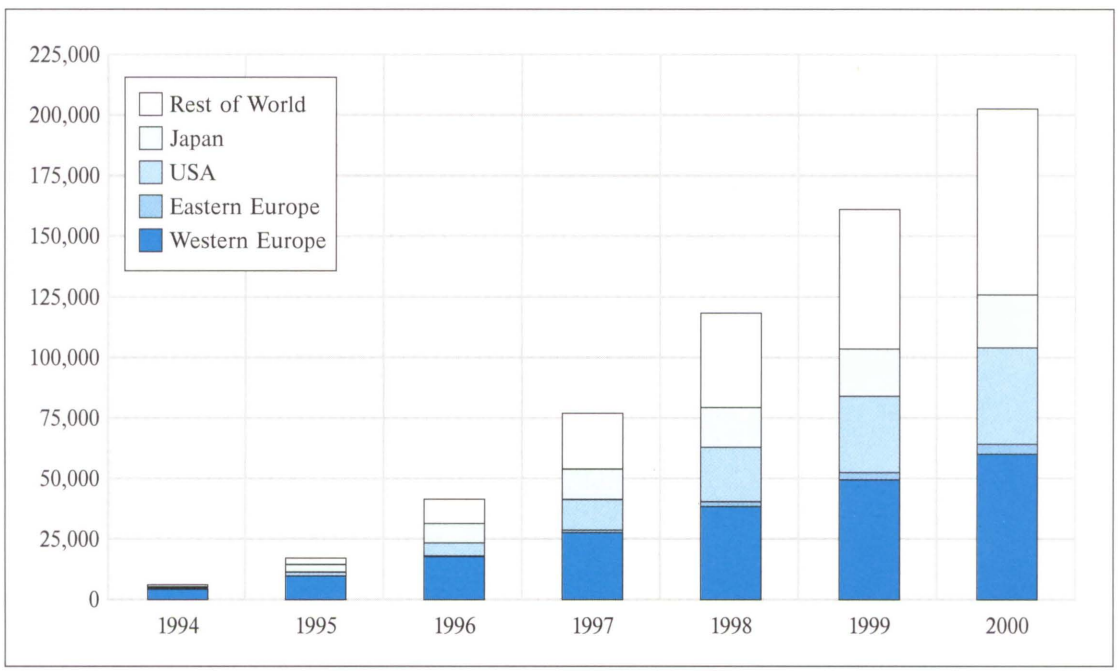
	1994	1995	1996	1997	1998	1999	2000	CAGR '95-2000 %
France	424	370	310	240	160	70	0	- 100.0
Germany	753	680	640	600	550	500	450	- 7.9
Italy	2,165	3,400	3,900	4,000	3,800	3,600	3,400	0.0
Spain	412	900	1,200	1,300	1,200	1,100	1,000	2.1
UK	3,060	4,000	4,300	4,200	4,100	3,900	3,700	- 1.5
Rest of Western Europe	3,347	3,900	4,050	4,000	3,800	3,250	2,500	- 8.5
Western Europe	**10,161**	**13,250**	**14,400**	**14,340**	**13,610**	**12,420**	**11,050**	**- 3.6**
Eastern Europe	244	420	560	710	800	850	870	15.7
Total Europe	**10,405**	**13,670**	**14,960**	**15,050**	**14,410**	**13,270**	**11,920**	**- 2.7**
USA	23,674	31,500	35,500	36,500	34,500	32,500	31,000	- 0.3
Japan	2,928	5,000	4,000	3,000	2,000	1,000	0	- 100.0
Rest of World	11,573	18,630	23,000	24,000	24,000	23,000	21,500	2.9
World	**48,580**	**68,800**	**77,460**	**78,550**	**74,910**	**69,770**	**64,420**	**- 1.3**

Table 7
Analogue Mobile Telephone Subscribers (in Thousands), Installed Base

Table 7a
Digital Mobile Telephone Subscribers (in Thousands), Installed Base

	1994	1995	1996	1997	1998	1999	2000	CAGR '95-2000 %
France	459	980	1,890	3,260	4,840	6,730	8,500	54.0
Germany	1,723	3,220	4,760	6,600	8,550	10,600	12,550	31.3
Italy	75	450	1,450	2,850	4,500	6,100	7,600	76.0
Spain	0	50	400	1,000	1,900	2,900	4,000	140.2
UK	464	1,400	2,900	4,700	6,400	8,000	9,400	46.4
Rest of Western Europe	1,518	3,700	6,450	9,300	12,200	15,150	18,100	37.4
Western Europe	**4,239**	**9,800**	**17,850**	**27,710**	**38,390**	**49,480**	**60,150**	**43.7**
Eastern Europe	82	230	440	990	1,900	2,950	4,130	78.2
Total Europe	**4,321**	**10,030**	**18,290**	**28,700**	**40,290**	**52,430**	**64,280**	**45.0**
USA	460	1,500	5,500	12,500	22,500	31,500	40,000	92.8
Japan	523	3,050	8,000	12,500	16,500	19,500	22,000	48.5
Rest of World	811	2,570	10,000	23,000	39,000	57,500	76,500	97.1
World	**6,115**	**17,150**	**41,790**	**76,700**	**118,290**	**160,930**	**202,780**	**63.9**

Figure 2
Digital Mobile Telephone Subscribers (in Thousands), Installed Base



	1994	1995	1996	1997	1998	1999	2000	CAGR '95-2000 %
France	127	135	137	136	133	129	124	- 1.7
Germany	89	99	108	112	105	100	95	- 0.8
Italy	46	60	88	104	131	144	153	20.6
Spain	106	118	130	142	154	167	180	8.8
UK	46	50	52	52	47	40	35	- 6.9
Rest of Western Europe	150	166	184	203	224	245	265	9.8
Total of Western Europe	**564**	**628**	**699**	**749**	**794**	**825**	**852**	**6.3**

Table 8
Public (X 25) Packet Switch Access Ports in Service (in Thousands)

Today FR is mostly used by large corporations, but in 2000 it should also be used by SMEs (Small and Medium Enterprises). In 1995 in Europe there were about 10,000 FR connections, which should grow to about 150,000 in 2000. The vast majority of users is connected to 64 Kbit/s services but the use of 2 Mbit/s connections will increase especially from the large corporations. The most important market is the UK, followed by Finland and France. The total European FR market will grow from 60 million ECU in 1994 to about 1 billion ECU in 2000.

3.5. Fast Packet Switching Networks

Fast packet switching networks permit data transmission rates at higher speed than 2 Mbit/s: MANs (Metropolitan Area Networks) and ATM-based networks, can permit data transmission at 34 Mbit/s and above. A fast packet switching market is emerging especially to interconnect remote high-speed LANs, since present data networks such as X25 represent a bottleneck. Metropolitan area networks are the first example of fast packet switching networks. They were introduced in the late '80s by most of the European carriers for interconnecting high-speed LANs in the main urban centres.

ATM is being adopted by corporate users for high-speed LANs, in competition with Ethernet and FDDI (Fibre Distributed Data Interfaces) technologies supporting high-speed LANs. From 1996 ATM will become an essential technology in corporate networking, thanks to its scalability and to the increasing user needs for real-time voice and video applications, such as high-speed file transfer, client/server computing, image processing, groupware, multimedia and transaction processing. It can be forecast that by the end of the '90s ATM will become the prevalent LAN technology for new installations.

It can be forecast that in 2000 in the five largest European countries there will be 2,200 connections to fast packet switching networks at speeds between 2 Mbit/s and 34 Mbit/s. However, because of the high level of tariffs for these services in Europe, this market will account only for a minor fraction of data service revenues. In the long term fast packet switching networks could converge with broadband ISDN, or the information superhighways.

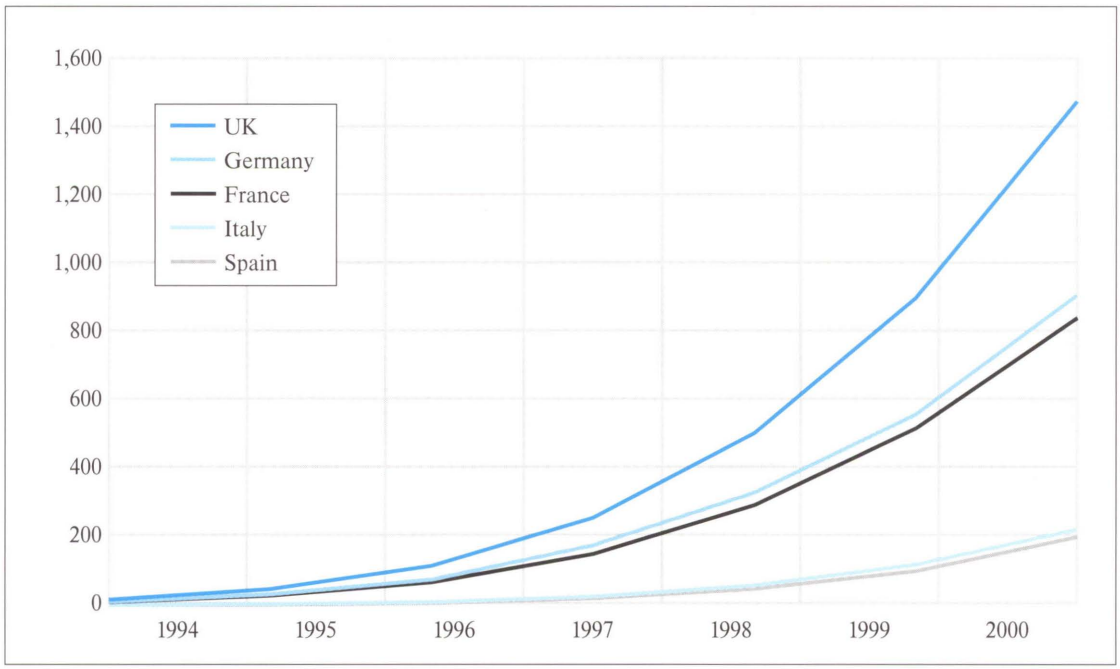


Figure 3
Fast Packet Switching Networks in 5 European Countries: Number of Connections at 2-34 Mbit/s

3.6. Cable TV

At the end of 1995 there were about 40 million households subscribing to cable TV services in Europe, that is about 27% of all European households. The first cable TV networks developed in the '70s in the smallest multilingual and multiborders countries, such as Belgium, the Netherlands, Luxembourg, for broadcasting foreign TV programmes. These countries have today the highest level of homes passed by cable networks. Government plans in the '80s in the major European countries (Germany, France, UK) for setting up national cable TV networks had mixed and controversial results. While France and the UK were not successful – for many reasons, among them the scarcity of market demand – Deutsche Telekom in Germany succeeded in setting up a cable TV network that reached over 16 million households in 1995.

Cable TV competes with traditional broadcasting and satellite services. Between satellite TV and cable TV there is both competition and some complementarity. The competition between cable TV services and satellite TV will probably increase because of the introduction of hundreds of new satellite digital TV channels planned in 1996 which permit the offering of Near Video on Demand (NVoD) services, allowing the customer choice between a limited number of programmes (for example 5-15 recent hit movies).

At present in many European countries – such as the UK and France – the percentage of cable pay-TV subscriptions of the total of homes passed by cable networks is quite low (about 20%). This phenomenon often generates a low rate of cable TV business profitability, which is pushing cable operators to enrich their offering with other services, like telephone services. In the UK cable TV networks are already

	1994	1995	1996	1997	1998	1999	2000	CAGR '95-2000 %
France	1,800	2,200	2,600	3,000	3,400	3,800	4,200	13.8
Germany	14,600	16,400	17,535	18,670	19,480	20,290	20,780	4.8
Italy	0	0	100	300	600	1,100	2,100	n. a.
Spain	130	300	600	900	1,300	1,600	1,900	44.7
UK	909	1,428	2,145	3,135	4,140	5,120	6,000	33.3
Rest of Western Europe	16,500	16,945	17,425	17,920	18,450	18,995	19,480	2.8
Total Western Europe	**33,939**	**37,273**	**40,405**	**43,925**	**47,370**	**50,905**	**54,460**	**7.9**
USA	59,800	60,110	61,250	62,250	63,120	63,940	65,000	1.6
Japan	9,228	10,000	11,100	12,600	13,300	15,000	16,400	10.4
World	**177,000**	**190,000**	**204,000**	**219,000**	**235,000**	**253,000**	**273,000**	**7.5**

Table 9
Total Cable TV Subscribers (Homes Connected, in Thousands)

allowed to carry voice telephony services, and this feature increases substantially the number of subscriptions. UK cable operators had installed 790,000 residential telephone lines by March 1995 and 83,000 business lines, about three quarters of the total number of homes which take cable television; 57 out of 75 cable franchises offered telephony with television services.

Cable TV networks of the past generation achieved broadband transmission, but their architecture did not permit interactivity. This kind of network (by far the most widespread in Europe and elsewhere) is strictly unidirectional, though it can be upgraded for carrying interactive services. The newly developed fibre-coax (fibre optical plus coaxial cable) networks already permit interactivity and can potentially carry telephone services as well as other more sophisticated services, like Video on Demand (VoD), allowing unlimited choice of TV programs. For example, in Italy cable TV will be available from 1996 on the fibre-coax network planned by Telecom Italia (see also following section 3.7).

3.7. Integrated Broadband Digital Networks

Broadband digital networks is the technical definition of the networks supporting the Global Information Infrastructure. They are high-speed communication networks (over 2 Mbit/s), using advanced transmission and switching techniques (ATM), carrying full multimedia capabilities (video, voice, data) to the user. While there is general consensus that the broadband backbone and main transport networks will be based on optical fibres and ATM switches, different solutions are being tested for the local distribution network or so-called access network (local loop), which is the most expensive and complex part of the network to update. For details see *Table 10.*

The ADSL technique (Asymmetric Digital Susbscriber Loop) has been developed to carry broadband capacity on the copper cable of the basic telephony network: its technical shortcomings (limited distance, unpredictable quality of old installed copper cable networks, asymmetry) are now causing carriers to privilege fibre-coax solutions.

Table 10
Pros and Cons of Alternative Broadband Access Network Architectures

Access network architecture	Comments
FTTH (Fibre To The Home): Optical fibre to the user	- Needs convergence of telecom and audio-visual field - Requires sufficient revenues to support investment - High costs due to both equipment and civil works - Application may be limited to high-density areas - High investment requirement may lead to high usage tariffs and risk of cross-subsidy from basic telephony services
FTTC (Fibre To The Curb) plus Coaxial cable	- Can be supported by entertainment services alone - No obvious solution for voice services – at present mainly overlay, with trials of integrated solutions under way in the US - Probably the standard CATV architecture over the next decade - High costs mainly due to civil works associated with installation
FTTC plus copper cable (ADSL)	- Maximizes use of existing infrastructure - Allows continued separation of telecoms/audio-visual service provision - Need sufficient revenue from telecoms and quasi-entertainment services - Defensive TO strategy for entertainment services, but currently seen as expensive in relation to potential revenues
FTTC plus radio tail (wireless local loop)	- Requires separate provision of telecoms and audio-visual services in the short-run, due to narrow bandwidth available on radio-path - European mobile/PCN leadership is crucial - Under-developed fixed infrastructures areas are the initial beneficiaries - Needs rapid evolution of data-compression technology - Evolution to UPT (universal personal telephony) could result in low per-user costs and greater capacity

Source: EC Green Book on Liberalization of Telecom Infrastructure and Cable TV networks, 1995

Most industrialized countries have plans to install broadband digital networks, either brand new or by upgrading cable TV networks.

In Germany 16.4 million households have been cabled by Deutsche Telekom. It is building a new optical network in East Germany where it plans to connect 1.2 million subscribers by 1996.

In France the Plan Cable launched in the early '80s has not been very successful. Private companies have already entered the cable market with the goal of building up broadband networks for offering both television and telephone services. The Théry Report on Information Superhighways, committed by French government, advocated for greater engagement by the French telecom national operator on this issue. According to the Théry Report, total investment for setting up information superhighways will amount to about 23 to 30 billion ECU within a 20 years period. France Telecom has already committed itself to launching the first phase of its deployment of optical fibre: it will build fibre networks to serve between 50,000 and 100,000 homes over the next two years, starting in Paris.

In 1995 Telecom Italia announced a very ambitious plan for connecting 10 million of households to a new fibre-coax network by 1998 with an investment of about 5.6 billion ECU. However, the service offered will be initially just pay-TV and either NVoD or VoD and telematic services; telephony services will be offered from the year 2000. A new but controversial law is under discussion to allow other competitors entrance in the market.

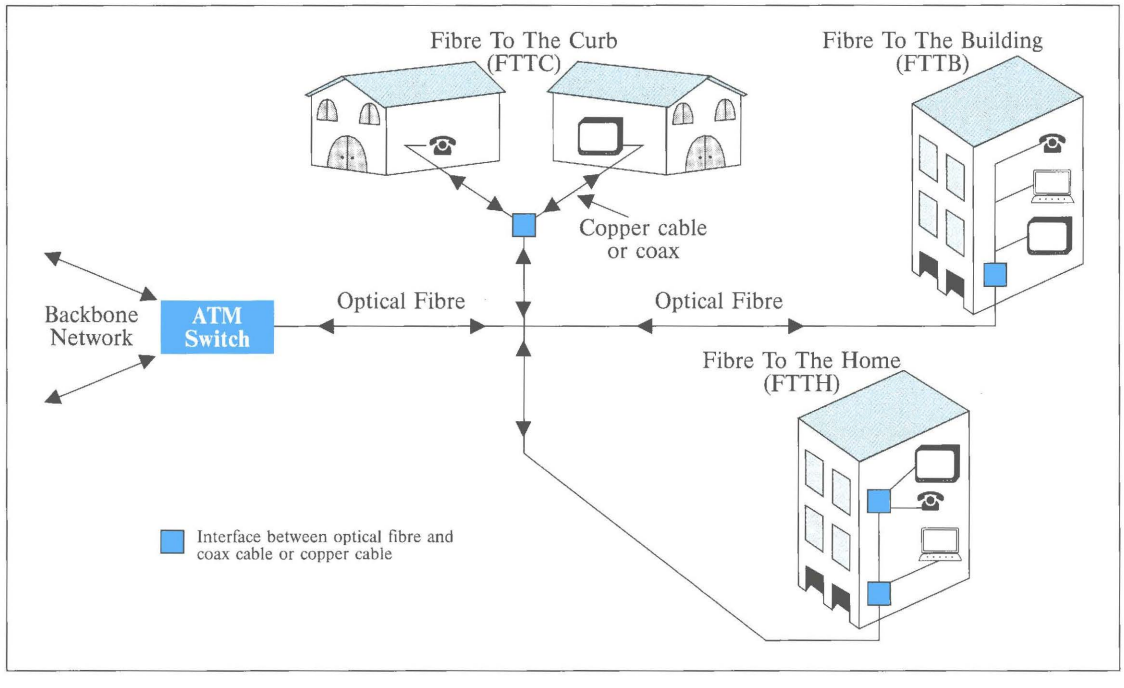


Figure 4
Broadband Digital Networks: Alternative Technical Solutions

4. Outline of Value-added Services

Value-added services (VAS) require special treatment of the transmitted data and involve special resources in the transport network. VAS can be classified in various ways: for our purposes, we can distinguish between VAS aimed at the business market and aimed at the mass market (residential/professional). Moreover we can distinguish between communication services (message switching), transactional services (electronic fund transfer), and information services (on-line data bases), where the value of the information carried on the network is absolutely prevalent in comparison with the value of transport services.

Though the boundaries between low value-added services and high value-added services are also increasingly blurring from the technological point of view, it is still useful to distinguish between VAS that can be supplied by the network itself and VAS that require additional external resources. In fact the former, according to the European regulations, can be provided directly by the carriers in competition with private companies (for instance, voice-mail, videotex and enhanced facsimile), while the latter cannot be provided directly by national operators unless they set up an autonomous company dedicated to supplying them. This is to avoid cross-subsidization and for reasons of transparency.

In the following chapters, the market estimates refer to the public services, that is services provided by third parties.

4.1. VAS for the Business Market

4.1.1. Electronic Mail

Electronic Mail (E-mail) is the transmission of computer-generated messages between a sender and receiver/s by means of telecommunications links. E-mail messages can be transmitted through corporate networks or public networks: of course, only public networks E-mail services can be taken in account for market estimates. E-mail services took-off in the early '80s but in Europe, unlike in the USA, they have not grown rapidly (with the exception of the UK), mainly because of competition from fax, and, at the beginning, because of lack of shared standards and absence of linking between different provider networks. Today the X400 standard is well established and provided by all suppliers: providers usually offer gateway services not only to X400 or their proprietary systems, but also to facsimile, telex and Internet services. It can be foreseen that Internet E-mail services will compete increasingly successfully with E-mail and X400 services offered by VAS providers and will gain the largest share of traffic.

4.1.2. Electronic Document Interchange

According to the Edifact Board Definition, Electronic Document Interchange (EDI) is the electronic transfer from computer to computer of commercial or administrative transactions using an agreed standard to structure the transactions or messages data. The EDI market includes: data transport services (such as for instance X 25 services), format conversion, customer software, and support services like training, organizational and technical consulting. In the EDI market it is crucial to offer services and software packages capable of integration with the different computerized company processes (administration, production, logistics) to allow just-in-time techniques.

In most European countries, except the UK, Sweden and the Netherlands, EDI has grown slowly, because it requires significant organizational changes, generates hidden costs, and because of the lack of common standards. EDI introduction is driven by major companies, or industry associations and public administrations and it has developed above all in the automobile, retail, transport, banking and public sectors to exchange documents with subsuppliers, especially SMEs. The majority of traffic is based on industry-specific protocols but all the sectors are by now converging on the Edifact standard promoted by UNO.

4.1.3. Electronic Fund Transfer from Point of Sale

Electronic Fund Transfer from Point of Sale (EFT-POS) services permit on-line transactions between retail and financial companies through debit and credit cards and, with regard to payments with credit cards, also permit on-line authorization services. EFT-POS grants rapid and secure payments to final customers and retail users; moreover it favours the financial companies, eliminating the heavy costs connected to processing cheques and money transactions. Usually EFT-POS terminals are multifunctional, that is they can offer access to more than one service and are provided by specialized service providers often controlled by banks and/or credit card issuing companies (like Visa, Mastercard, Amex, etc.).

The market is driven by the increasing penetration of payment cards and the increasing diffusion of EFT-POS terminals, thanks, above all, to the banks desire to gain retailers as their clients. At the end of 1995 in Europe there were more than 1.5 million of EFT-POS terminals installed. The greatest limiting factor for the de-

	1994	1995	1996	1997	1998	1999	2000	CAGR '95-2000 %
France	39	48	64	80	115	149	210	34.3
Germany	50	62	77	105	143	195	245	31.6
Italy	13	18	25	35	50	65	86	36.7
Spain	7	11	15	20	29	38	52	36.4
UK	79	105	130	165	239	320	410	31.3
Rest of Western Europe	75	93	120	158	211	293	380	32.5
Total of Western Europe	**263**	**337**	**431**	**563**	**787**	**1,060**	**1,383**	**32.6**

Table 11
*Western Europe: E-mail Market (Million ECU)**

* Public services only

	1994	1995	1996	1997	1998	1999	2000	CAGR 95-2000 %
France	50	62	75	92	110	133	163	21.3
Germany	30	41	55	71	89	111	134	26.7
Italy	23	32	46	60	73	85	100	25.6
Spain	9	10	13	18	24	31	39	32.6
UK	60	74	88	103	123	142	164	17.3
Rest of Western Europe	93	113	135	158	182	212	240	16.3
Total of Western Europe	**265**	**332**	**412**	**502**	**601**	**714**	**840**	**20.4**

Table 12
*Western Europe: EDI Market (Million ECU)**

* Public services only

	1994	1995	1996	1997	1998	1999	2000	CAGR '95-2000 %
France	93	122	152	180	208	235	270	17.2
Germany	25	34	44	60	78	95	125	29.7
Italy	14	20	25	32	42	60	79	31.6
Spain	95	110	129	147	170	192	220	14.9
UK	41	61	88	124	168	221	270	34.7
Rest of Western Europe	107	140	176	215	265	310	370	21.5
Total of estern. Europe	**375**	**487**	**614**	**758**	**931**	**1,113**	**1,334**	**22.3**

Table 13
*Western Europe: EFT-POS Market (Million ECU)**

* Public services only

Table 14
Western Europe:
CRS Market
*(Million ECU)**

	1994	1995	1996	1997	1998	1999	2000	CAGR '95-2000 %
France	65	78	90	101	113	127	143	12.9
Germany	153	187	204	218	230	245	263	7.1
Italy	30	35	42	50	62	76	93	21.6
Spain	28	31	39	45	55	68	84	22.1
UK	120	158	182	196	210	217	225	7.3
Rest of Western Europe	200	247	281	308	338	370	408	10.6
Total of Western Europe	**596**	**736**	**838**	**918**	**1,008**	**1,103**	**1,216**	**10.6**

* Public services only

velopment of the EFT-POS market is the diffusion of smart cards, or chip cards - which are intrinsically secure enough to permit off-line payments - and pre-payment cards, which also do not require on-line transactions. In 1995 the EFT-POS market was 487 million ECU, up from 375 million ECU in 1994. Until 2000, when the market will reach 1,334 million ECU, the CAGR will be 22%.

4.1.4. On-line Computer Reservation Services

On-line Computer Reservation Services (CRS) permit increasingly not only the buying of airline tickets, but also car rental, train reservation and hotel booking. The market is driven by demand from travel agencies. The two main CRS competitors at European level are: Amadeus - a joint-venture between Air France, Lufthansa and Iberia - and Galileo International - the CRS company set up by British Airways, Alitalia, KLM, Swissair, Aer Lingus, Austrian Airlines, Olympic Airways, United Airlines and other companies. The two European companies use national distribution companies for offering their own and local services. The national markets are in general controlled by the CRS in which the national airlines have a share. Extra-European CRSs, such as Sabre and Worldspan from the US, also have a presence in several countries. In 1995 the CRS market was 736 million ECU, forecast to reach 1,216 million ECU in 2000.

4.1.5 VAS for the Business Sector: Total Market

In 1995 the Western European VAS market was worth about 1.89 billion ECU. The VAS market is smaller than the Data Networks market (3.650 billion ECU) but is more dynamic, because of increasing demand of more sophisticated services by the business customers. In 2000 the VAS market will be worth 4.77 billion ECU, with a growth rate of 20.3% from 1995 to 2000. In 1995 the largest sectors of the market were: CRS, followed by EFT-POS, e-mail and EDI. In 2000, e-mail will become the largest sector, followed by EFT-POS, CRS, and EDI. The UK is the largest market (398 million ECU) and, thanks to the more advanced process of liberalization, will remain so by 2000 (when it will reach 1,100 million ECU); Germany and France follow.

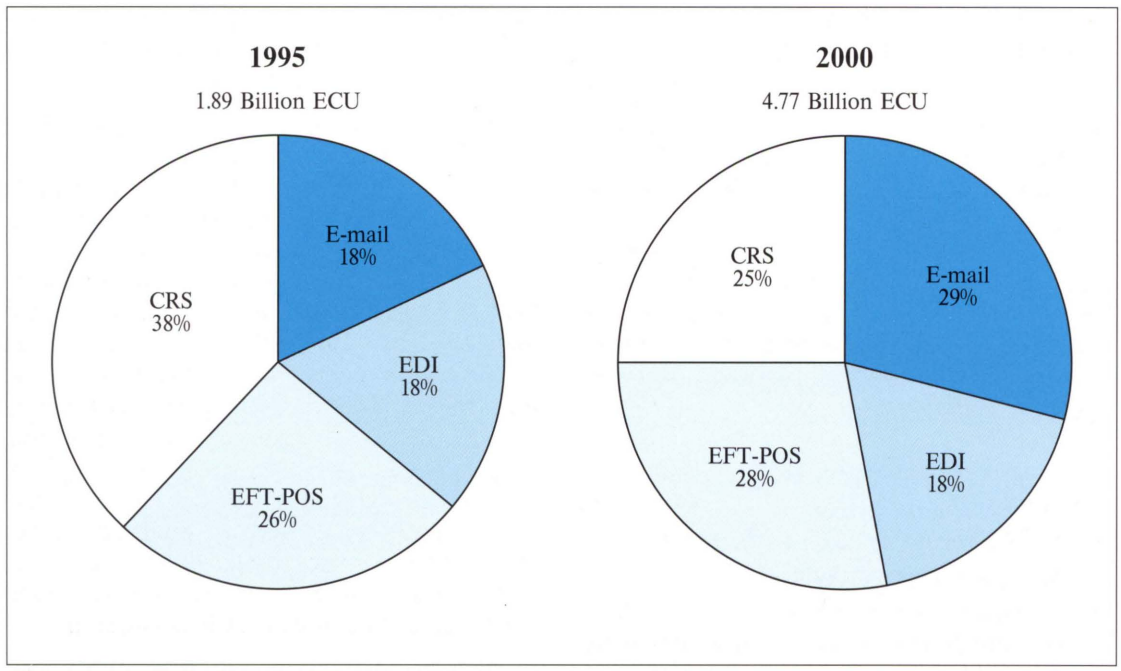


Figure 5
*VAS Market in Total Western Europe (Billion ECU)**

* Public services only

Legend: EDI = Electronic Data Interchange
EFT-POS = Electronic Fund Transfer - Point of Sale
CRS = On-Line Computer Reservation Service

4.2. VAS for the Mass Market

4.2.1. Videotex

Videotex was launched in the early '80s as a low-speed (1.2 kbit/s) screen-based data communications service, carried on the telephone network (and eventually supported by X25 network on the provider side), to offer VAS to the mass market. Videotex offers many cheap communication, information and interactive VAS, such as E-mail, home-shopping, home-banking, on-line data bases and financial services. Actually, first because of immaturity of demand and then because of its technological shortcomings, videotex has not been successful in most countries. Its market developed almost only in Europe and mainly in France, which has a 80% share of the European market. France Telecom has been successfully subsidizing the market (in the beginning distributing terminals for free) until it reached the critical mass for developing autonomously. In 1994 revenues from Teletel (the French videotex service) were about 1 billion ECU, shared equally by the carrier and the about 20,000 information providers; it reached 6.3 million of users generating over 110 millions of hours of traffic. At the beginning, electronic messaging was the most used category of services after the electronic directory, but afterwards professional services developed, until today they generate about 50% of traffic.

Videotex is also vital in Germany, where it counts 800,000 subscribers, is supported by ISDN with 64 kbit/s speed and has gateways to the Internet. However both in France and Germany the videotex market tends to converge in the long run with the larger Internet market.

4.2.2. The Internet and Internet-like Networks

The Internet is "a network of networks" interconnected through the TCP-IP protocol (Transmission Control Protocol/Internet Protocol). Born in the '70s as a US military and then academic network, in the early '90s the Internet has spread all over the world thanks to the large penetration of personal computers in offices and at home, the diffusion of cheaper telecom facilities and the explosive offer of a multitude of scientific, technological, commercial, information, communication, education and entertainment services. The Internet has doubled in size since 1988 and is the most successful telecom service ever. In fact neither the fax nor cellular telephony have grown so quickly.

The Internet offers applications like e-mail, file transfer, databases access, software downloading, remote connections to host computers and, last but not least, multimedia hypertextual services through the World Wide Web (WWW). It is estimated that the Internet has over 40 million users throughout the world (more than half are from the USA) and within a few years its users will outnumber all but the largest nations.

Individual creativity, openness and interactivity, cheapness and the bottom-up development pattern are the success factors of the Internet. Albeit in embryonic form because of its speed limitations and lack of security, the Internet already is the information superhighway. Tariffs of the Internet are very cheap and flat, that is independent of duration of use and distance: therefore they are within the reach not only of the business sector but also of residential users. In fact the Internet operates mainly on international and national leased lines which are charged with annual tariffs and which usually are used only by corporate users. Private service operators like Compuserve, Microsoft Networks, IBM, Europe On-line, are exploiting and contributing to its growth by combining access to the Internet with the offer of proprietary information and commercial services.

The Internet represents a very good business opportunity for telecom carriers, hardware vendors and software companies that provide Internet access both to the business community (possibly through direct connections) and to homes, through dial-up connections. Moreover the Internet is also an opportunity for content industries, such as media and publishing, and for all the companies which would like to use the Internet as a commercial channel for electronic commerce. Though electronic commerce is still hampered by barriers such as lack of security and vulnerability in electronic payments, in the next few years these barriers will be easily overcome thanks to the increasing diffusion of firewall and encryption systems and secure electronic money, such as Digicash.

It is expected that European residential subscribers to the Internet and Internet-like networks will be more than 14 million before 2000, considering that at least 40% of the 148 million European households will have a personal computer and that at least 25% of them could connect to telematic networks. It is forecast that Germany will be the country with the largest number of Internet connections (about 3.5 million) followed by the UK and France. By 2000 about 10% of the European households will be connected to the Internet and Internet-like networks: however, in 2000 Europe will still be on average about 5 years behind the USA, where, in 1995, about 30% of households had a personal computer and 10% of households were already connected to a telematic network. In 2000 we estimate that the companies subscribing to the Internet and Internet-like networks will be about 500,000, approximately 4% of the total number of companies in Europe (each corporate

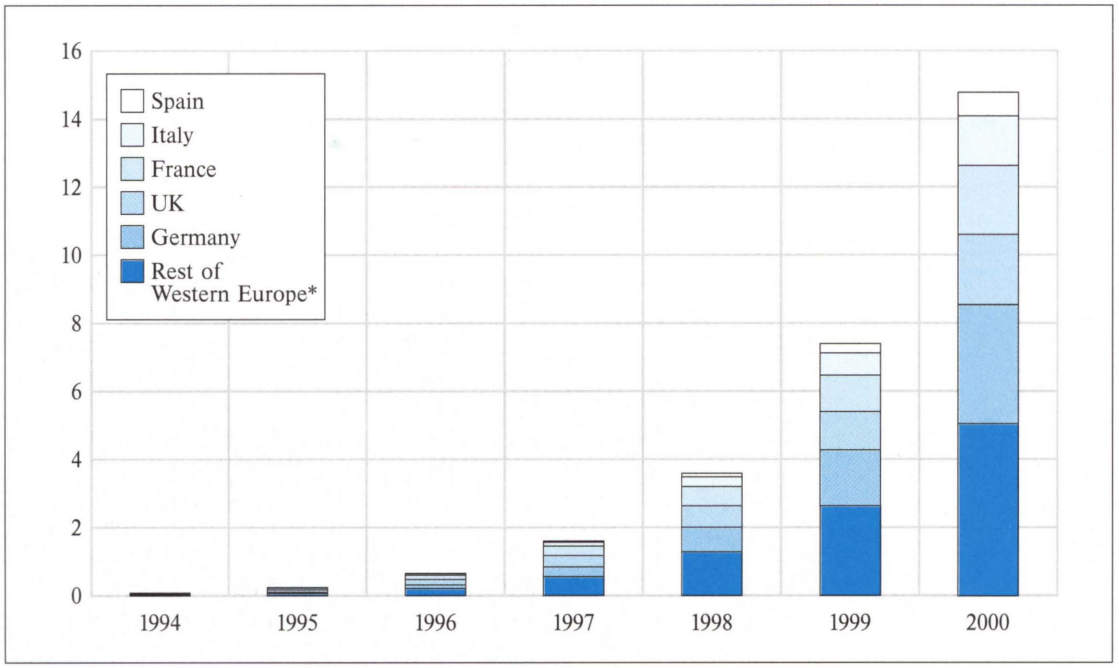


Figure 6
The Internet Market in Europe, 1994-2000
Number of Households with Internet Access (Millions)

* including: Austria, Benelux, Denmark, Finland, Greece, Iceland, Ireland, Netherlands, Norway, Portugal, Sweden, Switzerland

subscriber will connect tens of users thanks to LANs). It must be stressed that about 75% of the subscribing companies will be small companies, that is companies with less than 10 employees.

5. Outline of Enhanced Interactive Services

Though nobody can underestimate the inertia of behaviours, habits, attitudes of people and of institutions, the success of the Internet shows that the new advanced interactive services could expand very rapidly even in the short-and-medium-term by satisfying the ever increasing demand for information, entertainment and interactivity. In the long-term the introduction of high-speed broadband networks will constitute the success condition for the offering of the new multimedia services.

The range of possible applications and services emerging from the convergence of computing, telecommunications and media is so large that no one really knows which will prove popular and which will flop. This is a phase of trialing and exploration of potential markets, hindered by the scarcity of infrastructures able to exploit fully the potentiality of the new services. An indicative classification is offered in *Table 15*, based on the nature of the services and the market segments targeted, together with the networks required. The most interesting ones, where more trials and experiments are being carried out, will be described in detail.

Table 15
Classification of Enhanced Interactive Services

Description	Main applications	Market segments targeted	Networks/ technologies	Main suppliers	Life cycle phase
Entertainment services	VoD Videogames Interactive quizzes	Households	FTTC-FTTB FTTH-ADSL	Telephone and Cable companies Media	Testing
Information and Communications services	On-line (multimedia) publishing On-line (multimedia) data-bases E-mail Electronic Forum Videotelephony Videoconference	Households SOHO Business	ISDN FTTC-FTTB FTTH-ADSL Internet (and "Internet like" networks) Videotex	Telephone and Cable Companies Media Internet operators	Testing (ADSL FTTH, etc.) Introduction (ISDN, "Internet like" networks) Development (Internet) Maturity (Videotex)
Transactional services	Home Shopping Home Banking On-line Reservation Services On-line Trade Financial Services (TFS)	Households SOHO Business	FTTC-FTTB FTTH-ADSL Internet (and "Internet like" networks) Videotex Dedicated networks	Telephone and Cable Companies Media Industries (banks, finance, retail, etc.) Internet operators Specialized operators	Introduction (Internet and "Internet like" networks) Maturity (Videotex) Development (Specialized networks)
Professional services	Teleworking Telemarketing Financial services Teletraining	SOHO Business	ISDN FTTC-FTTB FTTH-ADSL Internet "Internet like" networks Videotex	Telephone and Cable Companies Industries Internet operators Specialized operators	Introduction (Internet, "Internet like" networks, ISDN) Maturity (Videotex) Development (Specialized networks)
Public services	On-line Central and Local Administrations services Tele-education Fiscal services On-line Healthcare services Electronic Museums and Galleries Electronic Libraries	Households SOHO Business Public Administrations	ISDN FTTC-FTTB FTTH-ADSL Internet "Internet like" networks Videotex	Telephone and Cable Companies Public Administrations Internet operators	Introduction (Internet, ISDN) Maturity (Videotex)
Monitoring	Tele-alarm Tele-security On-line automated activation and regulation	Households SOHO Business	PTSN ISDN FTTC-FTTB FTTH-ADSL Dedicated networks	Telephone and Cable Companies Specialized operators	Maturity (PSTN) Development (Specialized networks)

Legend:
SOHO = Small Office/Home Office Market
FTTC = Fibre To The Curb
FTTB = Fibre To The Building
ADSL = Asynchronous Digital Subscriber Loop
FTTH = Fibre To The Home
ISDN = Integrated Services Digital Network

New entertainment services is basically the area growing from interactive TV applications, where the main confrontation between telecom and cable and TV companies will take place to win new revenues from the residential market. *Information and communication services,* besides different content, include a greater interactivity between users. *Transactional services* are characterized by the presence of financial transactions with specific security requirements. *Professional services* are aimed at the business and small office/home office environment. *Public services* are provided by public administration organizations, and can be addressed to the general public (citizens) or to the administration themselves to support their interaction. Finally, *monitoring* applications have been singled out because they concern the specific field of home automation or security applications for business sectors.

An overall estimate of the potential market of these services is very difficult to carry out. However, according to a study carried out in 1995 for the European Commission, by 2004 the total market for business and residential multimedia applications (including video-on-demand, home shopping, home banking, residential information services, networked games and music on demand) is estimated at 25 billion ECU (14 for the residential market and 11 for the business market). The business market is expected to take off more quickly, but the potential of the residential market will be higher. Telecom operators share of these revenues for transport and distribution services, however, is estimated to be only 4.3 billion ECU in 2004, less than 20%. It could be more if the regulatory context will allow telecom operators to play a more active role in supplying value-added services and participating in content provision.

5.1. Video-on-Demand

Video-on-Demand (VoD) is widely expected to be one of the leading services in the early stages of broadband interactive access to the home, introducing to the market the concept of interactive service through the television. Video-on-Demand offers the possibility to select and see any TV programme at choice from the suppliers' videolibrary (movies are expected to have the greater appeal, but also special sports events or shows), providing also basic VCR functionalities (stop, forward, rewind, excluding recording). Present trials and the services to be offered on the market in the next few years confine themselves to this type of basic interactivity: in the future the interactivity with the programme is expected to increase, leading for example to the possibility to request personalized news programmes or interact with movies plots choosing different outcomes.

Technically speaking, VoD services will be offered to the home via broadband networks connected with a set-top box installed on the TV set. VoD is clearly in competition with traditional videocassette rentals, which will probably maintain a sizeable proportion of the market in the medium term, for several reasons:

- retail chains will have a considerable cost advantage for some time, and margins will probably allow further discounting and offering additional services;
- some consumers will be reluctant to adopt the new technology and continue to prefer traditional shops.

A threat to VoD is posed by Near Video on demand (NVoD) solutions offered by TV companies on satellite networks, which are not truly interactive systems, but allow the customer to choose between a limited number of programmes (around 5/15), for example a small

Table 16
Main VoD Trials in Europe

Operator/s	Timing	Location	Size (TVHHs)	Network technology
Belgacom/Alcatel Bell	1995	Woluwé, Belgium	500-1,000	n.a.
France Telecom	1995	France	10,000	ADSL + ATM
Deutsche Telekom	Q4 1994 Q1 1995 Q1 1995 Q2 1995 Q2 1995 Q3 1995	Berlin, Germany Hamburg, Germany Cologne/Bonn, Germany Leipzig, Germany Nuremberg, Germany Stuttgart, Germany	50-100 1,000 100 100 1,000 4,000	HFC/ATM coax HFC HFC ADSL HFC
STET/STREAM	Dec. 1995	Milan/Rome, Italy	1,000	ADSL
EDON	n.a.	Netherlands	n.a.	HFC
Netherlands PTT	early 1995	Netherlands	100	ATM
NV EGO/Bucai Groningen	Q1 1995	Netherlands	n.a.	n.a.
Norwegian Telecom	early 1995	Oslo, Norway	100s	ADSL
Telefonica	1995?	Barcelona/Madrid, Spain		ADSL
Svensk Kabel-TV	Q4 1994	Stockholm, Sweden	50	n.a.
Telia	Q4 1994 1996	Stockholm, Sweden	50 up to 1,500	ADSL
Swiss Multimedia	early 1996	Nyon, Switzerland	50	fibre to the home/ATM
British Telecom	Apr-Sep 1994 Q2/3 1995	Kesgrave, UK Colchester, UK	tech trial 70 mkt trial 2,500	ADSL+fibre to the home ADSL+fibre to the home
Cambridge Cable	Sep 1994	Cambridge, UK	100s	ATM

Source: Based on Screen Digest data

number of recently released film titles. It must be remembered that in the videocassette rental market, up to 70% of revenues are derived from the current ten best-selling releases. Studies show that VoD attracts sophisticated consumers, not necessarily well-off ones (even if they must have a disposable income for additional spending), but characterized by the cultural background to appreciate the ability to navigate and choose in a potentially endless supply of programmes. The results of American trials also suggest that the offer of entertainment services must be complemented by information and transaction services to build penetration.

The investment required to connect homes to broadband networks is considerable. Various estimates place the cost of connection per subscriber around 1,000 ECU in 1995, projected to decrease to 580 ECU in 2004. The cost of the set-top box is expected to fall from about 340 ECU today to about 60 ECU in 2004. A commercial strategy now envisaged by operators seems to be to package VoD services with traditional pay-TV or pay-per-view services and telematic services, especially in the countries where cable and satellite TV have a low penetration, since VoD services alone will probably not generate sufficient revenues to recover the investment in the short-to-medium-term.

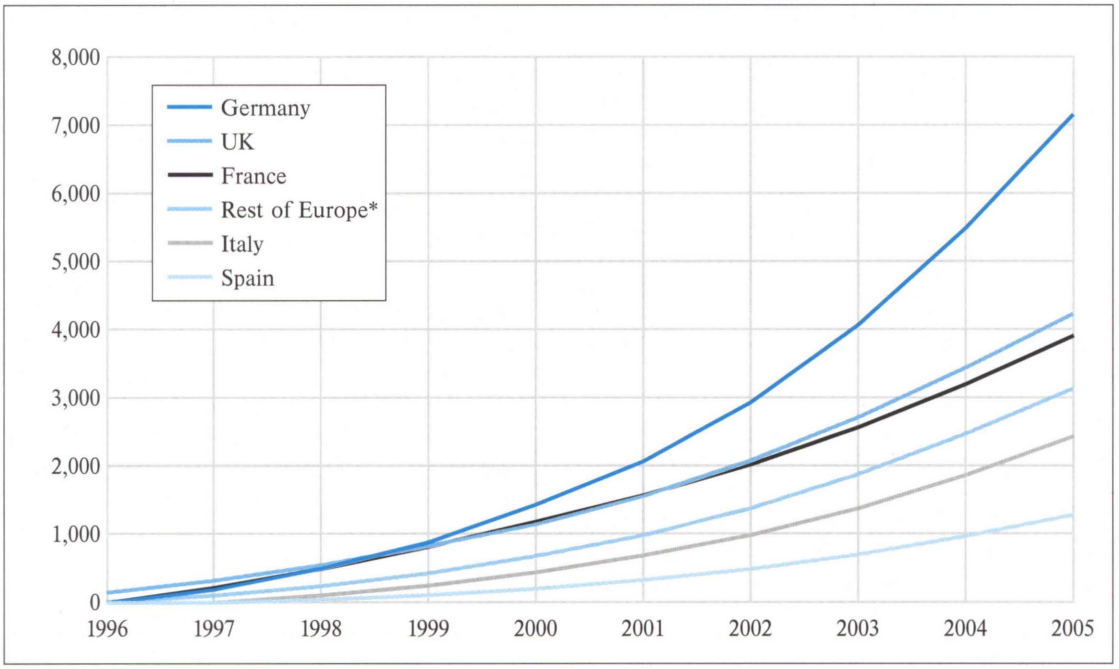


Figure 7
The Potential Market of VoD Services in Europe (Million Households)

* Includes Benelux, Denmark, Greece, Ireland, Netherlands and Portugal
Methodology: estimate of diffusion curve on households of the 12 EU countries, taking into consideration the diffusion of VCRs in European households (ranging from 45% in Italy and Spain to nearly 70% in the UK), the plans of implementation of broadband networks, likely date of introduction of the service and the curve of diffusion of cable TV networks.

In 1995 the telecom operators of nine European countries (see *Table 16*) have begun limited commercial tests of VoD for acquiring a deeper understanding about the reaction of users to the new offering. Almost all European countries are going to offer VoD services from 1997 on. VoD is expected to be the more popular service among households subscribing to broadband networks, which however will be the more well-to-do and responsive to innovative services. Overall, considering that VoD services could be introduced in Europe on average between 1998 and 2000, and assuming a rather quick take-off in the potential market, it is estimated that by the year 2005 about 16.6% of the 134 million households in the twelve countries constituting the European Union (before the entrance of Sweden, Austria, and Finland) will adopt it, that is 22 million households. Potential revenues from VoD services are likely to be a fraction of the average European family spending for pay TV systems. Global revenues in Europe for video-on-demand services could be about 2.1 billion ECU in 2005.

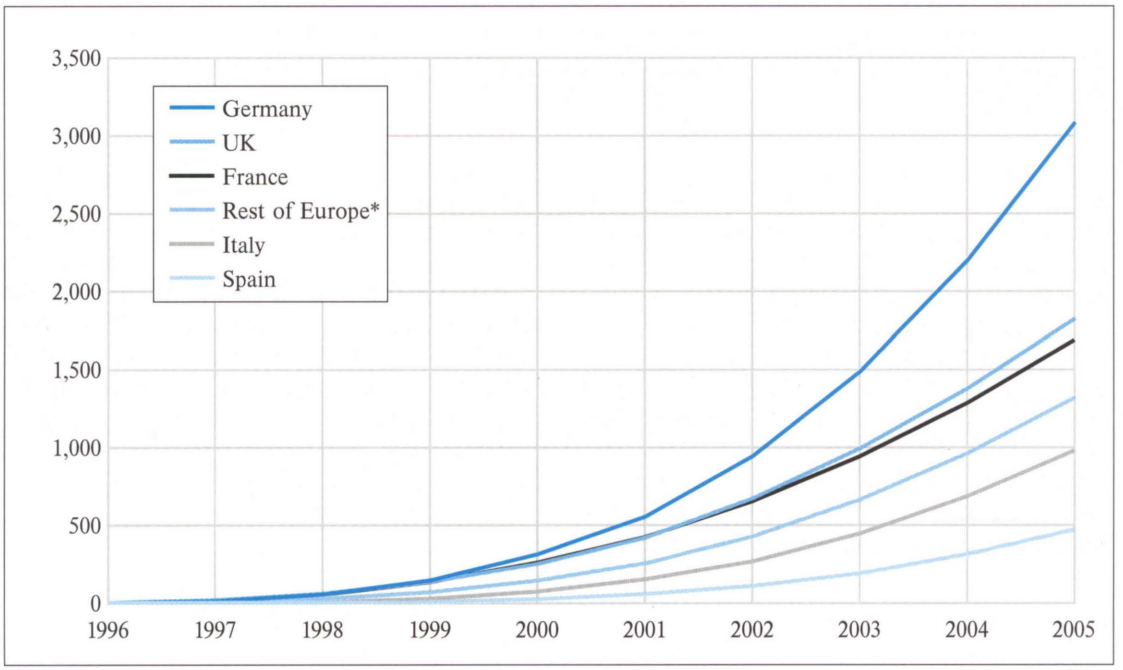
5.2. Interactive Home Shopping

Home shopping services have been offered by mail order operators, commercial broadcasters and cable TV operators for many years and reach tens of millions of consumers. Presently, home shopping in Europe as a whole represents about 34 billion ECU, 2.5% of the 1,400 billion ECU total retailing revenues, while in the USA it represents 3.5% and revenues from broadcast television shopping only already account for more than 1.9 billion ECU.

A distinction must be made between shopping over the telematic networks (which is already starting to happen on the Internet) and truly multimedia home shopping over the emerging broadband networks. While electronic shopping already offers to the customer considerable advantages in terms of convenience, range of choice, reduced prices thanks to the lower goods distribution cost and the direct relationship with the supplier, the addition of multimedia is key to add a much wider range of products and services where images and look are very important, such as the fashion market. In any case home shopping offers new means of marketing and promoting goods and services.

Today interactive electronic commerce is still at its infancy, in Europe as elsewhere. Even in the USA it is estimated that the interactive electronic business in 1994 was worth just about $ 100 million (84 million ECU). Most of that concerned software or databases information, which do not require images to be sold, even if new business is emerging.

Figure 8
The Potential Market of Home Shopping Services on Broadband Networks in Europe (Million Households)



* Includes Benelux, Denmark, Greece, Ireland, Netherlands and Portugal.

A major precondition for the diffusion of home shopping is ease and security of payments. These problems can already be solved thanks to encryption systems and electronic money, but it will take some time before a payment standard will emerge. Major credit card companies such as Visa, Mastercard and other companies such as the Dutch Digicash are actively working in this direction.

In Europe, as far as Minitel is concerned, the most widely used telematics network in Europe, electronic commerce is already worth about 10% of all the mail order revenues (that is 60.5 million ECU).

In the longer term, it is expected that home shopping on the broadband networks will capture a much higher proportion of total retailing revenues, which US sources place at between 5 and 15% of total retail business in 10 years. Retailers should be quick to exploit the ability of home shopping to reduce the need for retail premises, the total workforce, administration and cash handling overheads, and a large proportion of existing stock levels.

Even if in Europe initial use of the service will be relatively low, spending could increase rapidly. Assuming a starting date between 1997 and 2000 for the offering of home shopping over broadband networks in the 12 European Union countries, since it will be among the first services offered to subscribers it is estimated that by the year 2005 about 7% of the 134 million European households could be using home shopping, that is 9.3 million households. The service should be provided free. By the year 2005, when the service should be quite familiar to users, the value of the goods and services sold could be around 5 billion ECU. This makes home shopping potentially the service generating highest revenues among new multimedia services.

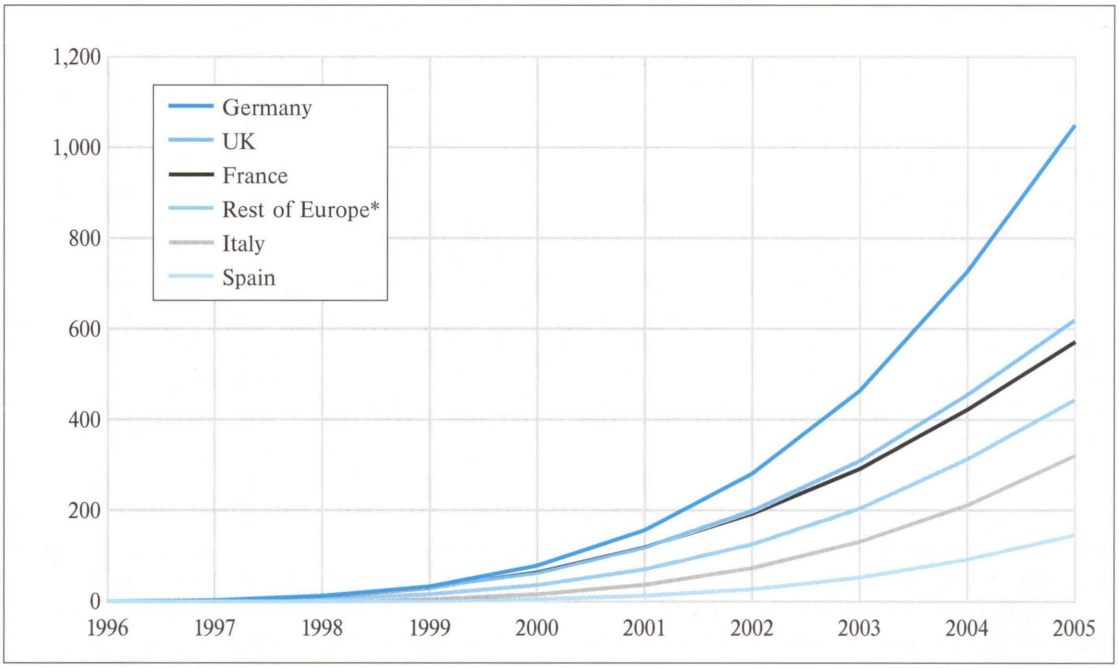
5.3. Home Banking

Banks increasingly tend to develop new electronic delivery channels with various goals, such as: customer retention, thanks to the offering of easily and readily available high quality products; cross selling (selling of banking and non-banking products, like insurance, travel, performances, etc.); getting new clients, also thanks to the offering of their services even where they have no branches, and, last but not least, reducing costs and increasing margins through automation of paperless transactions.

Most banks are investing heavily in advanced ATM (Automated Teller Machine) networks, multimedia kiosks and unattended branches. Home banking is spreading, by videotex or by telephone plus personal computers and modems. Phone banking is by far the most widespread network used for home banking, and it will probably remain so thanks to the ubiquity and ease of use of the telephone network. Electronic banking is also diffused among most users of videotex networks in France and Germany. In Germany, it is estimated that 80% of the over 800,000 subscribers of the Videotext network (most of them professional users or small companies) use electronic banking. Moreover, individually, many banks offer their services by personal computers, especially targeting the SOHO and professional market.

Though European banks have proved to be more cautious about the Internet than their US counterparts, because of problems of security, they cannot any longer ignore the phenomenon. Some European banks have already begun to offer their multimedia information services on the Internet thanks to WWW, but the offering of more sophisticated transactional services has so far been hampered by the lack of security. Barclays, the British bank, for example, has implemented a virtual supermarket on the Internet, offering on-line commerce and elec-

Figure 9
The Potential Market of Home Banking Services on Broadband Networks in Europe (Million Households)



* Includes Benelux, Denmark, Greece, Ireland, Netherlands and Portugal.

tronic payment services. Some European banks are involved in commercial tests of interactive TV offering "electronic purse" (through smart cards suited for electronic payments) and other banking services.

Through the Internet banks will be able to offer their services at international level, overcoming national boundaries. Competition will increase dramatically and each bank will have to differentiate its services in the electronic market. Banks will have to take the risk that new network operators, like software, telecom, publishing, and credit card companies, will replace them in maintaining and developing the relationship with customers. Moreover the network operators will not only have the direct relationship with customers, but will also define the condition of access and the tariffs both for customers and the banks.

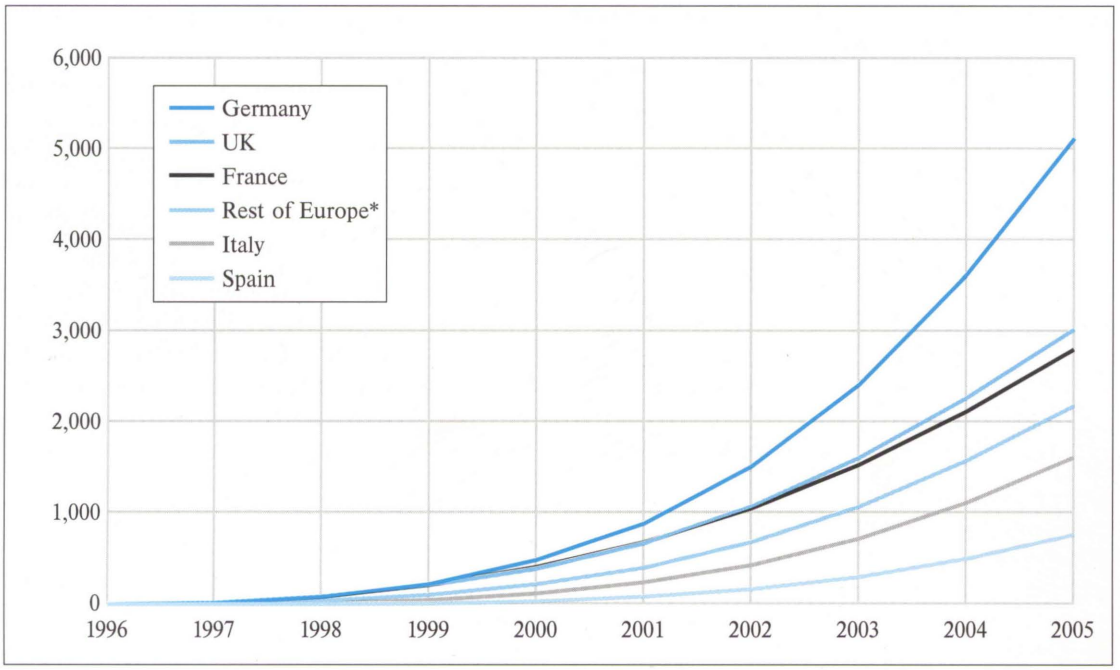
Multimedia is relevant for home banking for sophisticated applications, such as videoconferencing and advice from remote experts on personal investments or mortgages. Home banking on broadband networks therefore will probably be less popular than phone banking, and it is likely to be adopted by more sophisticated customers, usually experienced with business use of personal computers. The number of adopters of home banking in the 12 EU countries has been estimated about 3 million households in the year 2005, that is about 2.4% of the 134 million households, generating revenues of about 190 million ECU in the same year.

5.4. Residential Information Services

Information services to the residential and SOHO market are one of the major new market opportunities emerging from the diffusion of broadband networks. All major trials offer a range of services (even if there are yet no figures on consumer spending available) which can include education and edutainment (education plus entertainment) services, local information such as theatre and cinema programmes and bookings, holiday and travel information and reservations, employment agencies and jobs advertising. Naturally there will be many new services targeted to niche markets, as the networks expand and new service providers enter the market.

Trials show that consumers rate highly interactive information services, and may be prepared to pay a premium provided quality and content of services are high enough. It is however difficult to estimate how much. The only mass market service which can give some insight on the size of the market is the French Minitel market, which has 23,000 services available earning a total of about 1 billion ECU revenues in 1994, that is about 145 ECU per terminal per year.

We estimate that information services in one form or another will be adopted by a large percentage of subscribers to interactive TV/broadband networks. By the year 2005 we estimate that about 15.5 million households will be users of information services, representing circa 11.6% of households in the 12 EU countries, generating revenues of about 930 million ECU in the year 2005. However these revenues could change widely, depending on the range and pricing of services offered and the competition from off-line services such as CD-ROM titles for the residential market.



* Includes Benelux, Denmark, Greece, Ireland, Netherlands and Portugal.

Figure 10
The Potential Market of Multimedia Information Services in Europe (Million Households)

5.5. Teleworking

Major macroeconomic trends, such as the globalization of markets, growing competition, structural unemployment for less qualified categories of workers versus demand for new professional skills, is increasing the numbers of individuals spending part or all their working life as self-employed or semi-independent workers, working from home or small offices, using information and communications technologies to do what is called *telework* or *distance working*.

The adoption of teleworking can be driven by companies decentralizing their organization and pushing their employees to work from home or small satellite offices, or by individuals choosing to work as self-employed from personal offices. In Europe, there are still major barriers against the adoption of teleworking by companies, such as on one hand the rigidity of labour contracts and organizations, and on the other hand the lack of capacity of suitable communication infrastructures and the high level of tariffs. Teleworking experiments carried out by major companies, such as IBM and Italtel, tend to concern small groups of workers with mixed results, where the fear by workers to be marginalized from company life represents a high barrier. However, the growing diffusion of business processes reengineering finds in teleworking a useful tool, especially for services to the customer. A good example is free-toll numbers, which in the US is often handled by teleworkers. Given present barriers, teleworking by large companies has probably a large long-term potential of diffusion, but will probably not be widespread at least until the year 2000. Companies are instead adopting new technologies to support cooperative work among remote workgroups across their sites and with their subsuppliers, commercial networks and major customers.

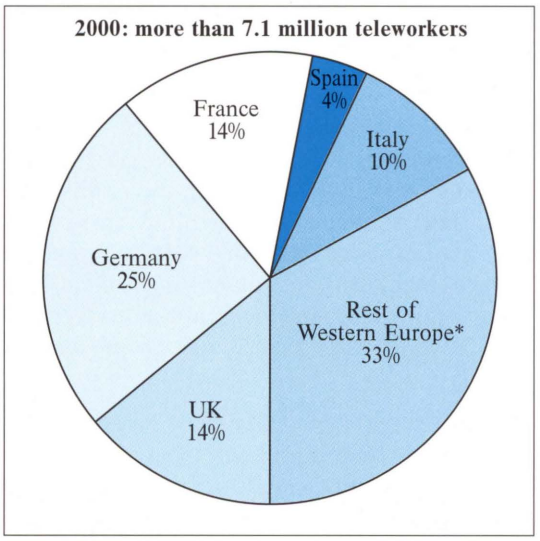
Self-employed teleworkers in Europe will in the medium-term be still a relatively small percentage of the total workforce, but very significant because of their role as pioneers and exemplars in exploiting the innovative potential of new media. The virtual community of teleworkers represents a new emerging social group, characterized by flexibility, greater autonomy in controlling the individual working life, ability to connect with others beyond local and national boundaries, awareness of one's worth on the labour market based on know-how and skills developed and cultivated in a life-long process of self-education and acquisition of knowledge and information. The price to be paid is clearly a lower security and the need to be adaptable to the changing environment. Because of these characteristics, teleworking also represents an innovative way to enter the labour market for the young with marketable skills, faced with a lower supply of stable jobs by companies, and for women appreciating flexibility as a way to match the need to work with family life obligations.

Thanks to the new media, the adoption of autonomous teleworking is possible and growing for knowledge-based and problem-solving work, requiring independent elaboration of information and/or independent activity on the territory.

There are three major fields of expertise where this phenomenon is evident:

- consulting services to large and medium companies across all sectors, including problems analysis and solving and planning, for infrastructural activities identified by Porter's value chain model as management and control, personnel management and education, the information system planning and development, research and development. These consulting services have in common the need of highly specialized and up-to-date know-how, which companies tend more and more to delegate externally while focusing on their core business. An example is personnel education and training, where external experts are usually called in to support management;
- commercial and customer care services, such as autonomous sales personnel (e. g. in the financial services sector) but also independent personnel for technical maintenance and post-sale services;
- consulting and creative activities in the new markets created by new media. Multimedia publishing especially is creating a new breed of independent authors: the creation of video-games for example is carried out most often by self-employed people.

There are already 18 million home offices in Europe (EITO 1995), forecast to rise to 19.5 million in the year 2000. On the basis of these considerations, and of the likely diffusion of networks supporting distance working such as the Internet, teleworkers in Europe from home it is estimated will be about 7.1 millions by the year 2000.



* Rest of Western Europe includes Austria, Benelux, Denmark, Finland, Greece, Iceland, Ireland, Netherlands, Norway, Portugal, Sweden, Switzerland.

Figure 11 Teleworkers in Western Europe: Scenario

In order to estimate the potential number of teleworkers in Europe, a starting point can be the number of home offices, which was estimated in EITO 1995 at about 18 million in 1994, rising to 19.5 million in the year 2000, of which about 40% used by self-employed individuals. At present a very low percentage of these home offices use some type of on-line connection, as proved also by our estimate of a total number of 172,000 households with Internet-like connections in Europe. However, Internet-like access is expected to grow very fast in the next few years, to 14.2 million households connected in the year 2000. We estimate that about 60% of Internet users carry out business applications on the networks, even if not all of them will be teleworkers. On this basis, considering that teleworkers will almost certainly also use Internet and Internet-like networks, we estimate that by the year 2000 there will be in Europe about 7.1 millions teleworkers from home.

6. Competitive Positioning: Europe Compared to the USA and Japan

The comparison of relative competitive positions between the triad competitors (Europe, USA and Japan) has to take into account several different factors, such as:

- macroeconomic factors, including in particular market size, level of market integration and residential incomes;
- regulatory factors, such as the degree of market liberalization, which has a positive impact on competitiveness and market growth;
- cultural factors, such as the presence of language barriers, the level of innovation propensity by the users and the level of entertainment spending;
- market factors, such as the penetration level of home PCs, computers in business sectors, VAS services;
- supply side factors, like competitiveness in microelectronics, computer, telecommunications, cable TV, consumer electronics, on-line information services, media industries, the level of integration and partnership between the players of multimedia market and the degree of internationalization of multimedia companies.

6.1. EU Points of Strength in the Global Market

Europe has very significant points of strength in the emerging global on-line multimedia market. Europe is the largest potential market in the world; EU telecom operators and manufacturing companies rank among the largest companies.

ISDN and GSM constitute great advantages of Europe in comparison with the USA. As far as the multimedia superhighways are concerned, European companies are still at a pre-introduction stage, like the US and Japan telecom operators. Europe is also well positioned as far as media, consumer electronics and computer services companies are concerned.

6.2. EU Points of Weakness in the Global Market

Europe suffers as well from some important points of weakness, especially vis-à-vis the USA. The EU market is in fact the less liberalized and integrated (both at European level and at the intersectorial level, between telecom, cable and media markets), even if some countries such as the UK, are even more deregulated than the US. However the liberalization and convergence process is accelerating in the US and its competitive pressure is a driving factor to liberalization in the EU. Moreover EU companies cannot easily compete with US companies in fixing the new standards of the technological platform (software, hardware, microprocessors and other sophisticated semiconductors) needed for the offering of the new on-line multimedia services.

Cable and media industry are other formidable points of strength of the US industry. Cable industry revenues amounted to 17 billion ECU in 1994 and it can be estimated that US companies control about 70% of the world TV and movie market. In general, US companies are more global than European companies: for instance, RBOCs and Cable TV companies are already well established in the liberalized British market.

Worldwide there are currently plans for over 90 different interactive cable ventures involving more than 50 different operators (cable and telecom, software and hardware companies). Over half of these ventures are located in the US, 18 in Europe, 9 in Japan and 7 in Asia and Australia. In Europe, the wave of financial, technological and commercial agreements between telecom operators and between telecom operators and media companies has already started.

Moreover US business customers are in general more innovative and likely to experiment with advanced services, because telecom services are far cheaper than in Europe thanks to competition. That is also the reason why in the USA VAS services, as e-mail, EDI, CRS are more diffused than in Europe. It is not by chance that the Internet, the most relevant phenomenon in the telecom world market in recent years, was born in the USA and that more than half of its users are Americans.

Users' entertainment consumption level is higher in the USA and Japan than in Europe: the average TV viewing time is 250 minutes per day in the USA, 255 mins in Japan, while in Europe only some countries, like the UK, Ireland, Portugal, Italy and Spain have an average TV viewing time of more than 200 mins. This could mean that the US (and Japanese) consumers are more willing to use new services, like interactive TV; but it could also mean that the potential market in Europe is very significant and not yet fully explored. Home PCs and mass market telematics are also more widespread in the USA in comparison with Europe, also because of the differencies between households income levels. About 20% of European households have a PC at home, while this percentage is 30% in USA; and while 10 million of US households are already connected to a telematic networks, in Europe just about 240,000 households are connected to the Internet and Internet-like networks (though the great success of French Teletel must not be underestimated).

Japan has the most important point of strength in the electronics consumer industry, where Japanese companies are the world leaders, competing with European and, to a lesser extent, with South-East Asian companies. But Japan has not many other points of strength in comparison with Europe. So far, in Japan the large spread of VAS targeted to the business market has been inhibited by the dominance of mainframes and centralized architectures and the limited penetration of personal computers. In Japan penetration of personal computers and telematic services in the home market is also lower than in Europe. Cable is not as widespread as in the USA and Europe, and telecom companies are not very internationalized, except in Asian markets.

6.3. Synthesis of Europe Competitive Positioning

Europe is well positioned to compete in the world market, and therefore to avoid the risks of increasing commercial deficit and delocalization of sophisticated production, for example of telecom services and media content. The European Commission guidelines, the processes of liberalization and re-regulation, are a good chance of closing the gap with the USA. Moreover, as far as the setting up of the new broadband networks is concerned, all world competitors start more or less from an equal position.

Nevertheless, the most important problem Europe (and not only Europe) must solve is perhaps the content bottle-neck. In the near future world, where cheap powerful technologies and a multitude of transmission channels will be largely available, users will demand and will need many new useful (or entertaining) services. Content will become the very scarce resource of the multimedia system. New multimedia services acceptance and their success will depend increasingly on the content quality and on the benefits that new services will actually transfer to customers.

In the emerging interactive television market, for instance, the economic and financial success of the operators will depend on the quality and the range of the content offered. The European media industry is strong enough to face the new challenge, but the European media market is too fragmented and therefore in Europe the level of internationalization and export of the national media industries is still too low (with some notable exceptions). But, once again, overcoming European market fragmentation will probably require eliminating not only national barriers but also traditional barriers between different markets, like media, cable and telecommunications. The formation of large European multimedia groups and joint ventures will be very important for facing global competition. However, especially in this phase of rapid change, SMEs will very probably play a strong role in launching innovative services and products, in opening new markets and satisfying particular market segments.

HANNOVER 28.8.–1.9.1996
CeBIT
HOME
ELECTRONICS

Hannover 14.– 20. 3. 1996
13.– 19. 3. 1997
CeBIT
World Business Center - Office - Information - Telecommunications
Further information: Deutsche Messe AG, Messegelände, D-30521 Hannover
Tel.: (511) 89-0, Telefax: (511) 89-3 26 26
DEUTSCHE MESSE AG, HANNOVER/GERMANY

The ICT Market in Europe's Banking and Financial Services

This paper has been provided by NOMOS ricerca in close cooperation with the EITO Task Force.

1. Introduction

The European Banking and Financial System is going through a period of structural changes and internal reorganization.

Can information technology play a strategic role as an agent of innovation in this general reorganization process?

Bank automation is now close to a saturation point in Europe. The most innovative areas, which are largely linked to new delivery and sales channels, are new departures for banks. ICT support tools for strategic areas such as sales and consultancy or decision-making are relatively new, reflecting a structural weakness in the bank sector.

Therefore this paper will:

- outline the structural changes in banking;
- analyse the current state of penetration of ICT in terms of: hardware, application software, IT expenditure;
- analyse the strategic perspectives and trends in banking and financial systems in relationship to emerging and innovative applications in order to evaluate the strategic role of ICT.

For definitions see section 8.

2. The Banking Sector in Europe

2.1. Contextual Analysis

An analysis of the main EU banking trends in recent years can be summarized as follows: Reduction in branches and banking network reorganization.

This trend is much more significant in Central-Northern European countries. As a general rule, the containment of the traditional network is accompanied by strategies aimed at creating and/or improving alternative sales channels and direct banking: self-service, remote and phone banking.

A second trend is the reduction of bank employees. This trend does not involve Southern countries, although both Spain and Portugal are introducing personnel reorganization processes, reduction of branch back offices, centralization of mass transactional activities. Banks tend to reduce the low cost activities while they are moving to increase sales and consulting activities.

A third factor contributing to the reorganization of the system is mergers and acquisitions. These trends are more significant in Southern Europe where, as the general structural data show, density levels are far lower than in Central-Northern Europe.

Increasing competition still involves mainly internal (national) financial markets, resulting from more competitive strategies of banks and other financial institutions. But in some countries, in Belgium for example, foreign banks play a significant role.

EU regulation is having an increasing impact on cross-border competition in the banking sector. Any credit institution established in an EU member state can establish a branch in other member states. This branch is not required to have an authorization from local authorities and is largely regulated and supervised by home regulations. This will reduce national monopoly in banking sector and will promote the so-called "two freedoms": to establish branches and to provide services.

2.2. European Regulations

In 1991, with the signing of the European Union Treaty at Maastricht, the Community made fundamental changes of historical importance in the institutional, political and economic sectors. The EMI - European Monetary Institute - has established the regulatory, organizational and logistic framework relative to the single monetary policy procedures, the structure of the payment systems, the collection and correlation of monetary statistics and the preparation of banknotes in ECU. The final phase was expected to begin by 1 January 1997 and in any case by 1 January 1999. Since 1 January 1995 Austria, Finland and Sweden also joined the EU. In the financial services sector, that in principle opened up the possibility of free trading across borders on the basis of a "single passport". On 1 November 1993 the Treaty of Maastricht took effect.

The EMI, precursor of the European Central Bank (ECB), should put into effect the Maastricht plans for European economic and monetary union (EMU) with the ultimate goal of a single currency. This should have an important impact on payment systems and interbanking transfer systems.

In 1995 a document of revision of the 1988 Agreement on Capital Adequacy was approved, in order to introduce asset and liability statement requirements to face market risks. This rule should allow banks to use their internal risk control models instead of a standard scheme. This new rule should be put into effect by the end of 1997 and already many banks (cf. section 6), are developing projects related to risk management.

But before the single market can become a reality, the plans laid down have to be adopted by individual member states and there is still scope for local interpretations of overall regulations. The financial services sector is still a long way from achieving a level playing field in cross-border competition. Banks in Europe are sceptical about prospects for achieving the Maastricht proposals according to the scheduled time-table and are also concerned about the costs of a single European currency[1]. Until all the directives have been put into effect by all member states and potential members, there is no way of knowing how they will effect the business and profitability of banks.

2.3. Quantitative Data

The European banking market is larger than Japan and the USA. In the EU there are more than 10,000 banks (including specialized credit institutions in France) and about 170,000 branches.

The various EU countries have so different positioning (according to various indicators as GDP growing, Deposits on GDP, number of branches per inhabitant, Deposit on number of banking employees) that it is not correct to describe EU banking sector as an homogeneous market. The various banking systems also aren't homogeneous according to the banking categories included in the "banking sector"[2].

[1] A survey in 400 banks and capital market organizations carried out by Arthur Anderson showed that few believe EMU will happen and they are not bothering to prepare for it.

[2] For a general view of "banking categories" see "Definitions" in section 8.

Other big differences are the number of operators and the concentration level. This is usually higher in the Central-Northern countries than in the Southern ones. Therefore we provide a comprehensive analysis of the important features of each single selected market that *(Table 1)* have a good level of representation in the EU banking system.

In the Central-Northern countries *(Figure 2)* there are more of the "very large" banks.

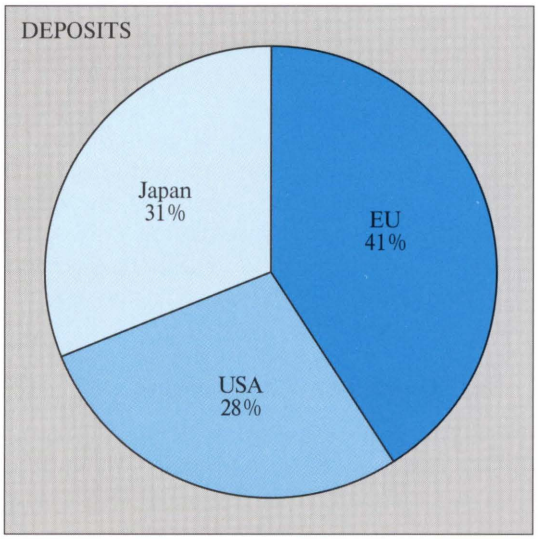


Figure 1
Total Banking Deposits by Geographic Area

	Number of banks	Number of branches	Number of branches per bank	Number of branches per 10,000 inhabitants	Total deposits (billion ECU)	Deposits per GDP in %	Deposits per inhabitant (million ECU)
Austria	134	2,097	15.6	2.7	112.9	63	14.4
Belgium	130	3,596	27.7	3.7	62.3	29	6.3
Denmark	149	3,079	20.7	6.0	60.6	58	11.8
Finland	527	2,804	5.3	5.6	48.1	49	9.6
France*)	2,048	25,664	12.5	4.5	563	58	9.9
Germany	4,170	39,747	9.5	6.2	750	60	11.7
Greece	39	1,376	35.3	1.4	38.8	75	3.8
Italy	1,037	22,133	21.3	3.8	640	69	11.1
Luxembourg	177	297	1.7	7.8	27.4	379	37.4
Netherlands	1,058	7,971	7.5	5.3	182.5	78	12.2
Portugal	223	1,991	8.9	1.9	39	71	3.7
Spain	361	35,084	97.2	9.0	269	64	6.9
Sweden	498	3,251	6.5	3.8	79.5	41	9.2
United Kingdom	726	21,185	29.2	3.8	702	90	12.5
Total EU	**11,277**	**170,275**	-	-	**3,577**	-	-
Average values	-	-	21.4	-	255	85	11.5

Table 1
Banks in the EU

*) Including "other credit institutions"

NOTE: This table refers to 1992. More recent information is available for the five selected countries: France, Germany, Italy, Spain and the UK in following sections

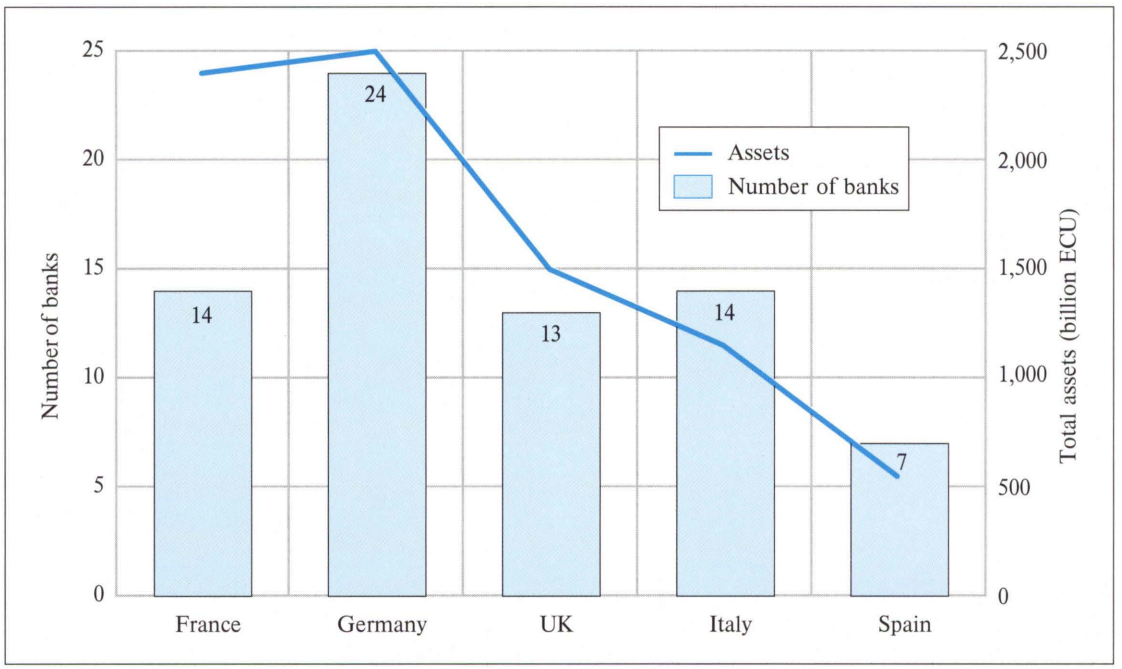


Figure 2
Ranking of Banks in Major EU Countries by Number and Assets (First 200 Worldwide Firms, 1992)

3. The Banking Sector in Main European Countries[3]

3.1. United Kingdom

Among European countries the UK is the less settled financial market. However it is the principal financial market in Europe. The role of the City as financial centre explains the high level of assets on GDP and the presence of foreign banks. Since the 1980s the building societies can operate as banks.

The government programs of privatization since the 1980s have stimulated the private purchase of shares: more than 10,000 citizens (1 out of 6) have shares.

- In 1993 the number of branches was less than 30,000, a decrease since 1985-1986.
- Foreign financial institutions have a significance which has no comparison in other EU countries.
- The concentration level is relatively high and it is impossible to find other banks of the same size elsewhere in Europe.

The most common model is the multi-functional group, although the global bank model is allowed by national regulations.

Since the 1980s, the overall UK banking system has a high level of debt. Increasing competition has introduced despecialization of financial institutions. In spite of this, the UK banking system has a satisfactory level of profitability, a good reputation for quality of services and products, and experience in the most innovative segments of the financial market.

[3] This section is based on: "Banking in the EU and Switzerland, 1994", a Financial Times Management Report; "I mercati finanziari internazionali" - IPSOA, "Il giornale della banca" 1993 - Mondadori, Banca d'Italia "Assemblea generale ordinaria dei partecipanti" 1995; "European banking and capital markets", A. Andersen 1993

Table 2
The Structure of Banking and Financial System in the UK

Main types	Number	Staff	Branches	% of assets	Description of structure and activities
UK Banks	**600**	**408,000**	**20,000**	**61.4**	The basic functions of the clearing banks are money transmission, deposits, lending, international business and financial services.
Major British banking groups - clearing or high street banks (MBBG)	9	313,000	11,500	44.3	These banks dominate the retail banking sector; originally known as clearing banks from their membership and control of the various money payments clearing houses.
Other UK banks	591	95,000	8,500	17.1	These include British overseas banks with head offices in the UK but which operate mainly abroad.
Foreign banks	527				These include branches, representative offices, subsidiaries and controlling interests in consortium banks.
Accepting houses/ Merchant banks				0.7	These do not operate through chains of branches; customers are companies, institutions and governments; they are wholesale rather than retail and more international than domestic. They are classified as a separate category of bank.
Other financial institutions					
Building societies	88			35.9	These are mutual organizations with the function of accepting deposits, lending money for mortgage purposes and offering basic banking services,
Finance houses (FHA members)	48				These provide medium term instalment finance, including hire purchase, leasing and personal lending.
National savings banks Post office facilities			20,000 UK Post Office branches	1.9	These offer bank deposit and cash withdrawal facilities through post offices,

Two other important features of the UK banking system are the high degree of integration between insurance and banking activities (which contributes to profitability), and the low level of personnel costs compared to other EU countries. This is mainly caused by the headcount reduction plans, started in the late '80s by the major banks, and by the less "labour intensive" products and services offered to clients.

Regulations and institutions

The Banking Acts of 1979 and 1987 defined banking activities, which were limited only to the "authorized institutions".

The Bank of England authorizes banking activities, according to criteria, that include the competence and fitness of directors and managers, the composition of the board of directors, the adequacy of accounting and other records and systems, the financial resources and the paid-up capital and reserves.

Banking supervision is based on flexibility, to accomodate changing markets and the different circumstances of institutions. Another important feature of the Bank of England supervision is the assessment of financial institutions on a consolidated basis to evaluate the total capital adequacy and the risk concentration of banks.

In 1989 the second EC banking directive was adopted. It gives any EU credit institution the right to establish a branch in other member states without the need for local authorization.

3.2. France

The French banking system, too, seems well positioned in the European market. Here is a group of large banks capable of satisfying the most sophisticated customers and competing with foreign banks at home and abroad, and also a widespread network of medium-small banks offering custom-sized services and products. The French banking system is ready to face the European competition without dramatic changes in its structure.

Although the French banking structure has been simplified in recent years, institutions vary from large commercial banks to specialist financial organizations which provide funds to personal and commercial customers.

Saving and cooperative-mutual banks (the latter are "non" AFB - Association Française des Banques) have a multi-layer structure: regional - central organizations carry out clearing - specialist functions. These banks, which include Crédit Agricole, are a federative structure.

The banking environment has been affected to some extent by mergers and acquisitions, which has reduced the number of players in the market.

In the past five years, the number of branches has also decreased, stabilizing at around 25,000. In the last year an important trend has been the development of "direct" banking, changing the role of the branches.

Staffing levels have generally remained stable at around 415,000 but, due to overstaffing in certain sectors and industry realignments arising from mergers, reorganizations, and industry trends, certain types of banking establishment began to lay off personnel. Increased automatization and Automated Teller Machines have also had some impact.

Despite these overall indications of stability, there is an underlying change and restructuring in the banking system, motivated partly by changes in the legal framework, coupled with difficulties encountered by individual players. In addition, some French banks have sold their network of branches to foreign players and subsequently specialized in more lucrative merchant banking activities. Others have attempted to reorganize their operations by merging networks and reducing personnel. Furthermore,

Table 3
The Structure of Banking and Financial System in France

Main types	Number	Staff	Branches	% of assets	Description of structure and activities
Banking institutions	**631**	**398,600**	**20,243**	**93.2**	Subject to the Banking Act: they are authorized to undertake all types of banking and financial activities.
Banks with commercial statutes	419	245,000	10,000	49.2	All commercial undertakings authorized to perform all types of banking and financial transactions.
Cooperative and mutual banks	155	118,000	5,943	27.0	They differ from banks proper by reason of the co-operative nature of their by-laws and federal structures.
Saving and provident banks	36	35,600	4,300	17.0	Established as entities with a special non-profit legal status, customers are limited by statute.
Municipal credit banks	21				Public entities the management of which is the responsibility of a local authority (often large towns).
Other credit institutions					Subject to the Banking Act: authorized to undertake only certain types of operation.
Financial companies	1,000	21,000			Specialized finance (housing or consumer credit, leasing, factoring etc.), means of payment (travellers' cheques, credit cards etc.), portfolio management etc.
Specialized financial institutions	32				Commercial credit, mortgage loans, clearing of market transactions etc.
Other financial institutions					They are not subject to the banking act.
Post Office					Deposit transfer and investment service.
Treasury accountants					Deposit transfer and investment service, revenues collectors and government paymasters.
Deposit and Consignment Office					Under public law, the Caisse centralizes funds from the tax-exempt deposit books etc.

shifts in the types of banking products and activities have resulted in a redeployment and restructuring of the employment pool.

Automated Teller Machines and self services increased in the last eight years by 93%.

Regulations and institutions

A new banking law was approved in 1984. Since then, most constraints on banking activities have disappeared, such as credit restrictions and exchange controls. Measures have been taken to permit the free establishment of foreign credit institutions and the free provision of services. The law defines the activities which fall under the heading of "bank transaction". The rules governing the credit institutions cover five areas: organization, paid-in capital, accounting information and procedures, management standards, risk exposure and resources.

The main supervisory institutions are:

- the Banking Regulatory Committee (CRB), responsible for defining the general rules applicable to credit institutions;
- the Credit Institutions Committee (CEC), responsible for authorization of banking activities;
- the Banking Commission (CB), responsible for enforcing rules by credit institutions;
- the Bank of France plays a central role in regulating and supervising banking activities, together with the above mentioned bodies.

3.3 Germany

In the banking industry the most important date was July 1, 1990 when the monetary union between the two Germanies was established and Deutsche-Mark became the only legal tender. On the same day West Germany's banking laws were introduced in East Germany. Ever since then, almost all banks conducting business in Germany have been active in the five new states, trying to gain new customers as well as building up branch networks.

The German banking system is a good example of integration between banking and industry, allowing the flow of investments towards the most efficient industrial sectors.

Another important feature of the German banking system is the prevalence of the so-called "universal bank", that is a bank with a complete offering of banking services and products and with divisions reporting to a strategic planning center.

Financial products are also offered by mail (22,000 branches). Products offered are postal saving services and an ever-increasing range of standard banking services, such as credit cards. Mail offices seem to be a valid competitor for banks, especially the small ones.

The number of banks will decrease in the near future and the number of branches stabilize, although the number of branches increased recently due to the opening of new branches (over 5,500 units) in Eastern Germany.

The number of employees increased from 1992 to 1994 (746,000 units to 755,000 units). Only 5 banks employ over 10,000 personnel, ninety-eight percent of banks are small.

The main problems and strategies related to the banking system are:

- concentration into larger units;
- rapid reduction of the business which preserves equity capital;
- the politicians want to limit the power of the banks.

The key challenges for the major banks are:

- structural reform with the aim of getting closer to consumers;
- consolidation of the self-service palette;
- thinning out the expansive vocational network;
- establishment of the so-called direct banks (without branch offices, client contact by letter, fax, telephone);

Table 4
The Structure of Banking and Financial System in Germany

Main types	Number	Staff	Branches	% of assets	Description of structure and activities
Universal (or multi-purpose) banks			**48,434**	**77.0**	
Commercial banks			7,017	25.5	
the "big banks"				9.3	The "big three" cover the entire field of banking except for mortgage operations. Customers are almost exclusively trade and industry.
the "regional banks"				13.7	These banks often have branches in more than one state: some are also allowed to operate as mortgage banks, some work like merchant banks.
the "foreign banks"				1.3	Subject to the German Banking Act and to the Bank Supervisory Authority. Many of them carry out only wholesale banking operations.
the "private bankers"				1.2	These conduct all banking activities but are usually specialized to some extent (customers or types of business); most of them do not have branch networks.
Savings banks and regional giro institutions			20,220	36.4	Special laws define the traditional tasks: savings and giro transaction facilities, credits, mortgages etc.
Credit-cooperative banks			21,197	15.0	Historically they support their members; nowadays both types of credit cooperatives also serve all kinds of customer.
Specialist banks				23.0	
Mortgage banks and building societies	33				These offer long-term housing loans secured by mortgages.
Securities-deposits banks	1				Several regional institutions merged into one single organization in 1989 that handles international securities business.
Investment companies	50				These manage funds for private and institutional investors.
Banks with other special functions					Institutions with special functions: examples are the German Post Office (separated in 1989 from the postal service) and a bank that provides medium and long-term loans for enterprises etc.
Total banks	**4,047**	**750,000**	**48,500**		
Post office			**22,000**		Financial products (postal saving services and credit cards) are also offered by post offices. This is a competitor for small banks.

- increasing product variety (new: money market funds).

Regulations and institutions

The banking system is controlled by three types of laws: central bank law, commercial bank legislation and other bank laws.

Central bank law covers the structure of the central bank system and the tasks of the Deutsche Bundesbank. This institution carries out the usual central bank functions and cooperates with the Bank Supervisory Authority in supervising the banking system.

Commercial bank legislation defines the supervision and inspection of the system, information to be given to the Bundesbank regularly by the banks, criteria for capital and liquidity requirements and management qualifications. This law is continuously being updated to be brought in line with the EC directives.

Other bank laws concern specialist banks.

3.4. Italy

In Italy there are more than 1,000 banks but more than 800 are very small banks that represent only 12% of the total banking system.

All banks and main financial institutions (about 1,500 entities in 1994) are ABI (Italian Banking Association) associated. ABI and Banca d'Italia (the Central Bank) play an important role also in promoting ICT banking projects. There is a special Committee called CIPA (Interbanking Committee for Automation) that promotes changes to the Payments Systems to reduce paper based transactions and in order to improve the services efficiency (for example: the cheque handling). This committee also keeps watch on the ICT in Italian banks to help with systems analysis and technology. The Interbanking network manager company - SIA - has recently, developed new services for money and capital markets (MID - Interbanking Deposits Market, MTS - State's Bonds Market, MIF - Interbanking Futures Market).

The main features of the Italian banking system are:

- a number of small banks;
- a network of branches which is still below European standards;
- a lack of alternative financial services and products offered by the banks, in comparison with the most advanced EU countries;
- high cost of personnel;
- a high spread between interest rates on deposits and on lendings;
- a high level of financial intermediation performed by the banking system;
- competition, both internal and external, has been limited and capital markets have been characterized by a low degree of sophistication and a limited number of financial instruments.

The most important trends of the Italian banking system are:

- Concentration by merger and acquisition (more than 40 each year in 1990-93). This means global IS revision projects etc. Another way to obtain a larger positioning is represented by holding and banking groups: there are 91 comprising about 200 banks and many financial companies;
- increasing number of branches (+ 40% from 1989) to gain European standard stature. Branches are still the focus of banks' strategies towards client, even showing a moderate interest in complementary new delivery channels such as self service, remote banking and, more important, banking by phone. They will have an important role in the medium-to-long-term in order to solve some banking problems such as the high costs of personnel and the need for a better use of human resources often involved in low value-added activities;

Main types	Number	Staff	Branches	% of assets	Description of structure and activities
Banking institutions	**991**	**349,515**	**21,982**	**76.2**	
Limited company banks	174	279,915	15,826	61.8	These are authorized to perform all types of banking and financial operations.
Cooperative banks	100	56,107	3,869	13.7	These are authorized to perform all types of banking and financial operations.
Rural and artisans' banks	671	13,493	2,226	0.5	These operate at a regional level, have some limitations in their activity by statute and have the purpose of supporting their members, even if they serve all kinds of customer.
Central credit institutions	5		11	0.2	These are the sectoral associations of some categories of banks.
Foreign banks	41		50		
Other financial institutions	**46**	**8,482**	**124**	**23.8**	
Special credit institutions	46	8,482	124	23.8	These make medium and long-term loans to business customers and are financed through bond issues.

Table 5
The Structure of Banking and Financial System in Italy

- no further increase in banking personnel. There is a movement of personnel from headquarters to branches, and from back office to front office and commercial activities.

Regulations and institutions

Legislative decree 385/1993 has given a new regulatory framework to the banking system, coordinating the old banking law with the many provisions that have been adopted to amend it, including the provisions of the second EC banking directives. Prior to this legislative decree, measures were taken to de-regulate the banking sector: liberalization of procedures for opening new bank branches, elimination of foreign exchange controls, a privatization programme for publicly owned banks. Measures to enhance competition were taken too: creation of Anti-trust Authority and law 197/1992 on transparency of contract conditions in financial intermediary - related activities.

The main effects of the 1993 legislative decree have been the following:

- an increase in the level of despecialization of credit institutions;
- banks must be constituted in the form of a company or cooperative limited by shares;
- reinforcement of the principle of separation between banking and commerce;
- the discretionary power of monetary authorities for supervisory activities has been limited, in favour of "prudential supervision" by the supervisory institutions.

The main supervisory institutions are:

The Interministerial Committee for Credit and Savings (CICR), which supervises credit, savings, foreign exchange and issues directives to the Bank of Italy.

The Bank of Italy, which regulates and supervises the banking system and, together with CONSOB, the stock market.

3.5. Spain

The Spanish banking system consists of three groups of institutions:

- private banks;
- savings banks;
- cooperative savings banks.

Each maintain their own characteristics, although they tend to offer the same services and to be controlled by the same regulations.

After private banks the savings banks sector is the second most important group in the Spanish financial system. This sector is made of 53 confederated savings banks plus the post office savings banks which has special characteristics.

The cooperative savings banks sector includes the rural banks (whose members are agricultural cooperatives) and general cooperatives. There is a total of 100 institutions but their importance within the Spanish financial system is very small.

Agricultural credit cooperatives also include some Associations: the Asociado Española de Cooperativas de Credito (26 rural banks and the Banco Cooperativo Español), the Sociedad de Servicios Financieros (17 rural banks and a rural cooperative) and the Grupo Asociado made up of the Banco de Credito Agricola and 25 rural banks.

The evolution of the system is linked to these main key factors:

- mergers and acquisitions;
- diversification of financial products.

The change has affected the saving banks specialized in retail banking activities and characterized by:

- their small size;
- presence in restricted geographical area;
- influenced by local authorities;
- higher profitability;
- higher operative costs than those substained by EU banks.

Regulations and institutions

The Spanish banking sector was greatly reorganized by the law regulating credit and banking of 14 April 1962.

All banking institutions are controlled and regulated by the Banco Español and the Official Credit Institute, responsible for the coordination, control and supervision of the official credit institutions, as well as for supplying funds.

4. The Structural Changes in Banking: Internal Efficiency and New Banking Offers

4.1. General Issues

1993 was a very important year for the European banking systems because the single market came into effect increasing competition between banking systems and single banks. It is important to understand the new scenarios in the various banking systems.

The Northern European markets are characterized by higher tensions than the Southern banking markets: lower profits and lower forcasted trend in revenues. All these factors have

Main types	Number	Staff	Branches	% of assets	Description of structure and activities
Private banks	159			49.0	Specialization stopped being statutory and become dependent on the character of each bank: merchant (exclusive right to issue bonds) and non-merchant. The criterion of geographical limits also allows to distinguish them between national, regional and local banks.
Savings banks	54			46.0	Established as entities with a special non-profit legal status in 1993 a Royal Decree liberalizes conditions for the creation of new savings banks.
The post office savings bank	1				It gained the status of a bank in 1991. It's now a public bank and the conditions for its operations are the same of the other savings banks.
The confederated savings banks	53				
Cooperative savings banks	100			4.5	These enjoy the advantage of a special fiscal regime; they may be local, regional or provincial.
Rural banks					These are sponsored by agrarian cooperatives and societies.
General cooperatives					These have origin in guilds and professional associations and bodies (industrial or commercial nature).
Official credit institutions				6.0	From 1992 these have been liable to the banking "coeficientes" subject to a gradual timetable; their shares are largely public but some of them are privatizing.
Total banks	**361**	**236,000**	**35,000**		

Table 6
The Structure of Banking and Financial System in Spain

recently led to higher attention to costs. In Northern Europe the banking systems are also much more concentrated, have few competitors which have very high market shares and have achieved a very high level of saturation (number of branches, personnel, intermediation level etc.).

Generally, in Southern Europe, markets are characterized by higher profits and costs have a lower - but increasing - importance. Banks are usually smaller and often there are still margins of growth. It is however important to emphasize that Southern Europe is characterized by lower homogeneity. The different structures have a great influence on the various trends.

There are however some common problems:

- increasing competition in financial markets;
- an increasing attention to cost (due to the lack of capital) and a strategic role given to technology as a competitive edge and "survival tool". Problems arise as the banks are not always clear about the correct cost-benefit ratio: this is increasing caution and pragmatism in all European banks in their approach to ICT.

The *main strategic guidelines* of European banks are:

- focus on *"the client":* customer satisfaction (services quality), marketing systems, target-clients analysis;
- focus on *commercial and sales activities;*
- focus on *business management;*
- focus on *investments and credit lending* areas: definite movement in the direction of new and more sophisticated financial products such as private banking, integrated products (i. e. investment funds and insurance), variable interest rate management with more and more sophisticated application solutions that help banks in forecasting the market trend and in choosing the best financial solutions for each client according to their requirements (more or less risk) while guaranteeing a minimum level of profitability;
- internal *process rationalization,* greater productivity, reduction of low added value activities, BPR (Business Process Reengineering), document processing projects and services efficiency;
- *payment systems* reorganization: in all EU countries automated payment systems and especially credit and debit cards are strongly increasing reducing cash payments and cheques. Credit and debit cards transactions per person is 24.9 in France, 14.4 in Belgium, 10.2 in Portugal, 3.6 in Spain (here only POS transactions are counted), 1.5 in Italy.[4]

Profitability and cost structure is different in various banking systems:

- services revenues are higher and increasing in Northern Europe (UK first): This situation can cause problems in Southern countries when money management profitability decreases for general economic reasons (this happened, for example, in Italy in 1994);
- personnel costs are a higher percentage of total costs in some countries: for example more than 45% in Italy, less than 40% in UK.

4.2. New Organizational Models

The traditional hierarchical structure still dominates. Nevertheless, this is a period of significant change in the banking sector, with the introduction of business reorientation strategies and internal production process reviews.

Current trends are *towards flatter organization structures* as sales networks acquire greater autonomy and, above all, towards creation of new divisions oriented more closely to business and the market, a reversal of the traditional product-service divisions.

Some examples of organizational models help us to understand how banks are moving towards new models. Examples show different solutions but a common trend. It is interesting to note that information technology can become a component of each new business unit (cf. examples no. 4 and 5). Quality and programme management can become banking divisions (cf. example no. 7):

[4] 1993 data, source Eurostat, Bankitalia

Table 7
Evolution in Payment Systems

	Share of GDP in %	Number of no cash operations per person	% Composition				% Average variation 1991-93			
			Cheques	Paper based transfers	Auto-mated transfers	Credit and debit cards	Cheques	Paper based transfers	Auto-mated transfers	Credit and debit cards
France	3.6	160	53.2	2.4	27.4	17.0	1.4	6.9	8.3	8.6
Germany	6.7	139	8.3	17.3	71.8	2.6	3.0	11.3	15.1	31.3
UK	2.8	115	43.1	6.4	29.6	20.9	- 3.9	3.3	5.4	15.4
Italy	5.8	35	36.5	38.5	20.9	4.1	- 5.0	4.0	6.5	13.3
Average values	**4.7**	**112**	**35.3**	**16.2**	**37.4**	**11.2**	**- 1.1**	**6.4**	**8.8**	**17.2**

Source: Banca d'Italia 1995

Table 8
Automated Teller Machines

	Automated Teller Machines					
	Number of systems 1993	% Average variation 1991-93	Inhabitants per system	Number of operations per system	Average amount in ECU	Estimated number of systems 1995
France	18,735	4.0	3,080	40,872	90	20,264
Germany	25,000	34.8	3,252	-	-	45,428
UK	18,700	2.5	3,112	64,064	85	19,647
Italy	15,227	14.7	3,756	12,308	230	20,033
Average values	**19,416**	**14.0**	**3,300**	**39,081**	**135**	**26,343**

Source: Banca d'Italia 1995

Table 9
Point of Sales

	Point of Sales						
	Number of systems 1993	% Average variation 1991-93	Inhabitants per system	Number of operations per system	Average amount in ECU	Estimated number of systems 1995	% POS diffusion in sale's points*)
France	429,000	10.6	134	3,263	68	524,768	75
Germany	28,000	- 10.1	2,904	2,468	63	22,630	nd
UK	220,000	7.6	265	-	-	254,711	67
Italy	77,206	30.0	741	230	142	130,478	11
Average values	**188,552**	**9.5**	**1,011**	**1,987**	**91**	**233,147**	**51**

Source: Banca d'Italia 1995

*) Source: ABI analysis

1. New departments: business clients and foreign trade, corporate finance, treasury and private clients, non-European countries etc.;
2. commercial divisions: domestic, fund, investment banking and global clients;
3. business units: private loans, business loans, insurance and fundings;
4. business units: personal banking (split into functional units such as telephone banking, credit strategy, *technology,* business support, branch network), corporate banking (similar in structure to the previous example), finance, resources (that includes head office functions such as personnel, marketing and distribution);
5. there is no overall ICT department, because it is included in business lines;
6. moving away from a *geographical-based* to a *business-based* structure;
7. banking divisions: information technology, customer services, marketing (including branch offices), finance, HR/personnel, quality control, programme management (i. e. BPR).

4.3. The Retail Banking and the New Market Approach

As we saw in the structural trends that characterize the EU banking sector there is a general reduction and development of complementary delivery channels. Banking is increasingly being conducted away from the traditional branches: this is not to say that branches no longer have their place within the strategy of a financial institution, but that new delivery channels (telephone, screenphone, PC, personal digital assistant, interactive TV etc.) are growing in popularity, especially with customers who like the "wherever, whenever and however" attributes of these service delivery media. But the new delivery forms also benefit the financial institutions themselves, which see potential cost savings and revenue generation associated with such offerings.

Phone banking (cf. *Figure 4*) is the most diffused. For some banks, this is the only alternative delivery medium that has been relatively successful, to date, for both the financial institution and its customers.

Telephone banks, branchless financial institutions that offer all their services by telephone, have also been growing rapidly in Europe as subsidiaries of some of the larger institutions in the market (mostly in the UK, but also in France).

Other new media are self service and home banking. Some banks are investing in unattended branches based on self service equipment, sometimes specialized kiosks for information and marketing and for banking transactions. Home banking, which is based on a PC link between banks and clients, at present is most diffused among corporate clients.

This is significant because "direct" banking is changing the business model of branches and, consequently, their organization and technological solutions.

The number of banks and the volume of new services is at present higher in the UK followed by France, at a medium level in Germany and Spain, and low in Italy. The upward trend is higher in Germany, followed by France, Spain and UK. In Italy banks are just starting with some projects.

Because of new services, branches are changing. In summary, we can say that:

- Banks are investing in branches also in countries, such as France, where home-remote banking is important;

- the area of consulting is becoming increasingly important (see *Figure 6)*. This is significant for ICT: the consulting area must be equipped with workstations capable of performing all the usual transactions but also new business intelligent operations: banking products and services, marketing on sales follow up, office automation - enterprise communication - document and "module" management, financial simulation etc. To achieve this, workstations have to integrate local (branch) procedures, centralized (on host) procedures, and external access to data bases (Reuter, Radiocor-Telerate etc.).

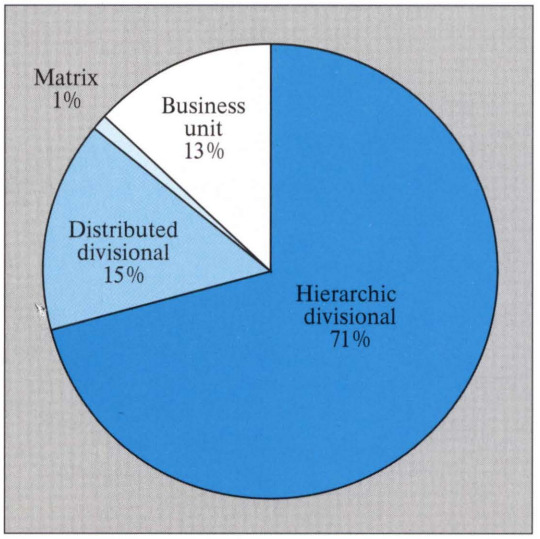


Figure 3
The Banking Organizational Models in the EU Countries Considered

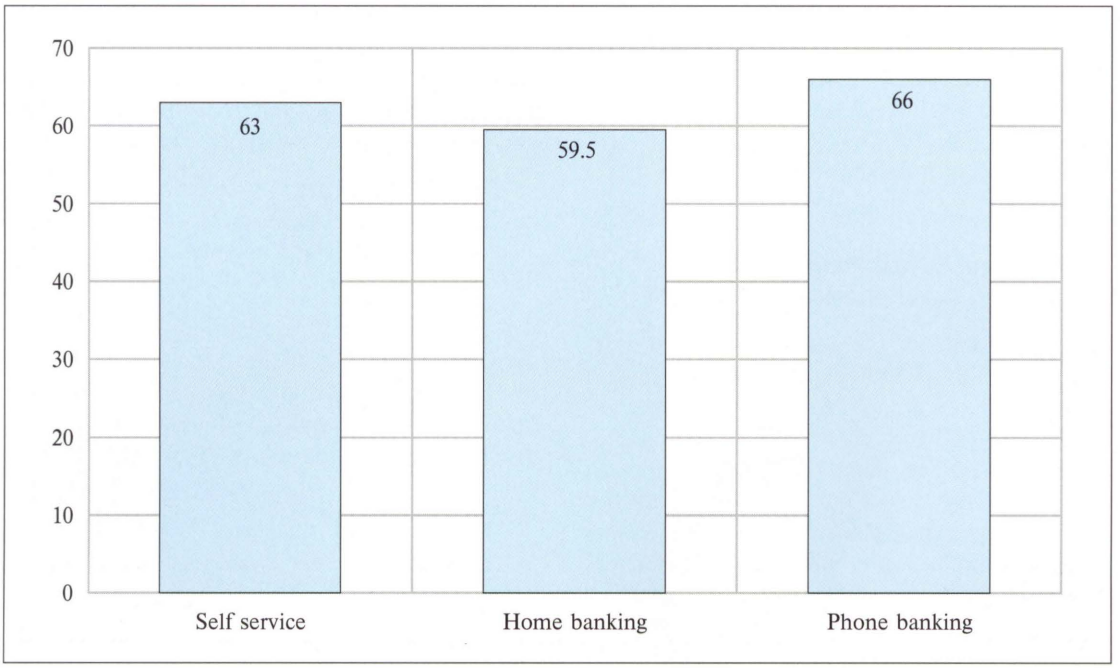


Figure 4
Present Diffusion of Complementary Delivery Channels in the EU Countries Considered (% of Banks)

Table 10
Bank's Clients Requirements

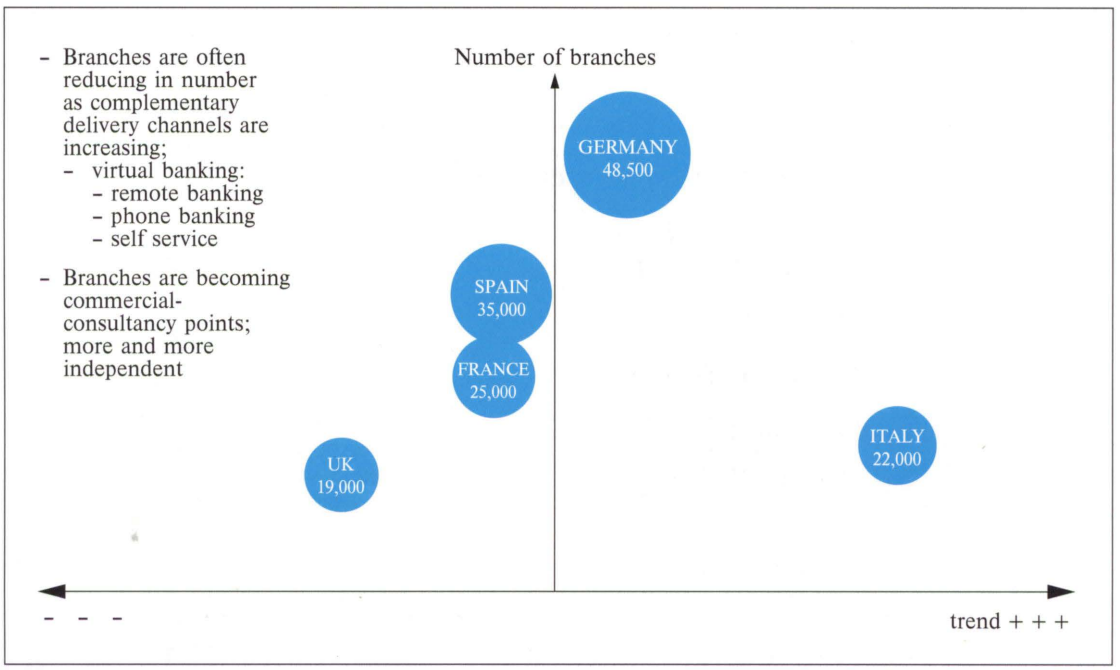
Why did you choose your bank?	
easy access	45%
Which is the main cause for dissatisfaction?	
Time-consuming, inefficiency	37%
Do you think that new delivery is useful for you? Yes:	
home banking	71%
phone banking	83%
self service	72%
What are the main benefits of new delivery?	
no queues and time saving	9.5
information at all times	9.2
do not go to bank	8.4
don't have any time limit	7.8

Currently there are few fully automated branches and the trend is catching on in few locations (i. e. in France).

Branches are becoming more independent and they are currently starting to be managed like small or medium-sized enterprises, leading to the development of new activities such as:

- global and local business information;
- management of business assets;
- assistance for sales;
- simulation and follow-up of the local decision.

Figure 5
Banking Branches Trend



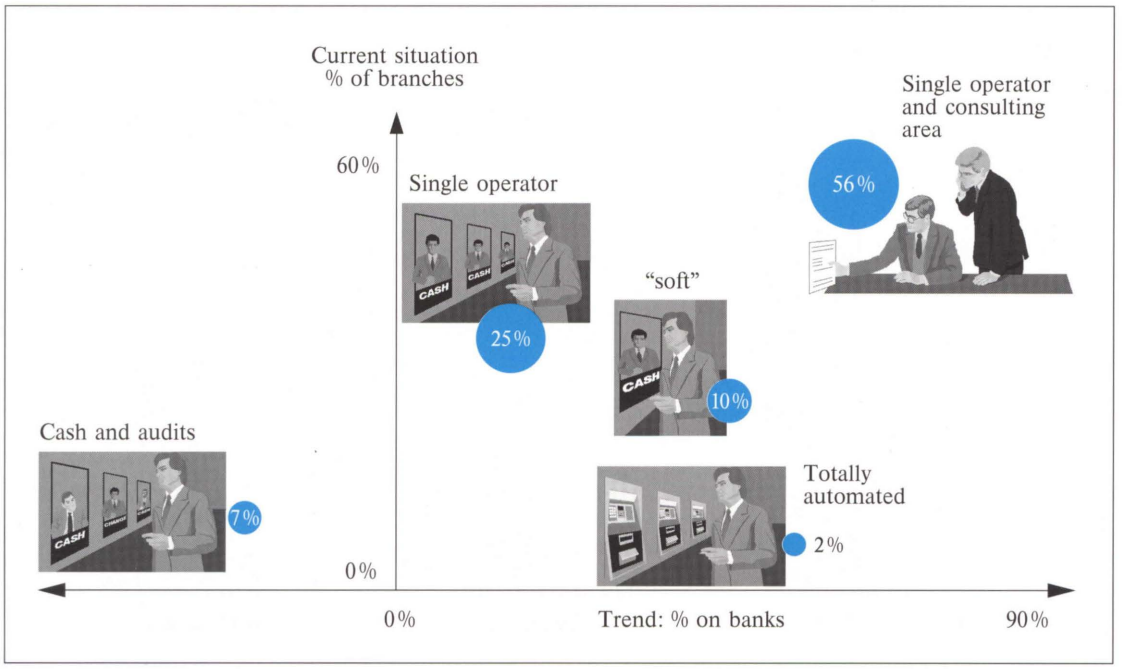


Figure 6
Branches Organizational Models: Present Situation and Trend

To improve productivity, banks are reducing back office activity and improving sales and consulting (moving from a cost mode to a profit mode). Branch employees are mainly cashiers *(Figure 8)*.

Branches are becoming more independent also from the technological point of view, with client server architectures, local databases and applications, new technology etc.

The organization of the front-office has been totally re-thought: there seems to be a consensus for offering customers a reception area, a self-service area, and a consulting area, while nevertheless retaining an increasingly smaller back-office. While the reception area contains very little equipment (advertising space and telephone to orient customers as soon as they enter the branch), the self-service area requires a full range of CATs and Automated

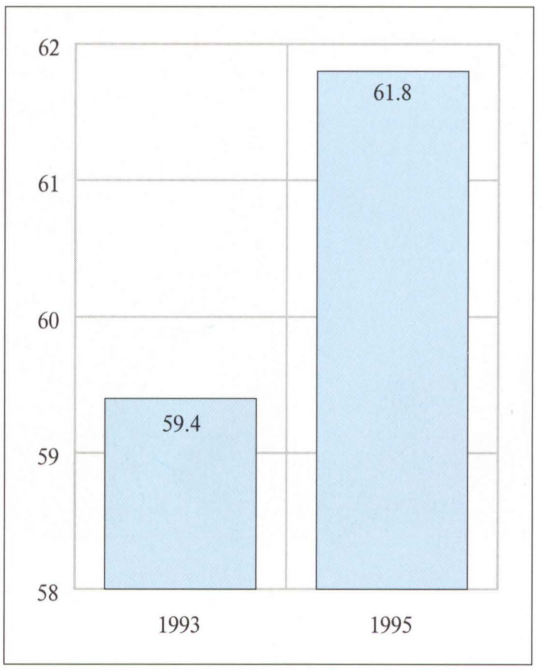


Figure 7
Banking Personnel Employed in Branches (% of Total Personnel)

Figure 8
Composition of Banking Personnel Employed in Branches (% of Total Branch Personnel)

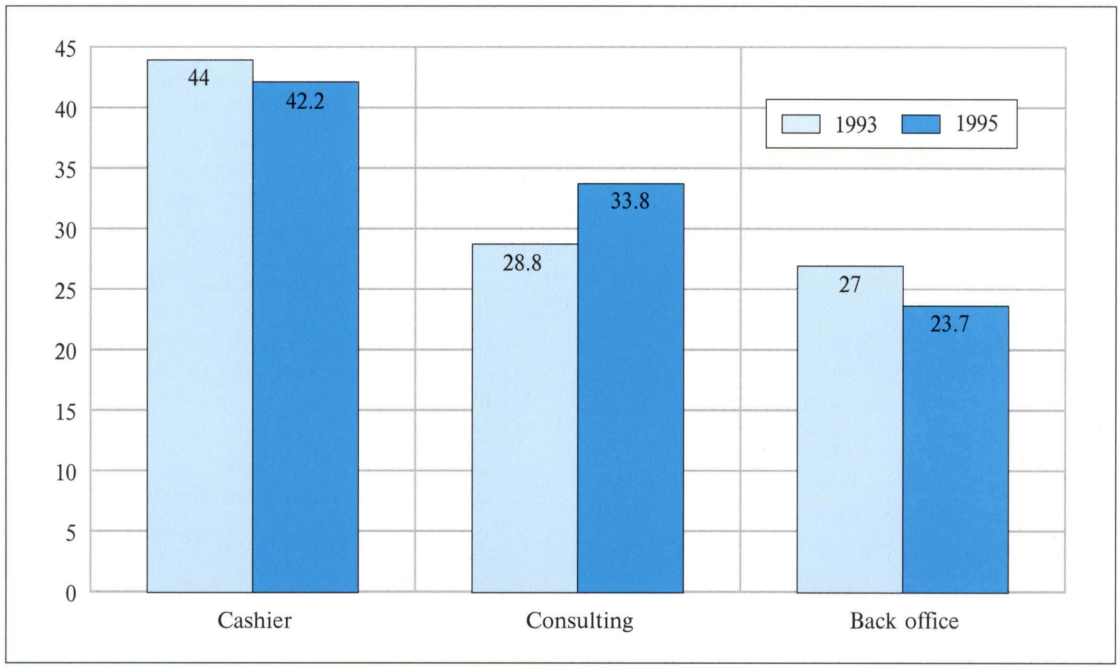
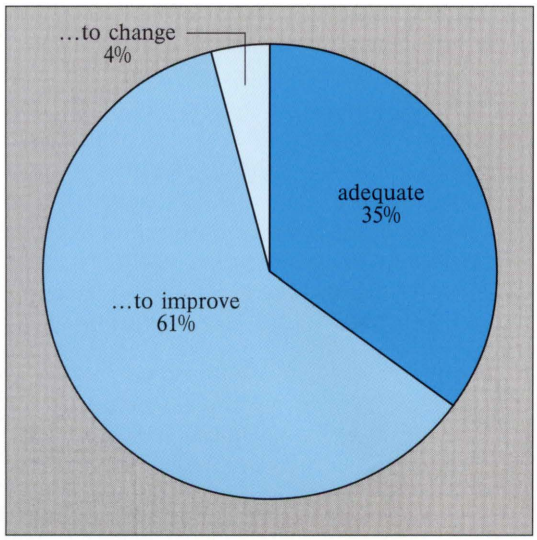


Figure 9
Branches' Organization and Application Software Adequacy



Teller Machines capable of handling all the common transactions: cash withdrawals, deposits, CATs for ordering cheque-books and self-service printers for printing out account statements.

The consulting area is equipped with workstations capable of performing all the usual transactions and business operations. It often includes a department for managing private assets, which requires complex functionalities close to those used in dealing rooms (access to Reuter, etc.).

The management of the branch is equipped with the same hardware as the consulting area, but it is used as a workstation for office automation and business information.

The major problem generated by this change in banking involves personnel management: too many aging administrators unable to carry out sales initiatives and to keep up with the new technology. Experiments have been made using Artificial Intelligence, but the results have never been satisfactory.

If this situation describes well the general EU trend led by the Central-Northern countries, it is interesting to note that branches are also fast changing in Southern countries. There is an interesting trend in Spain where there is a very high number of branches (see *Figure 5*).

In Spain most branches have few employees, a strong personal relationship between bank's operators and clients, and poor automation. Although there are no completely automatic branches, the goal is to create 6% of unattended branches.

A reorganization of branches is forecast. They will become multi-function offices giving support in very specialized financial consulting areas. The scale of activity depends on the location: urban branches develop more financial consulting services than the regional ones. Banks' strategies focus on reorganizing their branches network, establishing new branches in strategic geographical areas and reducing the massive concentration of branches in the local area. There is an important decrease in the number of branches due to the increase in alternative channels of promotion and sale of banking products - Automated Teller Machines, POS, virtual office - and the development and use of electronic and telephone-banking. Automated Teller Machines have expanded their services offering a wider range of choices to the customer (investment funds information, accounts transactions, payments utilities).

Gradually, the clerical work of branches is being supported by Central Services or by Branch Operational Centres (BOCs) which will help branches to process massive operations. Automation and the changing trends of focusing the branches as the direct point of sale, unloading clerical work, are causing a gradual decrease in employees (especially in branches) within the banking sector.

In all the countries under consideration new and more sophisticated financial products are emphasized. New software is required as we shall examine later.

5. The Current State of Automation and Trends

5.1. The Key Role of ICT in Banking

The banking sector is one of the most important components of the IT market in the EU, not only because it represents about 15% of the total IT market in the EU (excluded office equipment), but also because of the importance of IT in the banking companies. There is a very high number of terminals per employee, very high expenditure per employee, and a very high number of programmes that are near to the saturation point. Nevertheless the upward trend of IT expenditure in the banking sector is often higher than in other sectors. We can understand this key point by analyzing the role of IT in the changes of business, organization and strategies of banks described in the previous sections.

Banks are changing from an organizational and business point of view. These changes also have an impact on the organization of ICT, on the architecture, and on the software applications?

The traditional division-based hierarchical structure was accompanied by traditional centralized architecture and by a *"vertical"* approach in software application development: the key issues were transactions *"processing"* and *"automation"*.

The transforming of banks into *"business companies"* and the customers-oriented strategies (section 4.3) are changing the banking organization (section 4.2) and, consequently, the role and structure of *IT*. The new key issues are *"communications"* (therefore we speak now of *ICT*) and applications *"integration"* in order to:

- provide banks with business management tools (planning and control, risk management, EIS - Executive Information System etc.);
- provide banks with marketing and sales tools;
- provide banks with new delivery channels in order to complement the traditional bank/client relationship with "direct" channels based on telecommunication technologies (telephone, call centers, on line Personal Computers, self service equipments, electronic commerce, non cash payment systems etc.).

According to this scenario usually banks evaluate that the importance of ICT is increasing, althought the already very high ICT intensity.

5.2. Data Processing Outsourcing

Starting from the increasing attention to the costs it's generally growing the propensity of banks (above all the medium and small ones) to the outsourcing of the Information system management *(Table 11)*.

In medium and small banks we are talking about total outsourcing, while in the large banks we are talking about partial outsourcing (e. g. of network management or payment systems management).

In some cases the banks mention outsourcing considering the subcontract in the development area (e. g. in Spain).

It is important to examine some differences by country:

Global processing outsourcing is a trend which is virtually non-existent in France and which occurs mainly among medium sized banks.

In Italy the situation is different with a relevant trend in medium and small banks to adopt global outsourcing by externalizing the ICT management (facility management) and, very often, also application software development. The outsourcing providers are very often banking consortia.

Short importance in large Spanish banks.

In the UK too, outsourcing is currently very low in large and medium banks. Some smaller building societies have no ICT department, having contracted out all ICT operations. Most banks and building societies use outsourcing to some degree and the extent is usually greater, smaller organizations. The amount of outsourcing is expected to continue to increase. Although outsourcing of systems development is growing, most is still performed in house. Techniques are still evenly split between state of the art tools and environments and more traditional development approaches.

Finally outsourcing is traditionally very high in Germany, but also in this country the survey found a stable situation.

5.3. Present Architectures and Trend

European banks have now clearly identified the client/server architecture as the best ICT system configuration *(Table 12)*. This almost always means integrated multivendor environments, with the host acting as a centralized database and controller for a range of transaction-intensive applications.

	projects development	Data Processing Center management: GLOBAL OUTSOURCING	Data Processing Center management: PARTIAL OUTSOURCING
FRANCE			
present situation	LOW	LOW	LOW
trend	stable	stable	decreasing
GERMANY			
present situation	HIGH	HIGH	MEDIUM
trend	stable	stable	stable
UK			
present situation	MEDIUM	MEDIUM	HIGH
trend	increasing	stable	increasing
ITALY			
present situation	MEDIUM	HIGH	LOW
trend	increasing	increasing	increasing
SPAIN			
present situation	LOW	LOW	HIGH
trend	increasing	stable	stable

Table 11
Outsourcing: the Degree of Externalization

The differences between countries reflect the fact that individual countries have reached different stages in the current reorganization process. Spain is the most backward country closely followed by Italy.

Operating environment (at the server level) is far more complex and varied; there are no market standards among the various countries. In the last few years banks have displayed a certain instability and uncertainty in their choice of systems. Therefore, against this background of uncertainty and lack of uniformity, the banks' main requirement is for open, multi-system environments.

5.4. Hardware Equipment and Installed Base

About 1,500 large systems are installed in banks in the EU. This represents a significant number of the total EU installed base and is due to the traditional centralized systems in banks. As already stated, banks are moving towards client/server solutions. This does not seem, in many cases, to eliminate large systems, but, to a large extent, to change their role. The only country with significant experiences of downsizing is the UK.

An important role is played by medium and small computers: they are traditionally host computers in the smaller banks, but they are also application, data and communication servers in the emerging client-server architectures in the largest branches and banking departments. We estimate that there are more than 100,000 mini and small systems installed in banks in the EU.

Table 12
Architectures in Banks in %

	France		Germany		UK		Italy		Spain	
	1993	1995	1993	1995	1993	1995	1993	1995	1993	1995
Prevailing centralized architecture (e. g. 3270)	44	36	20	13	15	10	45	29	45	36
Host and some decentralized applications	11	2	35	28	30	23	12	4	15	16
Prevailing client/server architecture	45	62	45	59	55	67	43	67	40	48
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 13
IT Hardware Installed Base in Banking Sector in the EU (Units 1995)

	Large	Medium & small systems	Workstations	PCs
France	210	19,000	14,000	400,000
Italy	200	15,000	6,000	290,000
Germany	490	28,000	26,000	700,000
Spain	110	8,600	4,500	165,000
UK	270	20,000	17,000	450,000
Others	220	19,400	8,500	295,000
Total EU	**1,500**	**110,000**	**76,000**	**2,300,000**

Finally it is very important to analyse workstations and PCs. We estimate that there are about 76,000 workstations and about 2,300,000 PCs in banks in the EU.

Workstations traditionally play an important role in some specialized banking departments (for example in the trading rooms). A new role for workstations is emerging also in branches. As we stated in the previous section, there is a trend towards using workstations for the consulting area, to perform both the usual transactions and business information operations such as the management of private assets, which requires complex functions like those used in dealing rooms (access to Reuter, etc.).

In many banks, workstations will also play an important role in supporting TBT (Technology Based Training). Many large banks are investing to provide branches with dedicated areas for personnel training to develop new multimedia or computer-based courses. This is essential to respond to increasing training needs and costs saving requirements. Training decentralization allows banks reduce indirect costs (they are higher than the actual training costs) and to reduce the impact of training on banking operations.

In some banks workstations are used for all banking automation taking the place of PCs.

Finally, PCs are replacing the dependent terminals. Usually the share of PCs of total peripherals depends on the adopted prevailing architectures (for example there are more dumb terminals - compared to the number of PCs - in Spain than in the other countries). It is however important to underline that in many banks PCs are still used as terminal emulators.

The number of PCs and terminals per banking employee, a partial indicator of the level of computerization in the banking sector, is very high. In some situations the total number is even higher than the number of employees. This is due to the automation of some departments, such as trading rooms, where each operator has often more than one system. This is also due to new trends in some countries: in France, for example, some banks are using notebook PCs for mobile marketing.

5.5. Information Technology Expenditure

The banking sector represents one of the most important components of the European Information Technology market with different weight by country: higher in Spain where banks represent more than 24% of total Information Technology expenditure, lower in Germany (less than 14%). The German situation is due to the presence of a strong manufacturing sector, to the presence of many small banks and to the very high diffusion of outsourcing at Electronic Data Processing Interbanking Centers.

In recent years the banking IT market has experienced higher growth than the global IT market. This is due both to the lower impact of the economic crisis on the banking system than in other sectors (e. g. manufacturing) and to the increasing importance of ICT in the banking industry. ICT is considered a competitive advantage by a large majority of banks and a recent survey presented by the Italian Banking Association showed that higher ICT investments allow banks higher profits and market shares (the survey analysed a significant sample of banks in the USA and Europe).

The IT banking market is growing more in '95 than in '94. There are only two exceptions, Italy and the UK.

Higher expenditure, combined with more computerization, has translated into higher growth in the UK compared with other banks in the EU. Financial constraints in the last two years have led to cut-backs in Italy.

In all the countries the cost of software and services (professional and processing services) is higher than the cost of hardware. However, hardware expenditure is comparatively lower in France, Italy and Germany (about 30-35%) and higher in Spain and the UK (more than 40%).

The gap between the two components is rapidly increasing due to increasing investment in software and services.

5.6. A New Role of Networking and Telecommunications

Networking and telecommunications traditionally play an important role in banking automation in the areas of payment systems, interbanking transactions (money market), capital market, and TP (Transaction Processing) front office automation.

As banks change (BPR, direct banking etc.) so too the role and importance of networking and telecommunications are changing.

To understand this important change we have to analyze two environments.

Table 14
IT Market in Banking Sector in the EU: Trend 1993-95 (Million ECU)

	1993	1994	1995	Δ 94/93 %	Δ 95/94 %
Large	2,296	2,106	1,910	- 8.3	- 9.3
Medium and small	1,737	1,775	1,770	2.2	- 0.2
Workstations	346	389	443	12.5	13.8
PCs	1,851	2,114	2,434	14.2	15.2
PC printers	413	458	516	10.9	12.9
Automated Teller Machines & POS	245	274	303	12.0	10.5
Hardware	**6,888**	**7,115**	**7,376**	**3.3**	**3.7**
System software	1,639	1,746	1,868	6.5	7.0
Application software	1,571	1,730	1,932	10.1	11.7
Software products	**3,210**	**3,476**	**3,800**	**8.3**	**9.3**
Professional services	3,626	3,964	4,380	9.3	10.5
Processing services	1,744	1,836	1,932	5.2	5.3
Network services	351	385	451	9.8	17.0
Hardware maintenance & support services	2,303	2,295	2,319	- 0.3	1.0
Services	**8,024**	**8,480**	**9,082**	**5.7**	**7.1**
Software and services	**11,234**	**11,956**	**12,882**	**6.4**	**7.7**
Total IT	**18,122**	**19,071**	**20,258**	**5.2**	**6.2**

1. The more traditional one is represented by the use of networking in internal processes reorganization. LANs have a very large and increasing diffusion in banking branches and departments according to the trend of client/server architectures.

Networking in banks is also changing their characteristics.

The traffic carried by banks will consist of both expanded volumes of traffic similar to that already being carried and traffic generated by new applications spawned by the ongoing digital revolution. Firms whose business consists largely of the transfer of information, such as banks and other financial institutions, will naturally be in the vanguard of such expansion. More than simply reflecting the increasing importance of international business, this expansion will also be driven by the changing character of the transactions. Imaging will increase the size of the financial documents being transmitted, while electronic signatures will expand the range of participants in the exchanges. The result will be changes in the requirements for banking networks. Financial institutions have also pioneered the use of powerful multimedia workstations for their analysts, facilitating distributed processing. In support of these activities, interconnected local-area networks (LANs),

	1993	1994	1995	Δ 94/93 %	Δ 95/94 %
France	3,535	3,689	3,888	4.4	5.4
Italy	2,334	2,462	2,568	5.5	4.3
Germany	4,707	4,800	5,031	2.0	4.8
Spain	1,106	1,124	1,197	1.7	6.5
UK	3,843	4,196	4,351	9.2	8.0
Others	2,597	2,800	3,044	7.8	8.7
Total EU	**18,122**	**19,071**	**20,258**	**5.2**	**6.2**

Table 15
IT Market in Banking Sector in the EU by Country: Trend 1993-1995 (Million ECU)

	France	Italy	Germany	Spain	UK
IT banking expenditure/ total IT expenditure in %	17.5	21.6	13.7	24.4	21.5
IT banking expenditure/ banking employees (ECU)	8,916	6,556	6,358	4,449	10,366
IT banking expenditure/ assets in %	0.55	0.52	0.39	0.37	0.56
IT banking expenditure/ GDP in %	0.35	0.30	0.32	0.28	0.55

Table 16
EU Banking IT Expenditure Indicators by Country (1994)

Integrated Services Digital Network (ISDN), and frame-relay technology will continue to expand the communications techniques in global financial networks.

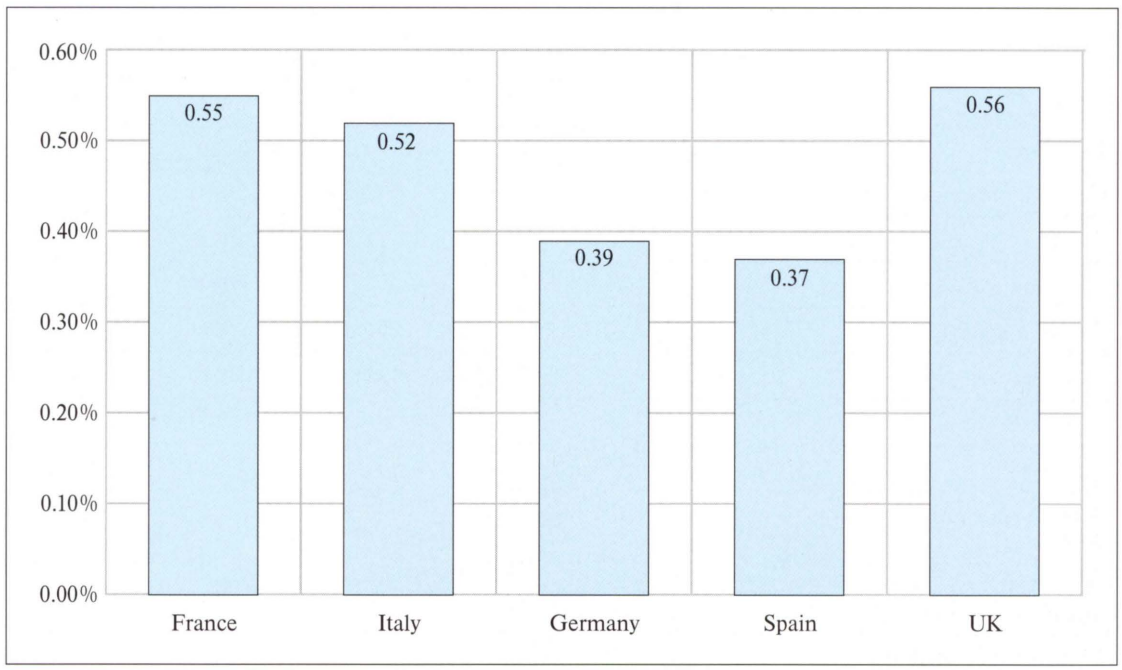
2. Banks are also investing in new delivery modes (section 4.3) – virtual or direct banking – including electronic commerce, above all in the UK and France.

To forecast the development of this market in the EU a number of factors must be considered, including infrastructure, technology and technology application.

Some weak points have to be noted in order to understand the lower diffusion of banking electronic services in EU countries compared with the USA.

- *Infrastructure:* Europe does not have its own information superhighway infrastructure: the building of a standardized, European-wide infrastructure will probably not be achieved until after 2000. In the meantime, the Internet is fast gaining in popularity as a stopgap solution, especially for business users.
- *Technology:* Europe does not have widespread asynchronous transfer mode (ATM) technology to facilitate the high-speed transmission of large amounts of multimedia data. Some limited broadband networks exist in some countries used chiefly by a few large corporate users. Integrated Services Digital Network (ISDN) is becoming widely available, but few information service providers offer ISDN access. Cable television is widely available in only a few countries.

Figure 10
IT Banking Expenditure as Share of Total Banking Assets (1994)



Average PC penetration in households is well below 20 percent, compared with more than 35 percent in the United States a large number of the household PCs are not IBM- or Apple-compatible and country variations are wide. Modems are used regularly by only 3 percent of households.

This scenario is however fast changing:

- interactive television trials – in applications such as video-on-demand, home shopping and home banking – are taking place in Germany and the United Kingdom. Although not linked to the Internet, these initiatives exploit the cable television fibre networks that are burgeoning across Europe;
- the home market is the fastest-growing PC segment in Europe. Gartner Group estimates that by 2000, nearly 50 percent of homes will contain a PC;
- hardware vendors are increasingly bundling modems with PCs, in a successful attempt to increase the penetration of network access hardware and to stimulate the use of network services in Europe;
- some European countries (such as United Kingdom, some Scandinavian countries and France where Minitel, the national videotex system is dominant) are already ready for the kind of widespread electronic commerce offered by many online services providers in the United States.

The European scenario therefore does not permit a forecast, in the short term, of "direct banking" diffusion similar to the USA, where in 1994 47% of banking transactions were realized using tele-channels (Automated Teller Machines, phone, PC and TV) – 69% is forecast for 2004. Undoubtedly, many European banks have also invested or plan to invest in new delivery channels; forecast growth is therefore relevant.

	1993	1994	1995	Δ 94/93 %	Δ 95/94 %
France	**3,535**	**3,689**	**3,888**	**4.4**	**5.4**
Hardware	1,086	1,107	1,134	1.9	2.5
Software & services	2,449	2,582	2,753	5.4	6.6
Italy	**2,334**	**2,462**	**2,568**	**5.5**	**4.3**
Hardware	793	818	768	3.1	- 6.1
Software & services	1,541	1,645	1,800	6.7	9.5
Germany	**4,707**	**4,800**	**5,031**	**2.0**	**4.8**
Hardware	1,680	1,700	1,756	1.2	3.3
Software & services	3,027	3,100	3,275	2.4	5.6
Spain	**1,106**	**1,124**	**1,197**	**1.7**	**6.5**
Hardware	499	482	497	- 3.4	3.2
Software & services	607	642	700	5.9	9.0
UK	**3,843**	**4,196**	**4,531**	**9.2**	**8.0**
Hardware	1,679	1,777	1,896	5.8	6.7
Software & services	2,164	2,419	2,635	11.7	8.9
Others	**2,597**	**2,800**	**3,044**	**7.8**	**8.7**
Hardware	1,151	1,232	1,325	7.0	7.5
Software & services	1,446	1,568	1,719	8.4	9.6
Total EU	**18,122**	**19,071**	**20,258**	**5.2**	**6.2**
Hardware	6,888	7,115	7,376	3.3	3.7
Software & services	11,234	11,956	12,882	6.4	7.7

Table 17
IT Market in Banking Sector in the EU Composition by Country: Trend 1993-1995

But as the number of transactions a bank processes increases - and as the number of employees who must manually monitor these transactions decreases - banks are moving to automated fraud detection and prevention. At least two-thirds of the organizations in the financial industry have been investigating advanced technologies for performing fraud detection during the past three years. Some banking experiences show complex projects based on expert systems that automatically flag unauthorized or suspected fraudulent transactions.

Figure 11
Application Software in EU Banks: Importance and Adequacy

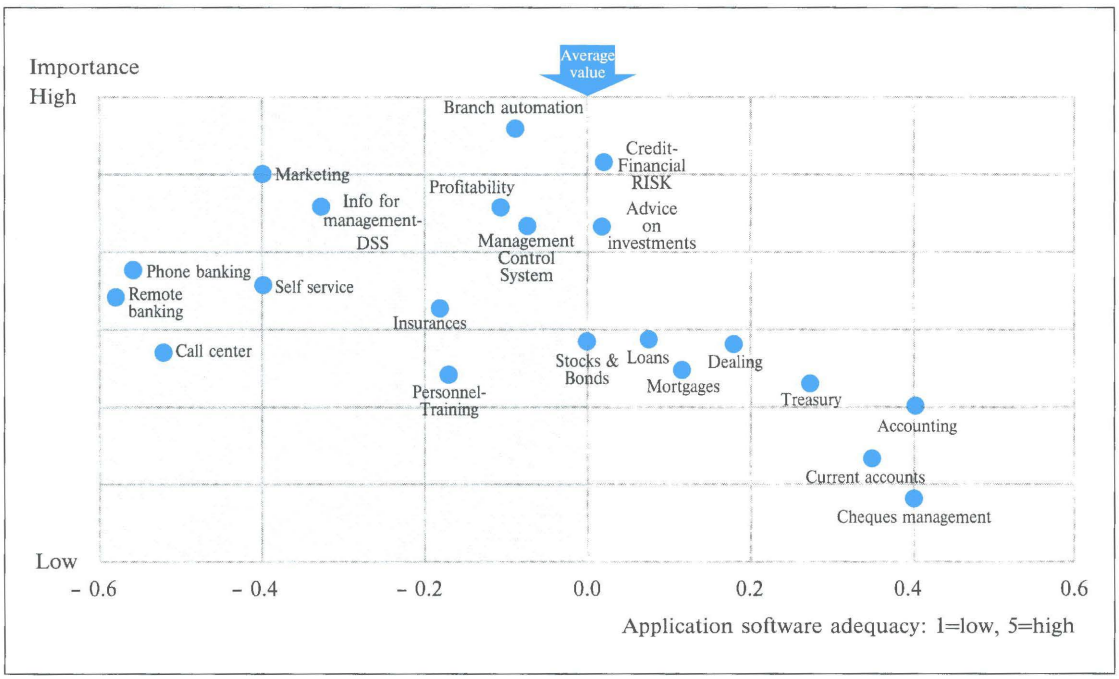
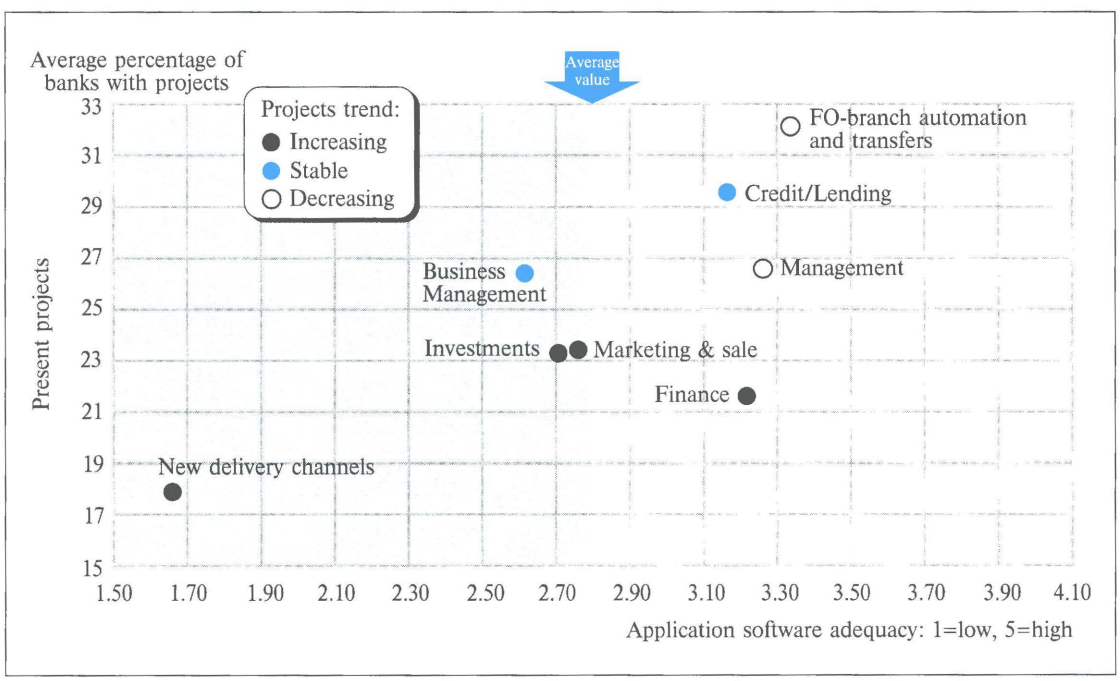


Figure 12
Application Software in EU Banks by Functional Area: Adequacy and Projects



Security is also the primary inhibiting factor for electronic commerce on the Internet. Companies with knowledge of information security are fully aware of the risks of unprotected communications over the Internet, so they install firewall hardware and software combinations that restrict access and filter data entering and leaving the enterprise. Many Internet firewalls are available from a number of vendors. To solve the problems related to protecting networked systems from unauthorized access from the Internet, as well as from potentially damaging activities from within a private network, many banks purchase encryption as part of a larger application that serves access control, user identification and authentication, data confidentiality, data integrity or non repudiation.

The banking sector is also one of the sectors most involved in back up and disaster recovery projects.

6. Traditional and Emerging Applications

Bank automation level is very high and is now close to saturation point.

But is this consideration true if we consider the changes in banking structure, organization, business, processes, and delivery modes that we analysed in the first sections of this paper?

In order to understand the application scenario in the banking sector we identified two application groups:

- We defined as traditional some functional areas that are characteristic of the core business of banking activities and which were automated in the first phases of banking automation *(Figure 14)*. They are consolidated areas in banking and in the market (many solutions are available) and banks have high knowledge about functional requirements and data models.

The impact of banking changes in these areas is summarized in a new integrated approach according to a matrix data model.

- We defined as innovative new products - services areas (new delivery channels, new financial products etc.), new or emerging banking activities that, in the "old" bank were less important (marketing, risk management, business management), and finally some areas - such as branch automation - where banks are developing new organizational models and activities.

These are not consolidated areas, both in banking and in the market (few solutions are available), and there is poor knowledge about functional requirements and data models.

According to this classification, banking automation is close to saturation point in the "traditional" areas.

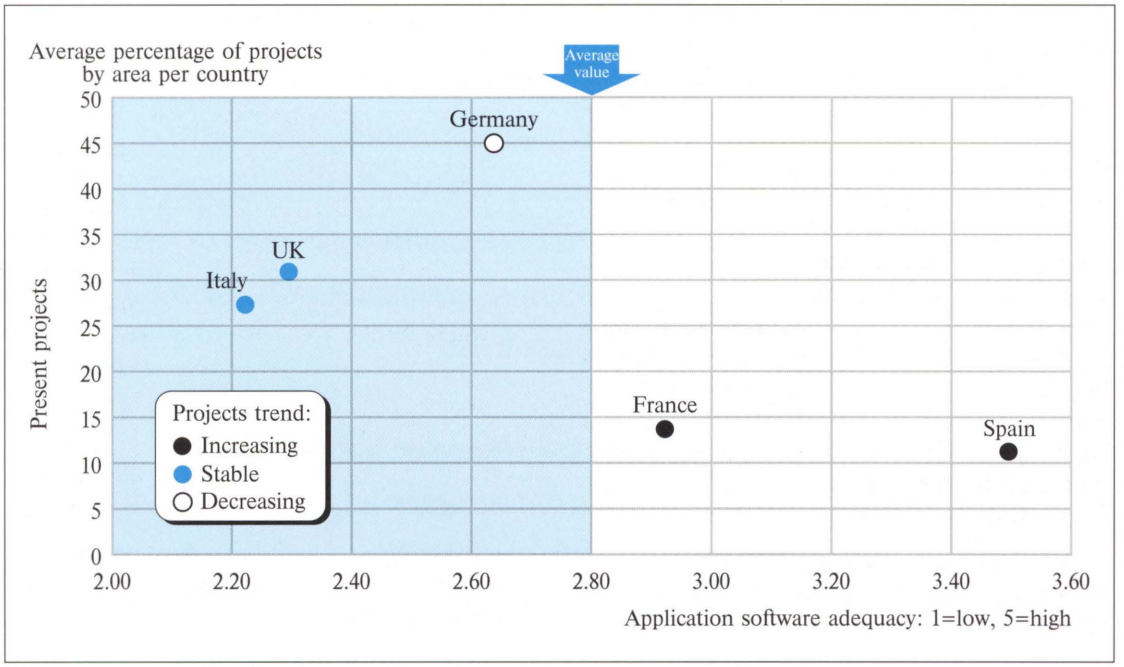
The most innovative areas - self-service, home banking, support tools for new users such as business door-to-door salespeople, etc., which are largely linked to new delivery and sales channels - are new departures for banks. Similar considerations explain the lower level of automation in a number of specific product areas such as insurance sales and management. ICT support tools for strategic areas such as sales and consultancy or decision-making are relatively infrequent, reflecting a structural weakness in the banking sector.

Nevertheless, a more precise assessment of bank automation requires joint analysis of both the degree of automation and, more significantly, the degree to which applications meet bank needs.

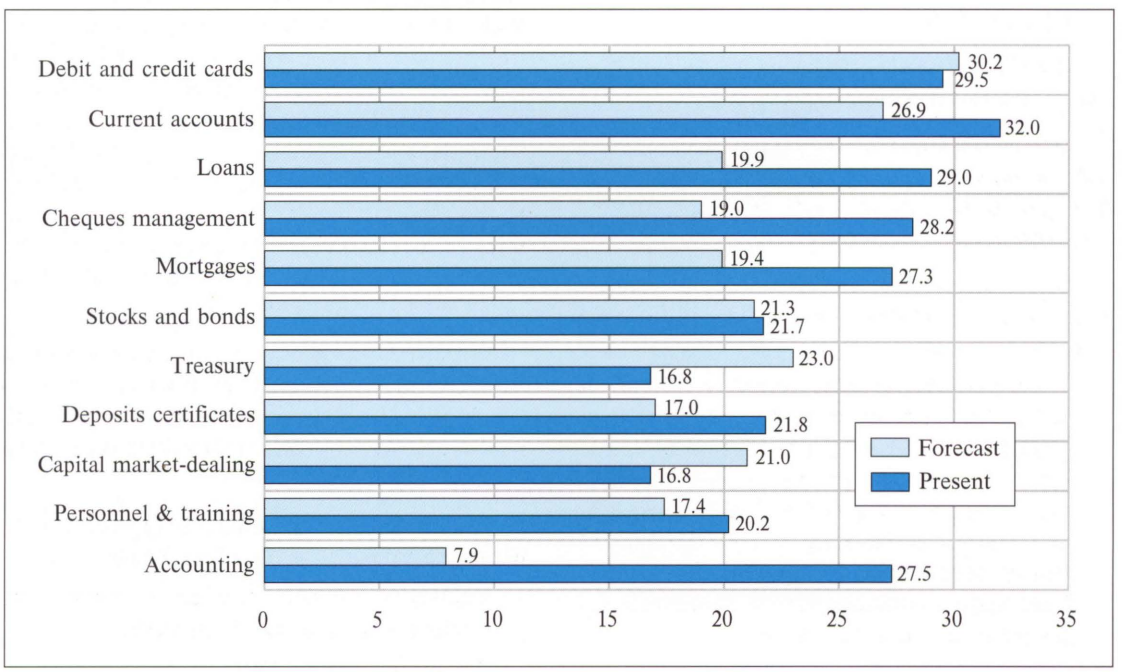
This qualitative-quantitative approach highlights the following areas of weakness:

- innovative delivery and sales channels to complement traditional channels;
- marketing support tools;

igure 13
pplication Software EU Banks by Country: dequacy and Projects



igure 14
he Application oftware Projects EU Banks: raditional Areas % of Banks)



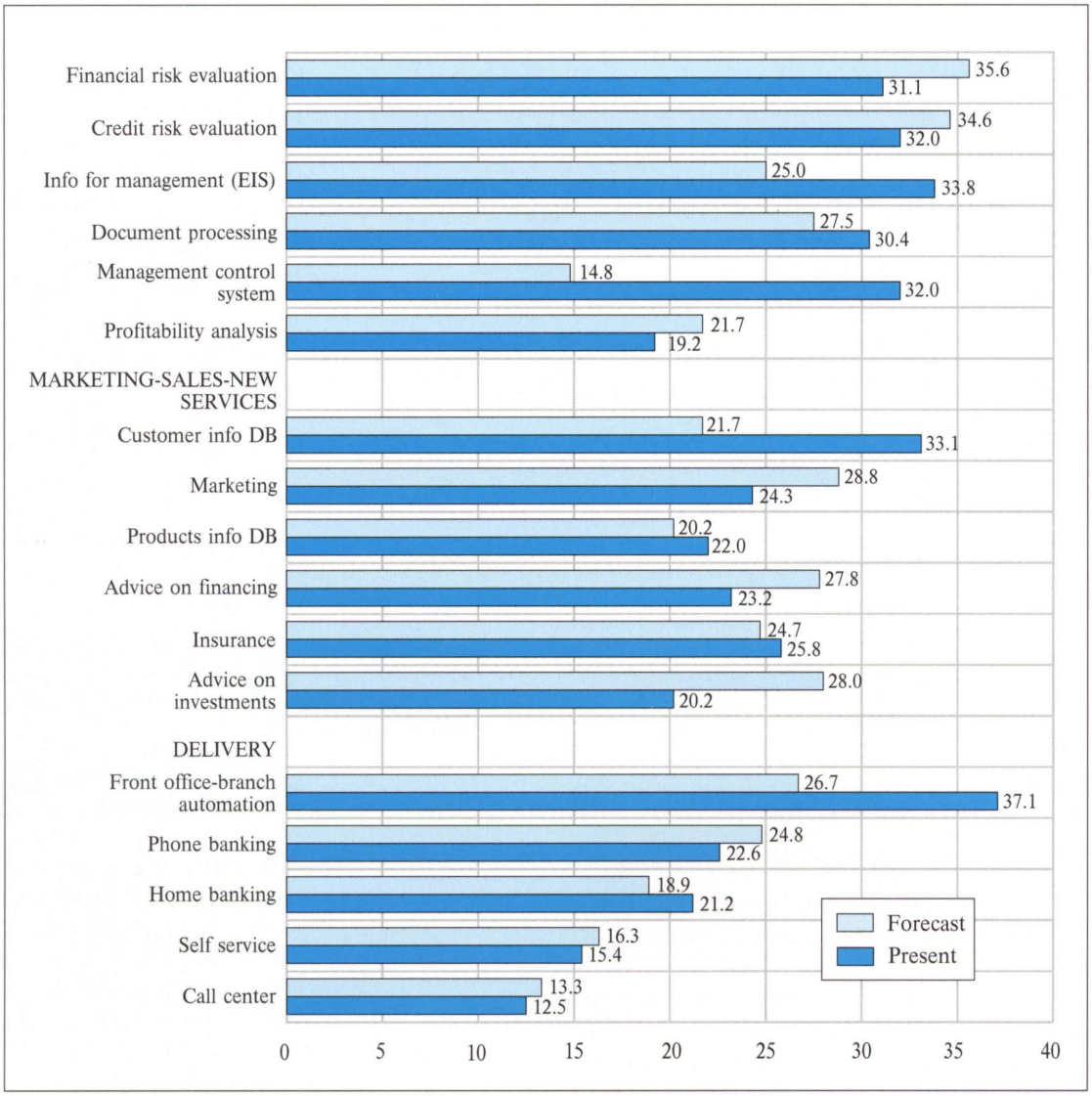


Figure 15
The Application Software Projects in EU Banks: Innovative Areas or Innovative Approach (% of Banks)

- planning and control tools: management control, EIS, profitability analysis, credit and financial risk analysis;
- management control systems, personnel (human resources) & training management;
- emerging product areas: insurance, investment consultancy, etc.;
- business management;
- use of innovative technology to improve internal processes such as document imaging processing.

In European banks there is a very high number of projects (present or planned), to provide adequate application and technological solutions to the new "emerging bank". European banks are investing most heavily in:

Table 18
The Application and Technological Projects Supporting Strategic Banking Goals (% of Banks)

	France	Germany	Spain	UK	Italy	Total
Delivery Front office transaction - Branch autom.	25	10	25	30	50	28
Phone banking	7	7	15	12	8	11
Self service	5	26	10	-	4	10
Home/remote banking	6	7	-	14	3	7
Marketing and business management Marketing	3	8	14	38	6	16
Risk management	13	20	12	10	5	13
Business management	6	5	25	10	9	11
Management control system	-	-	13	-	14	5
Private banking Investments - funds, integrated products etc.	34	16	2	7	6	14
Credit - lending	12	5	-	33	10	12
Finance	-	10	-	9	16	8
Information technology reviews Global review and integrations	-	10	25	-	13	10
New architectures - platforms	-	21	19	-	10	10
Networking	6	5	6	4	4	5
Multimedia - document processing	5	14	11	10	7	9

1. Branch-front office, credit risk, customer info DB, document processing;
2. credit cards, loans and mortgages, stocks & bonds and insurances, direct marketing, investments and financial consulting, management control system, financial risk and EIS;
3. cheques management, products information DB, sale tools, personnel and training, fund management, profitability analysis, home and phone banking.

Self-service involves a lower number of banks, but is of strategic importance to some banks.

Some remarks are important about the evolution of payment systems, even if these projects are not usually listed by banks among the most strategic projects. As we described in the section 4 of this paper, country positioning is still different, but some common trends can be underlined: all major countries are progressively replacing cheques with credit and debit cards and paper-based transfers with automatic (wire) ones. Concerning payments cards some trends have to be described:

1. The introduction of microchip cards offers more security and more functionalities if compared with the traditional magnetic tape cards.

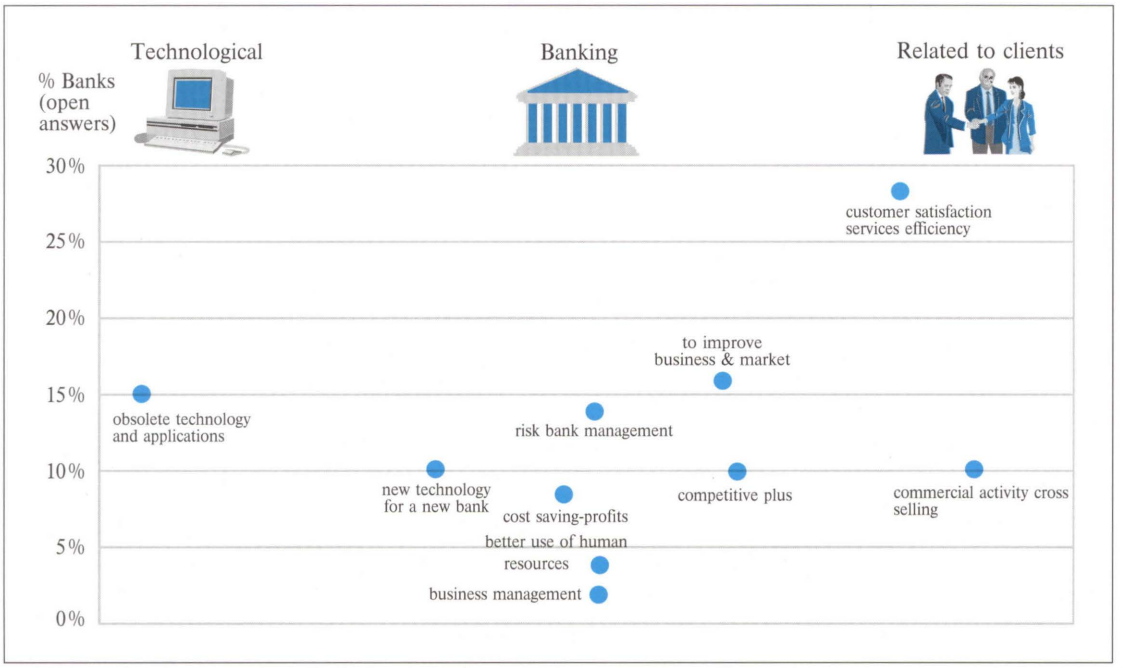


Figure 16
Main Banking Goals Related to the Most Strategic Application Software Projects

2. The introduction of electronic purse. First experiences were in Denmark some years ago; at present there are some important projects in Belgium, Finland, Spain, Germany, Portugal and France. Even if these projects refer to some EU standards, they are often still developed in a national context because of they are mainly focused on domestic commerce. All countries are now investing in defining a common EU standard of systems to allow interoperability.

   The "CAFE – Conditional Access for Europe" is an EU electronic purse project multicurrency, developed by the EU Commission inside the more general project of the EU Single Currency and security in electronic purses.

3. From a standardized EU point of view there is also the "Mondex" project: one bank for each currency issues an electronic money. This system is already circulating all over the world and allows private transactions without a centralized clearing bank.

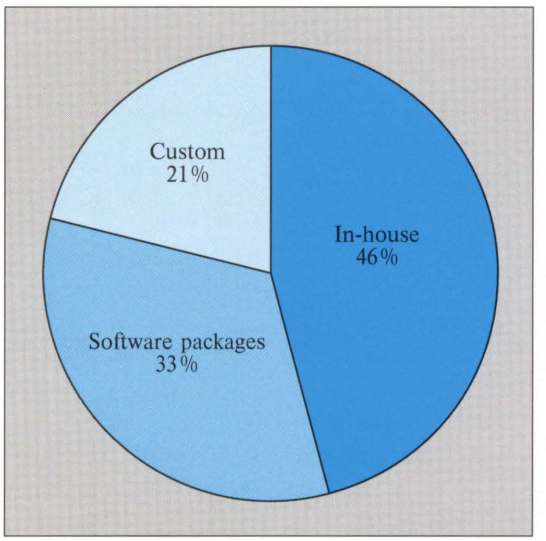
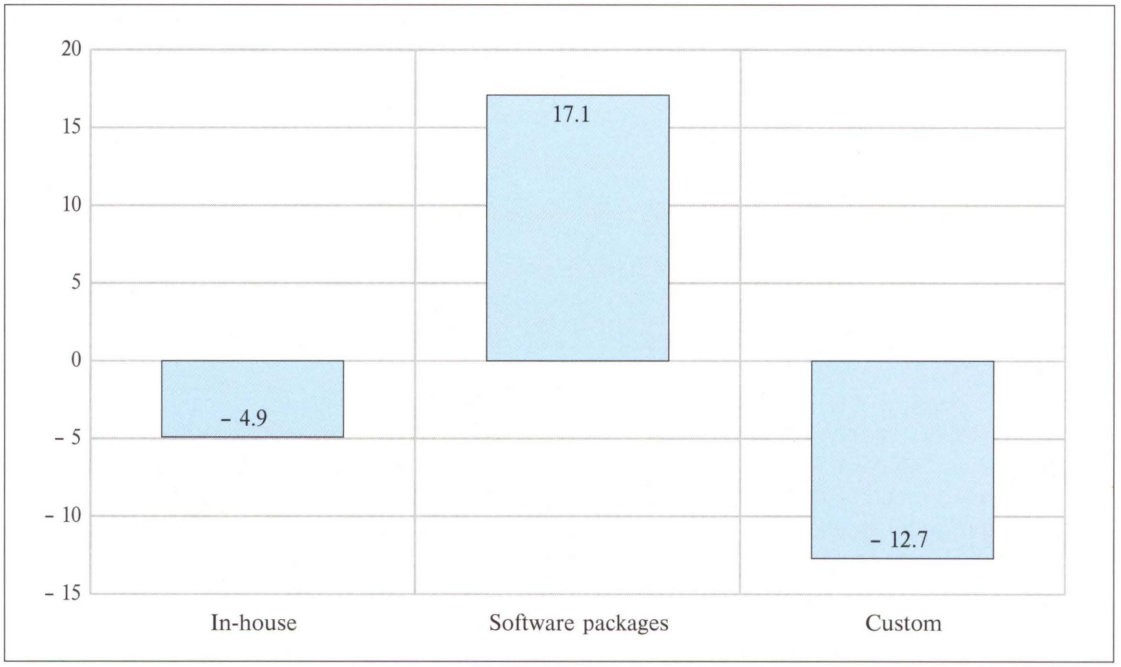


Figure 17
Present Projects Development Modes

These projects, inline with requirements, are largely focused on weaker areas, although there are a number of exceptions.

Figure 18
Differences Between Present and Forecast Development Modes (in %)



The principal exception is the main area – the branch front office (indicated by the largest number of the banks surveyed) – where automation is generally considered to be relatively adequate. This apparent anomaly is due to two reasons: first, branch upgrading and reorganization strategies, which involve application upgrading and implementation projects; second, and much more important, the trend towards the integration of the front office and the consultancy-sales area.

Branch automation is also the area that banks consider more strategic.

Our research suggests that front-office projects stem from the focus on the consultancy area and from general branch development trends, with a gradual shift away less profitable activities with a low value-added content (traditional delivery, accounting and back-office activities) towards activities with higher value-added: marketing, consultancy, sale of financial products, operations planning and control, etc. Many front office-branch projects, have the objective of providing sales, marketing and consulting tools to banks operators.

Analysis of present projects compared with projects planned for the next two years shows an increase in document processing, a very high increase in all sales and commercial tools (including investments and financial consulting) and, finally an increase in self-services.

Besides branch automation, banks emphasized other strategic projects:

- *marketing and sales:* Customer-Marketing Information Systems, Customer Data Base, new tools supporting sale activities (i. e. products-services profitability analysis for commercial employees, systems covering all aspects of sales and management, including after sale services), new systems based on "client philosophy" instead of "account philosophy", customers DB-EIS integrated systems, direct marketing, customer history, customer information facility etc.;

	Present			Forecast			Trend		
	In-house	Software packages	Custom	In-house	Software packages	Custom	In-house	Software packages	Custom
France	78	11	11	59	41	0	- 19	30	- 11
Germany	26	38	36	37	52	11	11	14	- 25
UK	47	34	18	30	64	6	- 17	30	- 13
Italy	26	58	16	23	62	15	- 3	4	- 1
Spain	53	22	25	59	29	12	6	8	- 14

Table 19
Projects Development Modes in %

- *risks management and business management:* ALM (Assets Liability Management), credit-financial and global risk management, group risk management, client profitability and bank's profitability analysis, EIS, synthesis architectures, directors reporting, new information structure for business management, multimedia systems for business management etc.;
- *investments:* new more sophisticated and complex financial products (often for private customers); example: integrated investments funds and insurances etc.;
- *credit/lending;*
- *new technological architecture and platforms,* global information system reviews, document processing - optical technology - OCR systems, banking network improvements, e-mail, new development (object-oriented) approach, Datawarehouse, new DB structure, application software environment integration;
- *new delivery channels:* phone banking, self service machines, home and remote banking.

The motivations behind the most strategic projects (see *Figure 16*) clearly reflect the priorities of European banks in this delicate phase of transition into the European marketplace amid increasing competition:

Priority is given to strengthening commercial operations and cross-selling, business and customer base through improved knowledge and identification of customer targets. Service quality and customer satisfaction are closely related to these objectives.

Less important are a number of "technological" reasons, including application obsolescence, architecture or platform migration, standardization and integration projects.

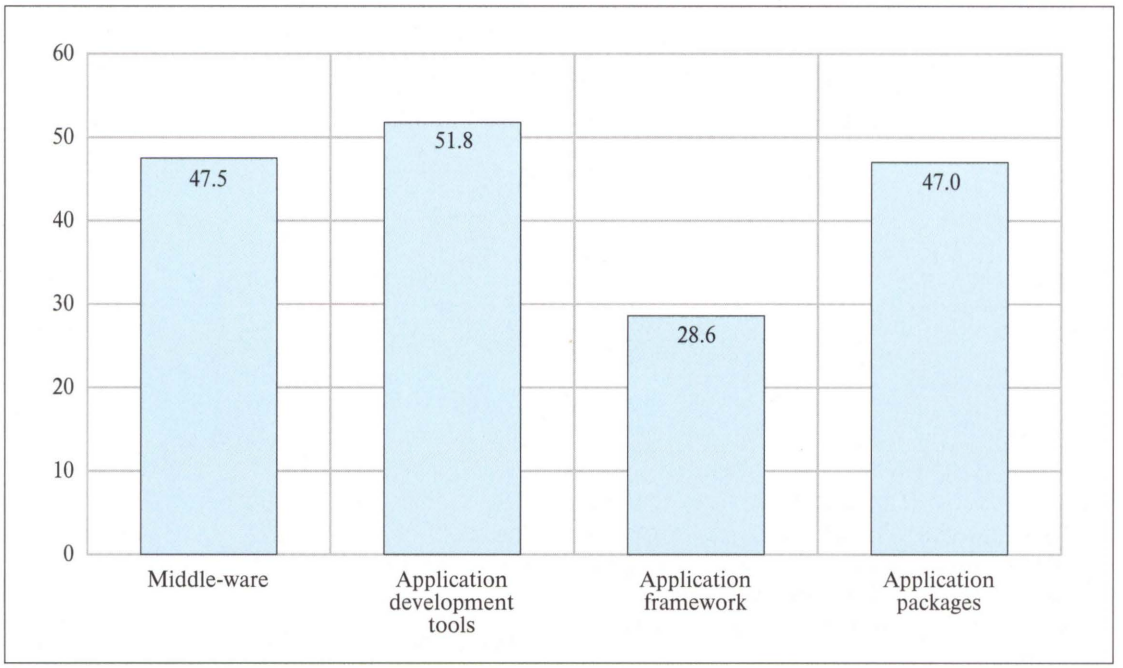
The need to improve risk analysis and management tools is important, especially in a number of countries including France. Aggressive or defensive competitive strategies, cost saving and reorganization strategies are also listed.

7. New Banking Requirements

Generally speaking, banks are moving from a totally in-house development of software projects towards joint development and the acquisition of products-services on the market (see *Figure 17* and *Figure 18*).

Situations of total outsourcing in projects management (system integration) are rare, given banks' desire to retain control and independence over information technology, which is considered an increasingly strategic support tool for any market strategy or internal reorganization process.

gure 19
New Demand of
oducts (% of Projects)



If there is a general trend towards more outsourcing in recent years, it is interesting to analyse the main reasons:

- weak markets (above all in a functional way) and costs (this last factor, sometimes depends on weak cost-control of in-house projects) are the main reasons when banks decided to develop in-house;
- lack of internal resources, inadequate internal skills and availability of suitable products-services are the main reasons for acquiring specific products and services on the market;
- skills and costs are the main reasons for joint projects choices. It is interesting to note that joint projects allow banks to acquire knowledge from partners in order to become more independent in application solutions management and improvement.

But the market trend shows also change in the products and services required by the market. The present projects are based on different software products:

- more than 50% of projects are based on development tools;
- nearly 50% on more traditional application packages;
- more than 40% on middleware;
- nearly 30% on application frameworks (kernels).

This is a new and very important change in the consumer demands and we think it is very useful to note the differences by country:

- application development tools are decidedly more important in the UK and France (about 70%) and Germany (60%);
- middleware is very important in France and Germany (about 60%);

	Middle-ware	Application development tools	Application framework	Application packages	Average Total
France	62	67	19	43	48
Germany	60	60	37	63	55
UK	49	71	26	43	47
Italy	28	23	5	65	30
Spain	38	38	54	21	38

Table 20
A New Demand of Products by Country (% of Projects)

	Custom project	Management consulting (Bus-Org)	Business process re-engineering	IT consulting	Project management – system integr.	Average Total
France	0	13	0	13	6	6
Germany	37	28	28	34	17	29
UK	31	40	20	57	10	32
Italy	21	15	7	29	22	19
Spain	33	24	12	44	12	25

Table 21
A New Demand of Professional Services by Country (% of Projects)

Client/server based solutions	75
Workflow	28
Image processing, multimedia, data-phone integration	18
Development tools, kernel products, middle-ware	14
Open-standard applications, standardized protocols, hardware independency	12
Object orientation, building blocks approach	8
Networking, LAN integration etc.	6

Table 22
Banking Products Unsatisfied Requirements: Open Answers Classified by Key Topics (% of Banks)

- application frameworks are more important for Spain (54%) followed by Germany (37%) and the UK (26%).

Finally, it is useful to analyse the professional services required according to the *project's phases externalized.* Banks mostly externalize the project roll out and the software maintenance. *The highest demand is for ICT consulting* in professional services.

Types of providers

Banks in the EU look for *suppliers who will act as partners* and work with the bank to build customized solutions. This means suppliers have to become problem solvers and move beyond the traditional sales approach designed to achieve maximum results immediately, which too often fails to take account of customers' real needs.

Banks listed some reasons which lead them to choose different providers' relationships:

- *partners* for problem solving, easier project management for the bank, more integration with providers and solutions with banks' strategies, closer relationships for strategic projects;
- *single products or services* in order to choose according to specific requirements;
- *turn key solutions,* rare and adapted only for small projects.

Generally speaking, *banks prefer to deal with a single supplier per project* in order to facilitate project management and coordination, and ensure a greater commitment from the supplier.

A guarantee of greater independence is the main consideration for banks which prefer to use more than one supplier (for example in France).

Analysis of the suppliers in banking projects reflects typical high fragmentation of the application software market. Only a small number of suppliers are mentioned by more than one bank (31%, out of the all suppliers named) and the number of suppliers present in at least two countries is even smaller (about 20%).

The suppliers of this second group are often system manufacturers or system software providers.

Buying criteria

Banks have at discretion listed the main criteria in choosing providers and solutions. They look obvious if we do not consider the range of importance attached, that shows also, for example, a new, in a banking environment, priority of costs-benefits:

Cost-benefit assessments are the chief factor in the choice of development methodologies, market suppliers and solutions.

The second criterion is the *functional adequacy of solutions:* the match with banks' business models; the ability to support business, image and marketing strategies; and alignment with user requirements.

The third criterion covers *technological characteristics:* technological compatibility is a significant factor taking into account the characteristics of the existing ICT system (very often, projects have to integrate new developments with existing applications) and current innovation and change; the solutions must also guarantee easy implementation, platform independence (support for upgrades, standards, open systems) and flexibility.

An equally important criterion is *the supplier characteristic.* The supplier is required to guarantee stability, reliability and the dimensions to handle projects of a certain importance; the supplier must also be a proven expert (good positioning in the banking market), a specialist, offering skills and professionalism, adopting a problem-solving approach. Previous experience and a good relationship with the bank are also taken into account.

The final criterion concerns *services:* quality of support services, prompt delivery (or ability to meet deadlines), ability to interact in the bank environment with the various areas involved in the project.

Finally we asked banks to list their unsatisfied needs:

Sales approach

- banks ask providers to fit users requirements and business strategies; to have a functionally-driven and not technology-driven "problem solver approach";
- price control (critical for professional services);
- partnership and joint projects with suppliers.

Company

- high functional specialization: better to focus offer on specific application areas than a non-specialized global offer etc.;
- local presence and knowledge of specific country requirements.

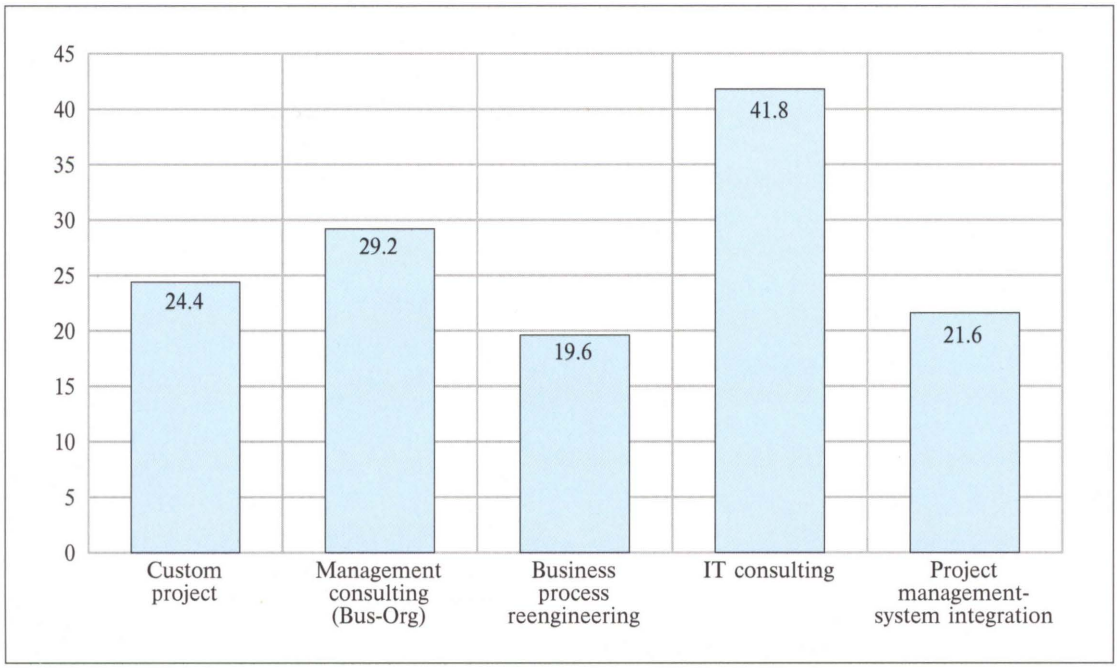


Figure 20
A New Demand of Professional Services (% of Projects)

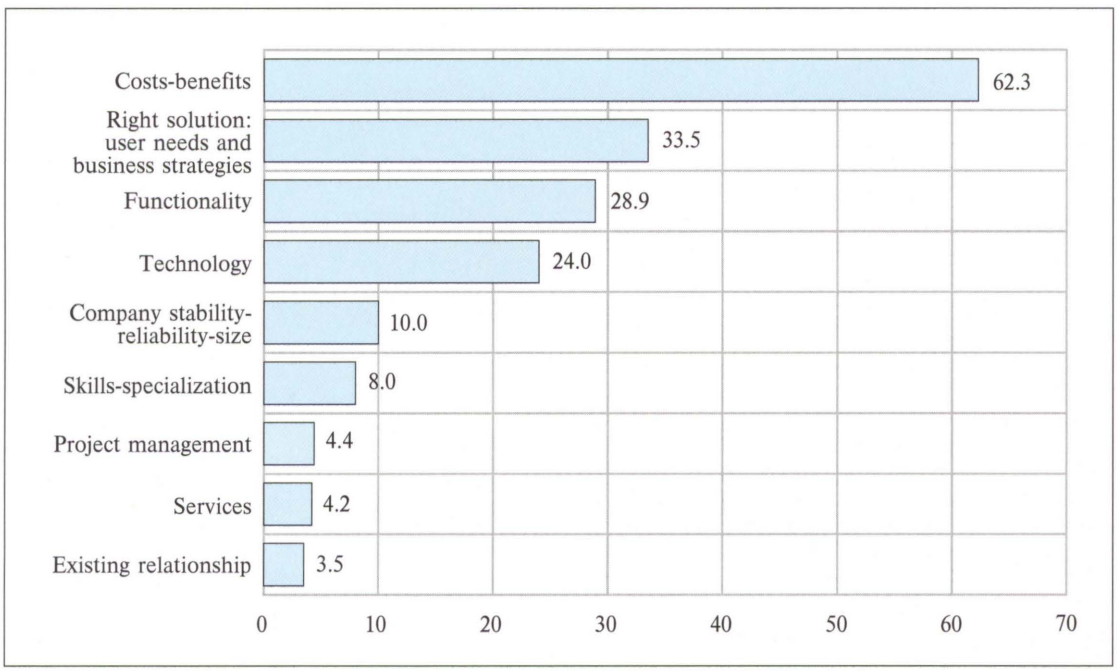


Figure 21
Buying Criteria: Open Answers Classified by Key Topics (% of Banks)

Services and banks' relationships

- good project management: timing and costs plan observance;
- after sale services, professional services quality, software upgrading;
- suppliers have to provide banks the knowledge about organizational, functional, technological solutions, as well as good products documentation in order to allow more independence of clients;
- providers have to integrate solutions.

Products type

- application framework, software development tools, single modules, parametrable products, easy customable products, re-usable object oriented software products etc.;
- products have also to be easy to use and adaptable;
- it is useful to have prototypes: "try before buy" approach.

Technology

- client/server for nearly all banks;
- workflow, open systems, imaging and document processing, multimedia, object orientation and building blocks, networking and LAN integration etc.

8. Methodology

Banks classification

It is complex to define a bank exactly: classification varies from country to country in accordance with the specific bank laws (see section 3).

In this paper we analysed all the banking and financial institutions "subject to the banking law" of each country.

However it is useful to classify banks according to size, geographical positioning and activities. We may distinguish:

- the *largest, international banks:* These rank in the first 50 European top banks and usually have a strong international network and provide universal banking operations;
- the *large general banks* that have strong domestic networks but a limited presence in foreign markets, including Crédit Agricole in France or some central saving institutions in Germany (where they often provide a global outsourcing for associated banks);
- the *medium size banks,* that usually include banks with global activities but with a regional or local positioning (about 20-100 branches);
- the *specialized banks:* these mainly focus activities on specialist financing in the private real-estate market, consumer lending, leasing, specific activities as treasury banks (specializing in securities and interbank transaction business) and the investment banks.

The *foreign subsidiaries* included branches of overseas banks.

Official information about structure and activities of banking systems refers:

- to 1992 data for all European Banks analysis;
- to more recent data for the five selected countries: France, Germany, Italy, Spain and the UK.

Market classification

Information Technology expenditure includes:

- *software and services*
- *hardware.*

Hardware installed base includes:

- *large systems*
- *medium and small systems*
- *workstations*
- *Personal Computers (PCs)*

according to the general EITO classification.

FINANCIALSMAU
AREA SIMULAZIONE
FINANCIALSMAU
AREA SIMULAZIONE
PUBBLISMAL E
SMART HOS

SMAU '96
OCTOBER 18-22

MILAN FAIR, ITALY

SMAU TODAY IS
the top exhibition for its sector in Italy,
one of the most important on the world scenario,
a reference point in the ICT market.

LAST YEAR'S FIGURES
300,000 visitors,
2,400 companies,
68,000 net square metres,
1,400 accredited journalists.

SMAU '96
focused on the convergence among
information technology, telecommunications and media,
and on the powerful expansion of the consumer market.

EXHIBITION AREAS
computer hardware and software,
telecommunications, office systems and products,
the printing universe.

Professional application areas
banks, finance, insurance,
public administration and health care,
open software systems, networking,
CAE.CAD-CAM and computer graphics.

Consumer application areas
multimedia and new services on Internet.

AND, IN ADDITION
institutional conferences, workshops,
company meetings,
the 29th Smau Industrial Design Award.

Smau on Internet
http://www.smau.it/magellano

smau

International exhibition of information & communications technology

The Evolution of ICT Distribution Channels in Europe

This paper has been provided by ROMTEC in close cooperation with the EITO Task Force.

1. Emergence of a Channel Structure

1.1. The Evolution of Distribution Channels

The genesis of what we now know as distribution channels can be traced back to the late 60s when the mainframe companies "unbundled". This milestone in the development of the computer industry caused the formation of independent software houses, systems consultancies and training organizations. Subsequently the concept of buying computer time from a computer bureau, first batch then on-line, emerged as a large and viable business.

In the early 70s, minicomputers created a further boost in business for independent service companies. After all, how could the minicomputer manufacturers implement application software in a vastly increased customer base without them? Indeed, they also encouraged their help in selling the hardware too by the mid 1970s. First it was on the basis of "promoting our brand name will raise the profile of your software products and services", then sales commission or discount was offered. Initially 5% was a generous offer!

Minicomputer manufacturers did much to support the development of independent distribution channels in the remainder of the 70s. Then came the PC! Rather surprisingly the minicomputer companies, apart from IBM, were not at the forefront of the PC revolution.

The market for IT in the 80s was largely technology driven with suppliers competing mainly on technology features. With operating system standardization and the rise of the PC, product-based differentiation became less and less viable towards the late 80s and channel-based differentiation took over (see *Figure 1).* Manufacturers who made innovative use of the channels and capitalized on new channels were those who prospered.

Relying solely on channel-based differentiation is now becoming an increasingly weak market strategy firstly, as the functions of manufacturer and channel become more and more blurred and secondly, as the same channels are effectively open to all manufacturers. As with other highly sophisticated markets, the successful ICT (IT, office product and telecoms companies as defined by EITO), manufacturers of the late 90s will need to add relationships as a key differentiator. Relationships with customers, channel partners and all third parties influencing the marketplace will need to be continuously developed to maintain competitive

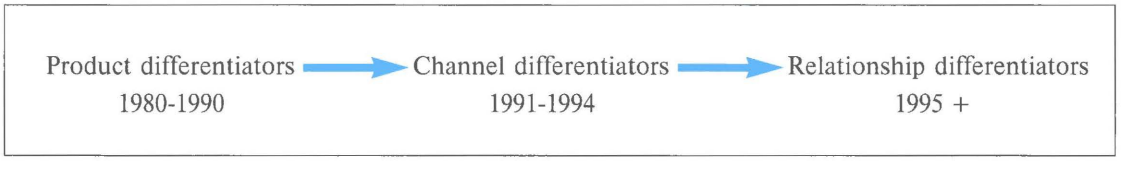
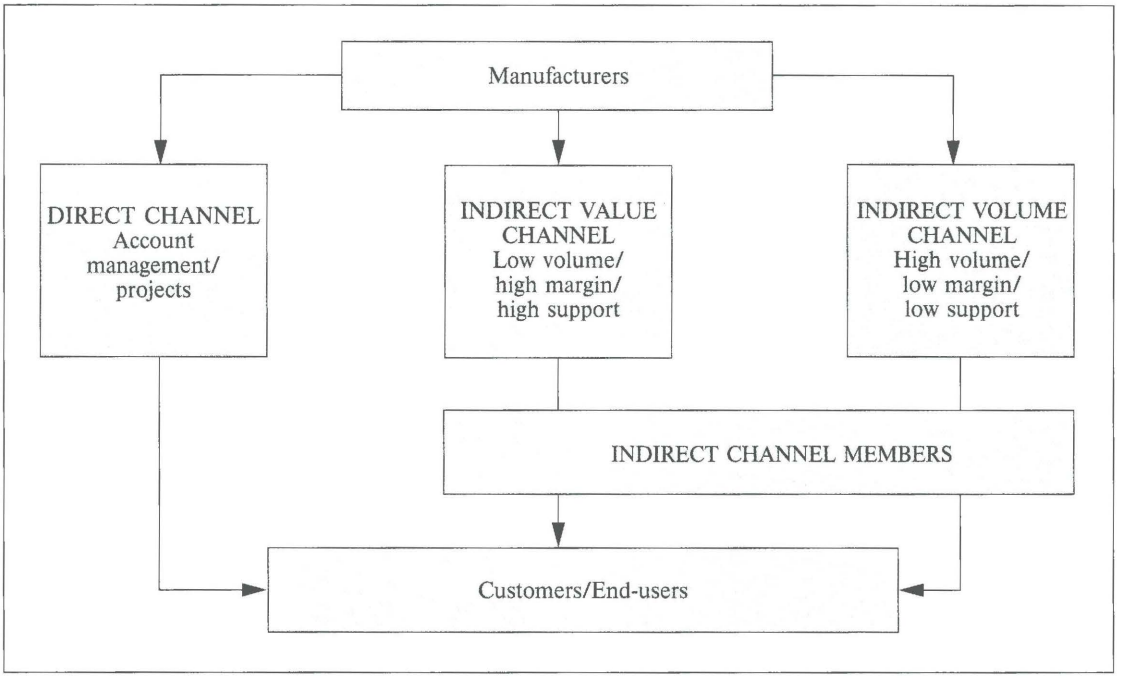


Figure 1
Leading Edge in Differentiation

Figure 2
Basic Channel Structure



edge. Indeed, the partnership aspect of relationships continues to gain support on all sides as a means of sharing risk and reward as opposed to unbridled supplier dominance.

1.2. Direct versus Indirect Channels

Over the past decade ICT manufacturers have had to adapt their distribution strategy and operations to encompass an ever-expanding and fragmented customer base as the PC has brought ever increasing processing power to the individual business desktop and personal domestic user. By the early 1990s, high volume sales of personal computers began to be an important feature of the industry. It was at this time that the key foundations for today's European ICT channels structure were built and the distinct polarisation between high volume/ low margin and low volume/high margin indirect channels became most visible as alternatives to the direct channel.

The result is a wide, complex and still evolving range of routes to market, from low volume/high margin/high technical support channels at the one extreme, to mass merchandisers and retailing outlets moving very large volumes at low prices and margins at the other. The cost structures, management skills and marketing programmes required for each 'polarity' are so different, that channel members have had to decide the channel arena which best fits their skills and where they can generate long term sustainable and profitable business in meeting customer needs.

The basic channel structure in *Figure 2* illustrates the channel differentiation developed in the early 1990s and indicates the scope now available for relationship differentiation. The relationships in the direct channel often involving third parties in the interface between manufacturers and customers differ fundamentally from those in the indirect channel in which the

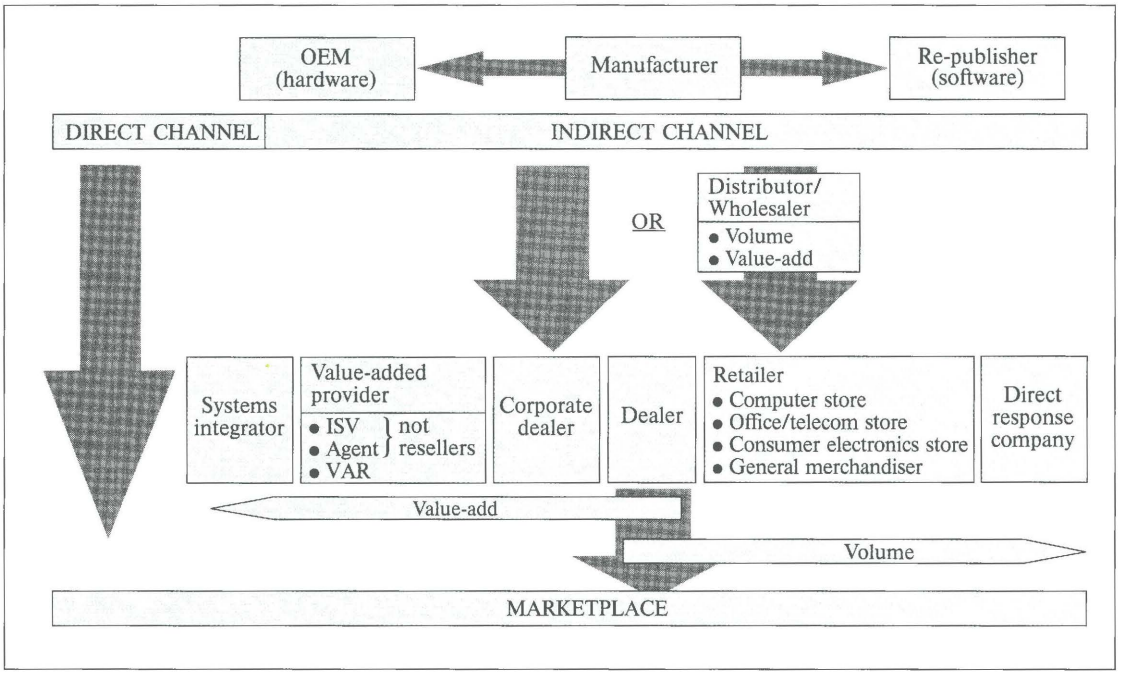


Figure 3
The EITO Channel Definition Standard - Structure

Definitions

- **Manufacturers** - original designer and producer or re-presenter of hardware or software product.
- **Channel** - vertical route to market involving few or many links in the chain of communications and supply. Such a channel contains channel members sharing a common business model.
- **Channel members** - are independent companies (indirect channel) or manufacturer departments (direct channel).

customer is remote from the manufacturer. Indirect channel members occupy the space between manufacturers and customers and as independent companies or indirect channel members operate in a variety of roles. The rich variety of indirect channel member roles is subdivided at the broadest level between value add and volume indirect channel member types.

1.3. The EITO Standard for Channel Definition

The concept of "open systems" implying a standard specification adopted by all was applied during 1995 to a channel definition standard. Many ICT manufacturers participated in and supported the process of developing a channel definition standard, initially for Europe. Those concerned see three major benefits in adopting such a standard:

Table 1
Indirect Channel Member Role Descriptions

Systems integrators: Integrates multiple platforms and operating systems with purpose developed software. Usually large project orientated businesses achieving > 75% services revenue. Outbound and account management sales with an emphasis on corporates.

Value-added providers: Collective term for *VARs, ISVs* and *Agents* each of which provides value-added in a different way. *VARs* provide turnkey solutions involving configuration and integration of third party products, the software component often sourced from an *ISV. ISVs* and *Agents,* unlike *VARs,* do not take title and enable and/or support system sales with their software and professional services.

Dealers: Straightforward configuration and integration of third party products. Often owner managed with three outlets or less. Concentrate on outbound sales, mainly to small and medium sized organizations. Can operate as a *Corporate dealer* in smaller countries.

Corporate dealers: Complex and simple configuration and integration of third party products, sometimes on large scale/volumes. Structured organizations, some publicly quoted, with more than three outlets. Sell mainly to medium and corporate customers with national coverage.

Retailers: High street and out of town based indirect channel members with shelf space and displays for 'walk in' customers. Sell mainly to consumers, and SOHO and small businesses. Sub categories of retail are: *Computer Store, Office/Telecom Store, Consumer Electrical/Electronic Store* and *General/Mass Merchandiser.*

Direct response companies: Sell simple or bundled products by fax, telephone, advertising, catalogue and mail. Predominantly inbound sales with limited customer contact. Sell higher volume lines at low prices.

Distributors/Wholesalers: Provide availability, despatch and credit on a large scale. May also represent "off shore" manufacturers. Sub categories: *Volume* and *Value-Add.* Volume distributors are seen as logistics orientated and broad based whereas Value-add distributors are seen to have a project and specialist orientation.

- market and channel information from different sources will be comparable by indirect channel member type,
- comparison will reveal differences and gaps which can be addressed with a view to improvement of consistency and quality, and,
- better information based on an open standard for channel/indirect channel member definitions will lead to better business decisions.

The EITO Channel Definition Standard (1995)* is an open standard for reference and adoption by all ICT manufacturers, channel players, consultants and market research firms. Excerpts from the full standard are given in *Figure 3* and *Table 1.*

* Copies of "The EITO Channel Definition Standard (1995) - An Open Standard for Europe" are available from EITO.

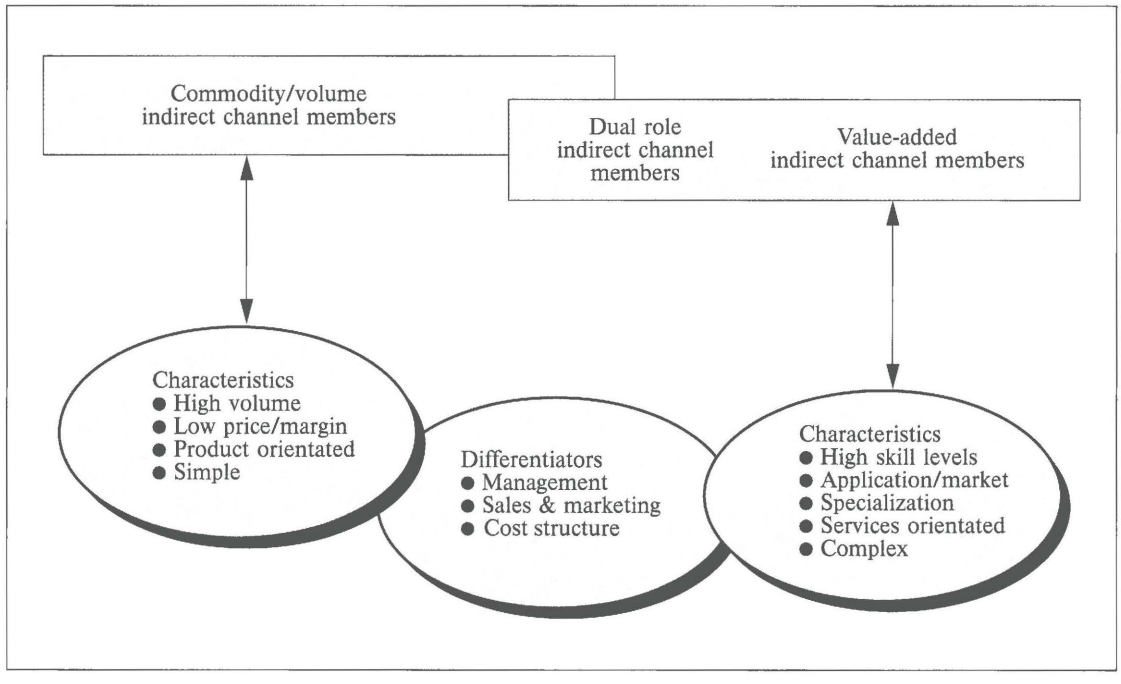


Figure 4
Value and Volume Indirect Channel Member Business Models

1.4. Value-added versus Volume Indirect Channel Members

The channel structure and indirect channel member role descriptions contain indirect channel members of two distinctly different inclinations - those that add significant value to the product being sold and those that trade in high volumes. Indirect channel members are sometimes advised to "Get big, get niche or get out" implying that they should focus on value-added or volume but not something in between. The indirect channel member business model is quite different in each case, as illustrated in *Figure 4.*

All things being equal (especially price) end-users will prefer to deal with a channel that provides a higher level of service output. "Service" in this context may be anything from convenience and availability of products to complementary development, installation and support which increase value for the customer. The more service outputs required by end-users, the more likely it is that intermediaries will form part of the value-added side of the channel structure and costs, i. e. prices, are also likely to be higher. Value-added providers *(VAPs)* and service companies would be the typical type of indirect channel member "intermediary" at the higher price end of this channel structure. On the other hand, the more the end-user is willing or able to participate in the "service" activities, such as product search or delivery mechanisms, the more likely they are to be compensated by lower prices through channel structures that reflect this involvement. Manufacturer direct, self-service *Retailers* and direct response companies fall into this category.

Clearly the experience, skills and commercial aspirations of indirect channel member company managers determine how they position their business model. In the 60s and 70s the choice did not really exist but since the 80s the volume product has become a major influence.

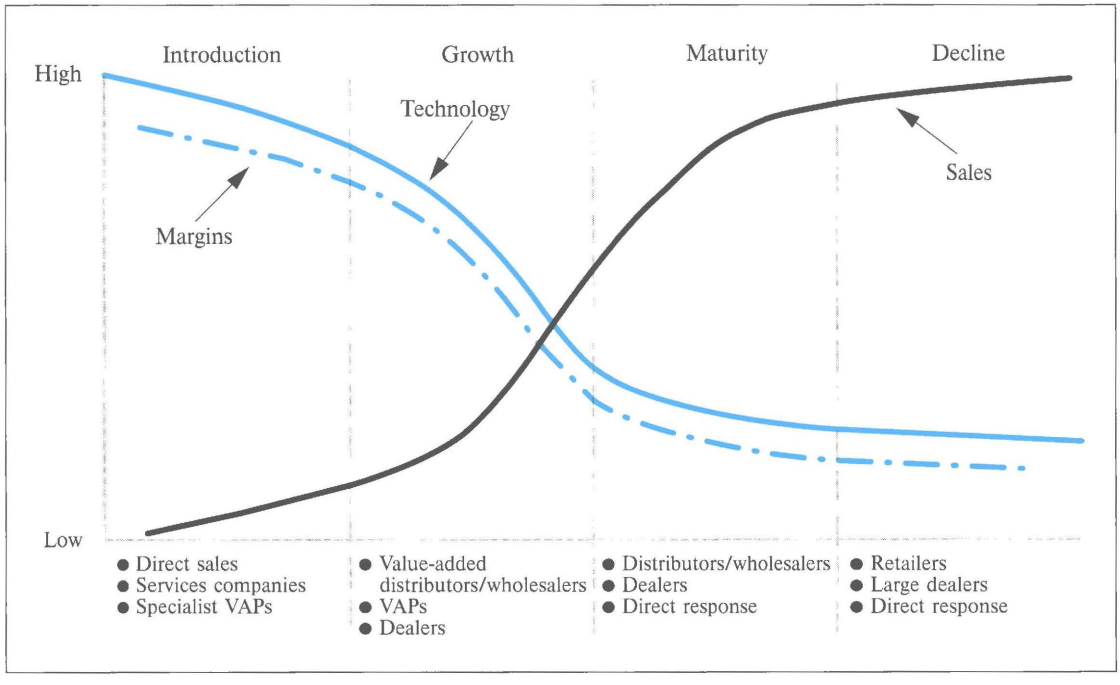


Figure 5
The Distribution Strategy and the Product Life Cycle

A further dimension to the value versus volume debate arises from examination of a typical product life cycle as depicted in *Figure 5*.

All products and services have a finite life cycle, during which they either become obsolete or redundant, or they move into new customer segments which will want different service outputs and therefore a different channel structure to provide them.

The chart shown in *Figure 6* is fundamental to understanding which is the most appropriate channel to meet user needs at each stage of the product life cycle. It is also important to recognize that some products will move across the chart through evolving channels of distribution during their product life cycle. Moving across the chart suggests that certain products will be handled by different indirect channel members at different stages in their life cycle (i. e. value first, then volume). Alternatively, larger indirect channel member organizations may operate separate value and volume sides of their business and progress products internally.

Clearly the principles of distribution strategy - product life cycle apply to products with high volume potential. Thus mainframes and other high capital value products may remain at the "left hand side" of the chart.

1.5. Indirect Channel Structure for the Mid 90s

The requirement for manufacturers therefore, is to understand the kind of service outputs desired by end-users and the product life cycle position and then to decide on how to deliver, taking into account the resource base and capabilities of alternative channel options, e. g. whether direct or indirect sales, or a mix, is most appropriate.

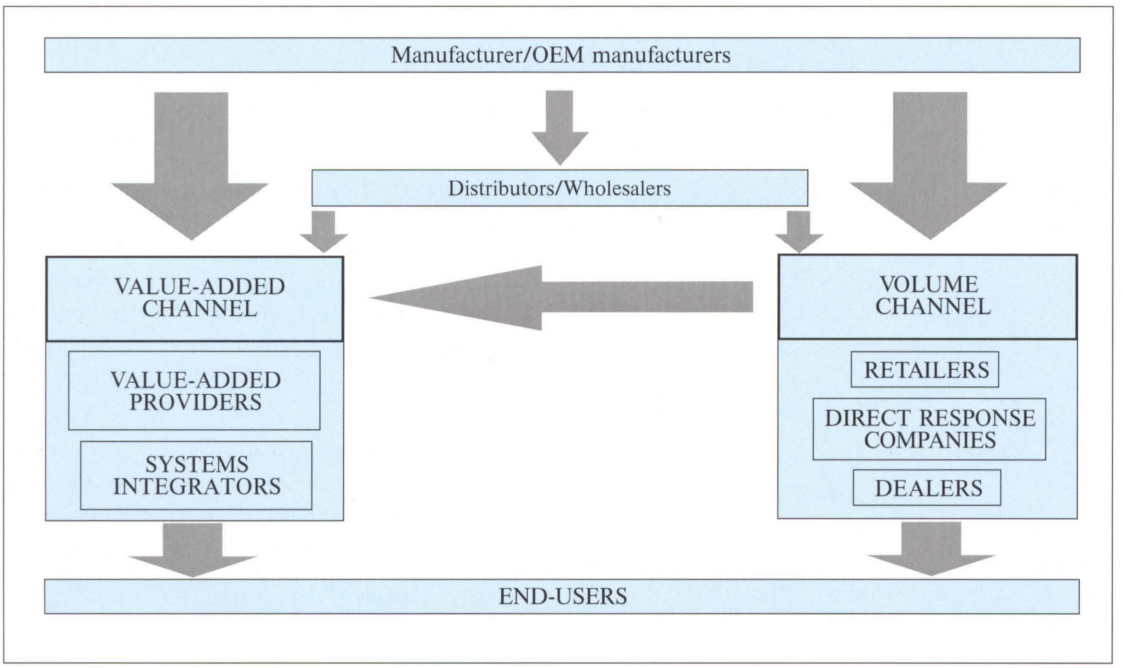


Figure 6
Indirect Value and Volume Routes to Market

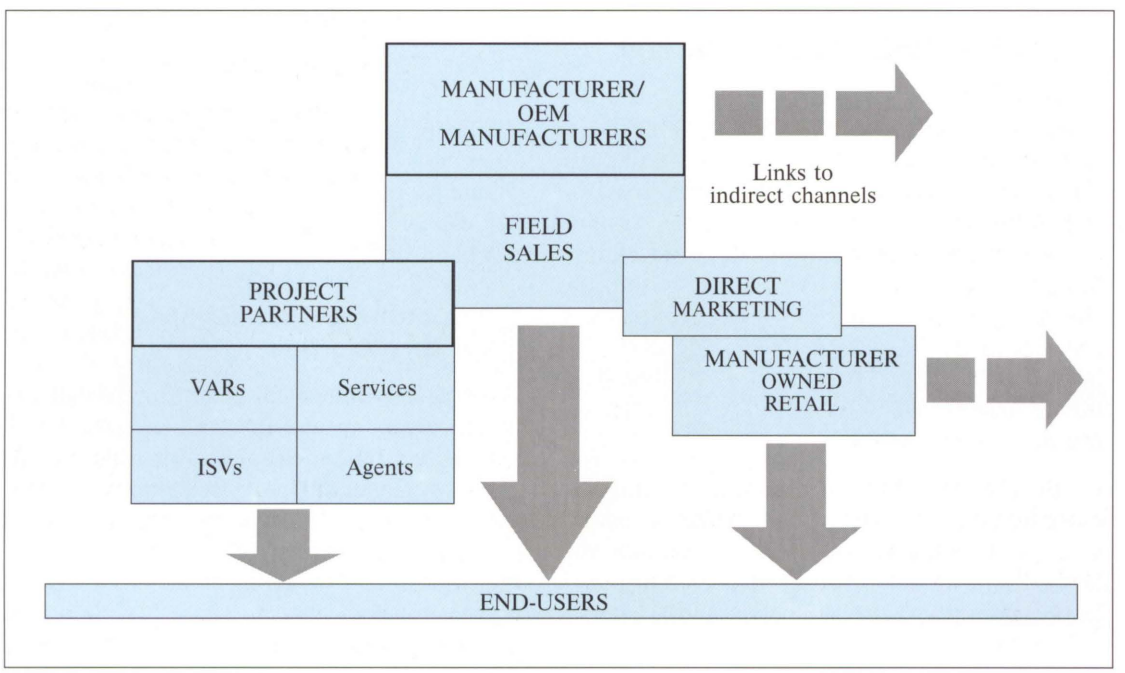


Figure 7
Variations on the Direct Route to Market

Table 2
European Indirect Channel Member Population

Country	Head Offices	Total including branches
Germany	6,300	7,800
France	5,800	7,100
UK	4,700	6,250
Italy	5,500	6,600
Spain	3,000	3,450
Other EU[1]	6,250	7,300
EFTA[2]	1,750	2,100
Western Europe	33,300	40,600

Notes: [1] Austria/Benelux/Portugal/Greece/Part Scand
[2] Switzerland/Part Scand

An indirect channels structure (see *Figure 6)* should be an optimal function of the demand by end-users for various service outputs and the channel members' needs to achieve scale economies for each of the relevant marketing flows.

1.6. The Direct Route to Market

Manufacturers sell direct when they sell to end-users without using any third party intermediary in the flow of title to the customer. This is not to say that third parties are not involved, as will be seen from the flow chart in *Figure 7.* Manufacturers' own field sales forces take orders or act as "sales enablers" for indirect channel partners. When selling major value-added projects, ICT manufacturers are likely to involve *VARs, ISVs, Agents* or other specialist service companies to enable them to offer a complete service to the customer.

To complete the direct route to market manufacturers may use direct marketing units to a lesser or greater extent (as in the case of Dell); they may also own a retail route to market (as in the case of Escom and Vobis).

Order fulfilment using third parties is also a noticeable trend. Physical delivery of products, even stock holding and invoicing, is increasingly being handled by logistics specialists, either fulfilment houses or courier companies.

If the PC example can be taken to be in any way representative, the direct route to market has now stabilized at a more modest level compared with the 1992 peak. As will be seen later, the potential in electronic distribution may stimulate a direct route for non hardware products such as commodity software, information and support services.

Whether the product is an office, telecoms or IT system, the end-user may believe the purchase was made direct. In fact, this is likely to be a form of virtual reality in which the third party links in the supply chain are invisible to the customer.

2. Channel Players – How Many and What Kind?

2.1. Europe in Summary

There are 33,300 indirect channel members in Western Europe, 25,300 being in the five main Western European markets. When branches are included, the number rises to 31,200 outlets *(Table 2).* In accordance with the Channel Definition Standard, an indirect channel member is a company in which reselling third party ICT products is a key part of the company's business. Some estimates of the numbers of indirect channel members in the indirect channel may be larger but these are known to include individuals at private addresses and businesses buying on trade terms. The population numbers given in *Table 2* relate to indirect channel member businesses employing more than one person for at least one trading year. These figures therefore exclude organizations such as training companies, third party maintainers and hardware *Manufacturers* where reselling third

party product is either a very minor activity or does not take place at all.

Dealers and *VAPs* combined, account for nearly three quarters of all indirect channel members. *Retailers* are the next most sizeable segment constituting some 11% of the total population.

PCs, printers and software are the staple products for Europe's indirect channel members with 80% of the population selling them. Conversely, workstations/mid-range systems are sold by only a quarter of the channel, since they remain non mass market products.

Reselling remains largely the function of small businesses, two thirds of Europe's indirect channel members having turnovers of less than 1.25 million ECU and only 13% having turnovers of 4 million ECU or greater.

2.2. Regional Variations

2.2.1. Indirect Channel Member Type

The Retail channel component is particularly strong in France (1.53 billion ECU) and Germany (1.45 billion ECU) with Italy (1.24 billion ECU) not far behind in 1995 revenues. In terms of 1995 revenues the UK market is well behind (0.58 billion ECU), which is surprising for a "nation of shopkeepers".

Direct response is a more developed channel in the UK than elsewhere in Europe. At the other extreme, *Direct response* is at an early stage of development in Italy as yet.

There are a greater proportion of distributors in Spain, which is likely to be due to the overlapping nature of Tier 1 and Tier 2 channels.

VAPs are most prevalent in the UK and France, with a corresponding reduction in the proportion of *Dealers*.

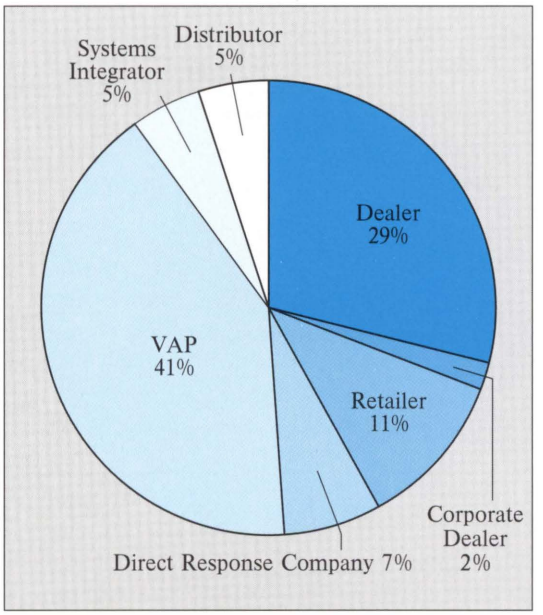


Figure 8
Breakdown of European Indirect Channel Population by Type (Percentage Selling a Product)

2.2.2. Products Sold

The extent to which manufacturers of ICT products have penetrated the overall indirect channel population can be seen in *Figure 12*. High percentages suggest a tendency to saturation whereas low percentages suggest a tendency to low utilization - or missed opportunity. For example it may be possible for more indirect channel members to sell office products.

There is a reasonably high degree of consistency within all five countries in terms of products sold, with high penetration (65% or more) for PCs, printers and software across all five countries, and low penetration (35% or less) for office equipment.

Greatest variances appear for mid-range systems/workstations, with as many as two thirds of Spanish indirect channel members claiming to sell mid-range systems/workstations and only 16% in France.

Figure 9
Products Sold by the Indirect Channel

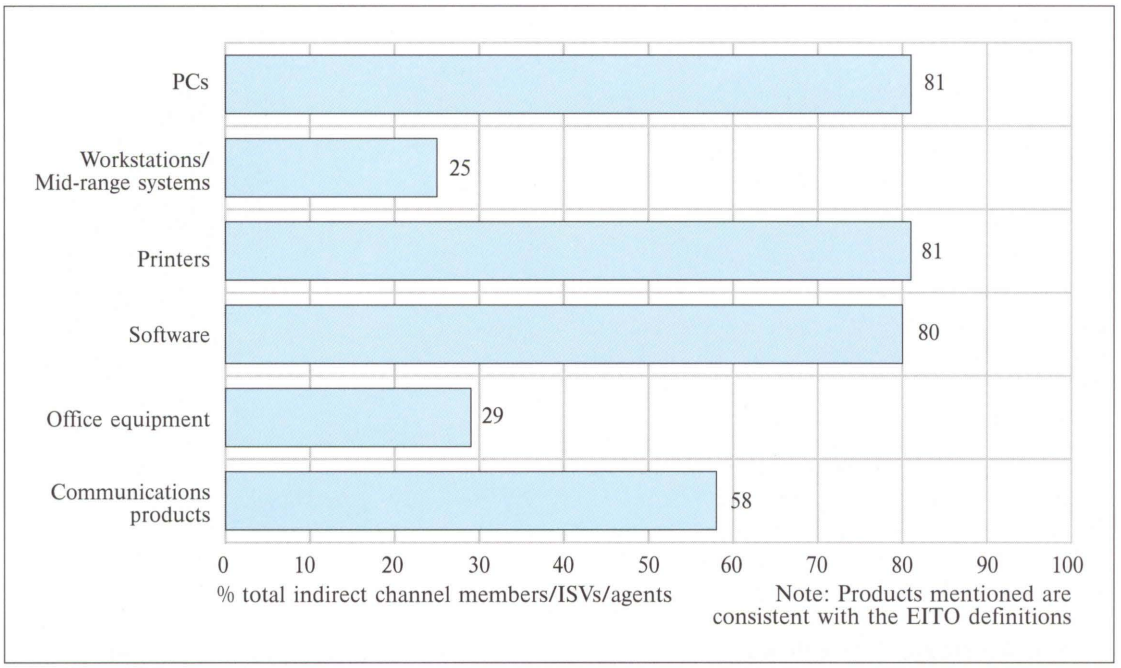
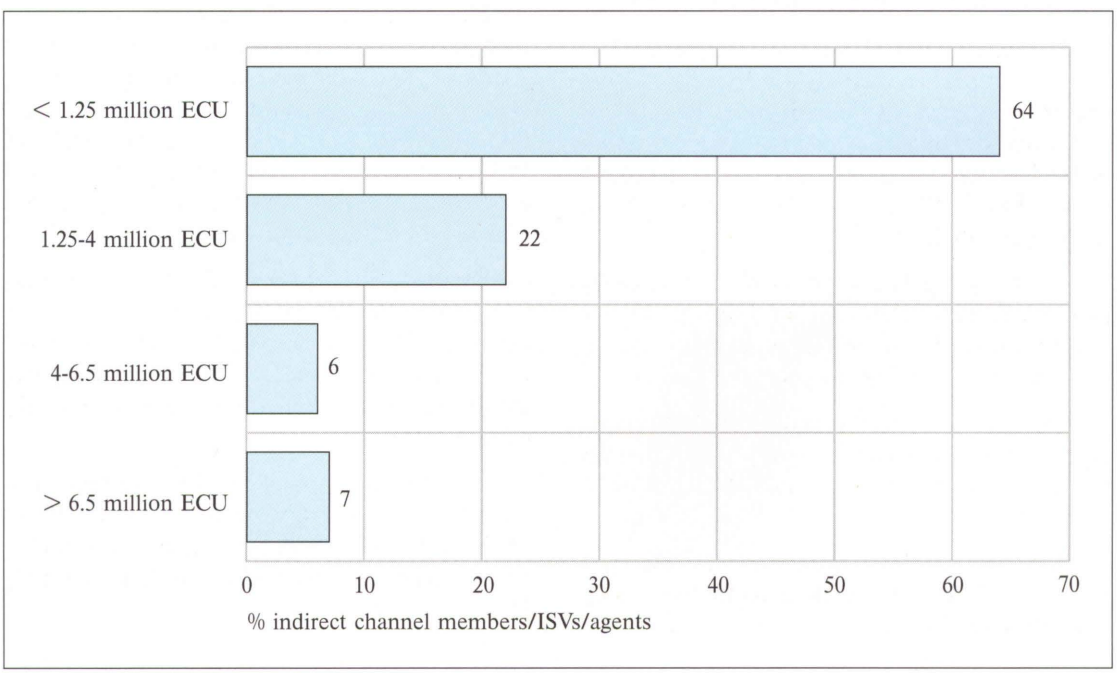


Figure 10
Breakdown of European Indirect Channel Member Population by Turnover



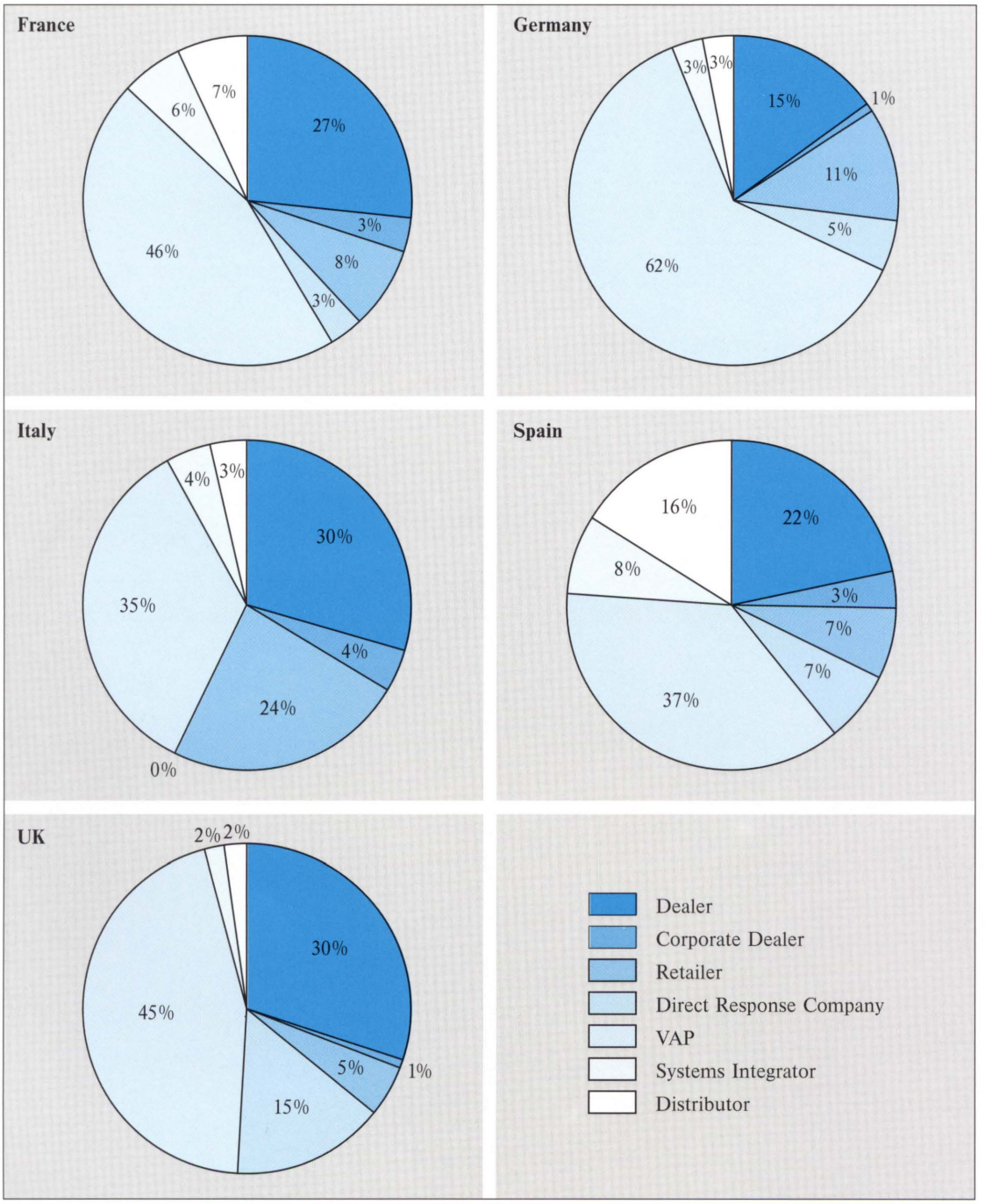
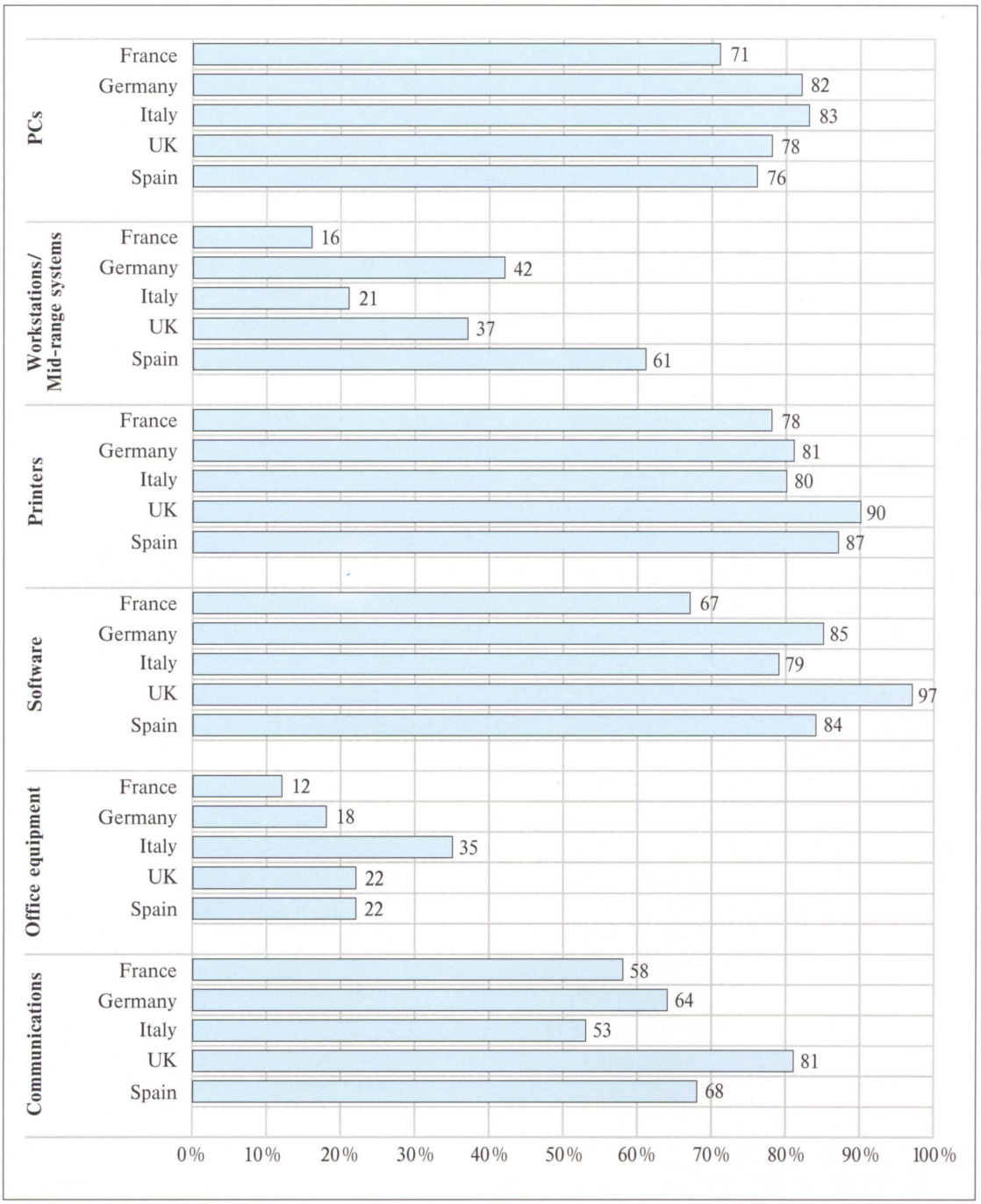


Figure 11
Breakdown of Country Indirect Channel Member Population by Type

Figure 12
Products Sold by the Indirect Channel Members by Country (Percentage of All Indirect Channel Members/ISVs/Agents)



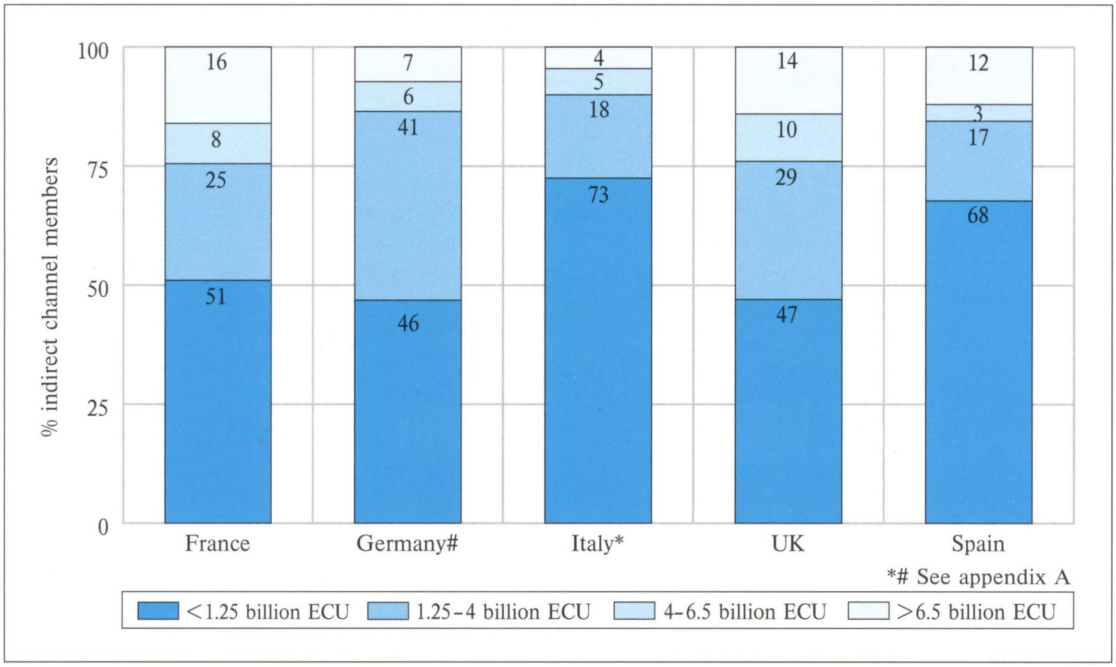


Figure 13
Breakdown of European Indirect Channel Member Population by Turnover

German and UK indirect channel members are more likely than the European average to sell communications products reflecting the relative maturity of indirect distribution for LANs and WANs in these two markets.

2.2.3. Indirect Channel Member Size

45% or more of indirect channel members have turnovers of less than 1.25 million ECU for all five countries (see *Figure 13*). Spain and Italy in particular are dominated by a large number of very small indirect channel members. The UK and France show the greatest proportion of larger indirect channel members with 24% having turnovers of 4 million ECU or more in each country.

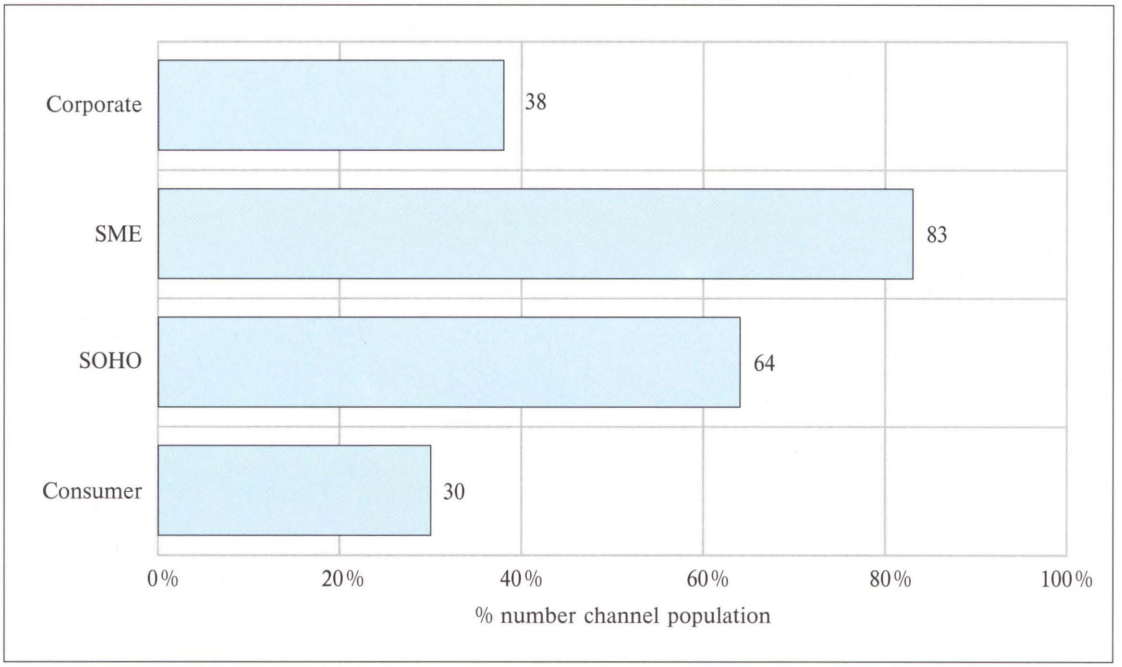
3. Channels, Indirect Channel Members and Markets Served

3.1. Direct and Indirect Supply Levels

The proportion of all indirect channel members, supplying each market segment is shown in *Figure 14*. The large involvement with the SME and SOHO segments is expected. Also, fewer indirect channel members are substantial enough to supply corporates. The lowest percentage serving consumers in the home suggests that this is a segment mainly addressed by relatively few major retailers and direct response companies.

The SME market is the most widely served by indirect channel members and significantly SOHO is also a key market for the channel.

igure 14
larkets Served
y the Indirect Channel



able 3
larket Segment
)efinitions

Consumer: Home based leisure, domestic and minor business users. Purchases are made out of household income.

SOHO: Home based business with < 20 employees

Small: Business or other organizations with 20-99 employees

Medium: Business or other organizations with 100-999 employees

} SME (Small/ Medium Enterprises)

Large/Corporate: Business or other organizations with > 1,000 employees

Only 38% have the skills, size and resources to sell to the corporate market. 30% already sell to the home and this number will inevitably grow as the market grows. Variations by country are shown in *Figure 15.*

3.1.1. Markets Served

Since the home consumer segment is the fastest growing and is fast approaching a comparable market value with the corporate segment it is surprising to see that, in addition to a low proportion of indirect channel members, this segment also represents a small proportion of direct channel business. The conclusion to be drawn is that home consumers are served by relatively few large retailers, mail order companies and direct selling manufacturers.

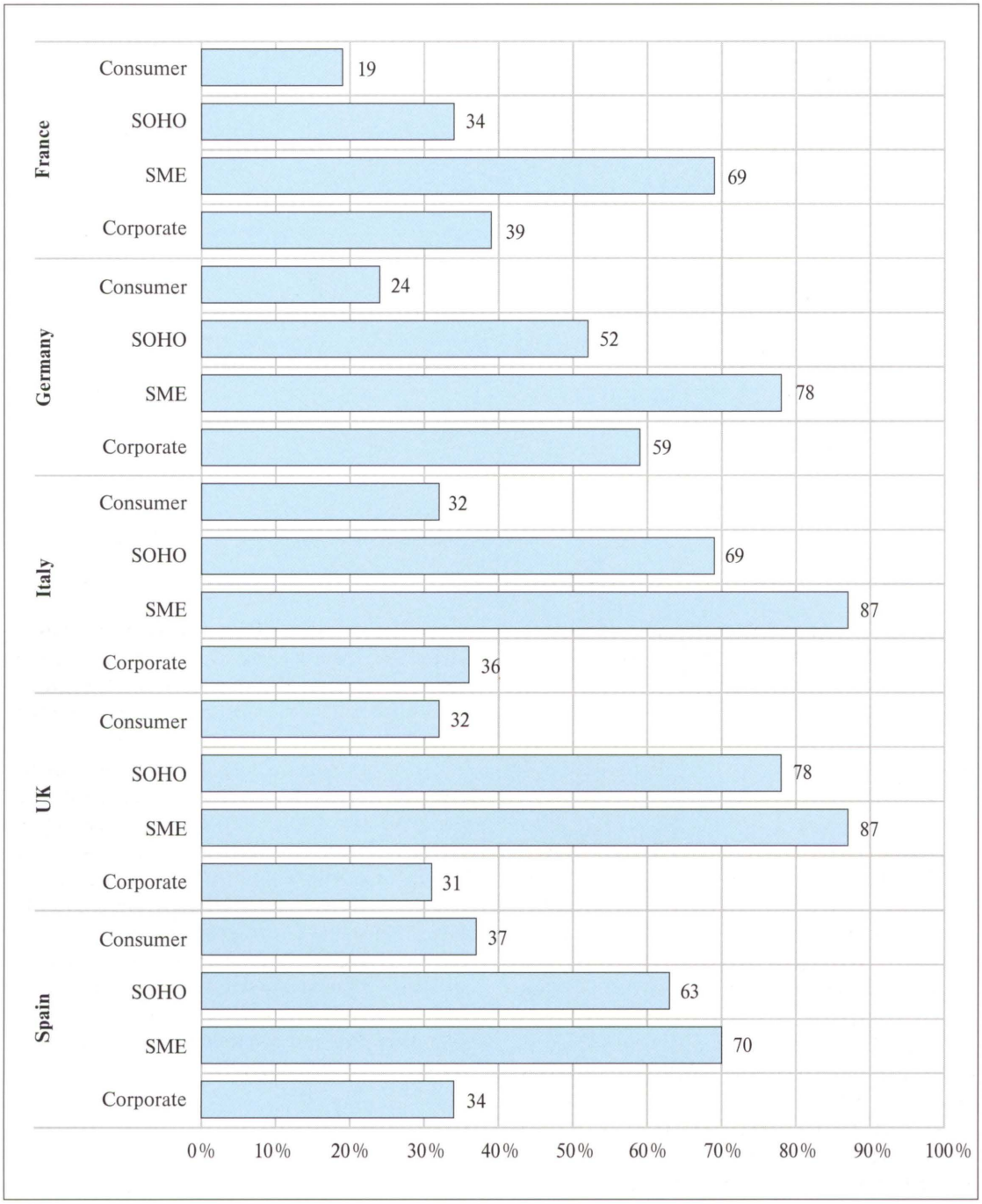
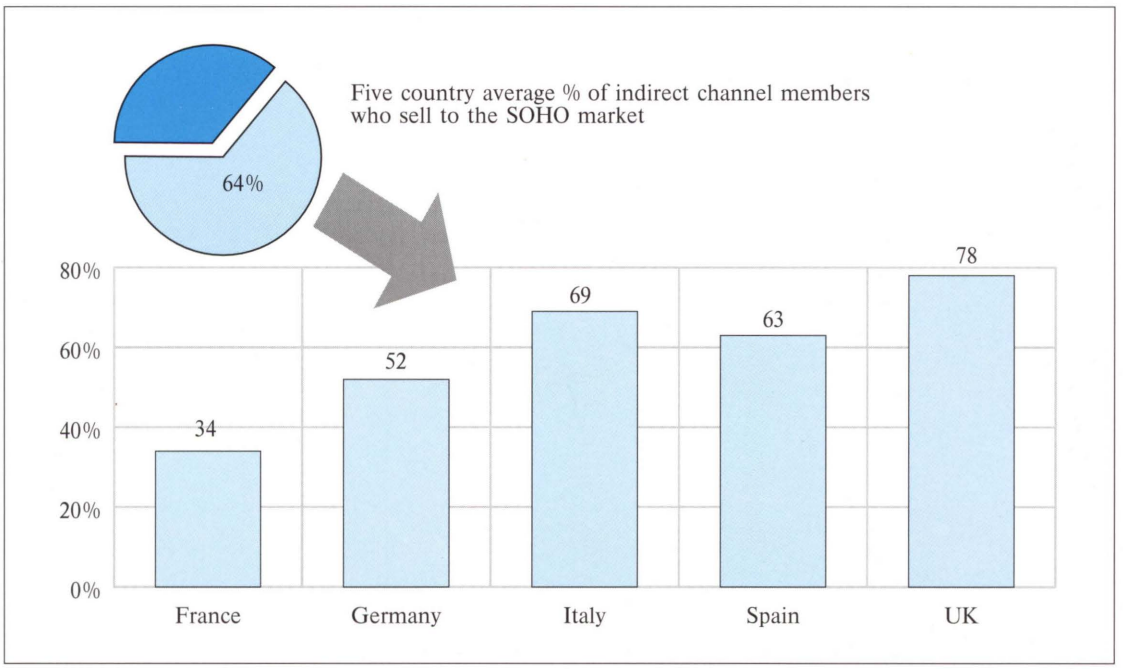


Figure 15
Markets Served by the Indirect Channel Member, by Country (Percentage of Indirect Channel Members)

gure 16
les to the SOHO
arket



3.2. Who Does Supply the Home and SOHO Market Segments?

The 90s brought a significant addition to the business of many indirect channel members – rapid growth in sales to SOHO businesses and home based consumers.

In all the major country markets except France over 50% of indirect channel members sell to the SOHO market (see *Figure 16).* This is consistent with Germany and the UK being the largest SOHO markets and France lagging on penetration. Nevertheless, France offers substantial potential since it does have a large number of single worker and small businesses. As evidence that this trend is occurring in reality, first time buyer growth among SOHO businesses was very strong in 1994 compared with other major country markets. Conversely, Germany and the Netherlands have the highest penetration of PCs into SOHO businesses.

The use of PCs within SOHO businesses in Germany is at a more advanced level, certainly when compared with France and the UK, where accounts is still the primary PC usage (although in the UK other applications have been installed). Accounts computerization is without doubt the major reason why SOHO businesses buy PCs, but in Germany usage has developed into a second stage, of customer database building and document production, as the main PC uses. The share of all PC sales accounted for by the SOHO sector is largely determined by the extent to which larger companies are buying PCs, but what is important in the SOHO context is the penetration of PCs into the sector. In the UK and France too many companies still do not see the need to buy PCs.

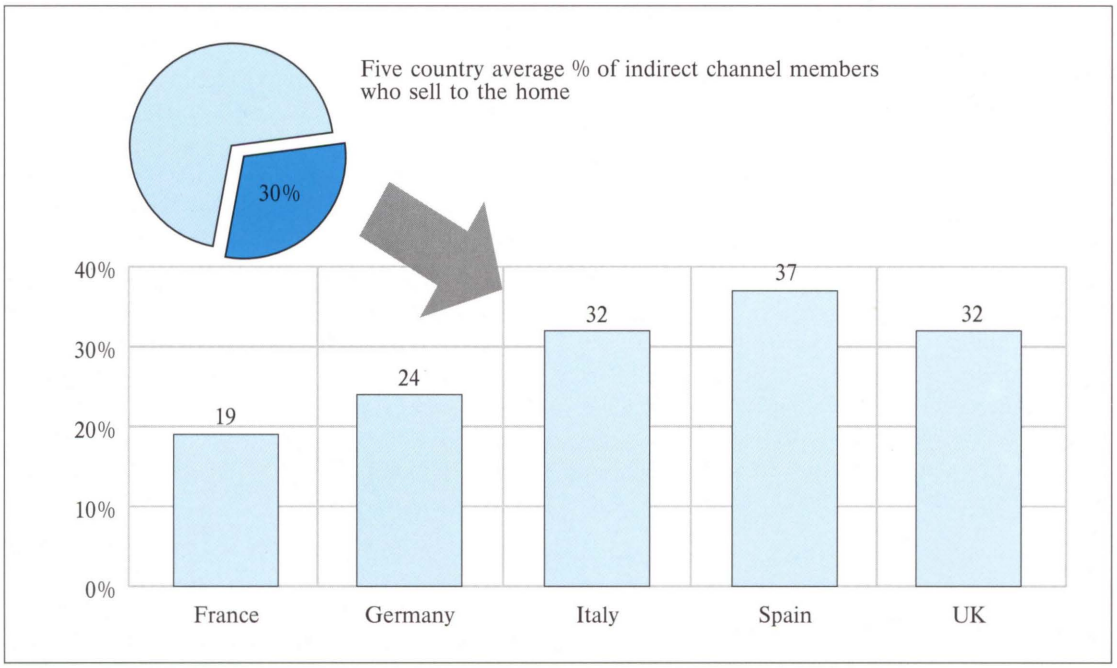


Figure 17
Sales to the Home Consumer

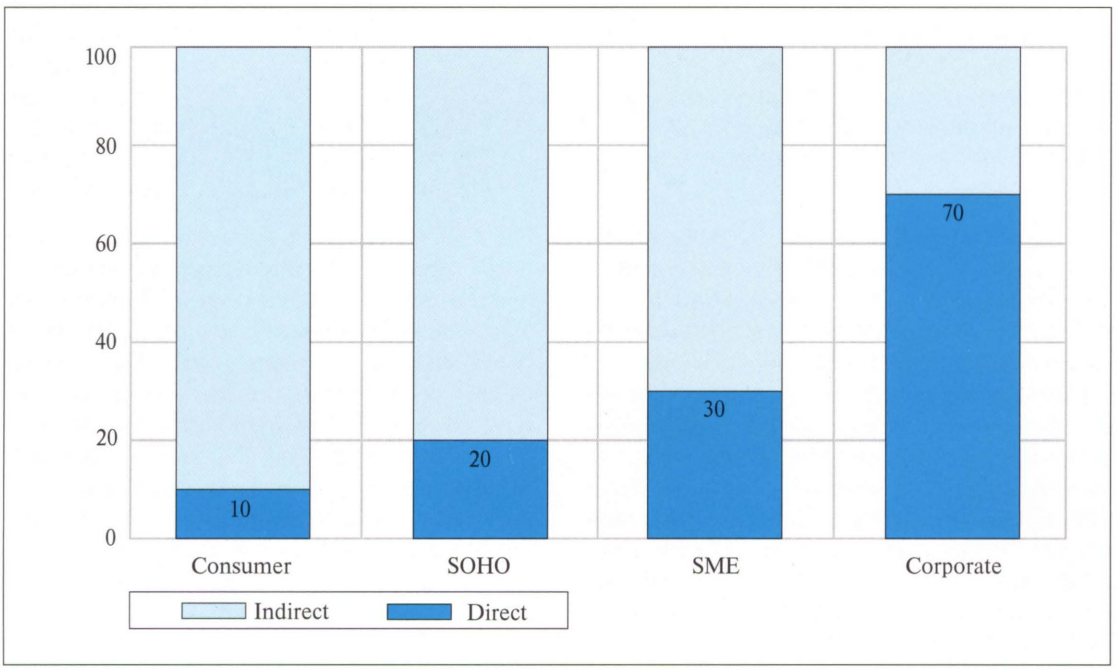


Figure 18
Percentage Market Valu Served by Channel Type (PCs and Related Products)

The proportion of indirect channel members selling to the home consumer segment follows a pattern similar to the SOHO model. In this case over 20% of indirect channel members in all major country markets except France sell to home based customers (see *Figure 17).*

Which indirect channel member types sell to SOHO and home consumers? Predominantly in the UK, France, and especially Germany, *Retailers* are the main players. They are available in "shopping hours" and offer keen prices. *Direct response* companies share a significant part of this market in the UK and Germany where this type of indirect channel member has a noticeable presence. *Dealers* participate in this market also, particularly where SOHO businesses need to install more complex applications or networks.

3.3. Direct versus Indirect Supply

So far we have seen how each market segment is supplied by what proportion of all indirect channel members. The next step in the development of this analysis is to define how these segments are served by the direct and indirect channels and to observe the level of participation by different indirect channel member types in each case.

The observation that home consumers, although supplied mainly by the indirect channel, are served mainly by relatively few large retailers, mail order companies and direct selling manufacturers is illustrated in *Figure 18.* It is expected that this trend will continue in favour of retailers and direct response companies, particularly for PCs, peripherals, software and cellular products. Some purchasing by businesses (SOHO, SME and Corporate) will continue to be made from retailers and mail order companies – more so at the SOHO end, but not excluding purchasing by individuals on Corporate budgets.

The share of the SOHO, SME and Corporate segments occupied by direct suppliers of mid-range and mainframe equipment is larger – 20% in the SOHO, 30% in the SME and 70% in the corporate sectors. Conversely, indirect office products and mobile telephone products and connection suppliers favour the indirect channel to a greater degree than suppliers of PCs.

The SOHO market being largely home based is subject to a similar buying pattern to home consumers but those small businesses employing more than five people will continue to have a tendency to go to Dealers for more complex installation and subsequent support. SOHO businesses are also more likely to deal with local suppliers.

SMEs purchase a low proportion of their ICT requirements from retailers although many use direct response companies for peripherals and consumables. Dealers and VAPs feature strongly in this sector because businesses employing more than 20 people expect suppliers to visit them and provide a complete service. The needs of SMEs in an increasingly competitive market for them will tend to specify more challenging requirements involving networking (LAN and WAN), online services, convergent systems and integrated applications at the desktop.

Corporates will continue to be served by Systems Integrators, Corporate Dealers and VAPs. Manufacturers of computers (but not so much software or networks) will also continue to play a significant role but usually with indirect channel partners. For corporates the emphasis is on competitive tendering by suppliers, the capability to plan and install complex multiplatform, and often multi-site, systems and provide excellent project management. From a sales perspective, account management plays a special part in doing business with Corporates.

4. The Forces Driving Indirect Channel Changes

4.1. Price/Margin Pressure

The constant downwards pressure on prices and margins for ICT hardware and software products will continue, as both business customers and consumers are better informed than ever before and have more choice between competing product brands and sources, many of which are substitutable.

Both themes are having, and will continue to have, significant influence on manufacturers, brands and products, primarily with PCs, PC software and printers and then secondarily with workstations, client/server, networking and computing services.

Ultimately, what is vital for continued manufacturer-indirect channel member prosperity is the value chain (see *Figure 19*) and the margin this provides for profit by each of the channel players concerned.

The dilemma for manufacturers is how to preserve their own margins whilst leaving enough opportunity for channel partners to be sufficiently profitable to survive. Distributor/wholesaler companies are known to operate on wafer thin profit levels (< 3% on turnover is not uncommon) and these companies are vulnerable to adverse swings in the value chain. Their salvation depends on changes to their business model which increase their opportunities to add value (and usually margins). Some distributors already describe themselves as "Value-added Distributors" in line with provision of more support for their own indirect channel member partners. Further opportunities may be available in fulfilment services and product assembly/configuration.

These challenges are less acute in the indirect volume channel for Retailers and Direct Response companies. These organizations have developed their high volume logistical efficiency over many years and negotiate from a position of strength with Manufacturers, and sometimes Distributors/Wholesalers.

The indirect value-adding channel is inherently better positioned to create margin and indirect channel members in this channel, providing they are properly managed, consistently outperform companies in other channels in terms of profit.

Last, and not least, there will always be a temptation for Manufacturers to go direct.

4.2. Moderation of the Direct Route

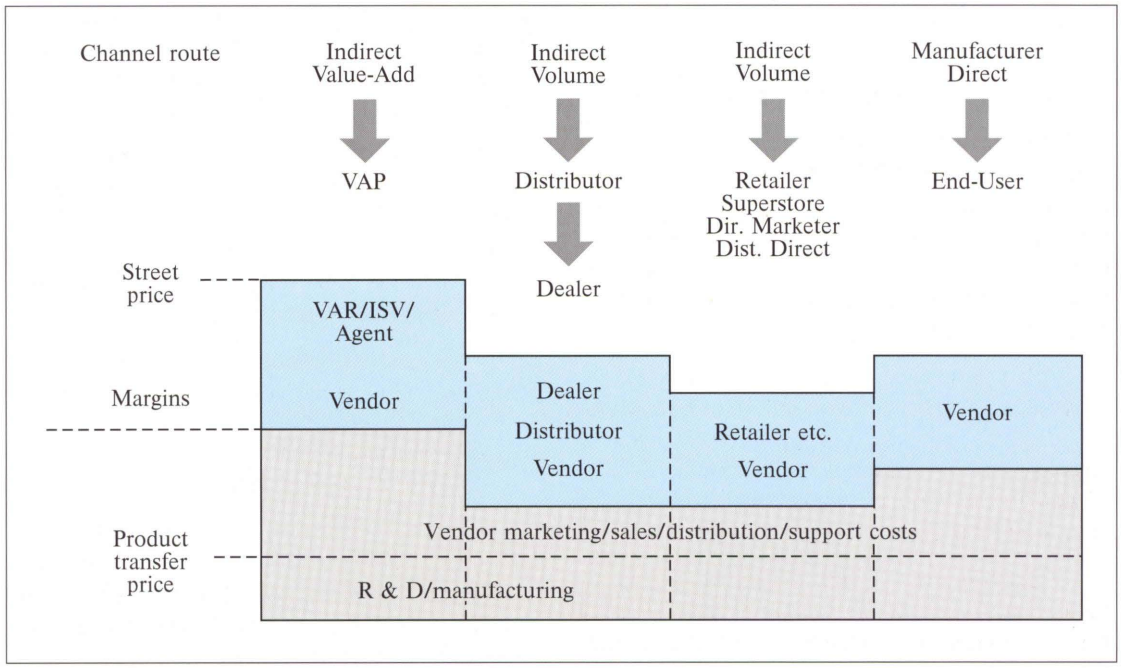
The channel profiles of individual European country markets will converge over the next three years, with the share of PC markets taken by direct sell PC manufacturers stabilizing at about 30-35% in the more developed markets (UK, Germany, France, Benelux) and approaching this figure from lower levels in the less developed ICT markets such as Italy and Spain. The original emergence of direct sell manufacturers – i. e. a manufacturer owning its own channel to the customer – was a response to flabby indirect channels. Now that indirect channels have been shaken up and made more efficient, it is the direct sell manufacturers who may be uncompetitive.

4.3. Increasing Importance of the Volume Channel

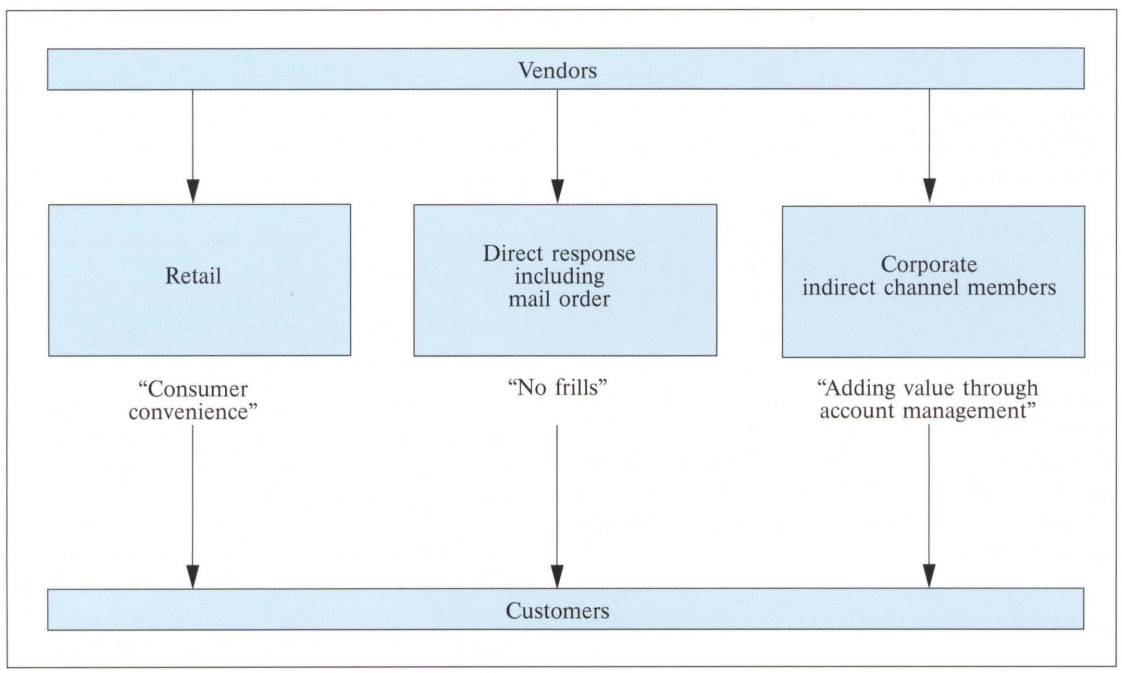
Three indirect channel member types in volume distribution for 1995 are each characterized by the most important differentiator they have, see *Figure 20.*

Whilst the critical differentiation for volume indirect channel members from a customer perspective is clear there are some additional challenges which have to be met in order to fulfil market growth potential.

igure 19
rice and Margin
ifferences by Channel



igure 20
'ritical Differentiators
)r Volume Indirect
'hannel Members



Strengths	Weaknesses
Best way to get to potential mass consumer market	*Retailers* may not be loyal to the brand
Can be a good way to get to SOHO businesses	Non-specialist *Retailers'* ability to provide appropriate support level is unproven
	Passive
Opportunities	**Threats**
High volume sales potential	*Retailers'* own brands
Could "leap frog" slower moving competitors	*Retailers* want special support, but low prices from *Manufacturers*
Building brand loyalty from customers	*Retailers'* margins
Emerging consumer market	Danger in not separately identifying and characterizing consumer and business markets
	Ignoring consumer price points

Figure 21
SWOT Analysis of the Retail Channel from a Manufacturers' Viewpoint

4.4. Retail – Strengths and Weaknesses

The retail channel for PCs, PC software and printers has grown rapidly from a low base over the last four years in Europe. However, national market characteristics are very different, such as the dominance by manufacturer-*Retailers* Vobis and Escom in Germany, a mixed third party/ manufacturer owned approach in France and Benelux, and a predominantly third party *Retailer* pattern in the UK.

The emergence of the retail channel has been a response first to the demand from consumers for PCs and secondly the demand from small businesses (SOHO sector), many of them computerizing for the first time. In these two cases, with a majority of non-expert first time buyers, an in-bound sales style has been appropriate, with the particular characteristic of convenience being pre-eminent.

Channel type	Customer segment			
	SOHO		Consumer	
	First time	Repeat	Novice	Expert
Specialist retail	√	√	?	√
Non-specialist retail	?	No	√	No

Table 4
Retail and Customer Segments

The third party retail channel has been exploited by manufacturers who have wished to establish their brands across all customer segments including consumer. There are examples of manufacturers such as Compaq who also sell through corporate indirect channel members and *Direct response* indirect channel members,

who have successfully broadened into retail to address consumer and SOHO segments. Other manufacturers, however, such as Dell, have found the price pressure from *Retailers* in the US market too great and have found the conflict with their own direct sales price list excessive. Dell's response has been to withdraw from the retail channel in the US, to concentrate on its original direct sales method. Interestingly, Dell is still active in the retail channel in the UK.

In the first flush of enthusiasm for retail distribution of PCs, some industry observers were predicting the eclipsing of the *Dealer* channel within three to five years. This would have required a complete shift in corporate buying behaviour, which has not happened as predicted. Instead, while retail has grown on the back of booming demand from consumers and the SOHO business sector, medium sized businesses and corporates have sought to optimize their relationships with corporate indirect channel members who can deliver the appropriate portfolio of professional and support services, but at the same time can also efficiently deliver competitively-priced products.

Within the retail channel, there will be a trend towards more expertise and service capability in newer specialist retail formats. This is because increasingly well informed consumers and SOHO buyers will want a source of new hardware and software that is more expert than they are, see *Table 4.*

4.5. Direct Response – What's the Pan-European Future?

With its advantage of being able to survive on gross margins of 10%-15%, compared to the 20%-28% that *Retailers* and many indirect channel members require, *Direct response* should be guaranteed a continuing role. However, *Direct response* is orientated towards passive, inbound sales, and this approach is only appropriate for part of the market. The "Off-the-page" approach is particularly suitable for some consumers and for some small businesses buying PCs. In addition, corporate users may use catalogues for low cost consumables or "top-ups" (non-strategic requirements). *Direct response* retains inherent advantages in terms of convenience - ordering directly from the desk or armchair.

It is significant that although *Direct response* is still forecast to increase its share of cross industry PC applications software sales, and increase its share of printer sales, its share of PC sales will decline slightly. This trend will be seen across developed European country markets. This is because PC choice is still a relatively complex process, with many brands still competing for customers' attention and where advice on technical specification and other service and support has to be available through the customer interface. The PC is still also the core purchase, and for corporates the natural vehicle for integration and support services.

By contrast, in application software and printer markets, one brand is very dominant in each (Microsoft and Hewlett-Packard respectively) and thus price and the physical aspects of delivery are more important in channel choice.

Direct response is not usually suitable for systems products such as workstations, servers and LAN installations which require a high degree of configuration and integration value-add. Catalogues such as DECdirect have been used successfully to sell ICT consumables and non-configurable "top-up" items such as dumb terminals to users, but many manufacturers are now unable to sustain profitable catalogue operations. Instead, some manufacturers have outsourced catalogues to third party indirect channel members. For example, even after the demise of Apple's own direct operation in the UK, MAC Warehouse maintains an education sector catalogue with an Apple branding.

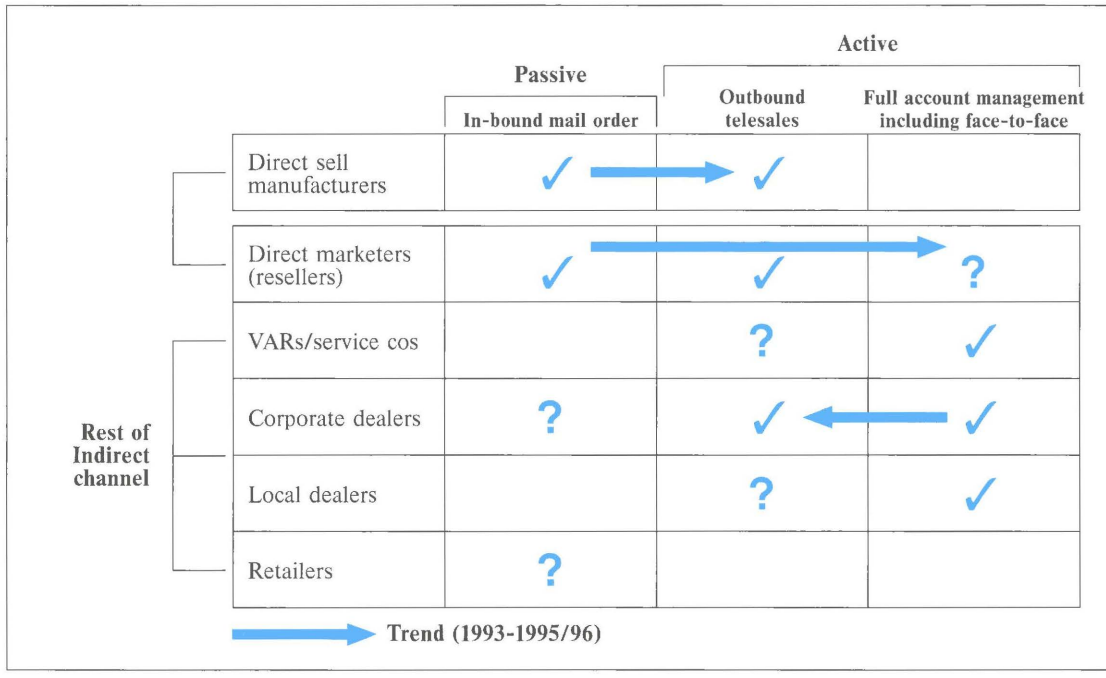
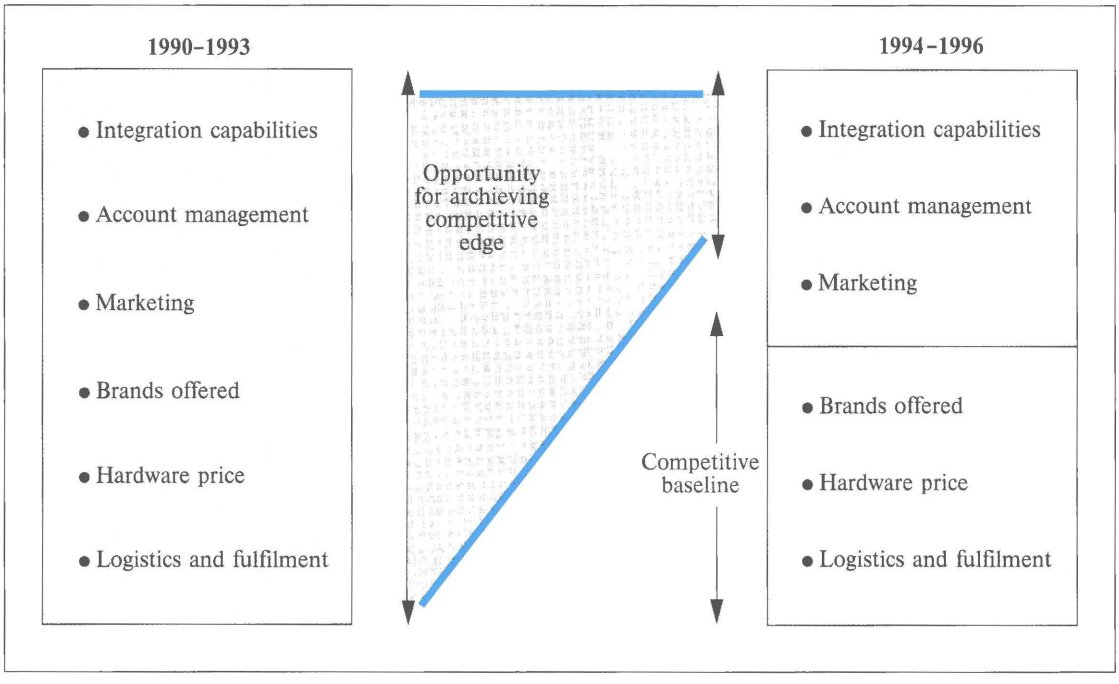


Figure 22
Trends in Selling Methods by Channel Type

While European economies were struggling with recessionary forces in the period 1990-1992/3, and despite some contraction in GDPs, there has been continuing growth in PC sales, fuelled by steady price cutting and new product launches. Millions of new customers for PCs emerged from the ranks of consumers and from small businesses, many of them first time buyers. Against this background of expanding demand, the easy availability of unbadged complete PCs or PC subassemblies, particularly from the Far East, made "off-the-page" sales operations relatively easy to establish. There were plenty of customers comparing prices and specifications and phoning in for exact quotes. These included consumers, SOHO businesses, and public sector organizations and some businesses in the private sector, all determined to get what they saw as better value for money. In Germany and France the importance of face-to-face deals and the loyalty to local businesses made retail the natural default instead of *Direct response.*

Now that there is a much reduced price premium on buying a branded PC from a conventional indirect channel member and corporates have rediscovered the virtues of expert service and support including integration, there is a clear trend towards direct marketing operations adding proactive sales skills, see *Figure 22.* This will include both indirect channel members and manufacturers. The first stage is to add a relatively low cost telesales capability, probably orientated to actively prospect for and sell the existing range of products. As this trend spreads, it will increase the pressure on any direct marketer without a product differentiator to follow suit into "active" marketing. Subsequent moves by a direct sell *Manufacturer* to add more value though integration services, for example, would be likely to need higher cost

ure 23
e Narrowing of
portunity for Indirect
annel Member
mpetitive Edge



full account management. It is unlikely that full account management can be justified unless integration and other professional services are being sold. Note that this positioning brings the *Direct response* indirect channel member or manufacturer into direct competition with *VARs* and *Corporate dealers.*

Strategies for use of the Direct response channel should either be of the "gap filling" or "setting out the stall" type.

A "gap filling" strategy is intended to achieve the broadest coverage of potential customer segments possible. In the case of *Direct response,* it may not even be a key part of a manufacturer's strategy but may instead be a consequence of broad distribution of competitive products which are then available through a wide range of indirect channel member sources and ordering methods. Products particularly suitable for *Direct response* include non-configurable or self-configurable items including those with strong cross-market brands. Buyers from *Direct response* sources may include expert consumers (second time buyers), small businesses or even departments within corporates.

"Gap filling" is most likely to be successful as a third party strategy and will avoid the channel conflict which a manufacturer's own direct sales channel can cause. Two examples here are Compaq's decision not to sell direct in Europe to avoid conflict with a loyal indirect channel member network and Apple's decision to withdraw its direct sell initiative following protests from indirect channel members. IBM has, however, decided to continue with IBM Direct in Europe for the time being.

Direct sell PC manufacturers may conclude that *Direct response* is "setting out the stall", even if they are evolving towards a more active approach to selling. This will still position them as welcoming new customers but will always require a high degree of price competitiveness, as the original proposition was always "compare our prices".

4.6. The Outsourcing of Fulfilment and Logistics

The channel function of fulfilment - where varied combinations of order-taking, telesales, and physical delivery into customers' hands are outsourced by manufacturers - is a new growth area. In highly competitive distribution channels, with reducing differentiation in terms of product, all channels whether value-added or not, need to be able to match competitive levels of operational efficiencies. This can be referred to as the "Competitive Baseline" where suppliers can not rely on this to give them competitive edge, but if they are not competitive in this area they will not be able to compete at all, see *Figure 23.*

Because some of these benefits come directly from economies of scale (for example having a single multi-lingual telemarketing centre serving customers across Europe), there are the same advantages to fulfilment as there are to data centre facilities management (i. e. FM company adds applications onto mainframes to increase utilization and thus efficiency), and there is a distinct pan-European dimension. It is also an area where high levels of investment in ICT systems, for example to support telemarketing staff, can provide competitive edge and raise barriers to entry. This development will make it more difficult for small *Dealers* selling widely available products, unless they also outsource at least the logistics process. They will thus be left with their account management, services and marketing capabilities as potential differentiators, see *Figure 23.*

Companies such as RR Donnelly (now merged with Corporate Software to form Stream), Manufacturer Services and 1&1 EDV, will all work with a broad range of manufacturers and even indirect channel members serving a range of customer segments including business customers and consumers.

4.7. Convergence

To date, indirect channel members handling office products have been different from those handling IT products and different again from those handling telecoms products. Convergence of the technologies involved at both product and application level now heralds a progressive overlap of the different indirect channel members involved. The ICT Distribution Structure has been defined with convergence in mind.

What does convergence mean in terms of business pattern? The following examples depict driving forces of a kind which will encourage convergence to occur:

- PCs are perceived and used increasingly as a connectivity and communications tool,
- PBXs may become an applications server option,
- PBX manufacturers may position their products as central to office networks,
- PTTs and other telcos will become channel players on a broad front,
- mobile computer integration needs telecoms.

The datacoms market remains primarily driven by product differentiation as was the case with PCs in the 1980s. The European market is characterized by a small number of nationally dominant suppliers. Distribution is still largely direct or reselling via ICT manufacturers whose strategy is to become more service-oriented. As user demand for standardization becomes reality, manufacturers will increasingly

rely on channel differentiators rather than product differentiators. Inevitably only those datacoms manufacturers with superior distribution channels will survive.

ICT channels, in particular pan-European *VARs* and services companies, are well-positioned to become a primary channel for datacoms. We anticipate a power struggle between "service-oriented" manufacturers and "manufacturer-oriented" services companies. Those organizations which have credibility amongst the growing band of Network Managers will succeed in this huge growth market.

4.8. Electronic Distribution

The technology and infrastructure to provide electronic distribution are largely available. The gaps which still exist, but not for much longer, concern security of company copyright and secure financial transaction procedures. Perhaps the ICT industry took a wrong turn in its early attempts to adopt CD-ROM as a marketing and delivery vehicle for software. CD-ROM is perhaps better regarded as an intermediate technology until comprehensive and commercially reliable on-line electronic distribution is available. It is anticipated that the broader theme of "electronic trading" is a more promising vehicle for the ICT industry.

Electronic trading is a broader concept than electronic distribution. It includes marketing, sales, delivery (administration and/or physical transfer) and payment through the medium of an on line service. Physical transfer of large files will require a broadband connection; it takes over 30 minutes to transfer a 1.6 Mb file over the Internet using a modem currently.

Electronic data interchange (EDI) is a "closed circuit" example of electronic trading. The wider and open implementation of electronic trading is expected to occur in the UK and other developed country markets in the next year. As a customer of either an indirect channel member or manufacturer it will be possible to make purchasing decisions from your desktop or network-connected notebook PC. The main features of these services can be summarized as follows:

- wide choice of brands, models and specifications,
- market data (e.g. brand share) to assist selection,
- independent reviews and recommendations to further assist selection,
- price and discount options, and,
- complete specifications and product pictures.

The user of an electronic trading service will be able to use the service for information only, for completing a purchase and (if appropriate) receiving the product or service.

How will electronic trading fit in to the channel structure? In principle it will be an enabler rather than a new indirect channel member type although existing indirect channel members may in some cases embrace this approach to replace existing trading methods. Operationally electronic trading will be adopted in the direct and indirect channels as an additional or replacement technology which reduces the cost of sale and increases customer service. The marketing, sales and fulfilment flows in the electronic trading model are shown in *Figure 24.*

Although not expected to create new indirect channel member types, the electronic trading model is expected to affect the indirect channel member business model. Manufacturers would be well advised to participate in and support the implementation of electronic trading. A by-product of this development will be the opportunity to recruit new players into the distribution channel structure, such as PTTs, cable companies and publishers. The early

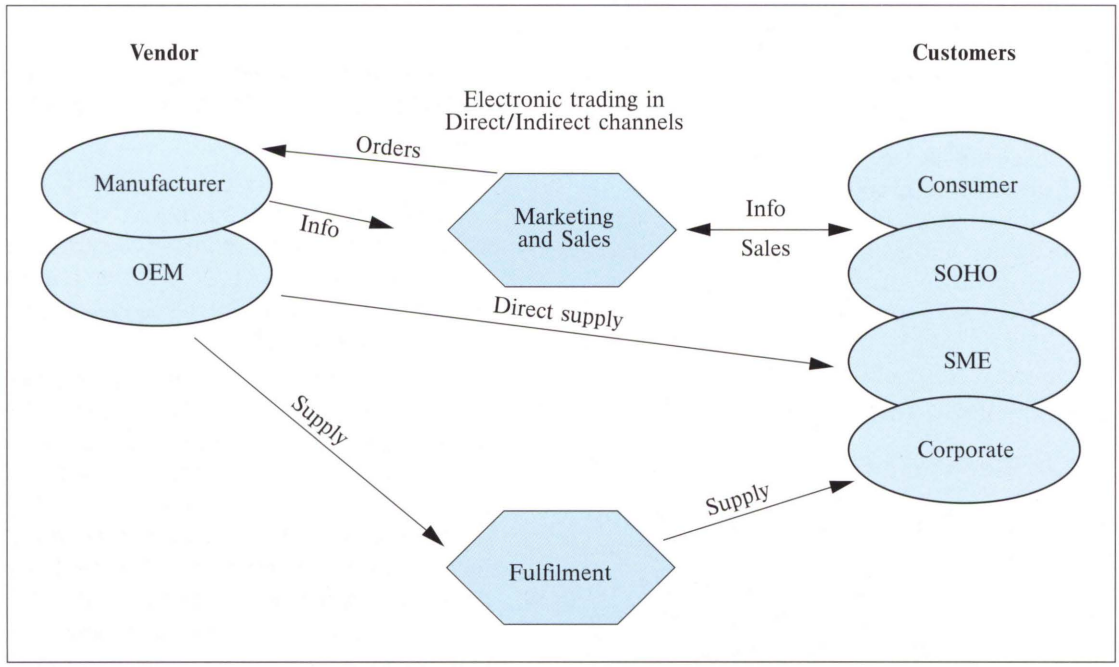


Figure 24
Electronic Trading Model

adopters among existing players are expected to be *Direct response* companies, Distributors/ Wholesalers, *Corporate dealers* and manufacturers with direct operations. Some illustrations of adoption could be proposed as follows:

- On-line information service providers (i. e. currently outside the ICT industry),
- PTTs and other fixed/mobile network providers as their business model for market entry. They will also be the principle infrastructure provider for electronic trading,
- Distributors/wholesalers as hubs of electronic trading networks in which *Dealers* operate the market and customer interface and distributors do the fulfilment.

Electronic trading offers a powerful benefit to indirect channel members, and especially manufacturers, namely that of knowing more about their customers. Major grocery and other *Retailers* now run customer loyalty schemes based on point of sale data collection and analysis. The ICT industry has the opportunity to solve the product/user registration problem, the upgrade problem and gain greater insight into customer uses and needs related information.

Providers of the electronic trading infrastructure will be of two kinds:

- transmission infrastructure only by subscription to a gateway, for example, the Internet, CompuServe, America On Line, Microsoft Network via Windows 95 and regular fixed and mobile network providers
- specialist electronic trading service providers who will set up a customer based electronic trading system or provide an outsourcing service. Such service providers may be companies in the first category or companies evolving from an existing on line information service capability.

Table 5
Manufacturer Action Areas for a Successful Future

Action areas for manufacturers
- Cost of sale reduction
- Relationship building and management
- Direct relationships with end-users
- Promote an organization-wide marketing culture
- Integrate sales, marketing and channel operators around end-user needs
- Plan and implement electronic trading

4.9. Customers

No review of driving forces could be complete without reference to customers. Traditionally, customers have been public and private sector organizations, with one or two obvious exceptions. The combination of lower price commodity products and an increasing tendency for people to work from home have caused a dramatic expansion of demand by the home based leisure and business user.

Furthermore, expectations of high quality, warranty and service levels will continue to keep the pressure on manufacturers to seek improvement. Customer satisfaction monitoring is already, and will continue to be, a key management tool which enables competitive edge to be maintained.

Customers will take an interest in price differentials across country borders and will continue to take advantage when practicable. The prospect of a single European currency and the likelihood that it could lead to harmonization of prices is not seen as a short to medium term factor. Globalization of purchasing by major multi-nationals and the corresponding need for global suppliers is seen as a current and future requirement of the ICT industry.

5. The Channel Model of the Future

5.1. Areas for Manufacturer – Indirect Channel Member Mutual Action

There are six important "action" areas that ICT manufacturers must understand and manage if they are to develop and maintain effective routes to market (see *Table 5*). These will affect relationships with the indirect channel significantly up to the year 2000.

- In an era of industry maturity, slowing growth rates and declining margins, the whole business operation must be geared to being more effective, in order to gain ongoing reductions in the cost of sale and remain competitive. Companies cannot expect to thrive as in the heady growth rates of the 1980s, but neither is it enough to simply survive if a long term future is to be assured.
- Relationship building and management skills will be at a premium. With fewer quality business relationships likely to be available – both with end-user and channel customers – stability and steady growth will go to those companies who have invested in this key area so that they can, in competitive terms, genuinely claim to "own" their important relationships. Included are relationship making, close vertical integration through outsourcing and joint ventures which allow higher performance in targeted customer segments.
- Developing an efficient direct marketing capability, so that a dialogue can be maintained with end-user and channel customers (whether actually supplying direct or not), is almost certainly a critical success factor for the next few years. Direct marketing is much more cost effective than personal visits, and because it is also very focused it can contribute significantly to reducing overall selling costs.

- It is not enough to simply set up a marketing department and expect it to weave its magic to improve results. Marketing is like quality, in that everyone in the company has a part to play in its ultimate success. It should be the aim of management to inculcate a marketing culture throughout the organization - for instance, in the expected "service" standards required for every potential customer access point to ensure satisfied customers - and this applies as much to the distribution function as to any other component of the marketing mix. This is especially important because indirect channels only really work if manufacturers have created customer demand for a recognized brand name. "Pull" will continue to be more important then "push" marketing, given limited margin and marketing capability in the channel.
- With the unbundling of services from products and the potential need for different channels for the delivery of products, software, services and information to reach possibly the same customer sets, the demand is for the integration of sales and marketing activities with channel operations (which includes the individual companies which constitute the channel or channels used by the company) on a scale never experienced before - in the ICT industry at least. Satisfying end-user requirements seamlessly across these different channel "flows" is a major challenge which promises real competitive advantage to the few who are likely to do it well!
- Electronic trading offers the potential for a more cost effective and responsive route to market. On the manufacturer side it will increase customer knowledge and on the indirect channel member side it will enable them to increase market penetration and lower rate costs. Both sides should be able to be more profitable despite price/margin pressure.

5.2. Channel Conflict

The term "channel conflict" is often mentioned in the course of channel related business discussions. Is channel conflict always a bad thing, or does it have some benefits?

The positive views stem from the realities that channel conflict exists and the general acceptance that competition is good for the customer. Channel conflict encourages indirect channel members to differentiate themselves and to win appropriate business on their strengths. The competitive process also creates market awareness which benefits the ICT industry in the long run.

Conflict without differentiation except on price is of course the less desirable side. This can cause major friction between manufacturers and indirect channel members which is potentially destructive in terms of the business relationship. Revenues and margins fall as a consequence, and the customer may suffer too because the indirect channel member's margin cannot stretch to adequate pre- or post-sales support.

Managing conflict by encouraging differentiation is the most profitable position to take!

5.3. Development of the Indirect Channel Member Business Model

The evolution of European distribution channels has made indirect channel members what they are today. The driving forces already described will cause continuing development of the indirect channel member business model. Development will, of course, take different forms according to indirect channel member type. However, in general terms, those on the ICT manufacturer side of the industry are currently expressing the opinion that indirect channel members should be preparing to live on an ever shrinking margin. Some, notably *Retailers* and distributors/wholesalers, are already familiar with this trend. Despite this constraint they are also expected to keep increasing service quality and customer satisfaction levels. In order to fulfil these criteria it is felt by the manufacturer community that indirect channel members need to:

- be better funded,
- improve financial management,
- improve marketing skills,
- develop successful market strategies,
- increase investment in training,
- become more customer responsive.

Beyond the business management issues, are there any external factors (i.e. not originating within indirect channel members themselves) which will influence the indirect channel member business model in the future? Almost certainly, there are some quite specific factors:

- Indirect channel members will adopt electronic trading as a means of achieving lower cost of sale and increased market penetration. It is expected that manufacturers will also adopt electronic trading but in support of indirect channel member operations.
- Convergence of ICT technologies is expected to broaden the scope of indirect channel member business in terms of product range, project content and geographic scope.
- Vertical integration with other channel partners and manufacturers is expected to increase through trading agreements and joint ventures.
- Indirect channel members are likely to be increasingly employed in a subcontract or outsource capacity by companies higher in the channel structure.
- New players, for example PTTs and other network providers, are expected to assume the role of indirect channel member.

The coming years promise a dynamic mix of threats, opportunities and challenges for indirect channel member businesses and their business model.

5.4. Channel Model of the Future

The diagrammatic representation of European ICT channels in the mid-1990s will be much the same as the present model but there will be substantial differences in the way it will operate. The changes that will be seen in the model are summarized in *Figure 25*.

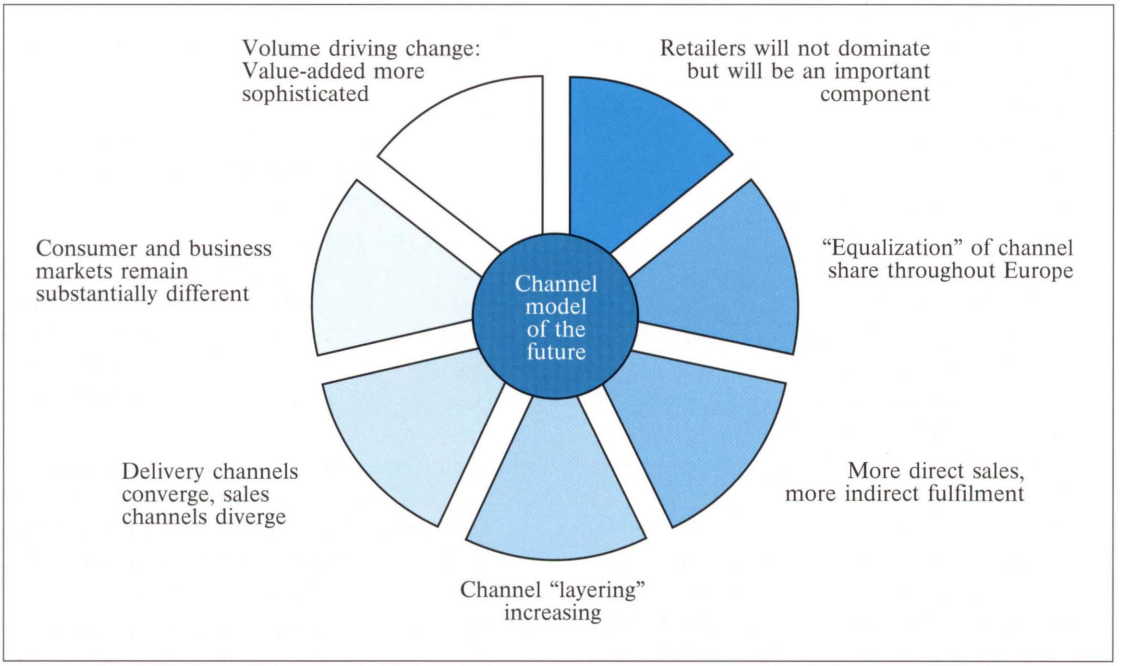


Figure 25
The European ICT Channel Model of the Future

The key points about this channel model of the future are:

- The growth of volume sales will continue to drive change, but the value-added channel will continue to be needed and be important. Successful value-added indirect channel members will be those which are closely focused on their specific areas of expertise, with technology based skills but price conscious, and with a sophisticated appreciation of managing product life cycle changes and their related product and service portfolios.

  An important example of the care needed to be taken by value-added indirect channel members in understanding where they can continue to make money from adding value, is the changing product and service margin rise generated from client-server installations.

Client-server products are currently seen as high margin, particularly servers. The proportion of profit generated from server type products can be up to twice the revenue share they generate. When services are added, it is easy to understand how value-added indirect channel members have focused on this market for their business future.

However, these high margins will not continue. The "client" element of client-server is already firmly in the high volume/low margin arena, and as client-server architecture with its related applications becomes more and more pervasive the "server" component will experience rapid price and margin reductions. Although related services will still be required they cannot be expected to retain a high margin requirement business indefinitely into the future.

This illustrates the dilemma for value-adders and why they will have to become ever more sophisticated in their offering and marketing expertise if they are to survive. Success will only come from a continuous movement up the new technology curve, where products and services will continue to require the support and service skills around which value-added indirect channel members build their business.

Any lapse in concentration, during which the value-added business can suddenly find itself operating in the commodity arena, can result in margin decay to the point from which a come-back is impossible. The future margins of client-server sales present this very danger to the value-added channel.

- Consumer and business-to-business markets will continue to need substantially different approaches and marketing skills. More manufacturers will have to decide where their focus lies, adopting "coverage" strategies such as that pursued by Zenith which has a major stake in the key retail player, Packard-Bell, whilst concentrating its own efforts on the volume corporate business market.
- This will result in greater co-operation between channels, requiring greater emphasis on relationship building and leading to more channel layering, as discussed earlier.
- As more and more customers become experienced and the "service outputs" required from the channel become more commodity type, there will be a significant growth in direct sales through direct marketing techniques and increasingly through electronic means such as interactive media, i. e. electronic shopping. The major difference to current direct sales operations, however, will be that delivery will be more through indirect channels, whose role (in the volume channel) will be increasingly more fulfilment and delivery (i. e. Europe is likely to move towards the US model, where many indirect channel members are already simply fulfilment operations).
- The result of these moves will be to generate an effective single-tier physical distribution system in line with the ever pressing need to contain costs and keep margins to sustainable profit levels, but with sales channels being multi-tiered in order to gain maximum market coverage.
- The share of the market taken by each channel (in volume markets) will tend towards equalization across Europe over time, in line with the increasing moves towards viable pan-European marketing operations.
- Because there will be limits to the ability of even *Retailers* to compete effectively in volume sales, with the pressure on retail margins already visible, they will not ultimately dominate the ICT channel as currently envisaged. Their share will increase over the next couple of years but will then stabilize or even decline as the direct sales grow as suggested. They are likely to remain important for PC and peripheral sales, i. e. hardware, but software sales will probably become no more important than their current levels through retail as prices, and therefore gross margins, decline even further.

Appendix A – Methodologies

Sample sizes

The sample sizes used to conduct the analysis and associated margins of error may be seen below.

Points to note

Due to the way in which turnover information is collected in Italy, the actual size bands used vary slightly and are:

> 5 million ECU

2.5 - 5 million ECU

1.25 - 2.5 million ECU

< 1.25 million ECU

Since turnover information is not available for Germany, turnover estimates were made based on a calculated correlation between turnover and number of employees, as follows:

1 < 10 employees = 1.25 million ECU

10 - 29 employees = 1.25 - 4 million ECU

30 - 49 employees = 4 - 6.5 million ECU

50 + employees = > 6.5 million ECU

The Spanish analysis was conducted using Romtec's Top European Indirect channel members database and other internal sources.

Since this analysis focuses on Tier 2 indirect channel members, only those distributors which sell to end-users have been analysed i. e. no 100% trade distributors feature.

The comprehensive picture of the demographics of Europe's indirect channel presented in this chapter has been achieved through analysis of the P.R.I.D.E partner databases. P.R.I.D.E, an acronym for Partnership for Indirect channel member and Installation Databases in Europe, is a consortium of leading ICT database publishers who collectively research and maintain profiles on some 30,000 European indirect channel members. The contributing P.R.I.D.E partners are compuBase - France, AMA - Germany, Sirmi - Italy and Romtec - UK.

Sample Sizes

Country	Sample sizes	Margin of error*
France	1,272 head offices	2.7%
Germany	1,000 head offices	3.1%
Italy	6,080 head offices and branches	1.3%
Spain	152 head offices	7.9%
UK	1,000 head offices	3.1%
Total	9,505 head offices and branches	1.0%

* e. g. we are 95% confident that the true result is ± 3% in the UK.

Appendix B – Frequency Analysis Tables

The complete analysis undertaken based on the following variable sets

Countries	France, Germany, Italy, Spain, UK
Products Sold	PCs, workstations/mid-range systems, printers, software, office equipment, communications products
Markets Served	Consumer, SOHO, SME, Corporate
Size	< 1.25 million ECU, 1.25 - 4 million ECU, 4 - 6.5 million ECU, > 6.5 million ECU

Product Definitions

PCs	All fully functioning Intel/Windows or Apple Mac compatibles and includes notebooks as well as desktop machines. This category excludes non-compatible computers such as Commodore Amiga, Amstrad PCW and various handhelds and PDAs.
Workstations/ Mid-range Systems	This category includes Intel and RISC-based technical workstations (e. g. Sun, IBM) and UNIX and proprietary multi-user systems (e. g. IBM AS400, Digital VAX, HP 9000).
Printers	All types of printers which are directly or indirectly attached to a system.
Software	All types of shrink wrapped software including applications software (e. g. word processing, spreadsheets, suites), database software, utilities (e. g. anti-virus) and languages.
Office Equipment	Includes typewriters, photocopiers and calculators.
Communications Products	All types of fixed communications hardware and software including LAN software, network cards, modems, multiplexers, routers, bridges, hubs, PABXs.

	Total %	Home %	SOHO %	SME %	Corporate %
Dealer	29	38	75	90	34
Corporate Dealer	2	11	48	93	89
Retailer	11	77	90	83	9
Direct Response Company	7	36	66	78	40
VAP	41	6	52	83	49
Systems Integrator	5	4	13	66	63
Distributor	5	7	17	45	25
Total	**100**	**30**	**64**	**83**	**38**

Breakdown of Indirect Channel Members Participating in Each Market for Europe

	Total %	< 1.25 million ECU %	1.25 million – 4 million ECU %	4 million – 6.5 million ECU %	> 6.5 million ECU %
Dealer	29	74	18	4	4
Corporate Dealer	2	22	32	23	22
Retailer	11	76	17	3	4
Direct Response Company	7	45	27	9	19
VAP	41	65	23	6	6
Systems Integrator	5	33	41	14	12
Distributor	5	11	41	20	27
Total	**100**	**64**	**22**	**6**	**7**

Breakdown of Indirect Channel Member Type by Indirect Channel Member Size for Europe

	Total %	PCs %	Workstations/ Mid-range Systems %	Printers %	Software %	Office Equipment %	Communi-cations %
Dealer	29	80	8	83	82	43	64
Corporate Dealer	2	78	8	79	78	29	73
Retailer	11	95	5	94	83	62	35
Direct Response Company	7	73	27	79	85	33	72
VAP	41	78	44	74	79	4	60
Systems Integrator	5	59	72	79	70	3	72
Distributor	5	70	13	70	59	24	56
Total	**100**	**81**	**25**	**81**	**80**	**29**	**58**

Breakdown of Indirect Channel Member Type Selling Each Product Category for Europe

Breakdown of Indirect Channel Members for Each Market by the Products Sold for Europe

	Total %	PCs %	Workstations/ Mid-range Systems %	Printers %	Software %	Office Equipment %	Communi-cations %
Home	14	94	6	96	77	31	19
SOHO	30	89	9	90	67	16	24
SME	39	63	20	64	60	21	35
Corporate	18	88	37	86	78	18	74
Total	**100**	**79**	**18**	**80**	**68**	**20**	**37**

Breakdown of Indirect Channel Member Size by the Product Categories Sold for Europe

	Total %	PCs %	Workstations/ Mid-range Systems %	Printers %	Software %	Office Equipment %	Communi-cations %
< 1.25 million ECU	64	90	15	90	84	50	75
1.25 - 4 million ECU	22	80	51	72	65	50	68
4 - 6.5 million ECU	6	83	70	83	84	21	80
> 6.5 million ECU	7	72	50	74	76	26	70
Total	**100**	**86**	**29**	**84**	**79**	**46**	**73**

Breakdown of the Indirect Channel Member Size by their Markets for Europe

	Total %	Home %	SOHO %	SME %	Corporate %
< 1.25 million ECU	64	76	92	91	37
1.25 - 4 million ECU	22	43	75	92	56
4 - 6.5 million ECU	6	30	81	93	76
> 6.5 million ECU	7	19	50	79	70
Total	**100**	**62**	**84**	**90**	**46**

	Total %	Home %	SOHO %	SME %	Corporate %
Dealer	27	23	42	79	40
Corporate Dealer	3	26	33	71	45
Retailer	8	50	41	45	5
Direct Response Company	3	29	32	55	32
VAP	46	12	32	69	47
Systems Integrator	6	7	18	64	42
Distributor	7	11	28	68	28
Total	**100**	**19**	**34**	**69**	**39**

Breakdown of Indirect Channel Members Participating in Each Market for France

	Total %	< 1.25 million ECU %	1.25 million - 4 million ECU %	4 million - 6.5 million ECU %	> 6.5 million ECU %
Dealer	27	58	24	6	12
Corporate Dealer	3	31	19	14	36
Retailer	8	34	22	11	34
Direct Response Company	3	42	21	5	32
VAP	46	59	24	8	9
Systems Integrator	6	47	36	7	10
Distributor	7	20	29	12	39
Total	**100**	**51**	**25**	**8**	**16**

Breakdown of Indirect Channel Member Type by Indirect Channel Member Size for France

	Total %	PCs %	Workstations/ Mid-range Systems %	Printers %	Software %	Office Equipment %	Communi-cations %
Dealer	27	85	16	92	87	16	77
Corporate Dealer	3	90	17	98	88	19	83
Retailer	8	82	9	91	82	41	59
Direct Response Company	3	76	8	71	79	18	68
VAP	46	62	19	71	52	3	45
Systems Integrator	6	73	20	80	66	6	56
Distributor	7	42	12	46	45	11	44
Total	**100**	**71**	**16**	**78**	**67**	**12**	**58**

Breakdown of Indirect Channel Member Type Selling Each Product Category for France

Breakdown of Indirect Channel Members for Each Market by the Products Sold for France

	Total %	PCs %	Workstations/ Mid-range Systems %	Printers %	Software %	Office Equipment %	Communi-cations %
Home	12	69	5	75	67	22	54
SOHO	21	38	8	67	55	14	47
SME	43	58	14	64	54	9	48
Corporate	24	60	14	59	47	8	44
Total	**100**	**55**	**12**	**65**	**54**	**11**	**47**

Breakdown of Indirect Channel Member Size by the Product Categories Sold for France

	Total %	PCs %	Workstations/ Mid-range Systems %	Printers %	Software %	Office Equipment %	Communi-cations %
< 1.25 million ECU	51	46	8	55	42	8	34
1.25 - 4 million ECU	25	46	15	48	42	5	37
4 - 6.5 million ECU	8	44	17	50	42	9	40
> 6.5 million ECU	16	46	12	47	42	10	39
Total	**100**	**46**	**11**	**52**	**42**	**7**	**36**

Breakdown of the Indirect Channel Member Size by their Markets for France

	Total %	Home %	SOHO %	SME %	Corporate %
< 1.25 million ECU	51	32	64	62	12
1.25 - 4 million ECU	25	29	76	86	28
4 - 6.5 million ECU	8	28	71	94	50
> 6.5 million ECU	16	19	44	67	46
Total	**100**	**29**	**64**	**72**	**25**

	Total %	Home %	SOHO %	SME %	Corporate %
Dealer	15	30	53	73	51
Corporate Dealer	1	33	67	67	50
Retailer	11	59	71	75	50
Direct Response Company	5	31	59	73	71
VAP	62	16	49	80	60
Systems Integrator	3	12	45	82	70
Distributor	3	11	37	70	81
Total	**100**	**24**	**52**	**78**	**59**

Breakdown of Indirect Channel Members Participating in Each Market for Germany

	Total %	< 1.25 million ECU %	1.25 million – 2.5 million ECU %	2.5 million – 5 million ECU %	> 5 million ECU %
Dealer	15	47	46	7	0
Corporate Dealer	1	0	0	0	100
Retailer	11	51	37	4	8
Direct Response Company	5	53	27	6	14
VAP	62	44	42	7	7
Systems Integrator	3	42	33	3	21
Distributor	3	37	52	4	7
Total	**100**	**45**	**41**	**6**	**7**

Breakdown of Indirect Channel Member Type by Indirect Channel Member Size for Germany

	Total %	PCs %	Workstations/ Mid-range Systems %	Printers %	Software %	Office Equipment %	Communi-cations %
Dealer	15	89	45	96	93	45	67
Corporate Dealer	1	83	33	100	100	83	33
Retailer	11	87	30	89	88	21	61
Direct Response Company	5	55	31	55	59	63	51
VAP	62	85	47	83	90	6	66
Systems Integrator	3	52	24	21	21	3	67
Distributor	3	30	15	41	48	22	37
Total	**100**	**82**	**42**	**81**	**85**	**18**	**64**

Breakdown of Indirect Channel Member Type Selling Each Product Category for Germany

Breakdown of Indirect Channel Members for Each Market by the Products Sold for Germany

	Total %	PCs %	Workstations/ Mid-range Systems %	Printers %	Software %	Office Equipment %	Communi-cations %
Home	11	83	38	85	89	23	51
SOHO	25	83	36	81	86	19	61
SME	36	81	38	80	84	17	65
Corporate	28	76	36	75	80	17	61
Total	**100**	**80**	**37**	**79**	**84**	**18**	**61**

Breakdown of Indirect Channel Member Size by the Product Categories Sold for Germany

	Total %	PCs %	Workstations/ Mid-range Systems %	Printers %	Software %	Office Equipment %	Communi-cations %
< 1.25 million ECU	45	82	40	83	84	18	60
1.25 - 2.5 million ECU	41	84	44	83	86	17	69
2.5 - 5 million ECU	6	74	48	75	85	17	64
> 5 million ECU	7	70	39	63	84	20	57
Total	**100**	**82**	**42**	**81**	**85**	**18**	**64**

Breakdown of the Indirect Channel Member Size by their Markets for Germany

	Total %	Home %	SOHO %	SME %	Corporate %
< 1.25 million ECU	45	26	55	76	54
1.25 - 2.5 million ECU	41	23	52	79	64
2.5 - 5 million ECU	6	16	44	79	64
> 5 million ECU	7	20	43	79	59
Total	**100**	**24**	**52**	**78**	**59**

	Total %	Home %	SOHO %	SME %	Corporate %
Dealer	30	39	82	94	33
Corporate Dealer	4	8	49	98	98
Retailer	24	80	96	87	6
Direct Response Company	0	0	0	0	0
VAP	35	0	53	86	50
Systems Integrator	4	0	0	63	73
Distributor	3	0	0	23	12
Total	**100**	**32**	**69**	**87**	**36**

Breakdown of Indirect Channel Members Participating in Each Market for Italy

	Total %	< 1.25 million ECU %	1.25 million – 4 million ECU %	4 million – 6.5 million ECU %	> 6.5 million ECU %
Dealer	30	83	14	2	1
Corporate Dealer	4	22	36	26	16
Retailer	24	82	15	2	2
Direct Response Company	0	0	0	0	0
VAP	35	76	15	6	4
Systems Integrator	4	24	46	18	12
Distributor	3	0	50	28	22
Total	**100**	**73**	**18**	**5**	**4**

Breakdown of Indirect Channel Member Type by Indirect Channel Member Size for Italy

	Total %	PCs %	Workstations/ Mid-range Systems %	Printers %	Software %	Office Equipment %	Communi-cations %
Dealer	30	78	1	78	78	49	57
Corporate Dealer	4	75	4	75	75	29	72
Retailer	24	97	3	94	82	67	30
Direct Response Company	0	0	0	0	0	0	0
VAP	35	81	48	70	78	3	58
Systems Integrator	4	55	100	86	75	3	81
Distributor	3	99	7	92	67	33	67
Total	**100**	**83**	**21**	**80**	**79**	**35**	**53**

Breakdown of Indirect Channel Member Type Selling Each Product Category for Italy

Breakdown of Indirect Channel Members for Each Market by the Products Sold for Italy

	Total %	PCs %	Workstations/ Mid-range Systems %	Printers %	Software %	Office Equipment %	Communi-cations %
Home	14	100	0	100	73	31	0
SOHO	31	97	1	93	60	14	6
SME	39	59	15	57	51	23	21
Corporate	16	100	41	95	82	20	84
Total	**100**	**83**	**13**	**81**	**62**	**21**	**23**

Breakdown of Indirect Channel Member Size by the Product Categories Sold for Italy

	Total %	PCs %	Workstations/ Mid-range Systems %	Printers %	Software %	Office Equipment %	Communi-cations %
< 1.25 million ECU	73	98	13	95	89	62	81
1.25 - 2.5 million ECU	18	89	66	71	56	84	74
2.5 - 5 million ECU	5	100	96	94	93	29	95
> 5 million ECU	4	94	84	93	94	47	93
Total	**100**	**96**	**29**	**91**	**83**	**63**	**81**

Breakdown of the Indirect Channel Member Size by their Markets for Italy

	Total %	Home %	SOHO %	SME %	Corporate %
< 1.25 million ECU	73	91	100	97	41
1.25 - 2.5 million ECU	18	58	83	98	69
2.5 - 5 million ECU	5	35	94	96	93
> 5 million ECU	4	19	53	84	98
Total	**100**	**79**	**95**	**97**	**51**

Breakdown of Indirect Channel Members Participating in Each Market for Spain

	Total %	Home %	SOHO %	SME %	Corporate %
Dealer	22	50	61	100	17
Corporate Dealer	3	50	100	100	100
Retailer	7	100	60	40	40
Direct Response Company	7	60	80	100	60
VAP	37	15	69	65	42
Systems Integrator	8	17	67	67	50
Distributor	16	36	43	36	14
Total	**100**	**37**	**63**	**70**	**34**

Breakdown of Indirect Channel Member Type by Indirect Channel Member Size for Spain

	Total %	< 1.25 million ECU %	1.25 million – 4 million ECU %	4 million – 6.5 million ECU %	> 6.5 million ECU %
Dealer	22	89	11	0	0
Corporate Dealer	3	0	0	50	50
Retailer	7	80	0	0	20
Direct Response Company	7	80	0	0	20
VAP	37	69	15	4	12
Systems Integrator	8	67	17	0	17
Distributor	16	43	43	0	14
Total	**100**	**68**	**17**	**3**	**12**

Breakdown of Indirect Channel Member Type Selling Each Product Category for Spain

	Total %	PCs %	Workstations/ Mid-range Systems %	Printers %	Software %	Office Equipment %	Communi-cations %
Dealer	22	89	39	89	94	17	83
Corporate Dealer	3	100	50	100	100	50	100
Retailer	7	80	20	100	80	100	60
Direct Response Company	7	80	40	100	80	80	80
VAP	37	92	69	92	96	8	88
Systems Integrator	8	17	67	100	83	0	17
Distributor	16	50	93	57	50	14	29
Total	**100**	**76**	**61**	**87**	**84**	**22**	**68**

Breakdown of Indirect Channel Members for Each Market by the Products Sold for Spain

	Total %	PCs %	Workstations/ Mid-range Systems %	Printers %	Software %	Office Equipment %	Communi-cations %
Home	18	79	29	86	82	37	68
SOHO	31	83	44	88	85	23	77
SME	34	87	43	92	91	23	81
Corporate	17	85	54	96	92	27	85
Total	**100**	**84**	**43**	**90**	**88**	**26**	**78**

Breakdown of Indirect Channel Member Size by the Product Categories Sold for Spain

	Total %	PCs %	Workstations/ Mid-range Systems %	Printers %	Software %	Office Equipment %	Communi-cations %
< 1.25 million ECU	68	85	46	90	87	23	79
1.25 - 4 million ECU	17	69	46	77	69	12	54
4 - 6.5 million ECU	3	100	50	100	100	29	100
> 6.5 million ECU	12	78	56	78	89	31	67
Total	**100**	**82**	**47**	**87**	**84**	**22**	**74**

Breakdown of the Indirect Channel Member Size by their Markets for Spain

	Total %	Home %	SOHO %	SME %	Corporate %
< 1.25 million ECU	68	37	65	75	31
1.25 - 4 million ECU	17	46	38	54	31
4 - 6.5 million ECU	3	50	100	50	100
> 6.5 million ECU	12	22	78	78	44
Total	**100**	**37**	**63**	**71**	**34**

	Total %	Home %	SOHO %	SME %	Corporate %
Dealer	30	49	85	88	28
Corporate Dealer	1	0	43	71	57
Retailer	5	71	92	82	14
Direct Response Company	15	38	76	85	32
VAP	45	15	74	88	33
Systems Integrator	2	16	79	84	37
Distributor	2	13	57	83	57
Total	**100**	**32**	**78**	**87**	**31**

Breakdown of Indirect Channel Members Participating in Each Market for the UK

	Total %	< 1.25 million ECU %	1.25 million – 4 million ECU %	4 million – 6.5 million ECU %	> 6.5 million ECU %
Dealer	30	50	28	10	12
Corporate Dealer	1	0	0	0	100
Retailer	5	59	20	10	10
Direct Response Company	15	42	29	12	17
VAP	45	48	32	8	13
Systems Integrator	2	53	21	21	5
Distributor	2	9	22	26	43
Total	**100**	**47**	**29**	**10**	**14**

Breakdown of Indirect Channel Member Type by Indirect Channel Member Size for the UK

	Total %	PCs %	Workstations/ Mid-range Systems %	Printers %	Software %	Office Equipment %	Communi-cations %
Dealer	30	82	24	95	96	36	85
Corporate Dealer	1	100	86	100	100	0	100
Retailer	5	88	14	98	96	53	61
Direct Response Company	15	77	30	88	96	25	80
VAP	45	76	52	86	100	8	82
Systems Integrator	2	63	53	84	100	0	74
Distributor	2	43	13	61	74	22	61
Total	**100**	**78**	**37**	**90**	**97**	**22**	**81**

Breakdown of Indirect Channel Member Type Selling Each Product Category for the UK

Breakdown of Indirect Channel Members for Each Market by the Products Sold for the UK

	Total %	PCs %	Workstations/ Mid-range Systems %	Printers %	Software %	Office Equipment %	Communi-cations %
Home	14	88	17	98	99	42	85
SOHO	34	79	33	91	97	25	81
SME	38	77	38	89	98	23	81
Corporate	14	72	47	85	96	17	80
Total	**100**	**79**	**34**	**90**	**98**	**25**	**82**

Breakdown of Indirect Channel Member Size by the Product Categories Sold for the UK

	Total %	PCs %	Workstations/ Mid-range Systems %	Printers %	Software %	Office Equipment %	Communi-cations %
< 1.25 million ECU	47	81	23	93	99	25	83
1.25 - 4 million ECU	29	77	47	87	97	24	77
4 - 6.5 million ECU	10	71	52	86	97	8	80
> 6.5 million ECU	14	75	53	86	92	20	83
Total	**100**	**78**	**37**	**90**	**97**	**22**	**81**

Breakdown of the Indirect Channel Member Size by their Markets for the UK

	Total %	Home %	SOHO %	SME %	Corporate %
< 1.25 million ECU	47	41	87	83	16
1.25 - 4 million ECU	29	29	80	91	30
4 - 6.5 million ECU	10	21	69	93	53
> 6.5 million ECU	14	17	55	86	65
Total	**100**	**32**	**78**	**87**	**31**

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 the end of November 1995.

In particular, figures for Germany have been based on the statistics provided by the German Information Technology Manufacturers Association within VDMA and ZVEI. Figures for Italy and Spain have been based on the statistics provided by 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 IT markets, within an international context, and the patterns of trade between them;
- the individual market structures with an eye on the competitive aspects, as well as comparative measures of IT penetration;
- the role of technological advancement in altering the underlying economics of IT.

Terms are defined at the end of the section.

2. Methodology

Government statistical bodies tend to model the world starting with the system of national accounts. Agreed classifications for industrial activity and trade thus become the measures against which markets are assessed. In many areas the restrictions imposed by such classifications and by the rigorous methods used to collect and process information are too great to make the resulting information useful to the business community. The IT market is a case in point, and the failure of the standard classifications to get to grips with the subject of software is a specific limitation.

This study is an attempt to shed light on some of the more important aspects of the European markets for telecommunications and information technology products (and services), including substantial elements of the associated market for office automation products.

The basis for the study is the marketplace. Thus, instead of defining the marketplace in terms of what is produced plus the balance of trade, the research is aimed at measuring the market. Valuation is based upon the revenues paid to primary vendors and research results are cross-checked against a continuous programme of end-user interviews and distribution channel monitoring. Data on trade flows has also been collected, and matched as closely as possible to market-oriented segmentation, since this 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 IT Market, to cast light onto the situation of the market's major players and the underlying competitive structures.

Given the extraordinary scope of this study in terms of subject matter and data sources, a degree of compromise is necessary in designing an appropriate methodology. The same principles apply to IDC's standard research into the IT industry. Because markets differ widely in structure and nature, and because consumers of

market research attach different values to various levels of data, a variety of methods are used to research different aspects of the IT landscape.

Thus, the overall methodology should be viewed not as a single simple entity, but rather as a complex product of an optimization process which reflects the value placed upon information by its consumers. To illustrate the composite nature of the methodology consider the contrasting markets for mainframe computers and PCs. Mainframes are generally sold by a direct sales force to the end-user organization without the intervention of channel intermediaries. As a result, this marketplace is sized by monitoring the revenues accruing to primary suppliers of mainframes and checked for consistency with end-user survey results. In the PC market, the heavy reliance on channel intermediaries means that to focus purely on primary suppliers' revenues understates the market size. As a result, measurements of the PC market rely upon units shipped at street price. The activities of value-added resellers and other distribution channels are also monitored to estimate end-user expenditure.

3. European ICT Markets and Patterns of Trade

For the purpose of this study, with an emphasis on the industry supplying goods and services in return for payment, we deal largely with the value of revenues paid to primary vendors for information technology goods and services. For an expanded discussion of the principles implicit within this study readers are referred to the section on definitions, which appears later in this volume.

All forecast data is prepared in local currencies and subsequently converted into constant 1994 ECU using the exchange rates listed at the end of the definitions section. 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 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.

In terms of geography, the presentation used here is based firmly upon market realities. As the rate of growth in information technology markets has reduced substantially, vendors have been encouraged to pursue opportunities in markets remote from their traditional operations. This is reflected in increased interest in the smaller EU markets, such as Greece, Ireland and Portugal, and further afield in Eastern Europe. As research continues into these markets and as the markets themselves develop, the level of detail at which information is meaningful will change. Until then, the basis of segmentation for some of these countries falls short of that used in the established markets.

Throughout the statistical section Eastern Europe is considered to refer to the Czech and Slovak Republics, Hungary, Poland and Russia. On January 1 1995, Austria, Finland and Sweden joined the European Union. The heading EU refers to Belgium and Luxembourg, Denmark, France, Germany, Greece, Italy, the Republic of Ireland, the Netherlands, Spain, Portugal, the UK and the three new members, including the data presented for 1993 and 1994. The sole exception to this definition of EU is Part 8 ICT Trade Flows where definitions of 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.

4. List of Tables

Page

Economic Growth. 1991-1997

1 Real GDP Growth 273
2 Nominal GDP Growth 273
3 Real Gross Private Non-residential Fixed Capital Formation Growth . . 274

Worldwide Markets

4 Worldwide IT Market Growth Trends at Constant Exchange Rates . 278
5 Worldwide TLC Market Growth Trends at Constant Exchange Rates . 278
6 Worldwide ICT Market Growth Trends at Constant Exchange Rates . 279
7 Worldwide IT Market Growth Trends at Current Exchange Rates . 279
8 Worldwide TLC Market Growth Trends at Current Exchange Rates . 280
9 Worldwide ICT Market Growth Trends at Current Exchange Rates . 280
10 ECU/$ and ECU/Yen Exchange Rates. 1992-1996. 281
11 Major Regional ICT Markets by Product. 1995 and 1997. 281
12 Major Regional ICT Markets by Product. % Average Annual Growth. 1995-1997 281

ICT and IT Market Value

13 ICT Market by Country 285
14 IT Market by Country 285
15 TLC Market by Country. 286
16 Austria 287
17 Belgium/Luxembourg 288
18 Denmark 289
19 Finland 290
20 France 291

Page

21 Germany 292
22 Greece 293
23 Ireland 294
24 Italy 295
25 Netherlands 296
26 Norway 297
27 Portugal 298
28 Spain 299
29 Sweden 300
30 Switzerland 301
31 UK 302
32 Czech & Slovak Republics 303
33 Hungary 304
34 Poland 305
35 Russia 306
36 EU 307
37 Western Europe 308
38 Eastern Europe 309

IT Hardware Shipments (Units)

39 Austria 310
40 Belgium/Luxembourg 310
41 Denmark 310
42 Finland 311
43 France 311
44 Germany 311
45 Greece 312
46 Ireland 312
47 Italy 312
48 Netherlands 313
49 Norway 313
50 Portugal 313

	Page
51 Spain	314
52 Sweden	314
53 Switzerland	314
54 UK	315
55 Czech & Slovak Republics	315
56 Hungary	315
57 Poland	316
58 Russia	316
59 EU	316
60 Western Europe	317
61 Eastern Europe	317
Production and Trade in ICT Hardware	
62 Production	318
63 Austria	319
64 Belgium/Luxembourg	319
65 Denmark	319
66 Finland	320
67 France	320
68 Germany	320
69 Greece	321
70 Ireland	321
71 Italy	321
72 Netherlands	322
73 Norway	322
74 Portugal	322
75 Spain	323
76 Sweden	323
77 Switzerland	323
78 UK	324
79 EU	324
80 USA	324
81 Japan	325
Market Structures and Penetration of ICT	
82 Austria	327
83 Belgium/Luxembourg	327
84 Denmark	327
85 Finland	328
86 France	328
87 Germany	328
88 Italy	329
89 Netherlands	329
90 Norway	329
91 Spain	330
92 Sweden	330
93 Switzerland	330
94 UK	331
95 Per Capita IT Expenditure	331
96 IT % GDP	331
97 Per Capita TLC Expenditure	332
98 TLC % GDP	332
99 Per Capita ICT Expenditure	332
100 ICT % GDP	332
Price Trends	
101 Evolution of Average selling Prices of PCs. US. 1991-1997	333
102 Evolution of Average selling Prices of PCs. Europe. 1991-1997	335

5. List of Figures

Page

Economic Background

1 Economic Developments in OECD Europe. 1980–1997 274

2 Economic Developments in Japan. 1980–1997. 275

3 Economic Developments in the USA. 1980–1997. 275

4 Growth of Gross Private Non-residential Fixed Capital Formation in OECD Europe, the USA and Japan. 1980–1997 276

5 Growth of Real Gross Domestic Product in OECD Europe, the USA and Japan. 1980–1997 276

Worldwide Markets

6 Worldwide ICT Market by Product. 1995 277

7 Western European IT Market. Growth Rates. 1988–1997 282

8 World Annual ICT Markets. Average Annual Growth. 1995–1997 . 282

9 World ICT Market. Regional Proportions by Product. 1995 283

10 World ICT Market. Product Proportions by Region. 1995 . 283

11 European IT Market by Region, 1995 and Market Growth, 1995–1997. . . . 284

12 Western European ICT Market. Proportions by Class of Business, 1995 and Market Growth, 1995–1997 . 284

Page

Price Trends

13 Evolution of Average Selling Prices for PCs. US. 1991–1997 333

14 Convergence of Average Selling Prices for 386SX PCs (US versus Europe). 1991–1997 . . 334

15 Convergence of Average Selling Prices for 486DX PCs (US versus Europe). 1991–1997 . . 334

16 Evolution of Average Selling Prices for PCs. Europe. 1991–1997. . . . 335

17 Evolution of PC NIC Average Selling Price. Worldwide. 1992–1999 . 336

18 Hard Disk Drive Price Dynamics . . 336

6. Economic Background

Table 1
Real GDP Growth
in %, 1991–1997

	1991	1992	1993	1994	1995	1996	1997
Austria	2.9	1.8	-0.1	2.7	2.3	2.0	2.3
Belgium	2.2	1.8	-1.6	2.2	2.1	2.2	2.6
Denmark	1.3	0.8	1.4	4.5	3.3	3.0	2.4
Finland	-7.1	-3.6	-1.2	4.0	4.8	3.3	3.0
France	0.8	1.3	-1.5	2.9	2.7	2.2	2.7
Germany	5.0	2.2	-1.2	2.9	2.1	2.4	2.7
Greece	3.2	0.8	-0.5	1.5	1.9	2.3	2.5
Ireland	2.2	3.9	3.1	6.7	6.5	5.5	5.0
Italy	1.2	0.7	-1.2	2.2	3.1	2.7	2.5
The Netherlands	2.3	2.0	0.2	2.7	3.0	2.5	2.9
Norway	2.9	3.4	2.1	5.7	4.5	4.0	2.4
Portugal	2.1	1.1	-1.2	0.9	2.6	3.2	3.0
Spain	2.2	0.7	-1.1	2.0	3.2	2.9	3.1
Sweden	-1.1	-1.4	-2.6	2.2	3.5	2.5	2.0
Switzerland	0.0	-0.3	-0.8	1.2	1.2	1.5	1.8
United Kingdom	-2.0	-0.5	2.3	3.8	2.7	2.4	2.7
Western Europe	1.5	1.2	-0.2	2.4	2.9	2.6	2.7
USA	-0.6	2.3	3.1	4.1	3.3	2.7	2.8
Japan	4.3	1.1	-0.2	0.5	0.3	2.0	2.7

Source: OECD December 1995

Table 2
Nominal GDP Growth
in %, 1991–1997

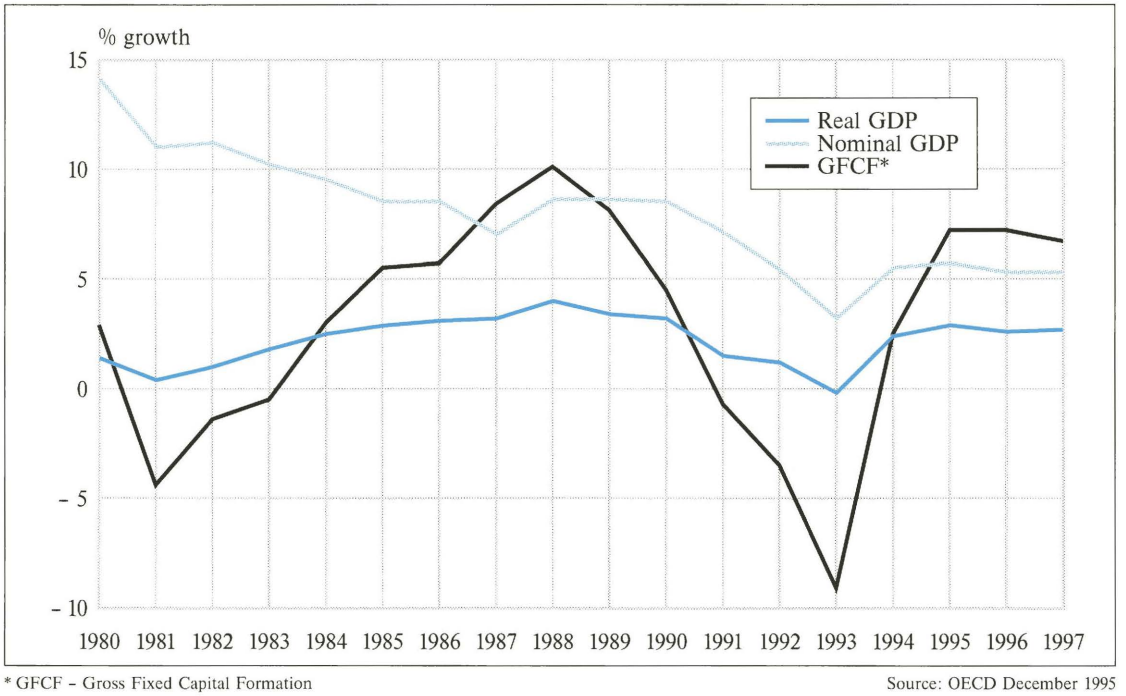
	1991	1992	1993	1994	1995	1996	1997
Austria	7.1	6.1	3.5	6.0	4.8	4.5	4.7
Belgium	4.9	5.4	2.4	4.9	4.1	4.5	4.8
Denmark	3.6	2.8	2.6	6.8	5.2	5.6	5.6
Finland	-4.8	-2.9	1.2	5.3	7.9	5.6	5.6
France	4.1	3.5	1.0	4.2	4.8	4.3	4.7
Germany	9.1	7.8	2.6	5.2	4.5	4.5	4.8
Greece	22.6	15.0	12.9	12.4	11.6	10.0	9.1
Ireland	3.9	6.0	7.3	8.0	7.9	6.6	6.4
Italy	8.9	5.2	3.1	5.9	8.3	7.2	6.3
The Netherlands	5.0	4.3	2.3	5.1	4.7	3.8	4.6
Norway	5.7	3.0	4.7	6.0	7.5	6.6	5.2
Portugal	16.7	14.5	6.3	6.1	7.1	7.0	6.8
Spain	9.5	7.5	3.2	6.2	7.6	6.5	6.3
Sweden	6.4	-0.4	0.0	5.2	7.5	5.3	5.2
Switzerland	5.4	2.3	1.2	2.6	2.8	2.5	3.3
UK	4.4	3.8	5.6	6.1	4.6	5.0	5.1
Western Europe	7.1	5.4	3.1	5.5	5.7	5.3	5.3
USA	3.2	5.2	5.4	6.2	5.0	4.5	4.7
Japan	6.3	2.6	0.6	0.7	-0.5	1.5	3.0

Source: OECD December 1995

	1991	1992	1993	1994	1995	1996	1997
Austria	5.1	- 2.6	- 6.5	6.9	5.6	5.7	5.8
Belgium	- 2.7	- 4.5	- 8.8	- 0.8	8.6	7.4	3.7
Denmark	- 4.5	-11.2	- 2.8	2.6	18.3	9.5	5.0
Finland	-24.3	-21.3	-22.6	1.8	25.7	21.4	12.3
France	0.4	- 4.6	- 7.1	0.6	4.8	5.7	6.3
Germany	7.5	0.0	-10.0	0.7	3.2	5.5	7.1
Greece	- 6.8	3.2	0.4	5.0	9.0	11.5	10.0
Ireland	-11.9	- 8.3	- 1.4	9.7	13.6	11.7	6.8
Italy	- 0.3	- 1.1	-18.4	3.7	9.1	9.0	7.8
Netherlands	2.0	- 3.0	- 4.2	0.5	8.7	2.8	5.1
Norway	2.9	- 3.4	5.2	3.9	15.2	5.8	1.2
Portugal	2.4	5.4	- 4.8	3.5	7.5	8.0	7.5
Spain	2.0	- 1.4	-15.2	3.0	10.9	9.0	7.5
Sweden	-15.2	-15.5	-14.3	17.4	25.0	10.0	5.0
Switzerland	- 3.6	- 8.5	- 5.3	8.7	9.9	6.0	4.7
UK	- 9.5	- 6.2	- 0.6	2.2	3.8	6.8	6.2
Western Europe	- 0.6	- 3.4	- 9.1	2.5	7.1	7.1	6.7
USA	- 5.7	2.0	12.5	13.7	14.5	7.0	4.9
Japan	6.6	- 4.7	- 9.3	- 8.8	2.2	3.4	5.4

Source: OECD December 1995

Table 3
Real Gross Private Non-residential Fixed Capital Formation (Growth in %), 1991–1997

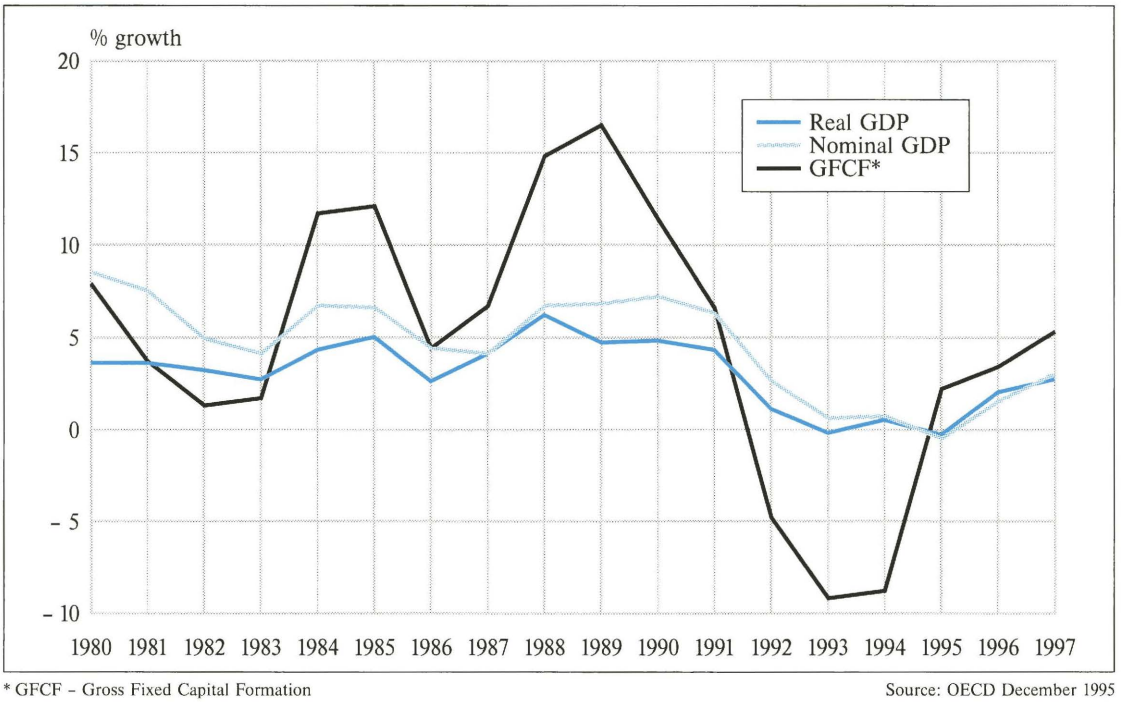


* GFCF - Gross Fixed Capital Formation

Source: OECD December 1995

Figure 1
Economic Developments in OECD Europe, 1980–1997

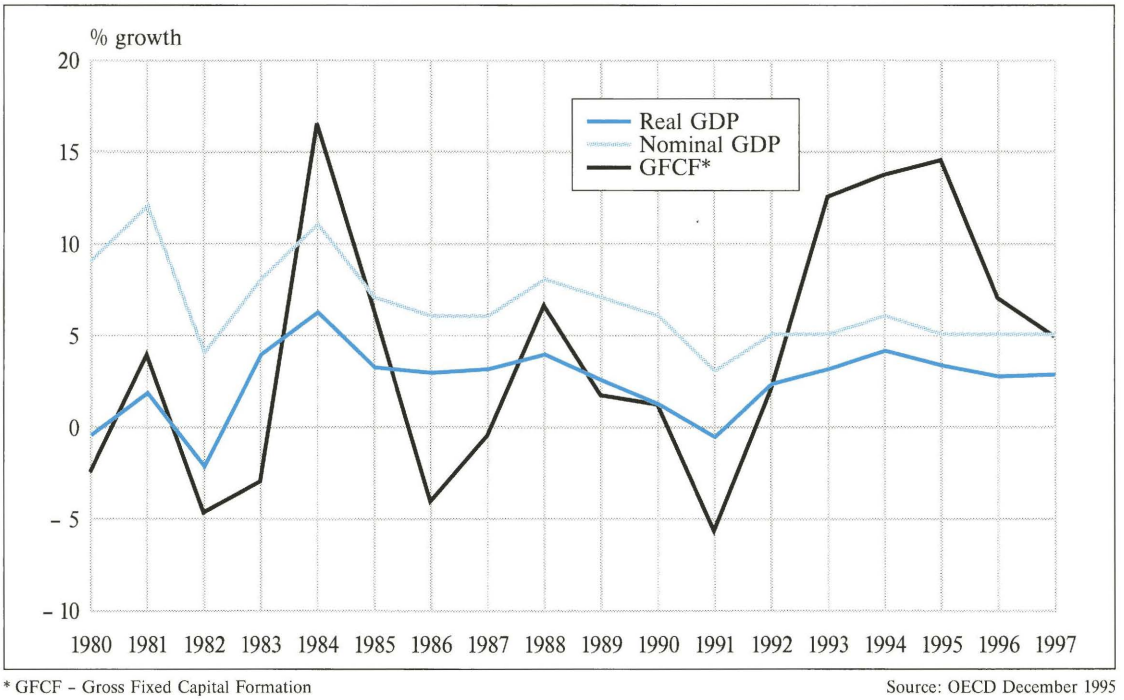
Figure 2
Economic Developments in Japan, 1980–1997



* GFCF - Gross Fixed Capital Formation

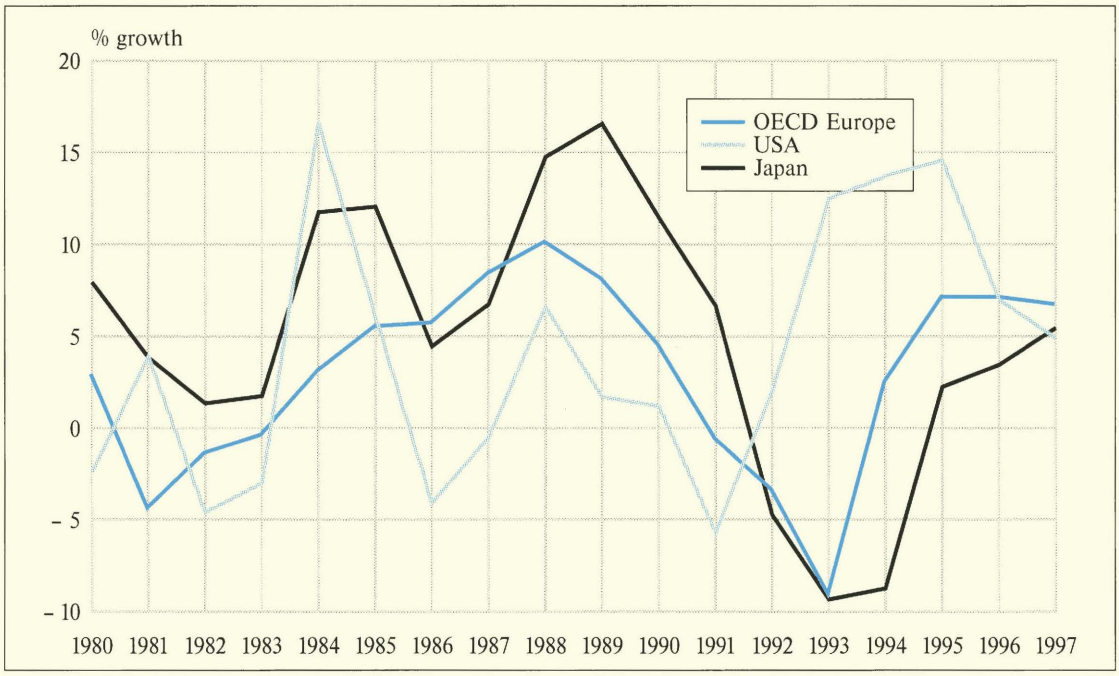
Source: OECD December 1995

Figure 3
Economic Developments in the USA, 1980–1997



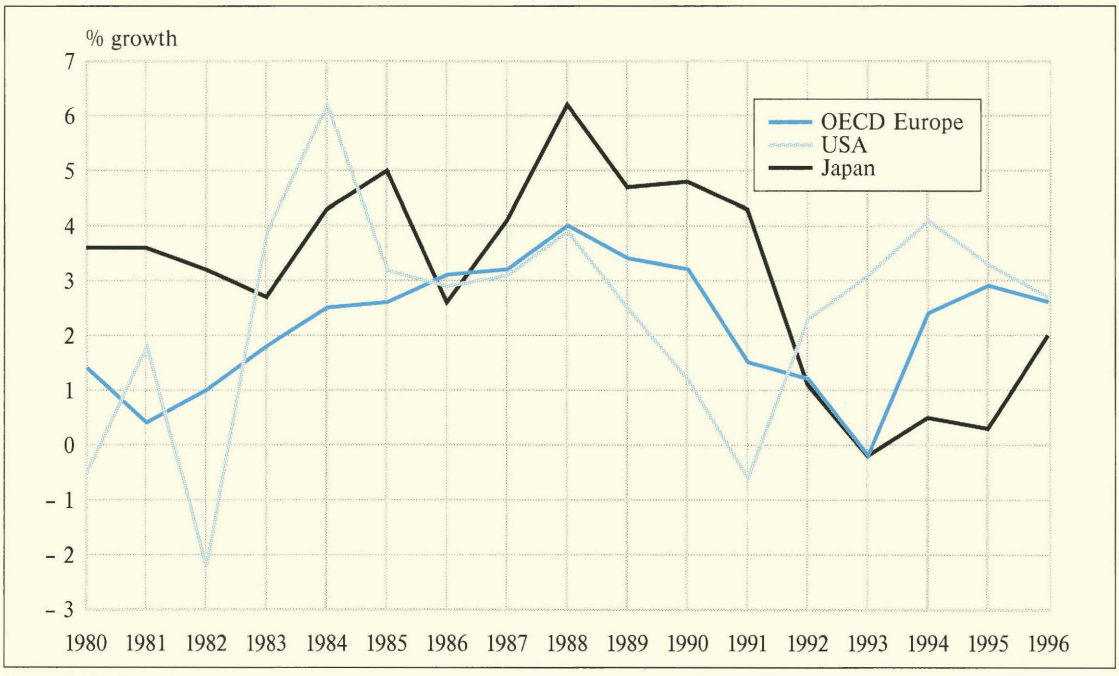
* GFCF - Gross Fixed Capital Formation

Source: OECD December 1995



Source: OECD December 1995

Figure 4
Growth of Gross Private Non-residential Fixed Capital Formation in OECD Europe, the USA and Japan, 1980–1997

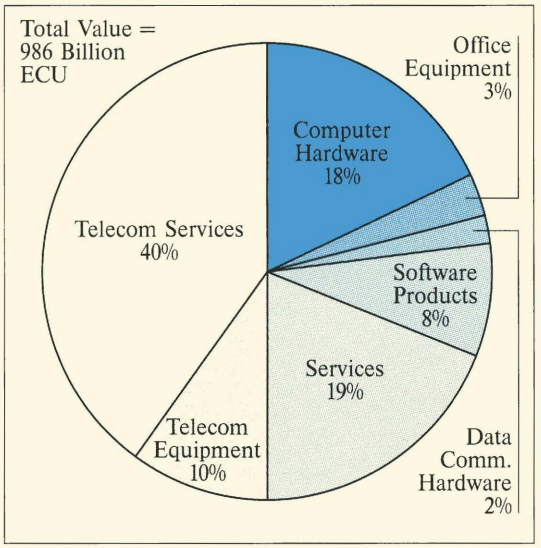


Source: OECD December 1995

Figure 5
Growth of Real Gross Domestic Product in OECD Europe, the USA and Japan, 1980–1997

7. International ICT Markets

Figure 6
Worldwide ICT Market by Product, 1995



Source: EITO

Million ECU	1993	1994	1995	1996	1997
Europe (incl. Eastern Europe)	128,473	136,014	146,613	157,247	167,623
US	161,040	177,120	197,289	216,648	237,092
Japan	67,365	70,530	74,600	77,914	82,684
Rest of World	48,581	55,706	64,463	74,233	87,164
Total	**405,459**	**439,370**	**482,966**	**526,041**	**574,563**
	% growth				
Europe (incl. Eastern Europe)	2.5	5.9	7.8	7.3	6.6
US	7.9	10.0	11.4	9.8	9.4
Japan	-6.1	4.7	5.8	4.4	6.1
Rest of World	15.1	14.7	15.7	15.2	17.4
Total	**4.1**	**8.4**	**9.9**	**8.9**	**9.2**
	% breakdown				
Europe (incl. Eastern Europe)	31.7	31.0	30.4	29.9	29.2
US	39.7	40.3	40.8	41.2	41.3
Japan	16.6	16.1	15.4	14.8	14.4
Rest of World	12.0	12.7	13.3	14.1	15.2
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 4
Worldwide IT Market Growth Trends. Market Value. Million ECU at Constant 1994 Exchange Rates

Million ECU	1993	1994	1995	1996	1997
Europe (incl. Eastern Europe)	142,872	155,262	168,795	185,272	205,666
US	135,059	137,395	140,043	143,036	145,528
Japan	59,951	63,811	66,142	72,157	75,716
Rest of World	109,374	118,194	127,756	138,126	149,372
Total	**447,256**	**474,661**	**502,736**	**538,591**	**576,282**
	% growth				
Europe (incl. Eastern Europe)	5.2	8.7	8.7	9.8	11.0
US	1.5	1.7	1.9	2.1	1.7
Japan	6.4	6.4	3.7	9.1	4.9
Rest of World	4.0	8.1	8.1	8.1	8.1
Total	**4.0**	**6.1**	**5.9**	**7.1**	**7.0**
	% breakdown				
Europe (incl. Eastern Europe)	31.9	32.7	33.6	34.4	35.7
US	30.2	28.9	27.9	26.6	25.3
Japan	13.4	13.4	13.2	13.4	13.1
Rest of World	24.5	24.9	25.4	25.6	25.9
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 5
Worldwide TLC Market Growth Trends. Market Value. Million ECU at Constant 1994 Exchange Rates

Table 6
Worldwide ICT Market Growth Trends. Market Value. Million ECU at Constant 1994 Exchange Rates

Million ECU	1993	1994	1995	1996	1997
Europe (incl. Eastern Europe)	271,345	291,276	315,408	342,519	373,290
US	296,099	314,515	337,332	359,684	382,620
Japan	127,317	134,340	140,742	150,070	158,400
Rest of World	157,955	173,899	192,220	212,358	236,536
Total	**852,715**	**914,030**	**985,702**	**1,064,632**	**1,150,845**
	% growth				
Europe (incl. Eastern Europe)	3.9	7.3	8.3	8.6	9.0
US	4.9	6.2	7.3	6.6	6.4
Japan	-0.1	5.5	4.8	6.6	5.6
Rest of World	6.6	10.1	10.5	10.5	11.4
Total	**4.1**	**7.2**	**7.8**	**8.0**	**8.1**
	% breakdown				
Europe (incl. Eastern Europe)	31.8	31.9	32.0	32.2	32.4
US	34.7	34.4	34.2	33.8	33.2
Japan	14.9	14.7	14.3	14.1	13.8
Rest of World	18.5	19.0	19.5	19.9	20.6
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 7
Worldwide IT Market Growth Trends. Market Value. Million ECU at Current Exchange Rates

Million ECU	1993	1994	1995	1996	1997
Europe (incl. Eastern Europe)	128,472	136,014	146,613	157,247	167,623
US	162,160	177,120	179,217	193,843	212,135
Japan	61,951	70,530	72,194	67,751	71,899
Rest of World	48,348	55,706	58,558	66,419	77,989
Total	**400,932**	**439,370**	**456,582**	**485,260**	**529,646**
	% growth				
Europe (incl. Eastern Europe)	2.5	5.9	7.8	7.3	6.6
US	19.7	9.2	1.2	8.2	9.4
Japan	18.6	13.8	2.4	-6.2	6.1
Rest of World	19.8	15.2	5.1	13.4	17.4
Total	**13.4**	**9.6**	**3.9**	**6.3**	**9.1**
	% breakdown				
Europe (incl. Eastern Europe)	32.0	31.0	32.1	32.4	31.6
US	40.4	40.3	39.3	39.9	40.1
Japan	15.5	16.1	15.8	14.0	13.6
Rest of World	12.1	12.7	12.8	13.7	14.7
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Million ECU	1993	1994	1995	1996	1997
Europe (incl. Eastern Europe)	142,872	155,262	168,795	185,272	205,666
US	137,327	137,395	127,214	127,980	130,209
Japan	55,026	63,811	64,008	62,745	65,840
Rest of World	110,520	118,194	116,053	123,586	133,648
Total	**445,745**	**474,661**	**476,071**	**499,583**	**535,364**
	% growth				
Europe (incl. Eastern Europe)	5.2	8.7	8.7	9.8	11.0
US	12.6	0.0	-7.4	0.6	1.7
Japan	34.5	16.0	0.3	-2.0	4.9
Rest of World	7.6	6.9	-1.8	6.5	8.1
Total	**11.6**	**6.5**	**0.3**	**4.9**	**7.2**
	% breakdown				
Europe (incl. Eastern Europe)	32.1	32.7	35.5	37.1	38.4
US	30.8	28.9	26.7	25.6	24.3
Japan	12.3	13.4	13.4	12.6	12.3
Rest of World	24.8	24.9	24.4	24.7	25.0
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 8
Worldwide TLC Market Growth Trends. Market Value. Million ECU at Current Exchange Rates

Million ECU	1993	1994	1995	1996	1997
Europe (incl. Eastern Europe)	271,345	291,276	315,408	342,519	373,290
US	299,487	314,515	306,431	321,823	342,344
Japan	116,977	134,340	136,202	130,496	137,739
Rest of World	158,868	173,900	174,612	190,005	211,637
Total	**846,676**	**914,031**	**932,653**	**984,843**	**1,065,010**
	% growth				
Europe (incl. Eastern Europe)	3.9	7.3	8.3	8.6	9.0
US	16.3	5.0	-2.6	5.0	6.4
Japan	26.3	14.8	1.4	-4.2	5.6
Rest of World	10.5	9.5	0.4	8.8	11.4
Total	**12.4**	**8.0**	**2.0**	**5.6**	**8.1**
	% breakdown				
Europe (incl. Eastern Europe)	32.0	31.9	33.8	34.8	35.1
US	35.4	34.4	32.9	32.7	32.1
Japan	13.8	14.7	14.6	13.3	12.9
Rest of World	18.8	19.0	18.7	19.3	19.9
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 9
Worldwide ICT Market Growth Trends. Market Value. Million ECU at Current Exchange Rates

Table 10
ECU Exchange Rates 1992–1996

	1992	1993	1994	1995	1996
$	1.29	1.17	1.19	1.31	1.33
Yen	164	130	121	124	138

Source: OECD

Table 11
Major Regional ICT Markets by Product, 1995 and 1997. Million ECU at Constant 1994 Exchange Rates

1995	Western Europe	Eastern Europe	US	Japan	Rest of World	World
IT Hardware	62,396	3,204	88,088	36,548	30,014	220,249
Software	29,239	556	36,674	7,646	5,648	79,763
IT Services	50,286	933	72,527	30,407	28,801	182,954
Telecom Equipment	30,621	2,165	27,372	13,306	28,217	101,680
Telecom Services	131,614	4,395	112,671	52,836	99,539	401,056
Total	**304,155**	**11,253**	**337,332**	**140,742**	**192,220**	**985,702**
1997	Western Europe	Eastern Europe	US	Japan	Rest of World	World
IT Hardware	71,428	3,930	101,894	42,183	38,977	258,412
Software	34,894	696	48,527	7,898	10,966	102,980
IT Services	55,525	1,151	86,671	32,603	37,222	213,171
Telecom Equipment	32,142	2,577	28,688	13,502	31,109	108,018
Telecom Services	165,714	5,233	116,840	62,214	118,263	468,264
Total	**359,703**	**13,586**	**382,620**	**158,400**	**236,536**	**1,150,845**

Table 12
Major Regional ICT Markets by Product. % Average Annual Growth by Value, 1995–1997

	Western Europe	Eastern Europe	US	Japan	Rest of World	World
IT Hardware	7.0	10.8	7.6	7.4	14.0	8.3
Software	9.2	11.9	15.0	2.1	39.4	13.6
IT Services	5.1	11.0	9.3	3.5	13.7	7.9
IT	7.0	10.9	9.6	5.3	16.3	9.1
Telecom Equipment	2.5	9.1	2.4	0.7	5.0	3.1
Telecom Services	12.2	9.1	1.8	8.5	9.0	8.1
Telecom	10.4	9.1	1.9	7.0	8.1	7.1
Total	**8.7**	**9.9**	**6.5**	**6.1**	**10.9**	**8.1**

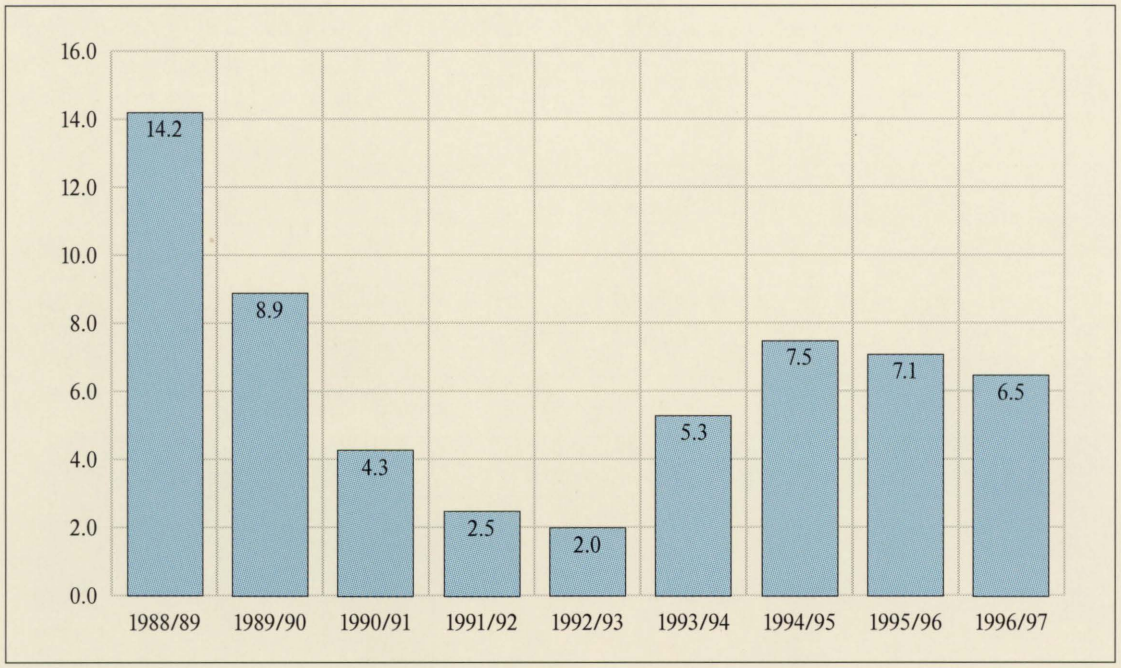


Figure 7
Western European IT Market Growth Rates in %, 1988–1997

Source: EITO

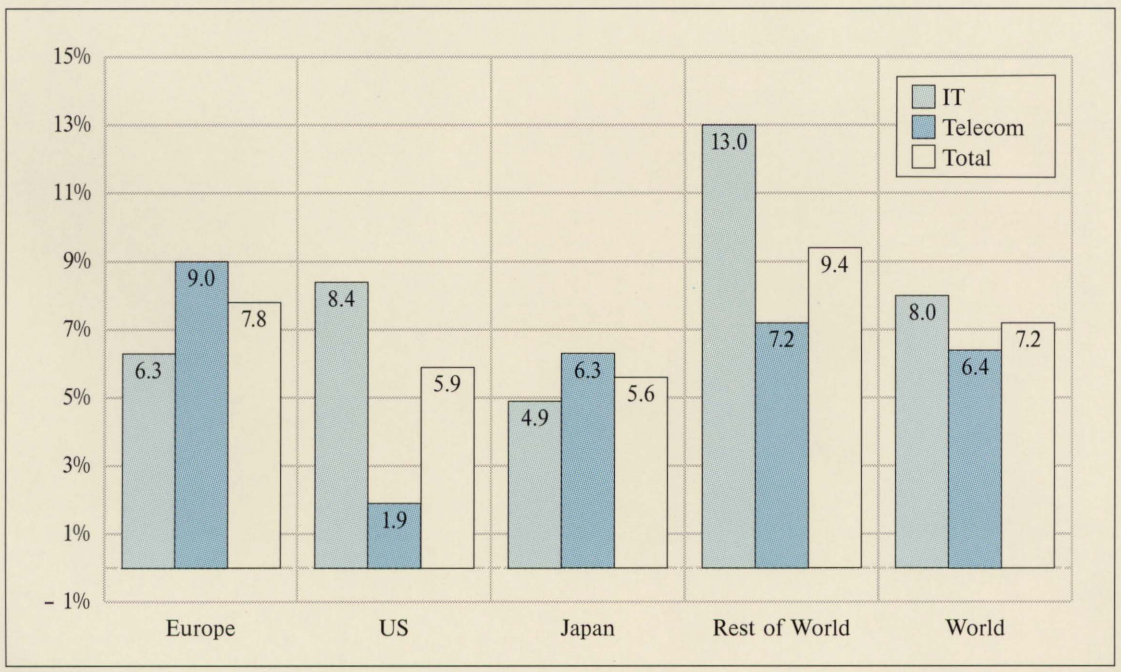
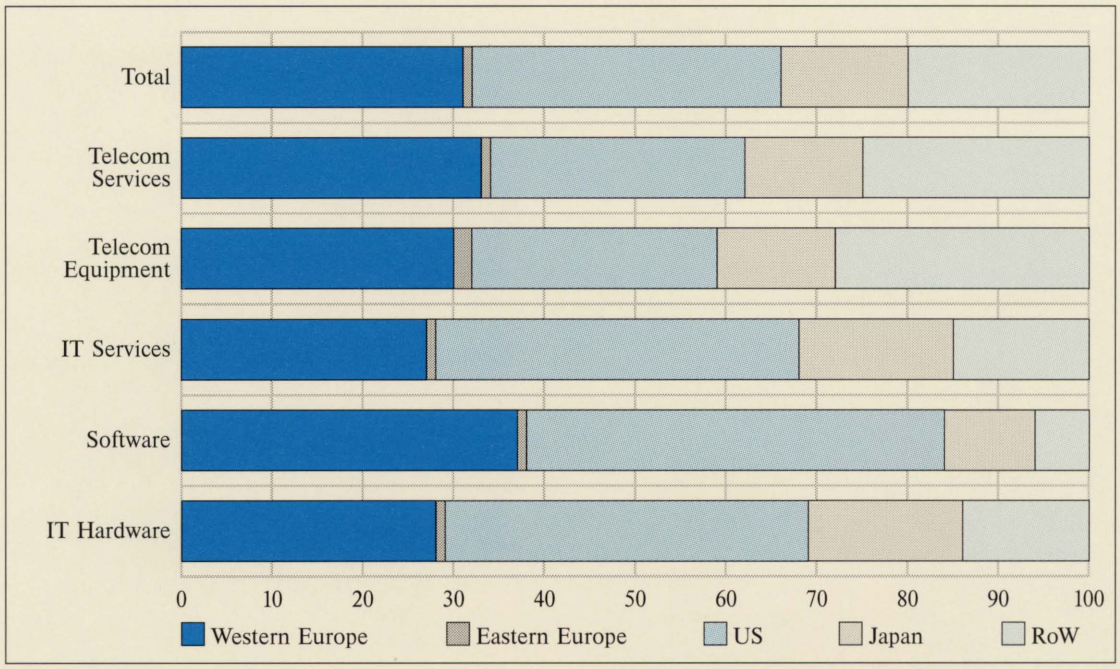


Figure 8
World Annual ICT Markets Average Annual Growth in %, 1995–1997

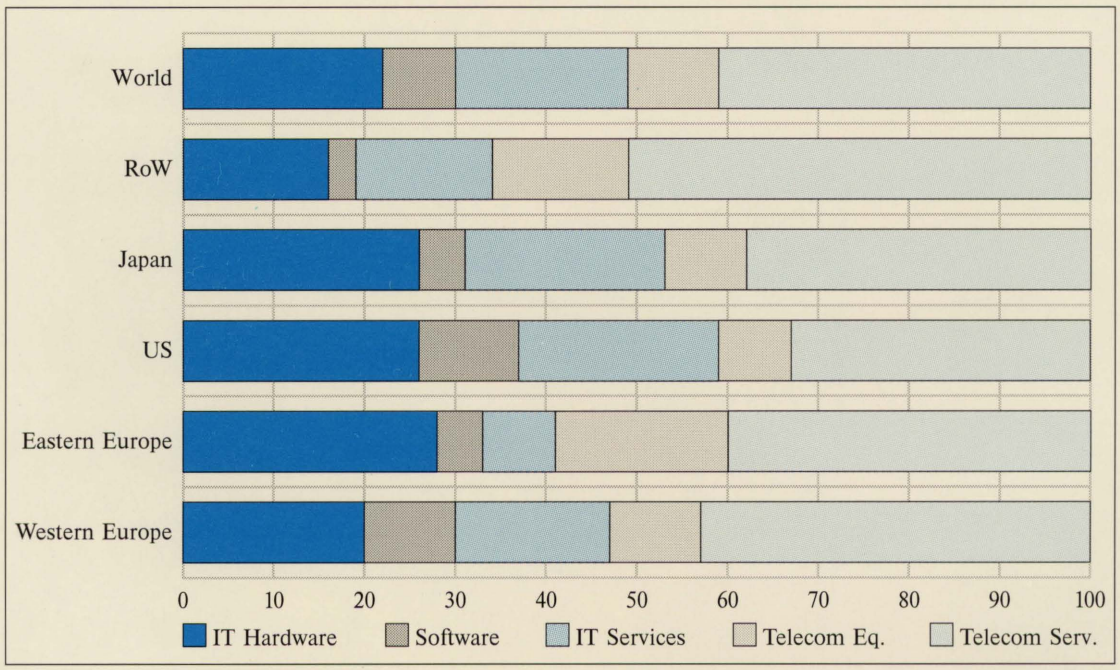
Source: EITO

Figure 9
World ICT Market
Regional Proportions
by Product in %, 1995



Source: EITO

Figure 10
World ICT Market
Product Proportions
by Region in %, 1995



Source: EITO

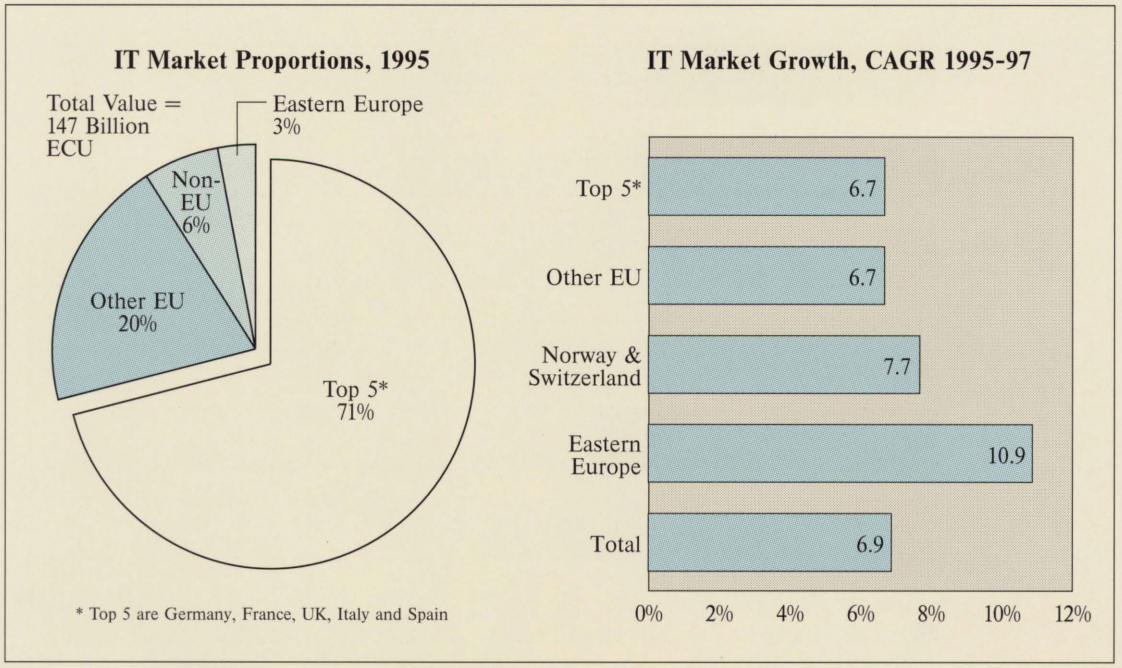


Figure 11
European IT Market by Region, 1995 and Market Growth, 1995–1997

Source: EITO

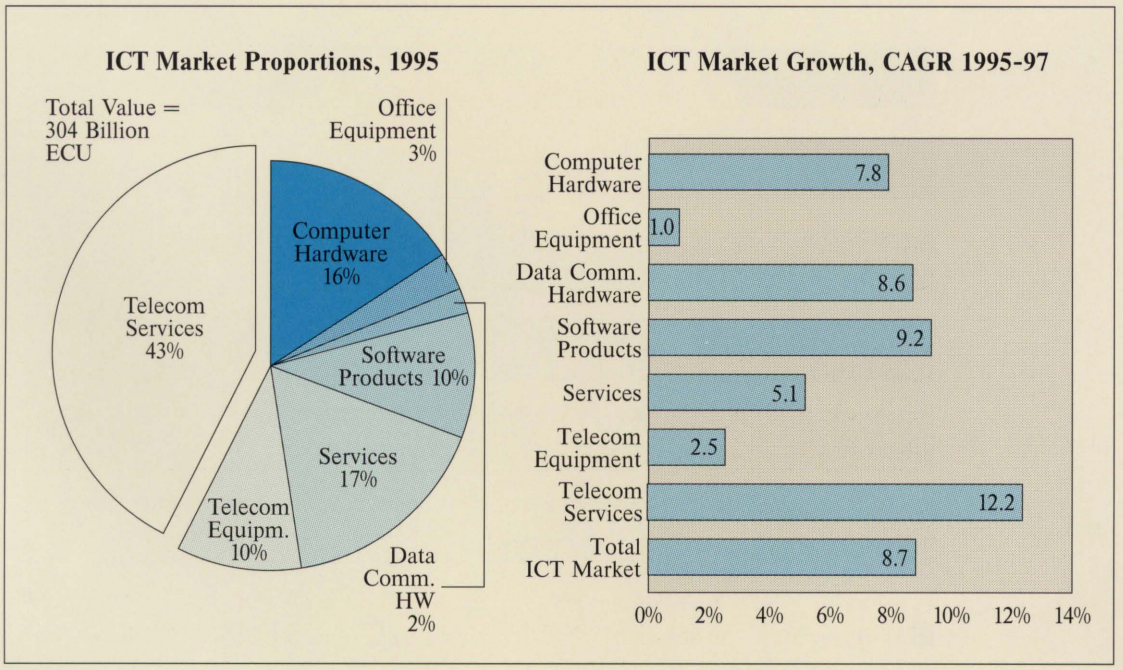


Figure 12
Western European ICT Market Proportions by Class of Business, 1995 and Market Growth, 1995–1997

Source: EITO

Table 13
ICT Market
by Country
(Million ECU)

	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Austria	5,940	6,452	6,843	7,480	8,232	8.6	6.1	9.3	10.0
Belgium/Luxembourg	7,716	8,119	8,748	9,686	10,707	5.2	7.7	10.7	10.5
Denmark	5,280	5,685	6,109	6,477	6,752	7.7	7.5	6.0	4.2
Finland	3,467	3,675	3,956	4,163	4,344	6.0	7.6	5.2	4.4
France	44,034	46,915	50,567	55,735	62,729	6.5	7.8	10.2	12.5
Germany	72,009	76,719	83,043	89,888	96,655	6.5	8.2	8.2	7.5
Greece	2,054	2,326	2,615	2,946	3,322	13.2	12.4	12.7	12.8
Ireland	1,921	2,017	2,137	2,300	2,459	5.0	5.9	7.6	6.9
Italy	26,026	27,621	29,712	31,954	34,424	6.1	7.6	7.5	7.7
Netherlands	13,030	13,783	15,416	16,726	18,440	5.8	11.8	8.5	10.2
Norway	4,730	5,080	5,395	5,661	5,973	7.4	6.2	4.9	5.5
Portugal	2,890	3,190	3,540	3,928	4,290	10.4	11.0	10.9	9.2
Spain	11,579	12,669	13,698	15,097	16,947	9.4	8.1	10.2	12.3
Sweden	8,865	9,605	10,525	11,135	11,649	8.3	9.6	5.8	4.6
Switzerland	11,770	12,787	13,808	15,086	16,503	8.6	8.0	9.3	9.4
UK	41,388	44,595	48,044	51,828	56,277	7.7	7.7	7.9	8.6
Western Europe	262,700	281,238	304,155	330,092	359,703	7.1	8.1	8.5	9.0

Table 14
IT Market
by Country
(Million ECU)

	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Austria	2,681	2,867	3,151	3,477	3,774	7.0	9.9	10.4	8.5
Belgium/Luxembourg	4,125	4,306	4,468	4,613	4,783	4.4	3.8	3.2	3.7
Denmark	2,984	3,243	3,540	3,786	3,948	8.7	9.2	6.9	4.3
Finland	1,710	1,821	2,036	2,182	2,291	6.5	11.8	7.2	5.0
France	21,896	22,514	23,730	25,255	26,865	2.8	5.4	6.4	6.4
Germany	35,353	37,305	40,079	42,906	45,514	5.5	7.4	7.1	6.1
Greece	451	495	553	619	707	9.8	11.7	11.9	14.4
Ireland	688	725	772	816	859	5.3	6.5	5.7	5.4
Italy	11,402	11,641	12,221	13,019	13,978	2.1	5.0	6.5	7.4
Netherlands	6,794	7,345	8,032	8,711	9,421	8.1	9.3	8.5	8.2
Norway	2,351	2,511	2,748	2,906	3,097	6.8	9.4	5.8	6.5
Portugal	778	810	861	922	987	4.1	6.3	7.2	7.0
Spain	4,718	4,773	5,127	5,573	6,048	1.2	7.4	8.7	8.5
Sweden	4,260	4,607	5,189	5,533	5,796	8.2	12.6	6.6	4.8
Switzerland	5,532	5,895	6,392	6,963	7,496	6.6	8.4	8.9	7.7
UK	19,681	21,143	23,023	24,723	26,282	7.4	8.9	7.4	6.3
Western Europe	125,403	132,001	141,920	152,005	161,847	5.3	7.5	7.1	6.5

	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Austria	3,259	3,585	3,693	4,003	4,458	10.0	3.0	8.4	11.4
Belgium/Luxembourg	3,591	3,813	4,279	5,073	5,924	6.2	12.2	18.5	16.8
Denmark	2,296	2,442	2,569	2,692	2,804	6.4	5.2	4.8	4.2
Finland	1,757	1,853	1,919	1,980	2,054	5.5	3.6	3.2	3.7
France	22,138	24,401	26,837	30,481	35,863	10.2	10.0	13.6	17.7
Germany	36,656	39,414	42,964	46,982	51,141	7.5	9.0	9.4	8.9
Greece	1,603	1,831	2,062	2,327	2,615	14.2	12.6	12.9	12.4
Ireland	1,233	1,292	1,365	1,484	1,600	4.8	5.6	8.7	7.8
Italy	14,624	15,979	17,492	18,935	20,445	9.3	9.5	8.3	8.0
Netherlands	6,236	6,438	7,384	8,015	9,019	3.2	14.7	8.5	12.5
Norway	2,380	2,569	2,647	2,755	2,877	7.9	3.0	4.1	4.4
Portugal	2,112	2,381	2,680	3,005	3,303	12.7	12.6	12.1	9.9
Spain	6,861	7,896	8,571	9,525	10,900	15.1	8.5	11.1	14.4
Sweden	4,606	4,998	5,336	5,602	5,853	8.5	6.8	5.0	4.5
Switzerland	6,238	6,892	7,416	8,123	9,006	10.5	7.6	9.5	10.9
UK	21,707	23,452	25,021	27,105	29,994	8.0	6.7	8.3	10.7
Western Europe	137,298	149,236	162,235	178,087	197,856	8.7	8.7	9.8	11.1

Table 15
TLC Market by Country
(Million ECU)

Table 16
Austria
ICT Market Value
(Million ECU)

Austria	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	141	134	121	120	113	- 5.2	- 9.9	- 1.0	- 5.7
Medium	129	123	127	130	133	- 4.2	2.7	2.5	2.6
Small	180	151	154	158	164	-16,5	2.5	2.2	4.4
Workstations	44	42	48	52	55	- 5.0	13.2	9.0	6.5
PCs - portable	80	104	134	176	194	31.3	28.8	30.5	10.8
PCs - desktop	315	410	486	559	617	30.0	18.6	15.0	10.3
PC printers	85	99	119	139	156	16.0	21.1	16.8	11.8
Computer hardware	**974**	**1,063**	**1,189**	**1,333**	**1,433**	**9.1**	**11.9**	**12.1**	**7.5**
Copiers	67	67	66	67	68	- 0.8	- 0.5	0.2	2.7
Other office equipment	72	70	70	71	71	- 3.1	- 0.6	2.1	0.4
Office equipment	**140**	**137**	**136**	**138**	**140**	**- 2.0**	**- 0.6**	**1.2**	**1.5**
LAN hardware	39	40	56	70	73	3.2	38.1	25.0	5.4
Other data communications	23	25	24	25	25	11.9	- 4.3	3.8	- 1.3
Data communications hardware	**62**	**66**	**80**	**95**	**98**	**6.4**	**21.8**	**18.6**	**3.6**
IT hardware	**1,176**	**1,265**	**1,405**	**1,565**	**1,671**	**7.6**	**11.1**	**11.4**	**6.7**
Systems software	258	293	338	392	455	13.7	15.4	15.8	16.1
Application software	234	275	322	377	441	17.3	17.2	17.0	16.9
Software products	**492**	**568**	**661**	**769**	**896**	**15.5**	**16.3**	**16.4**	**16.5**
Professional services	428	454	488	522	556	6.1	7.4	6.9	6.6
Processing services	174	175	179	183	186	0.5	2.3	2.1	1.5
Network services	27	30	35	38	42	7.6	17.7	10.3	9.2
HW maintenance & support services	382	374	383	400	423	- 2.1	2.3	4.5	5.8
Services	**1,013**	**1,034**	**1,085**	**1,143**	**1,207**	**2.1**	**5.0**	**5.3**	**5.6**
Software and services	**1,505**	**1,602**	**1,746**	**1,912**	**2,103**	**6.4**	**9.0**	**9.5**	**10.0**
Total IT market	**2,681**	**2,867**	**3,151**	**3,477**	**3,774**	**7.0**	**9.9**	**10.4**	**8.5**
Switching	216	214	205	206	202	- 1.2	- 3.8	0.5	- 2.0
Transmission	175	185	192	191	191	6.2	3.4	- 0.4	0.2
Mobile communications infrastructure	158	58	177	177	192	-63.5	206.9	0.0	8.5
Public network equipment	**548**	**457**	**574**	**574**	**586**	**-16.7**	**25.7**	**0.0**	**2.0**
PABX & key systems	45	44	42	41	39	- 2.1	- 3.5	- 3.7	- 3.8
Telephone sets	109	116	126	137	148	6.8	8.0	9.0	8.1
Mobile terminal equipment	24	24	25	27	29	0.8	0.8	9.6	6.4
Other terminal equipment	65	69	73	81	99	6.3	6.3	10.8	21.6
Private network equipment	**243**	**253**	**266**	**286**	**314**	**4.4**	**4.8**	**7.6**	**10.1**
Telecom equipment	**791**	**710**	**839**	**860**	**900**	**-10.2**	**18.2**	**2.4**	**4.7**
Telephone services	1,893	2,213	2,087	2,191	2,322	17.0	- 5.7	5.0	6.0
Mobile telephone services	114	134	157	195	238	16.9	17.6	24.1	22.0
Switched data and leased line services	371	418	472	538	614	12.6	12.9	14.0	14.1
CaTV services	90	110	138	220	385	22.2	25.0	60.0	75.0
Telecom services	**2,468**	**2,875**	**2,853**	**3,143**	**3,558**	**16.5**	**- 0.8**	**10.2**	**13.2**
Total telecom	**3,259**	**3,585**	**3,693**	**4,003**	**4,458**	**10.0**	**3.0**	**8.4**	**11.4**
Total ICT	**5,940**	**6,452**	**6,843**	**7,480**	**8,232**	**8.6**	**6.1**	**9.3**	**10.0**

Belgium/Luxembourg	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	237	234	213	195	188	- 1.3	- 8.6	- 8.7	- 3.6
Medium	150	143	150	150	151	- 4.7	4.8	0.2	0.8
Small	164	181	180	179	181	10.2	- 0.7	- 0.5	1.3
Workstations	61	71	78	84	89	17.5	9.5	6.9	6.4
PCs - portable	101	123	143	164	195	21.1	17.0	14.3	18.9
PCs - desktop	407	441	476	456	455	8.3	8.1	- 4.4	- 0.2
PC printers	113	115	127	140	150	2.1	10.9	9.6	7.3
Computer hardware	**1,233**	**1,307**	**1,368**	**1,367**	**1,409**	**6.0**	**4.7**	**- 0.1**	**3.1**
Copiers	121	120	123	128	132	- 1.0	2.8	3.5	3.7
Other office equipment	116	116	116	117	118	0.2	0.1	0.5	0.4
Office equipment	**237**	**236**	**240**	**245**	**250**	**- 0.4**	**1.5**	**2.1**	**2.1**
LAN hardware	59	83	91	111	114	41.1	9.3	21.9	2.7
Other data communications	34	35	35	37	38	3.5	0.4	5.0	2.7
Data communications hardware	**92**	**118**	**126**	**147**	**151**	**27.5**	**6.7**	**17.2**	**2.7**
IT hardware	**1,562**	**1,661**	**1,734**	**1,759**	**1,810**	**6.3**	**4.4**	**1.4**	**2.9**
Systems software	617	636	639	656	676	3.1	0.5	2.6	3.0
Application software	501	539	566	604	646	7.5	5.1	6.6	7.0
Software products	**1,118**	**1,175**	**1,206**	**1,259**	**1,322**	**5.1**	**2.6**	**4.5**	**4.9**
Professional services	518	538	570	596	621	3.7	5.9	4.7	4.1
Processing services	305	315	323	330	337	3.2	2.3	2.2	2.2
Network services	46	49	57	66	75	7.6	15.0	16.2	14.6
Hardware maintenance & support services	575	568	580	603	618	- 1.3	2.2	4.0	2.4
Services	**1,445**	**1,470**	**1,529**	**1,595**	**1,651**	**1.7**	**4.0**	**4.3**	**3.5**
Software and services	**2,563**	**2,645**	**2,734**	**2,855**	**2,973**	**3.2**	**3.4**	**4.4**	**4.1**
Total IT market	**4,125**	**4,306**	**4,468**	**4,613**	**4,783**	**4.4**	**3.8**	**3.2**	**3.7**
Switching	229	227	218	219	215	- 1.2	- 3.8	0.5	- 2.0
Transmission	185	197	203	202	203	6.2	3.4	- 0.4	0.2
Mobile communications infrastructure	147	147	167	167	61	0.0	13.9	0.0	-63,5
Public network equipment	**561**	**570**	**589**	**589**	**479**	**1.6**	**3.2**	**0.0**	**-18.7**
PABX & key systems	87	87	85	83	81	0.0	- 2.2	- 2.2	- 2.3
Telephone sets	115	123	133	145	157	6.8	8.0	9.0	8.1
Mobile terminal equipment	30	45	72	107	150	48.8	60.0	48.0	40.0
Other terminal equipment	69	73	78	86	105	6.3	6.3	10.8	21.6
Private network equipment	**302**	**329**	**368**	**421**	**493**	**9.0**	**12.1**	**14.5**	**16.9**
Telecom equipment	**863**	**899**	**957**	**1,010**	**971**	**4.2**	**6.5**	**5.6**	**- 3.8**
Telephone services	2,035	2,130	2,237	2,349	2,490	4.7	5.0	5.0	6.0
Mobile telephone services	46	72	119	186	278	56.6	66.1	56.1	49.5
Switched data and leased line services	317	350	550	1,007	1,404	10.3	57.2	83.1	39.3
CaTV services	329	362	417	521	781	10.0	15.0	25.0	50.0
Telecom services	**2,728**	**2,914**	**3,323**	**4,063**	**4,953**	**6.8**	**14.0**	**22.3**	**21.9**
Total telecom	**3,591**	**3,813**	**4,279**	**5,073**	**5,924**	**6.2**	**12.2**	**18.5**	**16.8**
Total ICT	**7,716**	**8,119**	**8,748**	**9,686**	**10,707**	**5.2**	**7.7**	**10.7**	**10.5**

Table 17
Belgium/Luxembourg
ICT Market Value
(Million ECU)

Table 18
Denmark
ICT Market Value
(Million ECU)

Denmark	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	137	147	122	121	116	6.9	-16.6	- 1.4	- 3.8
Medium	92	86	88	88	88	- 6.8	2.3	- 0.3	- 0.1
Small	100	104	104	101	101	4.5	- 0.4	- 2.6	- 0.4
Workstations	31	34	34	37	41	7.2	2.2	7.1	10.9
PCs - portable	83	109	127	144	159	30.6	17.2	13.3	10.0
PCs - desktop	342	457	592	662	676	33.6	29.8	11.8	2.0
PC printers	93	103	123	139	149	10.9	19.2	12.7	7.1
Computer hardware	**879**	**1,039**	**1,191**	**1,292**	**1,328**	**18.3**	**14.7**	**8.4**	**2.8**
Copiers	74	79	82	86	90	6.6	4.8	4.4	4.0
Other office equipment	75	73	73	73	73	- 2.4	- 0.4	0.3	0.7
Office equipment	**149**	**152**	**155**	**159**	**163**	**2.1**	**2.3**	**2.5**	**2.5**
LAN hardware	75	87	113	129	143	16.0	30.3	14.5	10.7
Other data communications	40	38	41	42	43	- 2.8	5.3	3.4	2.5
Data communications hardware	**114**	**125**	**153**	**171**	**186**	**9.5**	**22.6**	**11.6**	**8.7**
IT hardware	**1,141**	**1,316**	**1,500**	**1,622**	**1,677**	**15.3**	**14.0**	**8.1**	**3.4**
Systems software	253	270	284	298	309	6.7	5.2	4.8	4.0
Application software	216	232	247	260	274	7.6	6.2	5.4	5.5
Software products	**469**	**502**	**531**	**558**	**584**	**7.1**	**5.7**	**5.1**	**4.7**
Professional services	551	581	627	675	717	5.5	7.9	7.5	6.2
Processing services	483	500	520	542	556	3.5	4.0	4.1	2.7
Network services	66	72	85	102	118	9.8	18.5	19.1	16.2
Hardware maintenance & support services	274	272	276	288	296	- 0.9	1.7	4.4	2.6
Services	**1,374**	**1,425**	**1,509**	**1,606**	**1,687**	**3.7**	**5.9**	**6.4**	**5.0**
Software and services	**1,843**	**1,927**	**2,040**	**2,164**	**2,271**	**4.6**	**5.8**	**6.1**	**4.9**
Total IT market	**2,984**	**3,243**	**3,540**	**3,786**	**3,948**	**8.7**	**9.2**	**6.9**	**4.3**
Switching	147	146	140	141	138	- 1.2	- 3.8	0.5	- 2.0
Transmission	119	126	131	130	131	6.2	3.4	- 0.4	0.2
Mobile communications infrastructure	61	46	47	47	47	-25.1	3.6	0.0	0.0
Public network equipment	**327**	**318**	**318**	**318**	**316**	**- 2.9**	**0.1**	**0.0**	**- 0.8**
PABX & key systems	60	58	57	55	54	- 3.1	- 2.2	- 2.2	- 2.2
Telephone sets	74	79	86	93	101	6.8	8.0	9.0	8.1
Mobile terminal equipment	85	98	97	87	76	16.0	- 1.6	- 9.6	-12.8
Other terminal equipment	44	47	50	55	67	6.3	6.3	10.8	21.6
Private network equipment	**263**	**282**	**289**	**292**	**299**	**7.4**	**2.3**	**0.9**	**2.4**
Telecom eqipment	**590**	**600**	**607**	**610**	**614**	**1.7**	**1.1**	**0.5**	**0.8**
Telephone services	1,112	1,135	1,157	1,192	1,228	2.0	2.0	3.0	3.0
Mobile telephone services	216	279	321	349	370	29.4	15.2	8.6	5.9
Switched data and leased line services	271	305	335	364	388	12.4	10.0	8.4	6.7
CaTV services	107	123	148	178	204	15.6	20.0	20.0	15.0
Telecom services	**1,706**	**1,842**	**1,962**	**2,082**	**2,190**	**8.0**	**6.5**	**6.1**	**5.2**
Total telecom	**2,296**	**2,442**	**2,569**	**2,692**	**2,804**	**6.4**	**5.2**	**4.8**	**4.2**
Total ICT	**5,280**	**5,685**	**6,109**	**6,477**	**6,752**	**7.7**	**7.5**	**6.0**	**4.2**

Finland	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	28	28	29	28	27	- 0.9	1.5	- 0.9	- 3.9
Medium	52	50	50	49	47	- 3.7	- 0.3	- 0.8	- 5.1
Small	75	72	70	67	66	- 3.8	- 3.7	- 3.9	- 1.3
Workstations	24	39	51	56	62	63.3	32.7	8.9	11.0
PCs - portable	41	62	77	88	95	52.4	23.5	15.1	7.4
PCs - desktop	249	305	401	440	450	22.5	31.3	9.8	2.2
PC printers	48	52	63	71	79	9.4	20.7	12.9	10.0
Computer hardware	**517**	**609**	**740**	**800**	**826**	**17.8**	**21.6**	**8.2**	**3.1**
Copiers	45	46	47	47	49	0.6	2.2	1.4	2.4
Other office equipment	45	44	44	44	44	- 2.4	- 0.4	0.2	0.3
Office equipment	**91**	**90**	**91**	**91**	**93**	**- 0.9**	**0.9**	**0.8**	**1.4**
LAN hardware	60	53	75	87	99	-11.3	40.3	15.6	14.8
Other data communications	40	42	45	46	47	4.4	7.1	3.3	1.5
Data communications hardware	**100**	**95**	**119**	**133**	**146**	**- 5.0**	**25.8**	**11.0**	**10.2**
IT hardware	**707**	**793**	**950**	**1,024**	**1,064**	**12.2**	**19.7**	**7.8**	**3.9**
Systems software	149	151	161	170	181	1.8	6.5	5.6	6.5
Application software	133	136	146	155	165	1.9	7.1	6.3	6.5
Software products	**282**	**287**	**307**	**325**	**346**	**1.8**	**6.8**	**5.9**	**6.5**
Professional services	322	342	373	412	444	6.3	9.1	10.6	7.7
Processing services	213	217	222	227	233	2.2	2.0	2.2	2.8
Network services	21	19	20	23	27	-10.3	1.5	17.3	18.3
Hardware maintenance & support services	164	162	165	171	176	- 1.4	1.9	3.6	2.7
Services	**720**	**740**	**779**	**833**	**880**	**2.8**	**5.2**	**6.9**	**5.7**
Software and services	**1,002**	**1,028**	**1,086**	**1,158**	**1,226**	**2.5**	**5.7**	**6.6**	**5.9**
Total IT market	**1,710**	**1,821**	**2,036**	**2,182**	**2,291**	**6.5**	**11.8**	**7.2**	**5.0**
Switching	116	115	111	111	109	- 1.2	- 3.8	0.5	- 2.0
Transmission	94	100	103	103	103	6.2	3.4	- 0.4	0.2
Mobile communications infrastructure	64	48	59	59	59	-25.1	22.2	0.0	0.0
Public network equipment	**274**	**263**	**272**	**273**	**271**	**- 4.2**	**3.7**	**0.0**	**- 0.7**
PABX & key systems	58	58	57	55	53	0.0	- 2.9	- 3.0	- 3.0
Telephone sets	59	63	68	74	80	6.8	8.0	9.0	8.1
Mobile terminal equipment	117	133	120	103	86	13.6	- 9.6	-14.4	-16.0
Other terminal equipment	35	37	39	44	53	6.3	6.3	10.8	21.6
Private network equipment	**269**	**291**	**284**	**275**	**272**	**8.2**	**- 2.4**	**- 3.0**	**- 1.0**
Telecom equipment	**543**	**553**	**556**	**547**	**543**	**1.9**	**0.5**	**- 1.5**	**- 0.8**
Telephone services	825	834	842	859	885	1.0	1.0	2.0	3.0
Mobile telephone services	218	277	301	315	325	27.4	8.6	4.6	3.3
Switched data and leased line services	109	116	129	144	158	5.8	11.3	12.1	9.1
CaTV services	62	73	92	115	143	18.3	25.0	25.0	25.0
Telecom services	**1,214**	**1,300**	**1,363**	**1,433**	**1,511**	**7.0**	**4.9**	**5.1**	**5.5**
Total telecom	**1,757**	**1,853**	**1,919**	**1,980**	**2,054**	**5.5**	**3.6**	**3.2**	**3.7**
Total ICT	**3,467**	**3,675**	**3,956**	**4,163**	**4,344**	**6.0**	**7.6**	**5.2**	**4.4**

Table 19
Finland
ICT Market Value
(Million ECU)

Table 20
France
ICT Market Value
(Million ECU)

France	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	981	860	788	755	730	-12.4	- 8.4	- 4.1	- 3.4
Medium	943	921	919	915	913	- 2.4	- 0.2	- 0.4	- 0.2
Small	909	903	888	896	923	- 0.6	- 1.7	0.9	3.0
Workstations	322	370	404	455	517	15.0	9.1	12.5	13.8
PCs - portable	496	630	639	790	937	26.9	1.5	23.7	18.6
PCs - desktop	2,255	2,410	2,776	3,035	3,389	6.9	15.2	9.3	11.7
PC printers	582	587	667	759	842	0.9	13.5	13.9	10.9
Computer hardware	**6,489**	**6,682**	**7,080**	**7,605**	**8,251**	**3.0**	**6.0**	**7.4**	**8.5**
Copiers	714	723	724	743	762	1.2	0.2	2.5	2.5
Other office equipment	665	630	628	628	632	- 5.2	- 0.3	0.0	0.6
Office equipment	**1,379**	**1,353**	**1,352**	**1,371**	**1,394**	**- 1.9**	**0.0**	**1.4**	**1.7**
LAN hardware	302	364	443	532	582	20.7	21.6	20.1	9.5
Other data communications	314	310	320	333	345	- 1.4	3.2	4.2	3.7
Data communications hardware	**616**	**674**	**762**	**865**	**927**	**9.4**	**13.1**	**13.4**	**7.2**
IT hardware	**8,484**	**8,708**	**9,195**	**9,840**	**10,572**	**2.6**	**5.6**	**7.0**	**7.4**
Systems software	1,864	2,002	2,199	2,433	2,679	7.4	9.8	10.7	10.1
Application software	1,533	1,630	1,799	1,995	2,167	6.3	10.3	10.9	8.6
Software products	**3,397**	**3,632**	**3,998**	**4,428**	**4,847**	**6.9**	**10.1**	**10.8**	**9.5**
Professional services	5,010	5,205	5,523	5,832	6,113	3.9	6.1	5.6	4.8
Processing services	1,580	1,604	1,629	1,659	1,676	1.6	1.6	1.8	1.0
Network services	240	269	313	377	438	12.2	16.4	20.4	16.3
Hardware maintenance & support services	3,186	3,095	3,072	3,118	3,219	- 2.9	- 0.7	1.5	3.3
Services	**10,016**	**10,174**	**10,537**	**10,986**	**11,446**	**1.6**	**3.6**	**4.3**	**4.2**
Software and services	**13,412**	**13,806**	**14,535**	**15,414**	**16,293**	**2.9**	**5.3**	**6.1**	**5.7**
Total IT market	**21,896**	**22,514**	**23,730**	**25,255**	**26,865**	**2.8**	**5.4**	**6.4**	**6.4**
Switching	850	841	819	813	785	- 1.0	- 2.7	- 0.7	- 3.4
Transmission	389	429	480	520	553	10.4	11.8	8.4	6.3
Mobile communications infrastructure	505	765	557	463	389	51.5	-27.3	-16.9	-15.8
Public network equipment	**1,744**	**2,036**	**1,855**	**1,796**	**1,727**	**16.8**	**- 8.9**	**- 3.2**	**- 3.8**
PABX & key systems	600	600	588	576	564	0.0	- 2.0	- 2.1	- 2.1
Telephone sets	736	769	813	871	932	4.5	5.7	7.2	6.9
Mobile terminal equipment	220	282	406	568	723	28.0	44.0	40.0	27.2
Other terminal equipment	1,055	1,181	1,288	1,442	1,673	12.0	9.0	12.0	16.0
Private network equipment	**2,611**	**2,833**	**3,095**	**3,458**	**3,891**	**8.5**	**9.3**	**11.7**	**12.5**
Telecom equipment	**4,355**	**4,869**	**4,950**	**5,254**	**5,618**	**11.8**	**1.7**	**6.1**	**6.9**
Telephone services	14,398	15,262	16,177	17,310	18,521	6.0	6.0	7.0	7.0
Mobile telephone services	653	913	1,395	2,085	2,897	39.8	52.8	49.5	38.9
Switched data and leased line services	2,544	3,116	3,891	4,877	5,962	22.5	24.9	25.4	22.2
CaTV services	188	243	424	955	2,865	29.3	75.0	125.0	200.0
Telecom services	**17,783**	**19,533**	**21,887**	**25,227**	**30,245**	**9.8**	**12.1**	**15.3**	**19.9**
Total telecom	**22,138**	**24,401**	**26,837**	**30,481**	**35,863**	**10.2**	**10.0**	**13.6**	**17.7**
Total ICT	**44,034**	**46,915**	**50,567**	**55,735**	**62,729**	**6.5**	**7.8**	**10.2**	**12.5**

Table 21
Germany
ICT Market Value
(Million ECU)

Germany	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	2,382	2,198	2,088	1,984	1,904	- 7.7	- 5.0	- 5.0	- 4.0
Medium	2,172	2,119	2,149	2,213	2,280	- 2.4	1.4	3.0	3.0
Small	1,372	1,466	1,583	1,710	1,813	6.9	8.0	8.0	6.0
Workstations	1,523	1,706	2,047	2,354	2,637	12.0	20.0	15.0	12.0
PCs - portable	983	1,194	1,391	1,634	1,852	21.5	16.5	17.5	13.3
PCs - desktop	3,590	4,065	4,762	5,380	5,864	13.2	17.1	13.0	9.0
PC printers	1,365	1,461	1,709	1,914	2,087	7.0	17.0	12.0	9.0
Computer hardware	**13,387**	**14,209**	**15,729**	**17,189**	**18,437**	**6.1**	**10.7**	**9.3**	**7.3**
Copiers	1,321	1,334	1,347	1,361	1,374	1.0	1.0	1.0	1.0
Other office equipment	973	964	965	970	979	- 0.9	0.1	0.5	0.9
Office equipment	**2,294**	**2,298**	**2,312**	**2,331**	**2,353**	**0.2**	**0.6**	**0.8**	**0.9**
LAN hardware	517	590	651	723	781	14.1	10.3	11.1	8.0
Other data communications	228	215	218	216	223	- 5.7	1.4	- 0.9	3.2
Data communications hardware	**745**	**805**	**869**	**939**	**1,004**	**8.1**	**8.0**	**8.1**	**6.9**
IT hardware	**16,426**	**17,312**	**18,910**	**20,459**	**21,794**	**5.4**	**9.2**	**8.2**	**6.5**
Systems software	2,732	2,868	2,983	3,102	3,211	5.0	4.0	4.0	3.5
Application software	5,572	6,076	6,684	7,352	8,014	9.0	10.0	10.0	9.0
Software products	**8,304**	**8,944**	**9,667**	**10,454**	**11,225**	**7.7**	**8.1**	**8.1**	**7.4**
Professional services	4,159	4,341	4,558	4,786	5,025	4.4	5.0	5.0	5.0
Processing services	2,164	2,404	2,659	2,925	3,188	11.1	10.6	10.0	9.0
Network services	207	255	317	393	471	23.2	24.3	24.0	19.8
Hardware maintenance & support services	4,093	4,049	3,968	3,889	3,811	- 1.1	- 2.0	- 2.0	- 2.0
Services	**10,623**	**11,049**	**11,502**	**11,993**	**12,495**	**4.0**	**4.1**	**4.3**	**4.2**
Software and services	**18,927**	**19,993**	**21,169**	**22,447**	**23,720**	**5.6**	**5.9**	**6.0**	**5.7**
Total IT market	**35,353**	**37,305**	**40,079**	**42,906**	**45,514**	**5.5**	**7.4**	**7.1**	**6.1**
Switching	1,942	1,799	1,594	1,467	1,426	- 7.4	- 11.3	- 8.0	- 2.8
Transmission	1,433	1,447	1,331	1,257	1,201	0.9	- 8.0	- 5.6	- 4.4
Mobile communications infrastructure	658	580	525	500	445	-11.9	- 9.5	- 4.8	-11.0
Public network equipment	**4,034**	**3,826**	**3,451**	**3,224**	**3,072**	**- 5.2**	**- 9.8**	**- 6.6**	**- 4.7**
PABX & key systems	813	835	902	940	961	2.6	8.1	4.2	2.2
Telephone sets	1,300	1,371	1,467	1,548	1,624	5.5	7.0	5.5	4.9
Mobile terminal equipment	362	400	439	457	461	10.4	10.0	4.0	0.8
Other terminal equipment	882	1,025	1,140	1,294	1,483	16.2	11.2	13.5	14.6
Private network equipment	**3,358**	**3,631**	**3,949**	**4,240**	**4,529**	**8.1**	**8.8**	**7.3**	**6.8**
Telecom equipment	**7,391**	**7,457**	**7,400**	**7,463**	**7,601**	**0.9**	**- 0.8**	**0.9**	**1.8**
Telephone services	20,410	21,838	23,586	25,708	28,022	7.0	8.0	9.0	9.0
Mobile telephone services	1,698	2,124	2,628	3,149	3,689	25.0	23.8	19.8	17.2
Switched data and leased line services	5,830	6,814	7,890	8,922	9,903	16.9	15.8	13.1	11.0
CaTV services	1,327	1,181	1,460	1,740	1,926	-11.0	23.6	19.2	10.7
Telecom services	**29,265**	**31,958**	**35,564**	**39,519**	**43,540**	**9.2**	**11.3**	**11.1**	**10.2**
Total telecom	**36,656**	**39,414**	**42,964**	**46,982**	**51,141**	**7.5**	**9.0**	**9.4**	**8.9**
Total ICT	**72,009**	**76,719**	**83,043**	**89,888**	**96,655**	**6.5**	**8.2**	**8.2**	**7.5**

Table 22
Greece
ICT Market Value
(Million ECU)

Greece	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	11	11	11	11	11	0.0	- 3.0	0.8	- 3.8
Medium	18	21	23	24	26	13.7	8.8	5.9	7.7
Small	24	28	29	32	35	19.8	3.5	6.8	10.4
Workstations	9	10	12	14	17	14.5	17.0	19.5	21.0
PCs - portable	9	11	13	15	18	19.9	15.6	22.0	19.6
PCs - desktop	78	79	83	90	100	0.9	5.3	8.8	10.6
PC printers	36	42	54	64	73	16.4	26.7	18.7	15.1
Computer hardware	**186**	**203**	**224**	**250**	**280**	**9.1**	**10.5**	**11.5**	**11.9**
Copiers	42	42	43	44	45	1.0	1.9	2.5	2.5
Other office equipment	45	46	46	47	47	1.7	1.1	1.3	1.1
Office equipment	**87**	**88**	**89**	**91**	**92**	**1.3**	**1.5**	**1.9**	**1.8**
LAN hardware	8	10	11	13	15	16.8	18.1	16.6	11.6
Other data communications	9	9	11	14	16	9.1	14.6	25.2	21.2
Data communications hardware	**17**	**19**	**22**	**27**	**31**	**12.8**	**16.4**	**20.8**	**16.5**
IT hardware	**290**	**310**	**336**	**368**	**404**	**7.0**	**8.3**	**9.6**	**9.8**
Systems software	20	21	25	28	34	10.0	14.7	13.5	21.8
Application software	44	52	64	75	92	18.9	23.5	16.4	23.1
Software products	**63**	**73**	**89**	**103**	**126**	**16.1**	**20.9**	**15.6**	**22.7**
Professional services	53	61	72	82	99	16.1	16.5	14.5	20.8
Processing services	12	14	17	20	23	15.1	17.0	16.5	16.8
Network services	1	1	1	1	1	24.1	18.2	20.3	24.5
Hardware maintenance & support services	32	35	39	45	54	9.7	10.9	16.9	19.7
Services	**98**	**112**	**128**	**148**	**178**	**14.0**	**14.8**	**15.6**	**20.0**
Software and services	**161**	**185**	**217**	**251**	**304**	**14.8**	**17.2**	**15.6**	**21.1**
Total IT market	**451**	**495**	**553**	**619**	**707**	**9.8**	**11.7**	**11.9**	**14.4**
Switching	100	99	95	96	94	- 1.2	- 3.8	0.5	- 2.0
Transmission	81	86	89	89	89	6.2	3.4	- 0.4	0.2
Mobile communications infrastructure	92	61	36	36	36	-34.0	-40.1	0.0	0.0
Public network equipment	**274**	**246**	**221**	**221**	**219**	**-10.0**	**-10.3**	**0.0**	**- 0.8**
PABX & key systems	23	23	23	23	23	3.8	0.0	0.0	0.0
Telephone sets	51	54	58	64	69	6.8	8.0	9.0	8.1
Mobile terminal equipment	3	17	22	25	26	429.0	28.0	14.4	4.0
Other terminal equipment	30	32	34	38	46	6.3	6.3	10.8	21.6
Private network equipment	**106**	**126**	**137**	**149**	**164**	**18.7**	**8.7**	**8.8**	**9.6**
Telecom equipment	**380**	**372**	**358**	**370**	**383**	**- 2.0**	**- 3.8**	**3.4**	**3.4**
Telephone services	1,177	1,330	1,503	1,684	1,886	13.0	13.0	12.0	12.0
Mobile telephone services	23	103	172	240	308	358.0	66.0	39.6	28.4
Switched data and leased line services	24	25	29	33	38	6.1	15.0	15.5	14.6
CaTV services	n/a	n/a	n/a	n/a	n/a	-	-	-	-
Telecom services	**1,223**	**1,459**	**1,704**	**1,957**	**2,232**	**19.2**	**16.8**	**14.8**	**14.1**
Total telecom	**1,603**	**1,831**	**2,062**	**2,327**	**2,615**	**14.2**	**12.6**	**12.9**	**12.4**
Total ICT	**2,054**	**2,326**	**2,615**	**2,946**	**3,322**	**13.2**	**12.4**	**12.7**	**12.8**

Ireland	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	20	20	19	19	19	- 1.2	- 6.3	- 0.4	3.6
Medium	26	27	28	29	30	3.2	3.4	3.3	4.6
Small	45	41	45	48	53	- 7.5	8.9	7.1	9.4
Workstations	7	7	8	9	10	8.1	15.5	8.0	7.1
PCs - portable	20	24	29	32	36	18.4	19.5	10.7	11.7
PCs - desktop	117	123	132	140	145	4.7	7.1	6.6	3.3
PC printers	27	28	30	31	32	3.1	7.0	2.0	3.6
Computer hardware	**264**	**271**	**291**	**308**	**325**	**3.0**	**7.3**	**5.9**	**5.4**
Copiers	62	63	64	64	65	2.1	1.4	0.9	0.8
Other office equipment	64	64	63	63	62	- 0.7	- 0.5	- 0.7	- 0.6
Office equipment	**126**	**127**	**127**	**127**	**127**	**0.7**	**0.4**	**0.1**	**0.1**
LAN hardware	9	11	12	14	16	13.0	12.0	16.8	14.6
Other data communications	9	9	10	11	12	5.7	14.3	5.4	12.3
Data communications hardware	**18**	**20**	**22**	**25**	**28**	**9.5**	**13.1**	**11.5**	**13.6**
IT hardware	**407**	**418**	**441**	**460**	**481**	**2.6**	**5.5**	**4.5**	**4.4**
Systems software	58	65	71	77	80	13.3	8.5	8.1	5.1
Application software	46	53	58	64	69	15.7	10.5	9.7	7.4
Software products	**103**	**118**	**129**	**140**	**149**	**14.4**	**9.4**	**8.8**	**6.1**
Professional services	73	80	87	95	103	9.4	8.6	9.9	8.4
Processing services	29	31	32	33	35	5.9	2.8	2.7	6.7
Network services	8	9	11	12	13	17.7	20.9	8.7	11.2
Hardware maintenance & support services	68	70	73	75	79	2.3	4.5	3.1	4.5
Services	**178**	**189**	**202**	**215**	**230**	**6.5**	**6.7**	**6.3**	**6.9**
Software and services	**281**	**307**	**331**	**355**	**379**	**9.4**	**7.8**	**7.3**	**6.6**
Total IT market	**688**	**725**	**772**	**816**	**859**	**5.3**	**6.5**	**5.7**	**5.4**
Switching	79	78	75	75	74	- 1.2	- 3.8	0.5	- 2.0
Transmission	64	67	70	70	70	6.2	3.4	- 0.4	0.2
Mobile communications infrastructure	40	30	23	23	23	-24.4	-25.1	0.0	0.0
Public network equipment	**182**	**176**	**167**	**167**	**166**	**- 3.7**	**- 4.7**	**0.0**	**- 0.8**
PABX & key systems	26	26	25	25	25	- 0.7	- 1.8	- 1.8	- 1.9
Telephone sets	40	42	46	50	54	6.8	8.0	9.0	8.1
Mobile terminal equipment	11	13	15	20	22	14.4	20.0	28.0	12.0
Other terminal equipment	24	25	27	30	36	6.3	6.3	10.8	21.6
Private network equipment	**100**	**106**	**113**	**124**	**136**	**5.6**	**6.6**	**9.6**	**9.9**
Telecom equipment	**283**	**282**	**280**	**291**	**302**	**- 0.4**	**- 0.5**	**3.9**	**3.8**
Telephone services	822	855	889	926	962	4.0	4.0	4.1	3.9
Mobile telephone services	52	67	89	124	156	28.5	33.0	39.6	26.4
Switched data and leased line services	51	58	69	94	118	14.0	17.9	36.6	25.2
CaTV services	25	30	38	49	61	22.3	25.0	30.0	25.0
Telecom services	**950**	**1,011**	**1,085**	**1,193**	**1,298**	**6.4**	**7.3**	**10.0**	**8.8**
Total telecom	**1,233**	**1,292**	**1,365**	**1,484**	**1,600**	**4.8**	**5.6**	**8.7**	**7.8**
Total ICT	**1,921**	**2,017**	**2,137**	**2,300**	**2,459**	**5.0**	**5.9**	**7.6**	**6.9**

Table 23
Ireland
ICT Market Value
(Million ECU)

Table 24
Italy
ICT Market Value
(Million ECU)

Italy	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	773	688	625	587	558	-11.0	- 9.2	- 6.0	- 5.0
Medium	375	350	352	364	373	- 6.6	0.5	3.6	2.4
Small	677	647	642	655	681	- 4.4	- 0.8	1.9	4.1
Workstations	253	266	290	316	354	5.2	9.0	9.0	12.0
PCs - portable	199	231	272	309	348	16.0	18.1	13.4	12.6
PCs - desktop	1,083	1,140	1,387	1,649	1,933	5.3	21.6	18.8	17.2
PC printers	377	359	347	353	360	- 4.6	- 3.3	1.5	2.1
Computer hardware	**3,736**	**3,682**	**3,916**	**4,232**	**4,607**	**- 1.4**	**6.4**	**8.1**	**8.9**
Copiers	375	377	380	385	389	0.5	0.8	1.1	1.2
Other office equipment	332	335	332	331	330	0.8	- 0.9	- 0.4	- 0.4
Office equipment	**708**	**713**	**713**	**716**	**719**	**0.7**	**0.0**	**0.4**	**0.5**
LAN hardware	105	125	140	157	171	20.0	11.9	11.7	9.0
Other data communications	95	80	73	70	75	-16.0	- 8.3	- 4.6	7.5
Data communications hardware	**199**	**205**	**214**	**227**	**246**	**2.9**	**4.1**	**6.1**	**8.5**
IT hardware	**4,643**	**4,600**	**4,842**	**5,174**	**5,572**	**- 0.9**	**5.3**	**6.9**	**7.7**
Systems software	1,193	1,255	1,305	1,386	1,479	5.2	4.0	6.2	6.7
Application software	957	1,001	1,061	1,146	1,248	4.5	6.0	8.0	8.9
Software products	**2,150**	**2,255**	**2,366**	**2,532**	**2,727**	**4.9**	**4.9**	**7.0**	**7.7**
Professional services	2,698	2,847	3,036	3,267	3,539	5.5	6.6	7.6	8.3
Processing services	635	644	652	666	687	1.3	1.4	2.0	3.2
Network services	312	343	381	432	497	10.0	11.1	13.3	15.3
Hardware maintenance & support services	963	953	943	948	956	- 1.1	- 1.0	0.5	0.8
Services	**4,608**	**4,786**	**5,012**	**5,312**	**5,679**	**3.9**	**4.7**	**6.0**	**6.9**
Software and services	**6,759**	**7,042**	**7,379**	**7,844**	**8,406**	**4.2**	**4.8**	**6.3**	**7.2**
Total IT market	**11,402**	**11,641**	**12,221**	**13,019**	**13,978**	**2.1**	**5.0**	**6.5**	**7.4**
Switching	645	582	578	609	625	- 9.9	- 0.7	5.4	2.7
Transmission	654	621	627	650	638	- 5.2	1.0	3.8	- 1.9
Mobile communications infrastructure	39	96	320	310	206	146.2	233.3	- 3.1	-33.5
Public network equipment	**1,339**	**1,298**	**1,524**	**1,569**	**1,469**	**- 3.0**	**17.4**	**3.0**	**- 6.4**
PABX & key systems	266	240	229	217	206	- 9.7	- 4.7	- 4.9	- 5.2
Telephone sets	422	440	466	493	520	4.3	5.8	6.0	5.5
Mobile terminal equipment	259	421	489	528	549	62.4	16.0	8.0	4.0
Other terminal equipment	344	397	423	454	491	15.7	6.4	7.4	8.2
Private network equipment	**1,291**	**1,499**	**1,606**	**1,693**	**1,767**	**16.1**	**7.2**	**5.4**	**4.4**
Telecom equipment	**2,629**	**2,797**	**3,131**	**3,263**	**3,236**	**6.4**	**11.9**	**4.2**	**- 0.8**
Telephone services	10,684	11,325	12,005	12,725	13,616	6.0	6.0	6.0	7.0
Mobile telephone services	758	1275	1653	2035	2438	68.1	29.7	23.1	19.8
Switched data and leased line services	549	578	691	876	1,045	5.1	19.6	26.7	19.3
CaTV services	3	5	12	37	111	68.6	150.0	200.0	200.0
Telecom services	**11,995**	**13,182**	**14,361**	**15,673**	**17,209**	**9.9**	**8.9**	**9.1**	**9.8**
Total telecom	**14,624**	**15,979**	**17,492**	**18,935**	**20,445**	**9.3**	**9.5**	**8.3**	**8.0**
Total ICT	**26,026**	**27,621**	**29,712**	**31,954**	**34,424**	**6.1**	**7.6**	**7.5**	**7.7**

Netherlands	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	225	241	210	208	205	7.1	-12.9	- 0.8	- 1.8
Medium	285	260	259	257	258	- 8.6	- 0.6	- 0.6	0.4
Small	257	287	282	278	285	11.8	- 1.6	- 1.5	2.3
Workstations	114	97	106	114	120	-15,6	9.7	7.4	5.5
PCs - portable	143	203	271	341	396	42.7	33.4	25.8	15.9
PCs - desktop	808	932	1,160	1,304	1,465	15.4	24.4	12.4	12.3
PC printers	209	227	252	269	279	8.5	10.9	7.0	3.7
Computer hardware	**2,041**	**2,248**	**2,541**	**2,773**	**3,007**	**10.2**	**13.0**	**9.1**	**8.5**
Copiers	301	304	309	315	321	0.9	1.7	1.9	2.1
Other office equipment	270	266	265	265	266	- 1.6	- 0.1	0.0	0.1
Office equipment	**571**	**569**	**574**	**580**	**587**	**- 0.3**	**0.8**	**1.0**	**1.2**
LAN hardware	132	177	219	251	270	34.1	23.9	14.5	7.8
Other data communications	80	72	74	79	83	-10.5	3.7	6.2	5.2
Data communications hardware	**212**	**248**	**293**	**330**	**353**	**17.2**	**18.1**	**12.4**	**7.2**
IT hardware	**2,824**	**3,066**	**3,408**	**3,682**	**3,947**	**8.6**	**11.2**	**8.0**	**7.2**
Systems software	730	793	863	954	1,054	8.6	8.8	10.6	10.4
Application software	744	849	959	1,102	1,262	14.2	13.0	14.8	14.6
Software products	**1,474**	**1,642**	**1,822**	**2,056**	**2,316**	**11.4**	**11.0**	**12.8**	**12.7**
Professional services	1,013	1,172	1,321	1,452	1,583	15.7	12.8	9.9	9.1
Processing services	548	546	552	563	570	- 0.2	1.0	1.9	1.4
Network services	65	66	73	80	88	0.6	10.6	10.7	9.8
Hardware maintenance & support services	870	853	855	879	916	- 1.9	0.3	2.7	4.3
Services	**2,496**	**2,637**	**2,801**	**2,973**	**3,158**	**5.6**	**6.2**	**6.1**	**6.2**
Software and services	**3,970**	**4,279**	**4,623**	**5,029**	**5,474**	**7.8**	**8.0**	**8.8**	**8.9**
Total IT market	**6,794**	**7,345**	**8,032**	**8,711**	**9,421**	**8.1**	**9.3**	**8.5**	**8.2**
Switching	287	260	258	261	261	- 9.3	- 0.7	1.1	- 0.2
Transmission	139	160	173	177	183	15.3	7.9	2.6	3.2
Mobile communications infrastructure	309	42	340	63	63	86.4	709.5	-81.5	0.0
Public network equipment	**734**	**462**	**771**	**501**	**507**	**-37.1**	**66.8**	**-35.0**	**1.0**
PABX & key systems	237	239	241	243	245	0.8	0.9	0.9	0.9
Telephone sets	164	178	195	217	233	9.0	9.3	11.4	7.2
Mobile terminal equipment	131	156	211	288	334	18.4	36.0	36.0	16.0
Other terminal equipment	127	153	179	219	271	20.7	16.8	22.4	23.8
Private network equipment	**658**	**725**	**826**	**966**	**1,082**	**10.2**	**13.9**	**17.0**	**12.0**
Telecom equipment	**1,393**	**1,187**	**1,597**	**1,468**	**1,589**	**-14.7**	**34.5**	**- 8.1**	**8.2**
Telephone services	3,599	3,840	4,108	4,437	4,792	6.7	7.0	8.0	8.0
Mobile telephone services	210	264	386	598	796	26.0	46.0	55.0	33.0
Switched data and leased line services	581	633	703	803	957	8.8	11.1	14.3	19.1
CaTV services	453	514	591	709	886	13.4	15.0	20.0	25.0
Telecom services	**4,844**	**5,250**	**5,788**	**6,547**	**7,430**	**8.4**	**10.2**	**13.1**	**13.5**
Total telecom	**6,236**	**6,438**	**7,384**	**8,015**	**9,019**	**3.2**	**14.7**	**8.5**	**12.5**
Total ICT	**13,030**	**13,783**	**15,416**	**16,726**	**18,440**	**5.8**	**11.8**	**8.5**	**10.2**

Table 25
Netherlands
ICT Market Value
(Million ECU)

Table 26
Norway
ICT Market Value
(Million ECU)

Norway	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	31	31	30	30	29	0.5	- 2.2	- 1.1	- 3.6
Medium	51	54	54	54	52	6.9	- 0.8	0.0	- 3.1
Small	101	101	95	90	89	0.2	- 6.7	- 4.4	- 1.3
Workstations	37	50	51	53	58	33.2	3.2	4.1	8.8
PCs - portable	63	99	134	156	178	56.4	35.2	16.4	14.4
PCs - desktop	330	377	467	498	558	14.4	23.8	6.6	12.0
PC printers	65	69	81	93	104	6.3	17.3	14.4	11.9
Computer hardware	**678**	**782**	**912**	**974**	**1,069**	**15.3**	**16.7**	**6.8**	**9.7**
Copiers	53	54	54	55	56	1.3	1.2	1.3	1.5
Other office equipment	58	57	56	56	56	- 1.4	- 0.8	- 0.2	- 0.9
Office equipment	**111**	**110**	**111**	**111**	**112**	**- 0.1**	**0.2**	**0.5**	**0.3**
LAN hardware	67	64	95	105	121	- 4.6	48.8	10.5	15.0
Other data communications	37	38	40	42	43	2.8	5.7	4.7	2.5
Data communications hardware	**104**	**102**	**135**	**147**	**164**	**- 2.0**	**32.9**	**8.8**	**11.5**
IT hardware	**893**	**994**	**1,158**	**1,232**	**1,344**	**11.3**	**16.5**	**6.4**	**9.0**
Systems software	197	206	214	227	238	4.3	4.2	5.8	5.1
Application software	180	188	198	210	224	4.5	5.2	6.2	6.2
Software products	**377**	**394**	**413**	**437**	**462**	**4.4**	**4.7**	**6.0**	**5.6**
Professional services	427	460	494	527	561	7.9	7.3	6.6	6.5
Processing services	362	373	384	391	397	2.9	3.1	1.9	1.5
Network services	51	55	61	71	80	7.1	11.7	15.9	11.9
Hardware maintenance & support services	240	235	238	248	253	- 2.0	1.2	3.9	2.2
Services	**1,081**	**1,124**	**1,178**	**1,237**	**1,291**	**4.0**	**4.8**	**5.0**	**4.4**
Software and services	**1,458**	**1,518**	**1,590**	**1,674**	**1,753**	**4.1**	**4.8**	**5.3**	**4.7**
Total IT market	**2,351**	**2,511**	**2,748**	**2,906**	**3,097**	**6.8**	**9.4**	**5.8**	**6.5**
Switching	165	163	157	157	154	- 1.2	- 3.8	0.5	- 2.0
Transmission	133	141	146	146	146	6.2	3.4	- 0.4	0.2
Mobile communications infrastructure	96	72	54	54	54	-24.4	-25.1	0.0	0.0
Public network equipment	**393**	**376**	**357**	**357**	**354**	**- 4.3**	**- 5.2**	**0.0**	**- 0.8**
PABX & key systems	46	46	45	44	43	0.0	- 2.0	- 2.0	- 2.1
Telephone sets	83	89	96	104	113	6.8	8.0	9.0	8.1
Mobile terminal equipment	105	137	122	104	87	29.6	-10.4	-15.2	-16.0
Other terminal equipment	49	52	56	62	75	6.3	6.3	10.8	21.6
Private network equipment	**284**	**324**	**319**	**314**	**318**	**14.1**	**- 1.5**	**- 1.5**	**1.4**
Telecom equipment	**677**	**700**	**676**	**671**	**673**	**3.4**	**- 3.5**	**- 0.7**	**0.2**
Telephone services	1,269	1,320	1,373	1,442	1,514	4.0	4.0	5.0	5.0
Mobile telephone services	205	288	311	324	334	40.6	7.9	4.0	3.3
Switched data and leased line services	185	212	234	255	274	14.4	10.4	9.1	7.3
CaTV services	43	48	53	63	82	11.0	10.0	20.0	30.0
Telecom services	**1,703**	**1,868**	**1,971**	**2,084**	**2,204**	**9.7**	**5.5**	**5.7**	**5.8**
Total telecom	**2,380**	**2,569**	**2,647**	**2,755**	**2,877**	**7.9**	**3.0**	**4.1**	**4.4**
Total ICT	**4,730**	**5,080**	**5,395**	**5,661**	**5,973**	**7.4**	**6.2**	**4.9**	**5.5**

Table 27
Portugal
ICT Market Value
(Million ECU)

Portugal	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	47	44	45	47	49	- 7.1	3.8	3.7	3.6
Medium	55	56	58	60	62	1.5	3.0	4.3	2.8
Small	92	91	97	102	108	- 0.9	6.5	6.1	5.7
Workstations	9	14	16	18	20	53.3	18.9	11.8	10.6
PCs - portable	9	10	13	15	18	13.1	22.0	18.6	17.7
PCs - desktop	139	149	166	184	200	7.6	10.9	11.3	8.6
PC printers	19	20	20	20	20	4.2	1.6	0.0	2.4
Computer hardware	**370**	**384**	**414**	**447**	**477**	**3.8**	**8.0**	**8.0**	**6.7**
Copiers	48	49	50	51	52	1.7	2.0	1.9	2.2
Other office equipment	49	50	52	53	54	1.9	2.6	2.6	2.8
Office equipment	**97**	**99**	**101**	**104**	**106**	**1.8**	**2.3**	**2.3**	**2.5**
LAN hardware	11	11	12	12	13	5.0	4.3	3.2	3.1
Other data communications	15	15	15	16	16	1.4	1.8	1.0	0.5
Data communications hardware	**26**	**26**	**27**	**28**	**28**	**2.9**	**2.9**	**2.0**	**1.6**
IT hardware	**493**	**509**	**543**	**579**	**612**	**3.3**	**6.6**	**6.6**	**5.7**
Systems software	63	67	70	75	82	7.7	4.1	7.3	9.3
Application software	52	56	60	66	76	6.8	8.5	9.5	14.4
Software products	**115**	**123**	**131**	**141**	**158**	**7.3**	**6.1**	**8.3**	**11.7**
Professional services	65	70	76	87	97	8.2	8.0	14.5	11.5
Processing services	29	30	31	33	34	4.5	4.4	3.8	3.6
Network services	2	2	3	3	4	27.4	23.6	19.4	21.4
Hardware maintenance & support services	75	75	77	80	83	- 0.5	3.1	3.1	4.3
Services	**171**	**177**	**187**	**202**	**217**	**4.0**	**5.5**	**8.1**	**7.6**
Software and services	**285**	**300**	**318**	**344**	**375**	**5.3**	**5.7**	**8.2**	**9.3**
Total IT market	**778**	**810**	**861**	**922**	**987**	**4.1**	**6.3**	**7.2**	**7.0**
Switching	140	138	133	134	131	- 1.2	- 3.8	0.5	- 2.0
Transmission	113	120	124	124	124	6.2	3.4	- 0.4	0.2
Mobile communications infrastructure	125	85	73	73	73	-32.0	-14.3	0.0	0.0
Public network equipment	**378**	**344**	**330**	**330**	**328**	**- 9.2**	**- 3.9**	**0.0**	**- 0.7**
PABX & key systems	41	46	47	48	49	13.0	1.9	1.9	1.9
Telephone sets	71	75	81	89	96	6.8	8.0	9.0	8.1
Mobile terminal equipment	3	5	7	10	11	52.8	44.0	38.4	11.2
Other terminal equipment	42	45	47	53	64	6.3	6.3	10.8	21.6
Private network equipment	**157**	**171**	**183**	**199**	**220**	**9.3**	**7.0**	**8.8**	**10.3**
Telecom equipment	**535**	**515**	**513**	**529**	**548**	**- 3.8**	**- 0.3**	**3.2**	**3.4**
Telephone services	1,420	1,647	1,878	2,103	2,313	16.0	14.0	12.0	10.0
Mobile telephone services	52	83	126	187	236	59.9	52.8	48.2	25.7
Switched data and leased line services	105	136	163	185	206	29.1	19.3	14.1	11.2
CaTV services	n/a	n/a	n/a	n/a	n/a	-	-	-	-
Telecom services	**1,577**	**1,866**	**2,167**	**2,476**	**2,755**	**18.3**	**16.1**	**14.3**	**11.3**
Total telecom	**2,112**	**2,381**	**2,680**	**3,005**	**3,303**	**12.7**	**12.6**	**12.1**	**9.9**
Total ICT	**2,890**	**3,190**	**3,540**	**3,928**	**4,290**	**10.4**	**11.0**	**10.9**	**9.2**

Table 28
Spain
ICT Market Value
(Million ECU)

Spain	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	267	266	244	240	232	- 0.5	- 8.2	- 1.6	- 3.2
Medium	195	213	220	227	236	9.3	3.3	3.2	3.8
Small	326	338	337	344	362	3.6	- 0.4	2.1	5.4
Workstations	78	103	111	127	142	32.8	7.6	14.1	11.8
PCs - portable	118	101	125	168	205	-14.9	24.4	34.7	21.7
PCs - desktop	695	666	753	862	996	- 4.1	13.0	14.4	15.6
PC printers	193	212	226	249	264	9.7	6.7	10.3	6.1
Computer hardware	**1,872**	**1,898**	**2,016**	**2,217**	**2,438**	**1.4**	**6.2**	**10.0**	**9.9**
Copiers	245	236	235	236	243	- 3.3	- 0.5	0.2	3.0
Other office equipment	241	226	217	213	211	- 6.3	- 4.0	- 1.5	- 0.9
Office equipment	**485**	**462**	**452**	**449**	**454**	**- 4.8**	**- 2.2**	**- 0.6**	**1.2**
LAN hardware	60	90	111	137	143	49.1	23.3	24.1	4.0
Other data communications	56	60	61	66	68	7.6	2.4	8.1	2.0
Data communications hardware	**116**	**150**	**172**	**204**	**211**	**29.2**	**14.9**	**18.4**	**3.4**
IT hardware	**2,473**	**2,510**	**2,640**	**2,870**	**3,102**	**1.5**	**5.2**	**8.7**	**8.1**
Systems software	331	342	427	489	557	3.3	25.0	14.6	13.7
Application software	472	490	592	668	746	4.0	20.8	12.8	11.6
Software products	**803**	**832**	**1,020**	**1,157**	**1,302**	**3.7**	**22.5**	**13.5**	**12.5**
Professional services	586	603	641	683	738	2.9	6.3	6.6	8.1
Processing services	137	142	136	143	148	3.8	- 3.8	4.5	4.1
Network services	25	31	37	44	50	22.9	19.4	17.7	14.3
Hardware maintenance & support services	694	654	653	676	706	- 5.8	- 0.1	3.5	4.4
Services	**1,443**	**1,430**	**1,468**	**1,546**	**1,643**	**- 0.9**	**2.6**	**5.3**	**6.3**
Software and services	**2,245**	**2,262**	**2,487**	**2,703**	**2,945**	**0.8**	**9.9**	**8.7**	**9.0**
Total IT market	**4,718**	**4,773**	**5,127**	**5,573**	**6,048**	**1.2**	**7.4**	**8.7**	**8.5**
Switching	252	331	391	389	382	31.1	18.4	- 0.6	- 1.8
Transmission	301	334	346	343	337	10.9	3.7	- 0.9	- 1.6
Mobile communications infrastructure	146	688	515	389	292	372.0	-25.2	-24.4	-25.1
Public network equipment	**699**	**1,352**	**1,252**	**1,121**	**1,011**	**93.5**	**- 7.4**	**-10.5**	**- 9.8**
PABX & key systems	236	240	236	232	228	1.5	- 1.7	- 1.7	- 1.7
Telephone sets	256	262	271	288	308	2.3	3.3	6.4	6.7
Mobile terminal equipment	61	79	101	153	232	28.0	28.0	52.0	52.0
Other terminal equipment	134	135	149	174	215	0.6	10.2	17.0	23.7
Private network equipment	**688**	**716**	**756**	**847**	**983**	**4.0**	**5.7**	**12.0**	**16.1**
Telecom equipment	**1,387**	**2,068**	**2,008**	**1,968**	**1,994**	**49.1**	**- 2.9**	**- 2.0**	**1.3**
Telephone services	4,598	4,782	5,212	5,682	6,193	4.0	9.0	9.0	9.0
Mobile telephone services	194	271	378	603	961	39.5	39.6	59.4	59.4
Switched data and leased line services	671	761	948	1,211	1,568	13.4	24.5	27.8	29.5
CaTV services	11	14	25	61	184	30.2	75.0	150.0	200.0
Telecom services	**5,474**	**5,828**	**6,563**	**7,557**	**8,906**	**6.5**	**12.6**	**15.1**	**17.9**
Total telecom	**6,861**	**7,896**	**8,571**	**9,525**	**10,900**	**15.1**	**8.5**	**11.1**	**14.4**
Total ICT	**11,579**	**12,669**	**13,698**	**15,097**	**16,947**	**9.4**	**8.1**	**10.2**	**12.3**

Sweden	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	137	92	83	82	79	-33.1	- 9.6	- 1.0	- 3.4
Medium	106	113	119	121	124	5.8	5.6	1.5	2.5
Small	161	159	154	151	151	- 1.8	- 2.6	- 1.9	0.0
Workstations	105	128	146	161	175	21.8	13.9	10.7	8.4
PCs - portable	136	186	248	294	322	36.3	33.4	18.8	9.3
PCs - desktop	462	581	860	906	936	25.8	47.9	5.5	3.2
PC printers	132	134	153	173	189	1.1	14.7	13.0	9.3
Computer hardware	**1,240**	**1,391**	**1,762**	**1,889**	**1,976**	**12.2**	**26.7**	**7.2**	**4.6**
Copiers	93	96	97	99	101	2.9	1.4	1.7	1.9
Other office equipment	99	98	96	97	98	- 1.6	- 1.4	0.4	1.4
Office equipment	**192**	**193**	**193**	**195**	**199**	**0.6**	**0.0**	**1.0**	**1.6**
LAN hardware	110	134	162	186	200	21.9	21.4	14.6	7.5
Other data communications	54	59	62	66	69	9.1	4.9	6.4	4.4
Data communications hardware	**164**	**193**	**224**	**252**	**269**	**17.7**	**16.3**	**12.3**	**6.7**
IT hardware	**1,596**	**1,778**	**2,180**	**2,337**	**2,444**	**11.4**	**22.6**	**7.2**	**4.6**
Systems software	305	333	350	368	383	9.2	5.1	5.2	3.9
Application software	306	334	352	373	391	9.2	5.5	6.0	4.6
Software products	**611**	**667**	**703**	**742**	**774**	**9.2**	**5.3**	**5.6**	**4.3**
Professional services	1,108	1,224	1,355	1,476	1,584	10.5	10.7	8.9	7.3
Processing services	446	447	448	452	455	0.2	0.2	0.9	0.7
Network services	54	58	66	74	80	7.2	13.2	12.9	8.4
Hardware maintenance & support services	445	434	438	453	459	- 2.5	1.1	3.3	1.5
Services	**2,052**	**2,162**	**2,306**	**2,454**	**2,579**	**5.3**	**6.7**	**6.4**	**5.1**
Software and services	**2,663**	**2,829**	**3,009**	**3,196**	**3,352**	**6.2**	**6.4**	**6.2**	**4.9**
Total IT market	**4,260**	**4,607**	**5,189**	**5,533**	**5,796**	**8.2**	**12.6**	**6.6**	**4.8**
Switching	198	199	183	188	193	0.8	- 8.1	2.7	2.5
Transmission	150	165	168	170	177	10.1	1.9	1.1	4.3
Mobile communications infrastructure	95	75	75	75	75	-21.1	0.0	0.0	0.0
Public network equipment	**443**	**439**	**426**	**433**	**445**	**- 0.8**	**- 2.9**	**1.6**	**2.8**
PABX & key systems	149	139	133	128	122	- 6.2	- 4.2	- 4.4	- 4.6
Telephone sets	155	162	171	183	193	4.4	5.5	6.7	5.7
Mobile terminal equipment	201	188	251	219	186	- 6.4	33.6	-12.8	-15.2
Other terminal equipment	127	138	153	174	203	9.4	10.5	13.9	16.6
Private network equipment	**631**	**628**	**709**	**703**	**703**	**- 0.5**	**12.9**	**- 0.7**	**0.0**
Telecom equipment	**1,074**	**1,067**	**1,135**	**1,137**	**1,149**	**- 0.6**	**6.4**	**0.1**	**1.1**
Telephone services	2,484	2,583	2,687	2,794	2,850	4.0	4.0	4.0	2.0
Mobile telephone services	543	783	871	923	960	44.3	11.2	5.9	4.0
Switched data and leased line services	333	365	410	468	550	9.7	12.3	14.2	17.5
CaTV services	172	200	233	280	345	15.8	17.0	20.0	23.0
Telecom services	**3,532**	**3,931**	**4,201**	**4,465**	**4,704**	**11.3**	**6.9**	**6.3**	**5.3**
Total telecom	**4,606**	**4,998**	**5,336**	**5,602**	**5,853**	**8.5**	**6.8**	**5.0**	**4.5**
Total ICT	**8,865**	**9,605**	**10,525**	**11,135**	**11,649**	**8.3**	**9.6**	**5.8**	**4.6**

Table 29
Sweden
ICT Market Value
(Million ECU)

Table 30
Switzerland
ICT Market Value
(Million ECU)

Switzerland	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	253	199	179	163	160	-21.3	-10.2	- 9.1	- 1.9
Medium	160	151	160	167	175	- 5.9	6.5	4.1	4.6
Small	215	249	250	257	271	16.1	0.2	3.0	5.2
Workstations	130	138	156	175	189	6.6	12.5	12.2	8.2
PCs - portable	263	241	282	336	370	- 8.4	17.0	19.3	10.1
PCs - desktop	676	816	952	1,030	1,078	20.6	16.8	8.2	4.7
PC printers	127	156	181	209	231	22.4	15.9	15.8	10.1
Computer hardware	**1,825**	**1,950**	**2,160**	**2,337**	**2,473**	**6.9**	**10.7**	**8.2**	**5.8**
Copiers	25	26	27	27	27	3.1	1.2	1.3	1.4
Other office equipment	162	160	160	160	160	- 1.1	- 0.3	0.0	0.1
Office equipment	**187**	**186**	**186**	**187**	**187**	**- 0.5**	**- 0.1**	**0.2**	**0.3**
LAN hardware	70	88	120	154	156	25.7	35.8	28.3	1.3
Other data communications	32	33	34	35	36	4.5	4.1	2.0	1.7
Data communications hardware	**102**	**121**	**154**	**189**	**192**	**19.1**	**27.2**	**22.5**	**1.3**
IT hardware	**2,114**	**2,258**	**2,500**	**2,713**	**2,851**	**6.8**	**10.7**	**8.5**	**5.1**
Systems software	575	654	717	812	919	13.8	9.6	13.3	13.3
Application software	612	702	806	929	1,070	14.7	14.9	15.2	15.1
Software products	**1,186**	**1,356**	**1,523**	**1,741**	**1,989**	**14.3**	**12.3**	**14.3**	**14.3**
Professional services	960	1,032	1,089	1,156	1,230	7.4	5.6	6.1	6.4
Processing services	317	320	317	322	330	1.2	- 1.1	1.7	2.4
Network services	170	160	189	227	248	- 5.8	18.4	20.3	8.9
Hardware maintenance & support services	785	770	773	804	848	- 1.9	0.5	3.9	5.6
Services	**2,231**	**2,281**	**2,369**	**2,509**	**2,656**	**2.3**	**3.8**	**5.9**	**5.8**
Software and services	**3,418**	**3,637**	**3,892**	**4,250**	**4,645**	**6.4**	**7.0**	**9.2**	**9.3**
Total IT market	**5,532**	**5,895**	**6,392**	**6,963**	**7,496**	**6.6**	**8.4**	**8.9**	**7.7**
Switching	458	453	436	438	429	- 1.2	- 3.8	0.5	- 2.0
Transmission	370	393	407	405	406	6.2	3.4	- 0.4	0.2
Mobile communications infrastructure	138	258	158	58	58	86.1	-38.8	-63.5	0.0
Public network equipment	**967**	**1,104**	**1,000**	**901**	**893**	**14.2**	**- 9.4**	**-10.0**	**- 0.8**
PABX & key systems	125	126	123	121	119	0.8	- 1.8	- 1.9	- 1.9
Telephone sets	231	247	266	290	314	6.8	8.0	9.0	8.1
Mobile terminal equipment	104	98	99	102	114	- 6.4	1.6	2.4	12.0
Other terminal equipment	137	146	155	172	209	6.3	6.3	10.8	21.6
Private network equipment	**597**	**616**	**644**	**685**	**756**	**3.1**	**4.6**	**6.4**	**10.3**
Telecom equipment	**1,565**	**1,720**	**1,644**	**1,586**	**1,649**	**9.9**	**- 4.4**	**- 3.6**	**4.0**
Telephone services	3,787	3,976	4,136	4,301	4,494	5.0	4.0	4.0	4.5
Mobile telephone services	221	261	309	391	456	18.0	18.5	26.4	16.5
Switched data and leased line services	409	608	903	1,273	1,665	48.8	48.4	41.0	30.8
CaTV services	256	326	423	572	743	27.1	30.0	35.0	30.0
Telecom services	**4,673**	**5,171**	**5,771**	**6,537**	**7,357**	**10.7**	**11.6**	**13.3**	**12.6**
Total telecom	**6,238**	**6,892**	**7,416**	**8,123**	**9,006**	**10.5**	**7.6**	**9.5**	**10.9**
Total ICT	**11,770**	**12,787**	**13,808**	**15,086**	**16,503**	**8.6**	**8.0**	**9.3**	**9.4**

United Kingdom	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	1,032	901	767	716	682	-12.6	-14.9	- 6.6	- 4.8
Medium	791	776	833	903	984	- 1.9	7.3	8.4	9.0
Small	926	1,000	1,034	1,070	1,135	8.0	3.4	3.5	6.1
Workstations	414	442	529	594	639	6.7	19.7	12.3	7.6
PCs - portable	684	824	1,039	1,209	1,403	20.5	26.1	16.3	16.1
PCs - desktop	2,368	2,669	3,027	3,299	3,484	12.7	13.4	9.0	5.6
PC printers	599	720	817	895	957	20.3	13.4	9.6	6.9
Computer hardware	**6,814**	**7,332**	**8,046**	**8,687**	**9,285**	**7.6**	**9.7**	**8.0**	**6.9**
Copiers	698	710	718	725	730	1.7	1.2	0.9	0.8
Other office equipment	655	639	633	634	637	- 2.4	- 0.9	0.1	0.4
Office equipment	**1,353**	**1,349**	**1,351**	**1,359**	**1,367**	**- 0.3**	**0.2**	**0.5**	**0.6**
LAN hardware	507	682	801	952	1,017	34.5	17.4	18.9	6.8
Other data communications	485	463	457	440	414	- 4.6	- 1.3	- 3.8	- 5.9
Data communications hardware	**992**	**1,145**	**1,258**	**1,392**	**1,431**	**15.4**	**9.9**	**10.7**	**2.8**
IT hardware	**9,158**	**9,826**	**10,655**	**11,438**	**12,083**	**7.3**	**8.4**	**7.3**	**5.6**
Systems software	1,824	2,000	2,161	2,373	2,602	9.6	8.1	9.8	9.6
Application software	2,066	2,271	2,514	2,779	3,069	9.9	10.7	10.5	10.5
Software products	**3,890**	**4,270**	**4,676**	**5,152**	**5,672**	**9.8**	**9.5**	**10.2**	**10.1**
Professional services	2,769	3,172	3,712	3,981	4,198	14.5	17.1	7.2	5.4
Processing services	1,041	1,046	1,065	1,080	1,091	0.6	1.8	1.4	1.1
Network services	324	340	386	452	502	4.8	13.5	17.3	11.1
Hardware maintenance & support services	2,498	2,489	2,529	2,620	2,736	- 0.4	1.6	3.6	4.4
Services	**6,632**	**7,047**	**7,692**	**8,133**	**8,528**	**6.3**	**9.2**	**5.7**	**4.9**
Software and services	**10,523**	**11,317**	**12,368**	**13,285**	**14,199**	**7.5**	**9.3**	**7.4**	**6.9**
Total IT market	**19,681**	**21,143**	**23,023**	**24,723**	**26,282**	**7.4**	**8.9**	**7.4**	**6.3**
Switching	506	464	460	509	526	- 8.3	- 0.8	10.6	3.3
Transmission	465	508	571	602	648	9.3	12.4	5.4	7.6
Mobile communications infrastructure	674	525	413	364	364	-22.2	-21.3	-11.8	0.0
Public network equipment	**1,645**	**1,497**	**1,445**	**1,475**	**1,538**	**- 9.0**	**- 3.5**	**2.1**	**4.2**
PABX & key systems	512	482	463	443	424	- 5.9	- 4.0	- 4.2	- 4.4
Telephone sets	469	505	547	599	643	7.7	8.3	9.5	7.4
Mobile terminal equipment	505	723	752	692	609	43.2	4.0	- 8.0	-12.0
Other terminal equipment	527	655	763	923	1,159	24.4	16.4	21.0	25.6
Private network equipment	**2,013**	**2,366**	**2,525**	**2,657**	**2,835**	**17.5**	**6.7**	**5.2**	**6.7**
Telecom equipment	**3,658**	**3,862**	**3,969**	**4,132**	**4,373**	**5.6**	**2.8**	**4.1**	**5.8**
Telephone services	13,167	13,430	13,699	14,110	14,533	2.0	2.0	3.0	3.0
Mobile telephone services	1,743	2,647	3,170	3,484	3,714	51.8	19.8	9.9	6.6
Switched data and leased line services	3,033	3,317	3,693	4,277	5,061	9.4	11.4	15.8	18.3
CaTV services	107	196	490	1,102	2,313	83.6	150.0	125.0	110.0
Telecom services	**18,049**	**19,589**	**21,052**	**22,973**	**25,622**	**8.5**	**7.5**	**9.1**	**11.5**
Total telecom	**21,707**	**23,452**	**25,021**	**27,105**	**29,994**	**8.0**	**6.7**	**8.3**	**10.7**
Total ICT	**41,388**	**44,595**	**48,044**	**51,828**	**56,277**	**7.7**	**7.7**	**7.9**	**8.6**

Table 31
United Kingdom
ICT Market Value
(Million ECU)

Table 32
Czech & Slovak Republics
IT Market Value (Million ECU)

Czech & Slowak Republics	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	21	33	30	34	41	59.0	- 9.9	15.5	19.5
Medium	41	47	47	56	52	14.3	- 1.1	19.5	- 6.9
Small	41	53	46	48	56	27.8	-11.8	3.6	15.6
Workstations	9	12	15	19	24	31.0	27.3	27.8	21.7
PCs - portable	36	53	58	64	69	46.9	8.5	10.4	8.3
PCs - desktop	204	260	278	314	350	27.7	7.0	12.6	11.7
PC printers	89	87	102	113	119	- 1.5	17.0	10.4	5.9
Computer hardware	**441**	**545**	**576**	**648**	**711**	**23.7**	**5.6**	**12.4**	**9.7**
Copiers	42	45	49	53	55	6.6	9.7	7.3	4.8
Other office equipment	26	30	35	37	39	12.8	18.8	5.3	5.7
Office equipment	**68**	**75**	**84**	**90**	**95**	**9.0**	**13.3**	**6.5**	**5.1**
LAN hardware	3	4	4	5	6	17.5	9.3	13.5	12.9
Other data communications	3	4	4	5	6	17.5	9.3	13.5	12.9
Data communications hardware	**7**	**8**	**9**	**10**	**11**	**17.5**	**9.3**	**13.5**	**12.9**
IT hardware	**516**	**628**	**670**	**748**	**817**	**21.7**	**6.6**	**11.7**	**9.2**
Systems software	46	53	57	62	65	15.7	6.6	9.6	4.4
Application software	40	46	48	54	57	15.7	5.2	11.3	5.8
Software products	**86**	**99**	**105**	**116**	**122**	**15.7**	**5.9**	**10.4**	**5.1**
Professional services	92	155	168	176	193	68.2	8.1	5.0	9.5
Other services	75	86	94	99	103	14.6	9.8	5.4	4.2
Services	**167**	**241**	**262**	**276**	**297**	**44.2**	**8.7**	**5.1**	**7.6**
Software and services	**253**	**340**	**367**	**391**	**418**	**34.6**	**7.9**	**6.6**	**6.9**
Total IT market	**769**	**968**	**1,037**	**1,139**	**1,235**	**25.9**	**7.1**	**9.9**	**8.4**

Hungary	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	28	20	11	12	15	-28.9	-44.3	11.5	24.1
Medium	24	29	25	28	29	20.6	-14.0	10.0	5.5
Small	21	29	27	29	30	37.1	- 7.1	7.6	3.8
Workstations	5	10	13	17	20	103.8	22.4	33.3	20.0
PCs - portable	11	20	22	24	25	78.1	10.7	7.7	7.1
PCs - desktop	155	163	172	186	201	5.4	5.5	7.8	8.1
PC printers	50	58	58	62	68	15.8	- 0.9	7.4	9.9
Computer hardware	**294**	**329**	**327**	**356**	**388**	**11.9**	**- 0.6**	**9.0**	**8.9**
Copiers	32	35	37	38	39	9.1	4.8	2.3	4.4
Other office equipment	11	12	14	16	17	16.0	17.2	8.8	12.4
Office equipment	**43**	**47**	**51**	**53**	**57**	**10.8**	**8.0**	**4.1**	**6.8**
LAN hardware	3	2	2	3	3	-11.9	2.3	9.3	10.4
Other data communications	3	2	2	3	3	-11.9	2.3	9.3	10.4
Data communications hardware	**5**	**5**	**5**	**5**	**6**	**-11.9**	**2.3**	**9.3**	**10.4**
IT hardware	**342**	**381**	**383**	**415**	**451**	**11.4**	**0.5**	**8.3**	**8.7**
Systems software	30	44	48	55	62	45.8	9.8	14.5	12.1
Application software	30	44	48	55	62	45.8	9.8	14.5	12.1
Software products	**60**	**88**	**97**	**111**	**124**	**45.8**	**9.8**	**14.5**	**12.1**
Professional services	81	87	95	111	133	8.0	9.4	16.3	19.5
Other services	35	39	46	51	54	11.7	17.3	10.9	4.9
Services	**116**	**127**	**142**	**162**	**186**	**9.1**	**11.9**	**14.5**	**14.9**
Software and services	**176**	**215**	**238**	**273**	**311**	**21.7**	**11.0**	**14.5**	**13.8**
Total IT market	**518**	**596**	**621**	**688**	**761**	**14.9**	**4.3**	**10.7**	**10.7**

Table 33
Hungary
IT Market Value
(Million ECU)

Table 34
Poland
IT Market Value
(Million ECU)

Poland	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	0	3	10	11	16	-	187.5	18.3	39.0
Medium	21	34	33	34	35	64.4	- 2.8	1.5	4.7
Small	21	37	38	40	46	77.5	2.2	6.7	13.3
Workstations	5	7	12	14	18	48.1	63.5	20.9	31.0
PCs - portable	11	23	29	35	40	106.5	26.6	22.3	13.7
PCs - desktop	229	258	290	322	356	12.7	12.3	10.8	10.8
PC printers	87	86	96	105	119	- 1.3	12.0	9.3	12.8
Computer hardware	**374**	**449**	**508**	**562**	**631**	**20.1**	**13.1**	**10.6**	**12.2**
Copiers	52	56	62	64	66	8.9	9.8	3.1	2.6
Other office equipment	37	40	44	44	44	8.6	10.0	0.0	0.0
Office equipment	**89**	**97**	**106**	**108**	**110**	**8.8**	**9.9**	**1.8**	**1.6**
LAN hardware	8	9	10	12	13	3.0	13.1	23.9	11.7
Other data communications	8	9	10	12	13	3.0	13.1	23.9	11.7
Data communications hardware	**17**	**17**	**19**	**24**	**27**	**3.0**	**13.1**	**23.9**	**11.7**
IT hardware	**479**	**563**	**634**	**694**	**767**	**17.4**	**12.6**	**9.6**	**10.5**
Systems software	34	42	46	50	55	22.0	10.0	9.1	10.0
Application software	34	42	46	50	55	22.0	10.0	9.1	10.0
Software products	**69**	**84**	**92**	**101**	**111**	**22.0**	**10.0**	**9.1**	**10.0**
Professional services	63	69	86	102	113	9.3	24.4	19.6	9.8
Other services	66	71	78	88	93	9.0	9.4	12.9	5.7
Services	**129**	**140**	**164**	**191**	**206**	**9.2**	**16.8**	**16.4**	**7.9**
Software and services	**197**	**224**	**256**	**291**	**317**	**13.6**	**14.2**	**13.8**	**8.6**
Total IT market	**677**	**787**	**890**	**986**	**1,084**	**16.3**	**13.1**	**10.8**	**10.0**

Russia	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	24	29	41	52	65	20.6	39.2	28.4	23.5
Medium	13	28	37	46	61	120.2	31.3	24.1	31.3
Small	18	30	41	66	74	69.5	37.3	59.0	12.8
Workstations	22	28	39	56	67	26.0	38.4	44.7	19.5
PCs - portable	28	35	49	64	78	25.3	39.8	31.5	21.6
PCs - desktop	308	641	914	987	1,064	108.2	42.5	8.0	7.8
PC printers	117	171	223	246	272	45.7	30.6	10.6	10.3
Computer hardware	**530**	**962**	**1,343**	**1,518**	**1,680**	**81.6**	**39.6**	**13.0**	**10.7**
Copiers	45	59	64	74	84	32.3	8.3	15.0	14.3
Other office equipment	35	45	58	66	71	28.8	29.3	14.5	6.9
Office equipment	**79**	**104**	**122**	**140**	**155**	**30.8**	**17.4**	**14.8**	**10.8**
LAN hardware	11	20	32	34	36	79.3	56.7	7.2	7.1
Other data communications	8	13	21	23	24	79.3	56.7	7.2	7.1
Data communications hardware	**19**	**34**	**53**	**57**	**61**	**79.3**	**56.7**	**7.2**	**7.1**
IT hardware	**628**	**1,100**	**1,518**	**1,714**	**1,895**	**75.1**	**38.0**	**12.9**	**10.6**
Systems software	51	67	79	93	101	31.1	17.6	17.6	9.4
Application software	118	156	183	215	237	32.1	17.1	17.7	10.2
Software products	**169**	**223**	**262**	**308**	**339**	**31.8**	**17.2**	**17.6**	**10.0**
Professional services	162	185	200	223	254	14.3	8.3	11.5	13.8
Other services	146	154	166	185	208	5.3	7.5	11.6	12.5
Services	**308**	**339**	**366**	**408**	**462**	**10.0**	**8.0**	**11.6**	**13.2**
Software and services	**477**	**562**	**628**	**716**	**801**	**17.7**	**11.7**	**14.1**	**11.8**
Total IT market	**1,105**	**1,662**	**2,145**	**2,430**	**2,696**	**50.3**	**29.1**	**13.3**	**11.0**

Table 35
Russia
IT Market Value
(Million ECU)

Table 36
EU
ICT Market Value
(Million ECU)

EU	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	6,420	5,863	5,365	5,113	4,913	- 8.7	- 8.5	- 4.7	- 3.9
Medium	5,390	5,259	5,373	5,531	5,706	- 2.4	2.2	2.9	3.2
Small	5,309	5,469	5,600	5,792	6,059	3.0	2.4	3.4	4.6
Workstations	2,993	3,328	3,880	4,390	4,878	11.2	16.6	13.1	11.1
PCs - portable	3,103	3,811	4,521	5,380	6,178	22.8	18.6	19.0	14.8
PCs - desktop	12,907	14,428	17,061	18,967	20,709	11.8	18.3	11.2	9.2
PC printers	3,878	4,160	4,708	5,217	5,638	7.3	13.2	10.8	8.1
Computer hardware	**40,000**	**42,319**	**46,508**	**50,389**	**54,080**	**5.8**	**9.9**	**8.3**	**7.3**
Copiers	4,206	4,245	4,287	4,349	4,420	0.9	1.0	1.5	1.6
Other office equipment	3,702	3,620	3,601	3,606	3,623	- 2.2	- 0.5	0.2	0.5
Office equipment	**7,908**	**7,865**	**7,887**	**7,955**	**8,043**	**- 0.5**	**0.3**	**0.9**	**1.1**
LAN hardware	1,993	2,457	2,896	3,373	3,636	23.3	17.9	16.5	7.8
Other data communications	1,480	1,432	1,446	1,460	1,473	- 3.2	1.0	0.9	0.9
Data communications hardware	**3,473**	**3,889**	**4,342**	**4,833**	**5,110**	**12.0**	**11.7**	**11.3**	**5.7**
IT hardware	**51,381**	**54,072**	**58,738**	**63,177**	**67,233**	**5.2**	**8.6**	**7.6**	**6.4**
Systems software	10,395	11,097	11,877	12,801	13,783	6.8	7.0	7.8	7.7
Application software	12,876	13,993	15,426	17,016	18,660	8.7	10.2	10.3	9.7
Software products	**23,271**	**25,090**	**27,303**	**29,818**	**32,443**	**7.8**	**8.8**	**9.2**	**8.8**
Professional services	19,353	20,690	22,438	23,946	25,417	6.9	8.4	6.7	6.1
Processing services	7,796	8,117	8,465	8,852	9,220	4.1	4.3	4.6	4.1
Network services	1,398	1,543	1,783	2,097	2,409	10.4	15.5	17.6	14.9
Hardware maintenance & support services	14,322	14,082	14,052	14,245	14,532	- 1.7	- 0.2	1.4	2.0
Services	**42,868**	**44,432**	**46,739**	**49,140**	**51,578**	**3.6**	**5.2**	**5.1**	**5.0**
Software and services	**66,140**	**69,523**	**74,042**	**78,957**	**84,021**	**5.1**	**6.5**	**6.6**	**6.4**
Total IT market	**117,521**	**123,595**	**132,780**	**142,135**	**151,254**	**5.2**	**7.4**	**7.0**	**6.4**
Switching	5,707	5,492	5,261	5,218	5,160	- 3.8	- 4.2	- 0.8	- 1.1
Transmission	4,362	4,546	4,608	4,628	4,648	4.2	1.4	0.4	0.4
Mobile communications infrastructure	3,114	3,246	3,327	2,747	2,325	4.3	2.5	-17.4	-15.3
Public network equipment	**13,183**	**13,283**	**13,196**	**12,592**	**12,133**	**0.8**	**- 0.7**	**- 4.6**	**- 3.6**
PABX & key systems	3,153	3,117	3,128	3,110	3,074	- 1.1	0.4	- 0.6	- 1.2
Telephone sets	4,020	4,241	4,527	4,851	5,156	5.5	6.7	7.2	6.3
Mobile terminal equipment	2,013	2,583	3,006	3,282	3,492	28.3	16.4	9.2	6.4
Other terminal equipment	3,503	4,014	4,443	5,067	5,966	14.6	10.7	14.1	17.7
Private network equipment	**12,689**	**13,955**	**15,105**	**16,310**	**17,688**	**10.0**	**8.2**	**8.0**	**8.4**
Telecom equipment	**25,872**	**27,239**	**28,300**	**28,902**	**29,821**	**5.3**	**3.9**	**2.1**	**3.2**
Telephone services	78,625	83,205	88,067	94,068	100,612	5.8	5.8	6.8	7.0
Mobile telephone services	6,519	9,291	11,768	14,473	17,365	42.5	26.7	23.0	20.0
Switched data and leased line services	14,791	16,991	19,971	23,801	27,971	14.9	17.5	19.2	17.5
CaTV services	2,873	3,050	4,066	5,965	10,204	6.2	33.3	46.7	71.0
Telecom services	**102,808**	**112,537**	**123,872**	**138,308**	**156,152**	**9.5**	**10.1**	**11.7**	**12.9**
Total telecom	**128,680**	**139,776**	**152,173**	**167,210**	**185,973**	**8.6**	**8.9**	**9.9**	**11.2**
Total ICT	**246,201**	**263,371**	**284,953**	**309,345**	**337,227**	**7.0**	**8.2**	**8.6**	**9.0**

Western Europe	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	6,704	6,094	5,574	5,306	5,101	- 9.1	- 8.5	- 4.8	- 3.9
Medium	5,601	5,464	5,588	5,752	5,933	- 2.5	2.3	2.9	3.1
Small	5,624	5,820	5,944	6,139	6,419	3.5	2.1	3.3	4.6
Workstations	3,161	3,516	4,087	4,618	5,125	11.3	16.2	13.0	11.0
PCs - portable	3,429	4,151	4,937	5,872	6,726	21.1	18.9	18.9	14.5
PCs - desktop	13,913	15,620	18,480	20,495	22,345	12.3	18.3	10.9	9.0
PC printers	4,071	4,385	4,970	5,519	5,973	7.7	13.3	11.1	8.2
Computer hardware	**42,503**	**45,050**	**49,580**	**53,701**	**57,621**	**6.0**	**10.1**	**8.3**	**7.3**
Copiers	4,285	4,325	4,368	4,431	4,503	0.9	1.0	1.4	1.6
Other office equipment	3,921	3,837	3,816	3,822	3,839	- 2.1	- 0.5	0.1	0.4
Office equipment	**8,206**	**8,162**	**8,184**	**8,253**	**8,342**	**- 0.5**	**0.3**	**0.8**	**1.1**
LAN hardware	2,131	2,609	3,111	3,632	3,914	22.5	19.3	16.7	7.7
Other data communications	1,548	1,503	1,520	1,536	1,551	- 2.9	1.2	1.0	1.0
Data communications hardware	**3,679**	**4,112**	**4,632**	**5,169**	**5,465**	**11.8**	**12.6**	**11.6**	**5.7**
IT hardware	**54,388**	**57,324**	**62,396**	**67,123**	**71,428**	**5.4**	**8.8**	**7.6**	**6.4**
Systems software	11,167	11,956	12,808	13,840	14,940	7.1	7.1	8.1	8.0
Application software	13,668	14,884	16,431	18,156	19,954	8.9	10.4	10.5	9.9
Software products	**24,835**	**26,840**	**29,239**	**31,996**	**34,894**	**8.1**	**8.9**	**9.4**	**9.1**
Professional services	20,740	22,182	24,022	25,628	27,208	7.0	8.3	6.7	6.2
Processing services	8,475	8,810	9,166	9,566	9,947	4.0	4.0	4.4	4.0
Network services	1,619	1,758	2,033	2,396	2,736	8.6	15.7	17.8	14.2
Hardware maintenance & support services	15,347	15,087	15,064	15,296	15,633	- 1.7	- 0.2	1.5	2.2
Services	**46,180**	**47,837**	**50,286**	**52,886**	**55,525**	**3.6**	**5.1**	**5.2**	**5.0**
Software and services	**71,015**	**74,677**	**79,524**	**84,882**	**90,419**	**5.2**	**6.5**	**6.7**	**6.5**
Total IT market	**125,403**	**132,001**	**141,920**	**152,005**	**161,847**	**5.3**	**7.5**	**7.1**	**6.5**
Switching	6,330	6,108	5,853	5,813	5,743	- 3.5	- 4.2	- 0.7	- 1.2
Transmission	4,865	5,081	5,161	5,178	5,200	4.4	1.6	0.3	0.4
Mobile communications infrastructure	3,347	3,576	3,539	2,858	2,437	6.8	- 1.0	-19.2	-14.7
Public network equipment	**14,543**	**14,764**	**14,553**	**13,849**	**13,380**	**1.5**	**- 1.4**	**- 4.8**	**- 3.4**
PABX & key systems	3,323	3,289	3,297	3,275	3,236	- 1.0	0.2	- 0.7	- 1.2
Telephone sets	4,334	4,577	4,889	5,246	5,583	5.6	6.8	7.3	6.4
Mobile terminal equipment	2,223	2,817	3,228	3,488	3,693	26.7	14.6	8.0	5.9
Other terminal equipment	3,690	4,212	4,654	5,301	6,250	14.1	10.5	13.9	17.9
Private network equipment	**13,571**	**14,895**	**16,068**	**17,310**	**18,762**	**9.8**	**7.9**	**7.7**	**8.4**
Telecom equipment	**28,114**	**29,659**	**30,621**	**31,159**	**32,142**	**5.5**	**3.2**	**1.8**	**3.2**
Telephone services	83,682	88,502	93,576	99,811	106,620	5.8	5.7	6.7	6.8
Mobile telephone services	6,945	9,840	12,388	15,188	18,155	41.7	25.9	22.6	19.5
Switched data and leased line services	15,384	17,811	21,108	25,329	29,910	15.8	18.5	20.0	18.1
CaTV services	3,172	3,424	4,542	6,600	11,029	7.9	32.7	45.3	67.1
Telecom services	**109,184**	**119,577**	**131,614**	**146,928**	**165,714**	**9.5**	**10.1**	**11.6**	**12.8**
Total telecom	**137,298**	**149,236**	**162,235**	**178,087**	**197,856**	**8.7**	**8.7**	**9.8**	**11.1**
Total ICT	**262,700**	**281,238**	**304,155**	**330,092**	**359,703**	**7.1**	**8.1**	**8.5**	**9.0**

Table 37
Western Europe
ICT Market Value
(Million ECU)

Table 38
Eastern Europe
ICT Market Value
(Million ECU)

Eastern Europe	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	73	85	91	110	137	17.4	6.8	21.1	23.9
Medium	99	139	143	164	177	40.0	2.4	14.9	8.4
Small	101	148	152	182	205	47.4	2.5	20.1	12.2
Workstations	41	57	78	107	129	39.2	36.4	36.1	21.5
PCs - portable	86	130	157	186	212	51.7	20.3	18.8	13.8
PCs - desktop	896	1,323	1,655	1,808	1,971	47.7	25.1	9.2	9.0
PC printers	343	402	479	526	577	17.2	19.1	9.9	9.8
Computer hardware	**1,639**	**2,286**	**2,754**	**3,083**	**3,409**	**39.5**	**20.5**	**11.9**	**10.6**
Copiers	171	196	212	228	244	14.5	8.4	7.5	7.2
Other office equipment	109	127	152	163	172	16.8	19.5	7.6	5.3
Office equipment	**279**	**322**	**364**	**391**	**416**	**15.4**	**12.8**	**7.6**	**6.4**
LAN hardware	26	35	48	54	58	37.0	37.0	11.2	8.8
Other data communications	22	28	38	42	46	29.7	32.4	12.4	9.3
Data communications hardware	**48**	**64**	**86**	**96**	**104**	**33.6**	**34.9**	**11.7**	**9.0**
IT hardware	**1,966**	**2,671**	**3,204**	**3,570**	**3,930**	**35.9**	**19.9**	**11.4**	**10.1**
Systems software	162	206	230	261	284	27.5	11.5	13.3	8.9
Application software	223	288	326	375	412	29.5	13.1	15.0	9.9
Software products	**384**	**495**	**556**	**636**	**696**	**28.7**	**12.4**	**14.3**	**9.5**
Professional services	398	496	549	613	692	24.8	10.7	11.6	12.9
Other services	322	350	384	423	458	8.9	9.6	10.3	8.2
Services	**720**	**847**	**933**	**1,036**	**1,151**	**17.7**	**10.2**	**11.1**	**11.0**
Software and services	**1,104**	**1,341**	**1,489**	**1,672**	**1,846**	**21.5**	**11.0**	**12.3**	**10.4**
Total IT market	**3,070**	**4,013**	**4,693**	**5,242**	**5,776**	**30.7**	**16.9**	**11.7**	**10.2**
Total telecom	**5,574**	**6,026**	**6,560**	**7,185**	**7,810**	**8.1**	**8.9**	**9.5**	**8.7**
Total ICT	**8,644**	**10,039**	**11,253**	**12,427**	**13,586**	**16.1**	**12.1**	**10.4**	**9.3**

Austria	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	21	17	23	23	22	-19.0	35.3	0.0	- 4.3
Medium	368	271	373	382	394	-26.4	37.6	2.4	3.1
Small	4,313	3,773	4,880	5,252	5,678	-12.5	29.3	7.6	8.1
Workstations	4,482	3,181	3,777	4,339	4,902	-29.0	18.7	14.9	13.0
PCs - portable	35,766	46,012	58,435	73,044	84,001	28.6	27.0	25.0	15.0
PCs - desktop	195,427	244,385	297,256	337,237	408,423	25.1	21.6	13.5	21.1
PC printers	185,802	224,077	263,914	301,414	331,449	20.6	17.8	14.2	10.0
Typewriters	30,156	24,745	20,926	17,823	15,197	-17.9	-15.4	-14.8	-14.7
Calculators	418,005	418,666	426,309	438,410	454,721	0.2	1.8	2.8	3.7
Copiers	25,018	25,263	25,518	25,646	25,861	1.0	1.0	0.5	0.8
LAN cards	85,000	108,000	177,000	241,000	260,000	27.1	63.9	36.2	7.9

Table 39
Austria
IT Hardware Shipments
(Units)

Belgium/ Luxembourg	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	41	30	36	32	32	-26.8	20.0	-11.1	0.0
Medium	276	311	396	399	403	12.7	27.3	0.8	1.0
Small	4,274	4,855	5,438	5,647	5,902	13.6	12.0	3.8	4.5
Workstations	4,072	5,455	5,638	6,211	6,730	34.0	3.4	10.2	8.4
PCs - portable	54,633	54,666	64,506	76,117	89,057	0.1	18.0	18.0	17.0
PCs - desktop	234,786	249,466	269,272	294,439	318,274	6.3	7.9	9.3	8.1
PC printers	219,792	268,146	288,479	303,579	315,388	22.0	7.6	5.2	3.9
Typewriters	47,395	43,129	40,714	37,742	35,141	- 9.0	- 5.6	- 7.3	- 6.9
Calculators	537,636	569,895	590,228	610,122	630,866	6.0	3.6	3.4	3.4
Copiers	46,967	48,705	50,068	51,470	52,872	3.7	2.8	2.8	2.7
LAN cards	142,000	201,000	263,000	292,000	322,000	41.5	30.8	11.0	10.3

Table 40
Belgium/Luxembourg
IT Hardware Shipments
(Units)

Denmark	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	28	29	27	27	27	3.6	- 6.9	0.0	0.0
Medium	364	222	252	252	252	-39.0	13.5	0.0	0.0
Small	2,525	3,398	3,190	3,187	3,218	34.6	- 6.1	- 0.1	1.0
Workstations	2,255	2,287	2,350	2,525	2,810	1.4	2.8	7.4	11.3
PCs - portable	40,551	46,000	52,900	60,571	67,839	13.4	15.0	14.5	12.0
PCs - desktop	235,484	277,317	344,586	407,552	451,720	17.8	24.3	18.3	10.8
PC printers	193,317	250,345	293,451	314,212	325,323	29.5	17.2	7.1	3.5
Typewriters	27,392	24,653	22,255	20,074	18,127	-10.0	- 9.7	- 9.8	- 9.7
Calculators	442,543	437,233	442,042	449,999	456,285	- 1.2	1.1	1.8	1.4
Copiers	29,344	31,462	34,355	35,936	37,265	7.2	9.2	4.6	3.7
LAN cards	184,000	203,000	259,000	289,000	323,000	10.3	27.6	11.6	11.8

Table 41
Denmark
IT Hardware Shipments
(Units)

Table 42
Finland
IT Hardware Shipments
(Units)

Finland	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	9	4	8	8	8	-55.6	100.0	0.0	0.0
Medium	103	113	139	138	133	9.7	23.0	- 0.7	- 3.6
Small	2,136	2,316	2,145	2,138	2,159	8.4	- 7.4	- 0.3	1.0
Workstations	2,042	3,246	4,573	5,326	5,946	59.0	40.9	16.5	11.6
PCs - portable	19,804	24,920	33,891	38,467	43,583	25.8	36.0	13.5	13.3
PCs - desktop	135,686	177,958	236,000	273,011	299,990	31.2	32.6	15.7	9.9
PC printers	97,006	123,198	144,088	156,066	163,183	27.0	17.0	8.3	4.6
Typewriters	18,713	15,869	15,075	14,126	13,179	-15.2	- 5.0	- 6.3	- 6.7
Calculators	317,226	320,398	323,602	327,809	333,710	1.0	1.0	1.3	1.8
Copiers	32,313	32,608	33,586	34,359	34,806	0.9	3.0	2.3	1.3
LAN cards	133,000	174,000	224,000	253,000	278,000	30.8	28.7	12.9	9.9

Table 43
France
IT Hardware Shipments
(Units)

France	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	125	128	107	103	103	2.4	-16.4	- 3.7	0.0
Medium	1,548	1,287	2,022	2,020	2,022	-16.9	57.1	- 0.1	0.1
Small	21,596	22,280	24,254	25,412	26,891	3.2	8.9	4.8	5.8
Workstations	21,365	27,548	31,707	37,755	43,260	28.9	15.1	19.1	14.6
PCs - portable	239,886	272,882	316,543	390,298	467,577	13.8	16.0	23.3	19.8
PCs - desktop	1,309,525	1,436,508	1,630,482	1,910,091	2,241,524	9.7	13.5	17.1	17.4
PC printers	1,138,215	1,328,297	1,409,935	1,495,860	1,550,846	16.7	6.1	6.1	3.7
Typewriters	252,902	212,691	192,060	176,695	163,796	-15.9	- 9.7	- 8.0	- 7.3
Calculators	3,081,665	3,312,789	3,528,121	3,669,246	3,810,370	7.5	6.5	4.0	3.8
Copiers	260,706	265,920	273,897	282,662	291,707	2.0	3.0	3.2	3.2
LAN cards	693,000	914,000	1,144,000	1,403,000	1,616,000	31.9	25.2	22.6	15.2

Table 44
Germany
IT Hardware Shipments
(Units)

Germany	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	230	231	222	233	236	0.4	- 3.9	5.0	1.3
Medium	3,012	3,293	4,355	4,549	5,022	9.3	32.3	4.5	10.4
Small	29,414	29,582	36,918	39,918	43,559	0.6	24.8	8.1	9.1
Workstations	40,096	43,742	53,192	61,977	70,131	9.1	21.6	16.5	13.2
PCs - portable	377,160	441,036	597,163	686,737	792,838	16.9	35.4	15.0	15.5
PCs - desktop	2,464,944	3,010,549	3,289,151	3,668,731	4,012,527	22.1	9.3	11.5	9.4
PC printers	2,231,866	2,705,022	2,951,592	3,151,358	3,297,524	21.2	9.1	6.8	4.6
Typewriters	874,991	666,289	546,222	453,753	377,377	-23.9	-18.0	-16.9	-16.8
Calculators	9,592,627	8,888,342	8,446,698	8,082,884	7,862,170	- 7.3	- 5.0	- 4.3	- 2.7
Copiers	556,862	536,706	533,538	529,802	527,904	- 3.6	- 0.6	- 0.7	- 0.4
LAN cards	1,212,000	1,712,000	1,857,000	1,980,000	2,049,000	41.3	8.5	6.6	3.5

Greece	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	2	3	2	2	2	50.0	-33.3	0.0	0.0
Medium	75	71	80	83	87	- 5.3	12.7	3.8	4.8
Small	891	894	1,166	1,321	1,529	0.3	30.4	13.3	15.7
Workstations	626	1,004	1,276	1,525	1,749	60.4	27.1	19.5	14.7
PCs - portable	7,315	9,404	10,633	13,579	15,915	28.6	13.1	27.7	17.2
PCs - desktop	63,819	71,810	82,192	96,000	107,674	12.5	14.5	16.8	12.2
PC printers	16,789	23,108	33,576	40,224	46,378	37.6	45.3	19.8	15.3
Typewriters	129,410	153,399	166,160	173,305	177,638	18.5	8.3	4.3	2.5
Calculators	92,809	114,506	125,996	138,292	150,587	23.4	10.0	9.8	8.9
Copiers	21,265	18,603	16,242	15,219	14,732	-12.5	-12.7	- 6.3	- 3.2
LAN cards	56,761	57,579	58,969	61,210	63,964	1.4	2.4	3.8	4.5

Table 45
Greece
IT Hardware Shipments
(Units)

Ireland	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	3	3	4	4	5	0.0	33.3	0.0	25.0
Medium	59	67	83	86	92	13.6	23.9	3.6	7.0
Small	1,372	1,447	1,753	1,955	2,195	5.5	21.1	11.5	12.3
Workstations	2,248	2,733	3,406	4,182	4,868	21.6	24.6	22.8	16.4
PCs - portable	7,113	7,743	8,920	10,017	11,399	8.9	15.2	12.3	13.8
PCs - desktop	50,909	49,541	50,909	55,440	58,179	- 2.7	2.8	8.9	4.9
PC printers	32,726	36,829	40,180	42,913	46,131	12.5	9.1	6.8	7.5
Typewriters	45,730	40,738	32,620	26,988	22,454	-10.9	-19.9	-17.3	-16.8
Calculators	411,936	425,515	450,395	467,060	483,724	3.3	5.8	3.7	3.6
Copiers	31,426	30,242	29,202	29,348	29,700	- 3.8	- 3.4	0.5	1.2
LAN cards	21,630	23,005	23,931	25,845	28,249	6.4	4.0	8.0	9.3

Table 46
Ireland
IT Hardware Shipments
(Units)

Italy	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	83	76	106	106	107	- 8.4	39.5	0.0	0.9
Medium	1,811	1,152	1,180	1,156	1,144	-36.4	2.4	- 2.0	- 1.0
Small	16,141	18,620	19,322	19,892	20,881	15.4	3.8	3.0	5.0
Workstations	9,749	14,178	16,445	18,620	20,947	45.4	16.0	13.2	12.5
PCs - portable	151,375	148,991	182,514	209,891	235,078	- 1.6	22.5	15.0	12.0
PCs - desktop	703,126	738,283	893,322	1,019,280	1,121,208	5.0	21.0	14.1	10.0
PC printers	804,670	852,146	891,386	945,508	988,808	5.9	4.6	6.1	4.6
Typewriters	167,400	142,600	121,474	103,478	87,956	-14.8	-14.8	-14.8	-15.0
Calculators	2,187,000	2,036,000	1,918,000	1,824,000	1,732,800	- 6.9	- 5.8	- 4.9	- 5.0
Copiers	173,793	162,626	158,723	156,977	157,291	- 6.4	- 2.4	- 1.1	0.2
LAN cards	280,000	387,000	532,000	651,000	737,000	38.2	37.5	22.4	13.2

Table 47
Italy
IT Hardware Shipments
(Units)

Table 48
Netherlands
IT Hardware Shipments
(Units)

Netherlands	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	37	46	34	34	35	24.3	-26.1	0.0	2.9
Medium	659	418	687	677	680	-36.6	64.4	- 1.5	0.4
Small	6,705	8,060	7,876	8,146	8,586	20.2	- 2.3	3.4	5.4
Workstations	8,875	7,810	8,933	10,139	11,235	-12.0	14.4	13.5	10.8
PCs - portable	75,691	97,848	124,756	150,955	181,146	29.3	27.5	21.0	20.0
PCs - desktop	509,516	639,497	805,833	915,696	1,035,530	25.5	26.0	13.6	13.1
PC printers	418,877	495,113	612,297	572,359	580,873	18.2	23.7	- 6.5	1.5
Typewriters	115,006	96,950	89,756	84,256	79,285	-15.7	- 7.4	- 6.1	- 5.9
Calculators	1,161,098	1,172,700	1,184,427	1,195,087	1,204,648	1.0	1.0	0.9	0.8
Copiers	111,031	115,250	117,555	120,729	123,265	3.8	2.0	2.7	2.1
LAN cards	309,000	476,000	590,000	716,000	804,000	54.0	23.9	21.4	12.3

Table 49
Norway
IT Hardware Shipments
(Units)

Norway	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	12	17	10	10	10	41.7	-41.2	0.0	0.0
Medium	130	95	146	144	144	-26.9	53.7	- 1.4	0.0
Small	2,768	2,720	2,935	2,902	2,935	- 1.7	7.9	- 1.1	1.1
Workstations	2,954	3,899	3,976	4,105	4,522	32.0	2.0	3.2	10.2
PCs - portable	35,820	46,300	55,745	66,727	76,736	29.3	20.4	19.7	15.0
PCs - desktop	213,965	236,620	297,101	323,198	344,103	10.6	25.6	8.8	6.5
PC printers	115,056	157,281	173,631	187,399	197,727	36.7	10.4	7.9	5.5
Typewriters	24,584	21,367	19,665	18,052	17,005	-13.1	- 8.0	- 8.2	- 5.8
Calculators	363,356	354,635	343,287	335,048	331,362	- 2.4	- 3.2	- 2.4	- 1.1
Copiers	22,947	23,796	24,748	25,664	26,562	3.7	4.0	3.7	3.5
LAN cards	168,000	188,000	271,000	298,000	322,000	11.9	44.1	10.0	8.1

Table 50
Portugal
IT Hardware Shipments
(Units)

Portugal	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	1	2	3	3	4	100.0	50.0	0.0	33.3
Medium	84	95	108	112	118	13.1	13.7	3.7	5.4
Small	1,060	1,479	1,727	1,948	2,199	39.5	16.8	12.8	12.9
Workstations	640	1,000	1,231	1,462	1,611	56.3	23.1	18.8	10.2
PCs - portable	5,900	6,700	7,400	8,200	8,778	13.6	10.4	10.8	7.0
PCs - desktop	121,000	132,000	144,300	151,200	161,855	9.1	9.3	4.8	7.0
PC printers	110,600	124,100	136,262	148,117	159,522	12.2	9.8	8.7	7.7
Typewriters	136,405	165,685	191,035	200,969	201,572	21.5	15.3	5.2	0.3
Calculators	103,065	121,509	147,998	170,494	189,418	17.9	21.8	15.2	11.1
Copiers	24,276	21,260	21,898	22,949	24,142	-12.4	3.0	4.8	5.2
LAN cards	112,103	115,819	126,127	139,435	155,743	3.3	8.9	10.6	11.7

Spain	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	52	35	34	34	34	-32.7	- 2.9	0.0	0.0
Medium	573	448	575	593	619	-21.8	28.3	3.1	4.4
Small	7,978	7,631	10,366	11,174	12,264	- 4.3	35.8	7.8	9.8
Workstations	5,725	7,822	8,498	9,652	11,276	36.6	8.6	13.6	16.8
PCs - portable	86,265	68,549	80,888	91,808	106,222	-20.5	18.0	13.5	15.7
PCs - desktop	532,777	506,671	591,792	669,769	752,996	- 4.9	16.8	13.2	12.4
PC printers	564,437	580,806	604,709	648,901	674,222	2.9	4.1	7.3	3.9
Typewriters	132,345	115,140	94,415	82,141	74,173	-13.0	-18.0	-13.0	- 9.7
Calculators	1,411,823	1,468,296	1,515,282	1,562,255	1,591,938	4.0	3.2	3.1	1.9
Copiers	112,517	110,717	112,931	115,416	117,839	- 1.6	2.0	2.2	2.1
LAN cards	216,000	273,000	358,000	430,000	532,000	26.4	31.1	20.1	23.7

Table 51
Spain
IT Hardware Shipments
(Units)

Sweden	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	29	30	20	20	20	3.4	-33.3	0.0	0.0
Medium	381	335	351	360	368	-12.1	4.8	2.6	2.2
Small	4,309	5,467	5,387	5,487	5,618	26.9	- 1.5	1.9	2.4
Workstations	8,502	11,025	12,981	14,964	17,125	29.7	17.7	15.3	14.4
PCs - portable	76,427	92,910	111,492	128,216	144,884	21.6	20.0	15.0	13.0
PCs - desktop	343,573	436,345	583,876	630,560	658,521	27.0	33.8	8.0	4.4
PC printers	255,835	310,072	346,814	373,021	390,855	21.2	11.8	7.6	4.8
Typewriters	99,404	86,482	70,915	57,654	48,141	-13.0	-18.0	-18.7	-16.5
Calculators	1,383,587	1,409,564	1,454,670	1,499,765	1,546,258	1.9	3.2	3.1	3.1
Copiers	77,637	76,395	77,923	79,403	80,832	- 1.6	2.0	1.9	1.8
LAN cards	289,000	422,000	508,000	567,000	567,000	46.0	20.4	11.6	0.0

Table 52
Sweden
IT Hardware Shipments
(Units)

Switzerland	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	49	33	32	29	30	-32.7	- 3.0	- 9.4	3.4
Medium	397	330	407	429	451	-16.9	23.3	5.4	5.1
Small	5,689	7,429	7,562	8,159	8,871	30.6	1.8	7.9	8.7
Workstations	9,055	11,338	13,874	16,645	19,180	25.2	22.4	20.0	15.2
PCs - portable	87,549	98,936	121,691	139,458	154,380	13.0	23.0	14.6	10.7
PCs - desktop	335,136	406,451	496,544	575,982	640,764	21.3	22.2	16.0	11.2
PC printers	254,831	309,365	359,152	415,957	460,264	21.4	16.1	15.8	10.7
Typewriters	68,850	62,516	56,414	50,998	46,511	- 9.2	- 9.8	- 9.6	- 8.8
Calculators	739,901	748,780	766,001	784,386	805,564	1.2	2.3	2.4	2.7
Copiers	58,468	60,923	63,360	65,895	68,333	4.2	4.0	4.0	3.7
LAN cards	161,000	216,000	349,000	460,000	457,000	34.2	61.6	31.8	- 0.7

Table 53
Switzerland
IT Hardware Shipments
(Units)

Table 54
United Kingdom
IT Hardware Shipments
(Units)

United Kingdom	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	164	155	116	106	105	- 5.5	- 25.2	- 8.6	- 0.9
Medium	2,517	2,146	2,520	2,732	2,976	-14.7	17.4	8.4	8.9
Small	24,431	30,781	33,865	36,883	40,433	26.0	10.0	8.9	9.6
Workstations	27,188	33,062	43,387	52,294	59,981	21.6	31.2	20.5	14.7
PCs - portable	377,438	430,848	518,310	611,606	703,347	14.2	20.3	18.0	15.0
PCs - desktop	1,850,662	2,023,356	2,261,627	2,489,866	2,693,232	9.3	11.8	10.1	8.2
PC printers	1,344,105	1,573,947	1,719,830	1,843,942	1,924,001	17.1	9.3	7.2	4.3
Typewriters	313,968	269,070	238,665	215,037	194,179	-14.3	-11.3	- 9.9	- 9.7
Calculators	3,594,847	3,602,037	3,648,863	3,725,489	3,818,626	0.2	1.3	2.1	2.5
Copiers	283,928	292,446	305,606	318,136	328,634	3.0	4.5	4.1	3.3
LAN cards	1,100,000	1,720,000	1,859,000	2,050,000	2,214,000	56.4	8.1	10.3	8.0

Table 55
Czech & Slowak Republics
IT Hardware Shipments
(Units)

Czech & Slowak Republics	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	3	13	10	13	15	333.3	-23.1	30.0	15.4
Medium	115	143	144	156	172	24.3	0.7	8.3	10.3
Small	2,097	2,416	2,070	2,180	2460	15.2	-14.3	5.3	12.8
Workstations	927	821	1,050	1,230	1450	-11.4	27.9	17.1	17.9
PCs - portable	24,015	29,544	32,600	36,000	39000	23.0	10.3	10.4	8.3
PCs - desktop	169,915	199,736	218,400	248,000	279,800	17.6	9.3	13.6	12.8
PC printers	174,811	215,668	238,512	253,156	266,965	23.4	10.6	6.1	5.5
Copiers	20,900	22,300	24,000	26,000	28,000	6.7	7.6	8.3	7.7
LAN cards	67,966	79,894	87,360	99,200	111,920	17.5	9.3	13.6	12.8

Table 56
Hungary
IT Hardware Shipments
(Units)

Hungary	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	5	5	4	5	8	0.0	-20.0	25.0	60.0
Medium	54	73	75	87	92	35.2	2.7	16.0	5.7
Small	764	667	790	850	920	-12.7	18.4	7.6	8.2
Workstations	446	690	740	870	980	54.7	7.2	17.6	12.6
PCs - portable	5,210	9,052	10,100	12,000	13,200	73.7	11.6	18.8	10.0
PCs - desktop	101,030	107,628	118,400	129,400	142,300	6.5	10.0	9.3	10.0
PC printers	86,583	90,937	98,610	110,434	122,752	5.0	8.4	12.0	11.2
Copiers	13,000	14,500	16,000	16,800	17,100	11.5	10.3	5.0	1.8
LAN cards	52,536	46,280	47,360	51,760	56,920	-11.9	2.3	9.3	10.0

Poland	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	0	1	3	3	5	100.0	200.0	0.0	66.7
Medium	54	84	85	95	100	55.6	1.2	11.8	5.3
Small	650	906	960	1,090	1,200	39.4	6.0	13.5	10.1
Workstations	575	722	1,000	1,420	1,750	25.6	38.5	42.0	23.2
PCs - portable	7,540	13,075	18,000	25,000	30,000	73.4	37.7	38.9	20.0
PCs - desktop	207,910	232,605	263,000	300,000	335,000	11.9	13.1	14.1	11.7
PC printers	197,900	218,682	246,892	272,877	302,945	10.5	12.9	10.5	11.0
Copiers	25,000	26,750	28,650	32,000	35,000	7.0	7.1	11.7	9.4
LAN cards	79,005	81,400	92,050	114,000	127,300	3.0	13.1	23.8	11.7

Table 57
Poland
IT Hardware Shipments
(Units)

Russia	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	15	18	22	40	46	20.0	22.2	81.8	15.0
Medium	60	85	110	143	180	41.7	29.4	30.0	25.9
Small	640	1,100	1,860	2,900	3,220	71.9	69.1	55.9	11.0
Workstations	1,350	1,850	2,400	3,850	4,600	37.0	29.7	60.4	19.5
PCs - portable	18,500	25,000	35,000	46,000	56,000	35.1	40.0	31.4	21.7
PCs - desktop	390,000	700,000	915,000	980,000	1,050,000	79.5	30.7	7.1	7.1
PC printers	380,000	540,000	705,000	780,000	860,000	42.1	30.6	10.6	10.3
Copiers	25,500	33,700	36,500	42,000	48,000	32.2	8.3	15.1	14.3
LAN cards	97,500	175,000	274,500	294,000	315,000	79.5	56.9	7.1	7.1

Table 58
Russia
IT Hardware Shipments
(Units)

EU	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	825	789	742	735	740	- 4.4	- 6.0	- 0.9	0.7
Medium	11,830	10,229	13,121	13,539	14,310	-13.5	28.3	3.2	5.7
Small	127,145	140,583	158,287	168,360	181,112	10.6	12.6	6.4	7.6
Workstations	137,865	164,093	197,394	230,971	262,571	19.0	20.3	17.0	13.7
PCs - portable	1,555,324	1,748,509	2,168,351	2,549,506	2,951,664	12.4	24.0	17.6	15.8
PCs - desktop	8,751,235	9,993,686	11,480,598	12,918,872	14,321,654	14.2	14.9	12.5	10.9
PC printers	7,614,038	8,895,206	9,736,513	10,337,473	10,794,503	16.8	9.5	6.2	4.4
Typewriters	2,391,217	2,057,440	1,842,292	1,664,040	1,508,214	-14.0	-10.5	- 9.7	- 9.4
Calculators	24,735,860	24,297,450	24,202,631	24,160,911	24,266,123	- 1.8	- 0.4	- 0.2	0.4
Copiers	1,787,082	1,768,202	1,791,044	1,818,052	1,846,851	- 1.1	1.3	1.5	1.6
LAN cards	4,833,494	6,786,403	7,980,027	9,098,490	9,949,956	40.4	17.6	14.0	9.4

Table 59
EU
IT Hardware Shipments
(Units)

Table 60
Western Europe
IT Hardware Shipments
(Units)

Western Europe	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	886	839	784	774	780	- 5.3	- 6.6	- 1.3	0.8
Medium	12,357	10,654	13,674	14,112	14,905	-13.8	28.3	3.2	5.6
Small	135,602	150,732	168,784	179,421	192,918	11.2	12.0	6.3	7.5
Workstations	149,874	179,330	215,244	251,721	286,273	19.7	20.0	16.9	13.7
PCs - portable	1,678,693	1,893,745	2,345,787	2,755,691	3,182,780	12.8	23.9	17.5	15.5
PCs - desktop	9,300,336	10,636,757	12,274,243	13,818,052	15,306,521	14.4	15.4	12.6	10.8
PC printers	7,983,925	9,361,852	10,269,296	10,940,829	11,452,494	17.3	9.7	6.5	4.7
Typewriters	2,484,651	2,141,323	1,918,372	1,733,091	1,571,730	-13.8	-10.4	- 9.7	- 9.3
Calculators	25,839,116	25,400,865	25,311,919	25,280,344	25,403,049	- 1.7	- 0.4	- 0.1	0.5
Copiers	1,868,497	1,852,922	1,879,152	1,909,610	1,941,746	- 0.8	1.4	1.6	1.7
LAN cards	5,162,494	7,190,403	8,600,027	9,856,490	10,728,956	39.3	19.6	14.6	8.9

Table 61
Eastern Europe
IT Hardware Shipments
(Units)

Eastern Europe	1993	1994	1995	1996	1997	1994/93 %	1995/94 %	1996/95 %	1997/96 %
Large	23	37	39	61	74	60.9	5.4	56.4	21.3
Medium	283	385	414	481	544	36.0	7.5	16.2	13.1
Small	4,151	5,089	5,680	7,020	7,800	22.6	11.6	23.6	11.1
Workstations	3,298	4,083	5,190	7,370	8,780	23.8	27.1	42.0	19.1
PCs - portable	55,265	76,671	95,700	119,000	138,200	38.7	24.8	24.3	16.1
PCs - desktop	868,855	1,239,969	1,514,800	1,657,400	1,807,100	42.7	22.2	9.4	9.0
PC printers	839,294	1,065,287	1,289,014	1,416,467	1,552,662	26.9	21.0	9.9	9.6
Copiers	84,400	97,250	105,150	116,800	128,100	15.2	8.1	11.1	9.7
LAN cards	297,007	382,574	501,270	558,960	611,140	28.8	31.0	11.5	9.3

8. ICT Production and Trade Flows

The data presented on trade is based upon the Combined Nomenclature, an international standard for such data. The details concerning the product categories included is 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.

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 62
Production of ICT Hardware
(Thousand ECU)

EU	1993	1994	1993 % breakdown	1994 % breakdown
Austria	4,886	5,141	2.0	2.0
Belgium/Luxembourg	7,266	7,792	3.0	3.0
Denmark	4,325	4,774	1.8	1.8
Finland	3,571	3,785	1.5	1.4
France	41,796	44,256	17.1	16.8
Germany	66,653	71,141	27.2	27.0
Greece	1,574	1,872	0.6	0.7
Ireland	4,340	4,489	1.8	1.7
Italy	25,233	26,772	10.3	10.2
Netherlands	12,037	13,604	4.9	5.2
Norway	3,963	4,309	1.6	1.6
Portugal	2,324	2,614	0.9	1.0
Spain	10,150	11,200	4.1	4.3
Sweden	8,408	8,952	3.4	3.4
Switzerland	9,944	10,515	4.1	4.0
UK	38,606	42,416	15.8	16.1
Total	244,751	263,316	100.0	100.0

Table 63
Austria
Trade in ICT Hardware
(Thousand ECU)

	1992	1993	1994
Imports from EU	674,006	731,137	844,591
Imports from other countries	1,005,693	914,869	1,062,612
Imports total	1,679,699	1,646,006	1,907,203
Exports to EU	372,648	280,327	245,953
Exports to other countries	332,087	311,218	350,602
Exports total	704,735	591,545	596,555
Exports to EU/total exports	52.9%	47.4%	41.2%
Imports from EU/total imports	40.1%	44.4%	44.3%
Trade balance	-974,964	-1,054,461	-1,310,648
EU trade balance	-301,358	- 450,810	- 598,638

Table 64
Belgium/Luxembourg
Trade in ICT Hardware
(Thousand ECU)

	1992	1993	1994
Imports intra-EU	1,725,489	1,508,064	1,779,553
Imports extra-EU	697,639	620,923	754,058
Imports total	2,423,128	2,128,987	2,533,611
Exports intra-EU	939,282	1,066,922	1,203,070
Exports extra-EU	482,126	611,782	1,003,193
Exports total	1,421,408	1,678,704	2,206,263
Extra-EU/intra-EU exports	51.3%	57.3%	83.4%
Extra-EU/intra-EU imports	40.4%	41.2%	42.4%
Trade balance	-1,001,720	-450,283	-327,348
Extra-EU trade balance	- 215,513	- 9,141	249,135

Table 65
Denmark
Trade in ICT Hardware
(Thousand ECU)

	1992	1993	1994
Imports intra-EU	994,440	996,569	1,034,533
Imports extra-EU	465,585	463,542	525,029
Imports total	1,460,025	1,460,111	1,559,562
Exports intra-EU	244,109	160,414	201,857
Exports extra-EU	354,926	344,658	447047
Exports total	599,035	505,072	648,904
Extra-EU/intra-EU exports	145.4%	214.9%	221.5%
Extra-EU/intra-EU imports	46.8%	46.5%	50.8%
Trade balance	-860,990	-955,039	-910,658
Extra-EU trade balance	-110,659	-118,884	- 77,982

	1992	1993	1994
Imports from EU	235,809	244,334	313,118
Imports from other countries	539,831	564,865	832,954
Imports total	775,640	809,199	1,146,072
Exports to EU	390,783	455,376	599,216
Exports to other countries	281,115	458,167	657,178
Exports total	671,898	913,543	1,256,394
Exports to EU/total exports	58.2%	49.8%	47.7%
Imports from EU/total imports	30.4%	30.2%	27.3%
Trade balance	-103,742	104,344	110,322
EU trade balance	154,974	211,042	286,098

Table 66
Finland
Trade in ICT Hardware
(Thousand ECU)

	1992	1993	1994
Imports intra-EU	5,391,038	5,268,517	5,923,238
Imports extra-EU	3,337,009	3,382,821	4,014,284
Imports total	8,728,047	8,651,338	9,937,522
Exports intra-EU	4,194,973	4,063,636	4,734,635
Exports extra-EU	2,215,174	2,350,053	2,544,368
Exports total	6,410,147	6,413,689	7,279,003
Extra-EU/intra-EU exports	52.8%	57.8%	53.7%
Extra-EU/intra-EU imports	61.9%	64.2%	67.8%
Trade balance	-2,317,900	-2,237,649	-2,658,519
Extra-EU trade balance	-1,121,835	-1,032,768	-1,469,916

Table 67
France
Trade in ICT Hardware
(Thousand ECU)

	1992	1993	1994
Imports intra-EU	6,846,798	5,733,191	6,815,048
Imports extra-EU	8,900,954	9,467,006	10,063,036
Imports total	15,747,752	15,200,197	16,878,084
Exports intra-EU	5,311,209	5,084,938	5,677,217
Exports extra-EU	4,312,408	4,759,559	5,623,051
Exports total	9,623,617	9,844,497	11,300,268
Extra-EU/intra-EU exports	81.2%	93.6%	99.0%
Extra-EU/intra-EU imports	130.0%	165.1%	147.7%
Trade balance	-6,124,135	-5,355,700	-5,577,816
Extra-EU trade balance	-4,588,546	-4,707,447	-4,439,985

Table 68
Germany
Trade in ICT Hardware
(Thousand ECU)

Table 69
Greece
Trade in ICT Hardware
(Thousand ECU)

	1992	1993	1994
Imports intra-EU	233,266	381,898	372,957
Imports extra-EU	155,909	162,238	135,413
Imports total	389,175	544,136	508,370
Exports intra-EU	26,879	51,302	40,055
Exports extra-EU	7,477	13,004	14,571
Exports total	34,356	64,306	54,626
Extra-EU/intra-EU exports	27.8%	25.3%	36.4%
Extra-EU/intra-EU imports	66.8%	42.5%	36.3%
Trade balance	-354,819	-479,830	-453,744
Extra-EU trade balance	-148,432	-149,234	-120,842

Table 70
Ireland
Trade in ICT Hardware
(Thousand ECU)

	1992	1993	1994
Imports intra-EU	820,614	745,517	773,728
Imports extra-EU	763,753	1,565,713	2,055,872
Imports total	1,584,367	2,311,230	2,829,600
Exports intra-EU	2,545,101	2,873,709	3,518,890
Exports extra-EU	1,056,446	1,856,879	1,782,637
Exports total	3,601,547	4,730,588	5,301,527
Extra-EU/intra-EU exports	41.5%	64.6%	50.7%
Extra-EU/intra-EU imports	93.1%	210.0%	265.7%
Trade balance	2,017,180	2,419,358	2,471,927
Extra-EU trade balance	292,693	291,166	-273,235

Table 71
Italy
Trade in ICT Hardware
(Thousand ECU)

	1992	1993	1994
Imports intra-EU	3,404,664	3,081,983	3,348,104
Imports extra-EU	2,108,719	1,727,369	1,726,871
Imports total	5,513,383	4,809,352	5,074,975
Exports intra-EU	2,533,980	2,813,318	2,844,340
Exports extra-EU	920,428	1,203,399	1,381,542
Exports total	3,454,408	4,016,717	4,225,882
Extra-EU/intra-EU exports	36.3%	42.8%	48.6%
Extra-EU/intra-EU imports	61.9%	56.0%	51.6%
Trade balance	-2,058,975	-792,635	-849,093
Extra-EU trade balance	-1,188,291	-523,970	-345,329

	1992	1993	1994
Imports intra-EU	4,004,984	3,697,268	4,864,276
Imports extra-EU	4,778,019	4,092,617	5,800,501
Imports total	8,783,003	7,789,885	10,664,777
Exports intra-EU	4,838,998	5,350,143	8,485,912
Exports extra-EU	1,446,808	1,446,909	2,000,159
Exports total	6,285,806	6,797,052	10,486,071
Extra-EU/intra-EU exports	29.9%	27.0%	23.6%
Extra-EU/intra-EU imports	119.3%	110.7%	119.2%
Trade balance	-2,497,197	- 992,833	- 178,706
Extra-EU trade balance	-3,331,211	-2,645,708	-3,800,342

Table 72
Netherlands
Trade in ICT Hardware
(Thousand ECU)

	1992	1993	1994
Imports from EU	343,532	417,653	481,089
Imports from other countries	665,401	692,509	700,867
Imports total	1,008,933	1110162	1,181,956
Exports to EU	164,209	136,294	189,652
Exports to other countries	197,752	206,461	221,727
Exports total	361,961	342755	411,379
Exports to EU/total exports	45.4%	39.8%	46.1%
Imports from EU/total imports	34.0%	37.6%	40.7%
Trade balance	-646,972	-767,407	-770,577
EU trade balance	-179,323	-281,359	-291,437

Table 73
Norway
Trade in ICT Hardware
(Thousand ECU)

	1992	1993	1994
Imports intra-EU	585,768	487,667	508,383
Imports extra-EU	199,067	153,948	142,712
Imports total	784,835	641,615	651,095
Exports intra-EU	78,831	57,599	55,956
Exports extra-EU	25,851	18,488	19,537
Exports total	104,682	76,087	75,493
Extra-EU/intra-EU exports	32.8%	32.1%	34.9%
Extra-EU/intra-EU imports	34.0%	31.6%	28.1%
Trade balance	-680,153	-565,528	-575,602
Extra-EU trade balance	-173,216	-135,460	-123,175

Table 74
Portugal
Trade in ICT Hardware
(Thousand ECU)

Table 75
Spain
Trade in ICT Hardware
(Thousand ECU)

	1992	1993	1994
Imports intra-EU	1,696,539	1,929,631	1,973,748
Imports extra-EU	1,562,063	854,113	1,073,060
Imports total	3,258,602	2,783,744	3,046,808
Exports intra-EU	862,227	738,015	823,575
Exports extra-EU	431,107	616,954	753,848
Exports total	1,293,334	1,354,969	1,577,423
Extra-EU/intra-EU exports	50.0%	83.6%	91.5%
Extra-EU/intra-EU imports	92.1%	44.3%	54.4%
Trade balance	-1,965,268	-1,428,775	-1,469,385
Extra-EU trade balance	-1,130,956	- 237,159	- 319,212

Table 76
Sweden
Trade in ICT Hardware
(Thousand ECU)

	1992	1993	1994
Imports from EU	789,844	719,078	914,057
Imports from other countries	1,453,554	1,507,464	1,718,094
Imports total	2,243,398	2,226,542	2,632,151
Exports to EU	1,030,111	803,368	713,317
Exports to other countries	1,048,254	966,228	1,266,051
Exports total	2,078,365	1,769,596	1,979,368
Exports to EU/total exports	49.6%	45.4%	36.0%
Imports from EU/total imports	35.2%	32.3%	34.7%
Trade balance	-165,033	-456,946	-652,783
EU trade balance	240,267	84,290	-200,740

Table 77
Switzerland
Trade in ICT Hardware
(Thousand ECU)

	1992	1993	1994
Imports from EU	1,516,695	1,704,914	2,114,861
Imports from other countries	870,568	886,729	970,781
Imports total	2,387,263	2,591,643	3,085,642
Exports to EU	451,476	510,674	522,353
Exports to other countries	236,409	255,163	291,491
Exports total	687,885	765,837	813,844
Exports to EU/total exports	65.6%	66.7%	64.2%
Imports from EU/total imports	63.5%	65.8%	68.5%
Trade balance	-1,699,378	-1,825,806	-2,271,798
EU trade balance	-1,065,219	-1,194,240	-1,592,508

Table 78
UK
Trade in ICT Hardware
(Thousand ECU)

	1992	1993	1994
Imports intra-EU	5,286,266	5,752,384	6,818,219
Imports extra-EU	6,696,456	7,832,374	8,575,893
Imports total	11,982,722	13,584,758	15,394,112
Exports intra-EU	5,779,972	6,746,608	7,998,328
Exports extra-EU	3,137,812	4,056,396	5,216,541
Exports total	8,917,784	10,803,004	13,214,869
Extra-EU/intra-EU exports	54.3%	60.1%	65.2%
Extra-EU/intra-EU imports	126.7%	136.2%	125.8%
Trade balance	-3,064,938	-2,781,754	-2,179,243
Extra-EU trade balance	-3,558,644	-3,775,978	-3,359,352

Table 79
EU
Trade in ICT Hardware
(Thousand ECU)

	1992	1993	1994
Imports intra-EU	30,989,866	28,586,125	34,211,787
Imports extra-EU	29,665,173	30,322,665	34,866,729
Imports total	60,655,039	58,908,790	69,078,516
Exports intra-EU	27,355,561	28,846,193	35,583,835
Exports extra-EU	14,390,563	17,278,081	20,786,494
Exports total	41,746,124	46,124,274	56,370,329
Extra-EU/intra-EU exports	52.6%	59.9%	58.4%
Extra-EU/intra-EU imports	95.7%	106.1%	101.9%
Trade balance	-18,908,915	-12,784,516	-12,708,187
Extra-EU trade balance	-15,274,610	-13,044,584	-14,080,235

Table 80
USA
Trade in ICT Hardware
(Thousand ECU)

	1992	1993	1994
Imports from EU	2,632,015	3,130,113	3,400,252
Imports from other countries	55,099,913	53,307,180	44,583,765
Imports total	35,949,754	39,329,333	47,984,017
Exports to EU	9,833,745	10,348,033	11,187,845
Exports to other countries	16,656,896	19,866,173	22,597,626
Exports total	26,490,641	30,214,206	33,785,471
Exports to EU/total exports	37.1%	34.2%	33.1%
Imports from EU/total imports	7.3%	8.0%	7.1%
Trade balance	-4,533,422	-10,321,872	-14,198,546
EU trade balance	7,201,730	7,217,920	7,787,593

Table 81
Japan
Trade in ICT Hardware
(Thousand ECU)

	1992	1993	1994
Imports from EU	454,755	769,739	881,942
Imports from other countries	4,714,856	6,018,084	7,543,435
Imports total	5,169,611	6,787,823	8,425,377
Exports to EU	8,370,321	8,700,935	8,866,034
Exports to other countries	18,722,074	23,851,772	25,264,042
Exports total	27,092,395	32,552,707	34,130,076
Exports to EU/total exports	30.9%	26.7%	26.0%
Imports from EU/total imports	8.8%	11.3%	10.5%
Trade balance	21,922,784	25,764,884	25,704,699
EU trade balance	7,915,566	7,931,196	7,984,092

9. Market Structures and Penetration of ICT

The different markets in Europe freely share certain features with their neighbours, 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 are 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 considered a composite measure. The nature of the IT market in Europe makes this a necessity. Thus, it cannot be assumed that a figure under this heading gives the total market share of a single national supplier. The composite measure is designed to assess the degree to which the market leaders in various related sectors dominate those markets. A similar principle is used in arriving at a figure for market concentration. These figures refer to the cumulative market share of the top ten vendors, in each year, with the composition of the top ten varying each year. The software and services markets are here defined in terms which stress the independent structures. They are not therefore sensitive to the balance of power between the traditional hardware suppliers and the independent specialists. This is justified on the basis of the theory of de-integration of the industry and because of the predominance of the hardware suppliers in terms of the systems software that is essential for the operation of the machines, but not intimately associated with the solution of user oriented problems.

Throughout the Western European countries the ratios of the value of the ICT market compared to gross domestic product, or of the ICT market value to the total population, vary considerably.

Table 82
Austria
Market Structures
and Penetration of ICT

Austria		1992	1993	1994
Industry leader's share	Hardware	23.8%	23.7%	21.1%
	Software	1.7%	2.8%	7.9%
	Services	2.6%	3.0%	2.1%
Industry concentration (top 10 vendors)	Hardware	60.1%	63.4%	61.4%
	Software	9.8%	11.1%	20.0%
	Services	15.8%	15.9%	10.0%
Market comparisons	IT market versus GDP	1.57%	1.75%	1.74%
	Per capita IT expenditure (ECU)	311	339	360
	ICT market versus GDP	3.52%	3.88%	3.92%
	Per capita ICT expenditure (ECU)	698	751	811

Table 83
Belgium/Luxembourg
Market Structures
and Penetration of ICT

Belgium/Luxembourg		1992	1993	1994
Industry leader's share	Hardware	20.8%	20.2%	19.5%
	Software	4.1%	3.1%	3.1%
	Services	5.1%	2.9%	3.0%
Industry concentration (top 10 vendors)	Hardware	58.3%	60.5%	60.7%
	Software	14.8%	15.6%	10.1%
	Services	21.1%	19.5%	17.6%
Market comparisons	IT market versus GDP	2.15%	2.33%	2.26%
	Per capita IT expenditure (ECU)	382	412	429
	ICT market versus GDP	3.99%	4.36%	4.26%
	Per capita ICT expenditure (ECU)	709	771	809

Table 84
Denmark
Market Structures
and Penetration of ICT

Denmark		1992	1993	1994
Industry leader's share	Hardware	30.9%	27.1%	23.7%
	Software	3.6%	2.9%	7.4%
	Services	21.5%	4.4%	4.2%
Industry concentration (top 10 vendors)	Hardware	62.9%	62.0%	60.1%
	Software	14.9%	13.0%	17.4%
	Services	44.8%	16.8%	14.0%
Market comparisons	IT market versus GDP	2.42%	2.64%	2.65%
	Per capita IT expenditure (ECU)	553	575	624
	ICT market versus GDP	4.24%	4.67%	4.64%
	Per capita ICT expenditure (ECU)	971	1,018	1,094

Finland		1992	1993	1994
Industry leader's share	Hardware	14.2%	15.7%	13.9%
	Software	4.7%	5.6%	7.7%
	Services	11.0%	8.4%	9.5%
Industry concentration (top 10 vendors)	Hardware	51.1%	53.9%	57.7%
	Software	23.6%	24.7%	30.0%
	Services	30.2%	26.2%	22.3%
Market comparisons	IT market versus GDP	1.78%	2.42%	2.23%
	Per capita IT expenditure (ECU)	316	337	358
	ICT market versus GDP	3.65%	4.91%	4.50%
	Per capita ICT expenditure (ECU)	648	684	722

Table 85
Finland
Market Structures and Penetration of ICT

France		1992	1993	1994
Industry leader's share	Hardware	21.2%	19.5%	20.4%
	Software	6.7%	7.1%	10.4%
	Services	10.0%	4.4%	4.2%
Industry concentration (top 10 vendors)	Hardware	62.8%	60.3%	61.2%
	Software	19.0%	22.8%	27.8%
	Services	33.4%	22.3%	18.6%
Market comparisons	IT market versus GDP	1.96%	2.08%	2.02%
	Per capita IT expenditure (ECU)	380	380	388
	ICT market versus GDP	3.82%	4.19%	4.21%
	Per capita ICT expenditure (ECU)	739	764	810

Table 86
France
Market Structures and Penetration of ICT

Germany		1992	1993	1994
Industry leader's share	Hardware	19.6%	18.4%	17.1%
	Software	4.3%	5.9%	8.7%
	Services	3.6%	5.7%	3.3%
Industry concentration (top 10 vendors)	Hardware	56.2%	56.6%	56.9%
	Software	18.0%	14.9%	27.2%
	Services	16.2%	19.8%	10.3%
Market comparisons	IT market versus GDP	2.12%	2.20%	2.18%
	Per capita IT expenditure (ECU)	436	435	457
	ICT market versus GDP	4.21%	4.49%	4.48%
	Per capita ICT expenditure (ECU)	865	887	939

Table 87
Germany
Market Structures and Penetration of ICT

Table 88
Italy
Market Structures and Penetration of ICT

Italy		1992	1993	1994
Industry leader's share	Hardware	31.9%	28.5%	33.7%
	Software	2.1%	2.5%	4.6%
	Services	6.9%	8.1%	8.1%
Industry concentration (top 10 vendors)	Hardware	69.0%	62.6%	63.4%
	Software	13.2%	9.3%	15.2%
	Services	40.1%	30.8%	17.8%
Market comparisons	IT market versus GDP	1.13%	1.37%	1.35%
	Per capita IT expenditure (ECU)	204	203	208
	ICT market versus GDP	2.48%	3.13%	3.21%
	Per capita ICT expenditure (ECU)	447	464	493

Table 89
Netherlands
Market Structures and Penetration of ICT

Netherlands		1992	1993	1994
Industry leader's share	Hardware	19.5%	18.5%	19.5%
	Software	1.8%	4.2%	2.9%
	Services	28.2%	12.2%	10.4%
Industry concentration (top 10 vendors)	Hardware	61.1%	57.1%	58.9%
	Software	12.8%	17.8%	14.4%
	Services	67.7%	34.9%	27.9%
Market comparisons	IT market versus GDP	2.43%	2.62%	2.66%
	Per capita IT expenditure (ECU)	431	444	477
	ICT market versus GDP	4.64%	5.02%	4.99%
	Per capita ICT expenditure (ECU)	821	852	895

Table 90
Norway
Market Structures and Penetration of ICT

Norway		1992	1993	1994
Industry leader's share	Hardware	14.1%	14.1%	15.0%
	Software	4.2%	3.1%	11.1%
	Services	3.9%	2.5%	2.2%
Industry concentration (top 10 vendors)	Hardware	50.8%	49.2%	54.7%
	Software	26.0%	19.1%	26.1%
	Services	25.0%	14.2%	13.5%
Market comparisons	IT market versus GDP	2.30%	2.71%	2.74%
	Per capita IT expenditure (ECU)	509	545	580
	ICT market versus GDP	4.63%	5.45%	5.53%
	Per capita ICT expenditure (ECU)	1,026	1,097	1,173

Spain		1992	1993	1994
Industry leader's share	Hardware	25.0%	20.5%	19.1%
	Software	4.8%	6.4%	12.2%
	Services	15.3%	11.6%	9.0%
Industry concentration (top 10 vendors)	Hardware	59.6%	53.9%	54.7%
	Software	14.3%	19.7%	32.3%
	Services	26.1%	37.5%	37.3%
Market comparisons	IT market versus GDP	1.03%	1.17%	1.18%
	Per capita IT expenditure (ECU)	127	121	122
	ICT market versus GDP	2.40%	2.88%	3.13%
	Per capita ICT expenditure (ECU)	297	296	323

Table 91
Spain
Market Structures and Penetration of ICT

Sweden		1992	1993	1994
Industry leader's share	Hardware	22.5%	17.3%	17.3%
	Software	2.8%	2.7%	9.3%
	Services	8.0%	6.3%	5.7%
Industry concentration (top 10 vendors)	Hardware	57.1%	56.4%	56.0%
	Software	17.9%	12.7%	20.1%
	Services	22.4%	26.5%	24.4%
Market comparisons	IT market versus GDP	1.87%	2.74%	2.80%
	Per capita IT expenditure (ECU)	447	489	526
	ICT market versus GDP	4.03%	5.70%	5.83%
	Per capita ICT expenditure (ECU)	967	1,017	1,096

Table 92
Sweden
Market Structures and Penetration of ICT

Switzerland		1992	1993	1994
Industry leader's share	Hardware	20.8%	20.7%	21.7%
	Software	1.6%	2.9%	6.7%
	Services	5.9%	1.8%	1.6%
Industry concentration (top 10 vendors)	Hardware	57.6%	56.7%	58.6%
	Software	5.6%	8.3%	19.7%
	Services	11.6%	7.6%	4.8%
Market comparisons	IT market versus GDP	2.72%	2.84%	2.70%
	Per capita IT expenditure (ECU)	800	797	844
	ICT market versus GDP	5.69%	6.03%	5.86%
	Per capita ICT expenditure (ECU)	1,676	1,696	1,830

Table 93
Switzerland
Market Structures and Penetration of ICT

Table 94
United Kingdom
Market Structures
and Penetration of ICT

United Kingdom		1992	1993	1994
Industry leader's share	Hardware	14.3%	13.6%	13.8%
	Software	4.3%	5.4%	5.7%
	Services	6.2%	4.4%	4.4%
Industry concentration (top 10 vendors)	Hardware	52.5%	51.1%	50.3%
	Software	17.1%	16.5%	16.9%
	Services	30.9%	32.7%	27.0%
Market comparisons	IT market versus GDP	2.09%	2.49%	2.48%
	Per capita IT expenditure (ECU)	317	340	365
	ICT market versus GDP	4.52%	5.23%	5.23%
	Per capita ICT expenditure (ECU)	684	716	769

Table 95
Per Capita IT
Expenditure ECU
(left)

	1992	1993	1994	1995
Austria	311	339	360	394
Belgium/Luxemb.	382	412	429	445
Denmark	553	575	624	681
Finland	316	337	358	399
France	380	380	388	407
Germany	436	435	457	488
Greece	40	43	47	53
Ireland	181	193	203	216
Italy	204	203	208	218
Netherlands	431	444	477	519
Norway	509	545	580	632
Portugal	78	79	82	87
Spain	127	121	122	131
Sweden	447	489	526	589
Switzerland	800	797	844	909
UK	317	340	365	396
Western Europe	324	331	347	372
US	580	624	681	751
Japan	575	540	563	594

Table 96
IT % GDP
(right)

	1992	1993	1994	1995
Austria	1.57	1.75	1.74	1.81
Belgium/Luxemb.	2.15	2.33	2.26	2.23
Denmark	2.42	2.64	2.65	2.73
Finland	1.78	2.42	2.23	2.32
France	1.96	2.08	2.02	2.03
Germany	2.12	2.20	2.18	2.22
Greece	0.62	0.73	0.76	0.76
Ireland	1.50	1.72	1.66	1.65
Italy	1.13	1.37	1.35	1.31
Netherlands	2.43	2.62	2.66	2.77
Norway	2.30	2.71	2.74	2.79
Portugal	0.96	1.09	1.11	1.09
Spain	1.03	1.17	1.18	1.18
Sweden	1.87	2.74	2.80	2.96
Switzerland	2.72	2.84	2.70	2.84
UK	2.09	2.49	2.48	2.55
Western Europe	1.84	2.07	2.05	2.08
US	2.97	3.06	3.17	3.34
Japan	2.33	1.91	1.83	1.94

	1992	1993	1994	1995
Austria	387	412	450	461
Belgium/Luxemb.	327	359	380	426
Denmark	417	442	470	494
Finland	332	347	364	376
France	358	384	421	461
Germany	429	451	483	523
Greece	135	155	176	197
Ireland	333	346	362	382
Italy	242	261	285	312
Netherlands	390	408	418	477
Norway	516	552	593	609
Portugal	178	214	241	272
Spain	171	176	202	218
Sweden	518	528	570	606
Switzerland	877	899	986	1,054
UK	366	375	404	430
Western Europe	344	362	392	425
US	520	524	528	533
Japan	451	481	510	526

Table 97
Per Capita
TLC Expenditure ECU
(left)

	1992	1993	1994	1995
Austria	1.95	2.13	2.18	2.12
Belgium/Luxemb.	1.84	2.03	2.00	2.14
Denmark	1.82	2.03	2.00	1.98
Finland	1.87	2.49	2.27	2.18
France	1.85	2.11	2.19	2.29
Germany	2.09	2.28	2.30	2.38
Greece	2.12	2.61	2.81	2.83
Ireland	2.76	3.08	2.96	2.92
Italy	1.34	1.76	1.86	1.87
Netherlands	2.20	2.40	2.33	2.55
Norway	2.33	2.74	2.80	2.68
Portugal	2.20	2.97	3.25	3.41
Spain	1.38	1.71	1.95	1.97
Sweden	2.16	2.96	3.04	3.04
Switzerland	2.98	3.20	3.16	3.29
UK	2.42	2.75	2.75	2.77
Western Europe	1.96	2.26	2.32	2.38
US	2.67	2.57	2.46	2.37
Japan	1.83	1.70	1.66	1.72

Table 98
TLC % GDP
(right)

	1992	1993	1994	1995
Austria	698	751	811	855
Belgium/Luxemb.	709	771	809	870
Denmark	971	1,018	1,094	1,175
Finland	648	684	722	775
France	739	764	810	868
Germany	865	887	939	1,011
Greece	175	198	223	250
Ireland	514	540	566	598
Italy	447	464	493	531
Netherlands	821	852	895	996
Norway	1,026	1,097	1,173	1,241
Portugal	259	292	323	359
Spain	297	296	323	349
Sweden	967	1,017	1,096	1,195
Switzerland	1,676	1,696	1,830	1,963
UK	684	716	769	826
Western Europe	667	693	739	797
US	1,102	1,148	1,209	1,285
Japan	1,025	1,021	1,073	1,120

Table 99
Per Capita ICT
Expenditure ECU
(left)

	1992	1993	1994	1995
Austria	3.52	3.88	3.92	3.94
Belgium/Luxemb.	3.99	4.36	4.26	4.37
Denmark	4.24	4.67	4.64	4.71
Finland	3.65	4.91	4.50	4.50
France	3.82	4.19	4.21	4.32
Germany	4.21	4.49	4.48	4.61
Greece	2.75	3.35	3.56	3.59
Ireland	4.26	4.80	4.63	4.56
Italy	2.48	3.13	3.21	3.18
Netherlands	4.64	5.02	4.99	5.32
Norway	4.63	5.45	5.53	5.47
Portugal	3.19	4.06	4.36	4.50
Spain	2.40	2.88	3.13	3.15
Sweden	4.03	5.70	5.83	6.00
Switzerland	5.69	6.03	5.86	6.13
UK	4.52	5.23	5.23	5.32
Western Europe	3.80	4.33	4.37	4.46
US	5.65	5.63	5.63	5.71
Japan	4.15	3.62	3.49	3.66

Table 100
ICT % GDP
(right)

10. Price Dynamics

Figure 13
Evolution of Average Selling Prices for PCs, US (ECU) 1991–1997

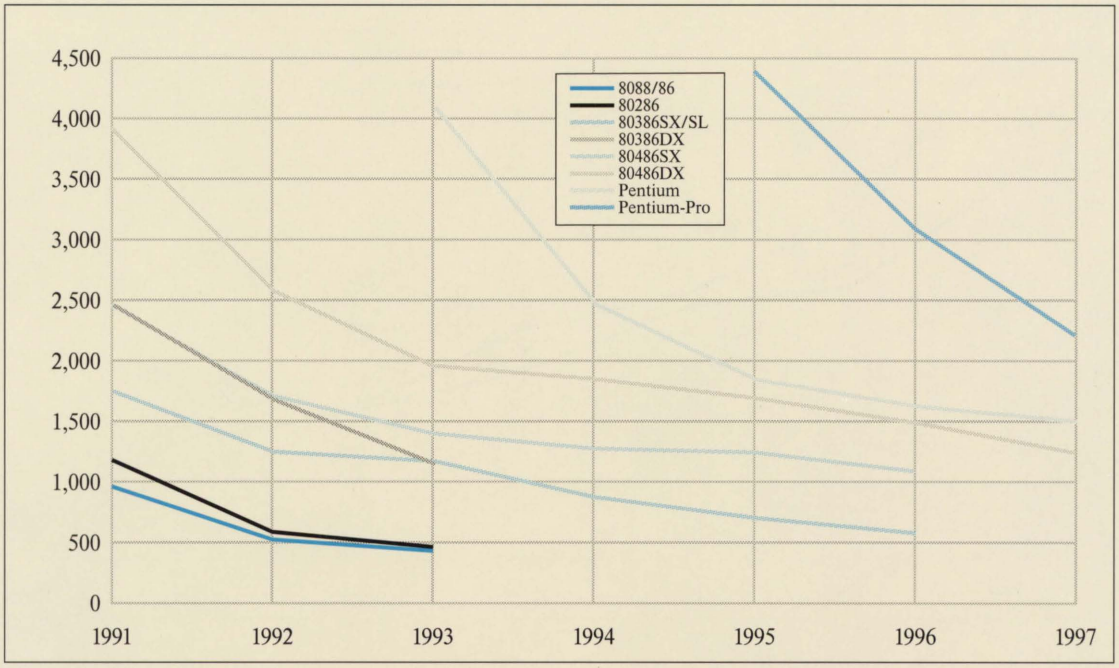


Table 101
Evolution of Average Selling Prices for PCs, US (ECU) 1991–1997

	1991	1992	1993	1994	1995	1996	1997
8088/86	946	519	436	n/a	n/a	n/a	n/a
80286	1,189	595	477	n/a	n/a	n/a	n/a
80386SX/SL	1,734	1,248	1,164	871	695	561	n/a
80386DX	2,454	1,667	1,131	n/a	n/a	n/a	n/a
80486SX	2,446	1,717	1,390	1,281	1,240	1,089	n/a
80486DX	3,928	2,596	1,960	1,851	1,692	1,491	1,248
Pentium	n/a	n/a	4,112	2,471	1,826	1,608	1,482
Pentium-Pro	n/a	n/a	n/a	n/a	4,397	3,099	2,203

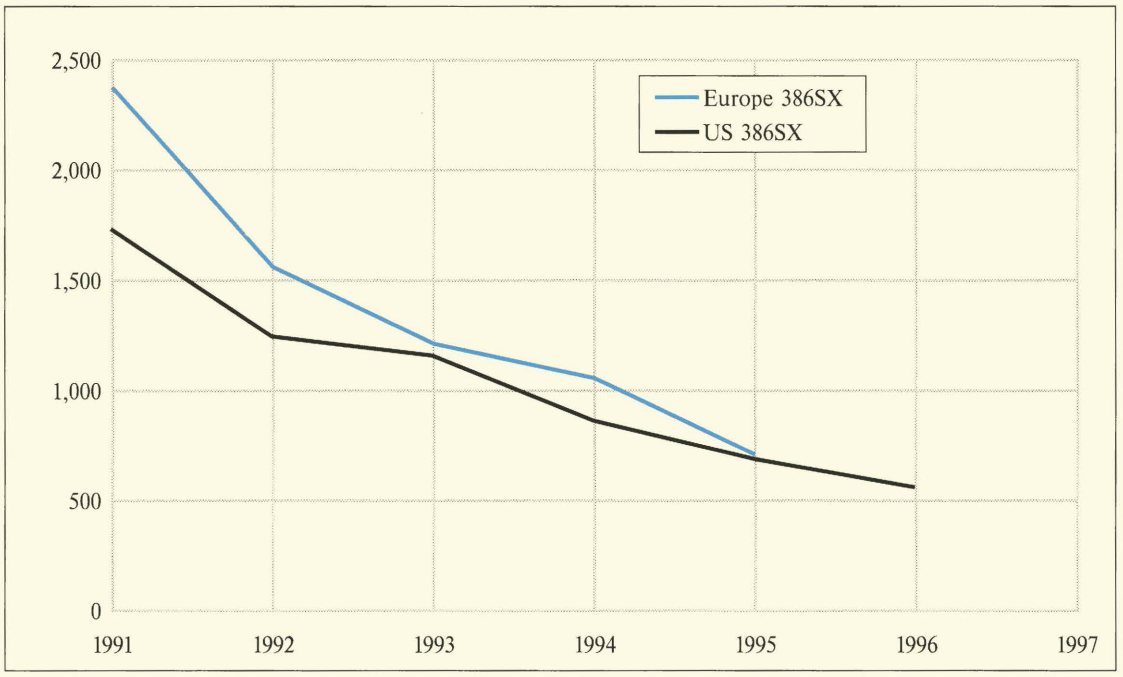


Figure 14
Convergence of Average Selling Prices for 386SX PCs (US versus Europe), ECU, 1991–1997

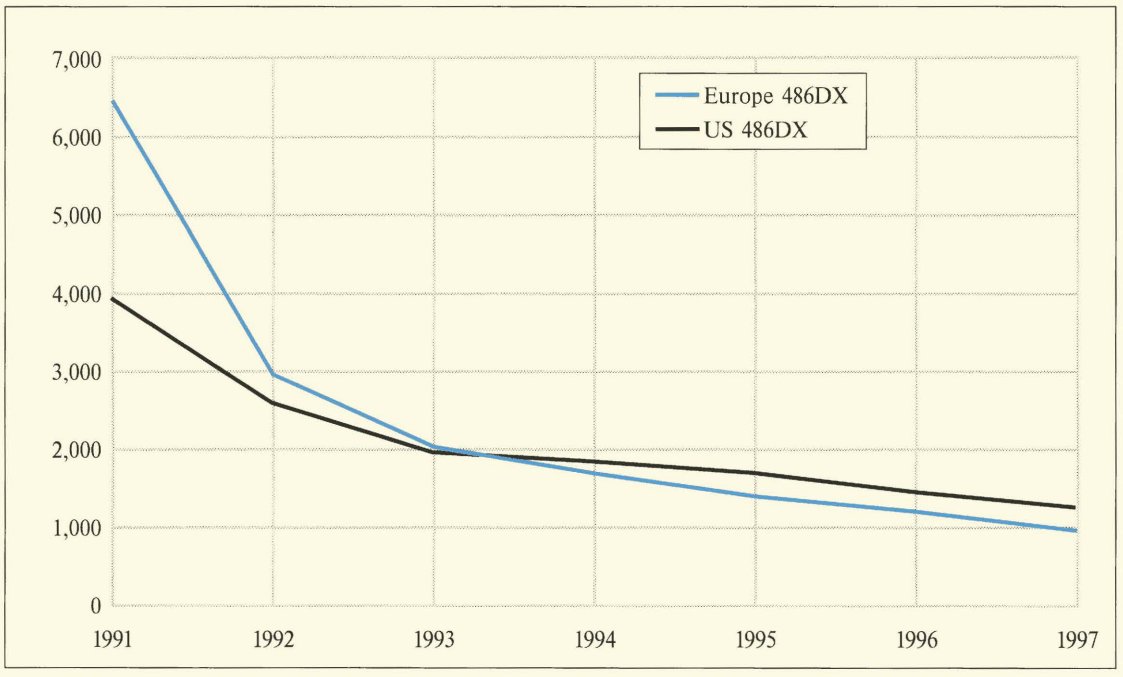


Figure 15
Convergence of Average Selling Prices for 486DX PCs (US versus Europe), ECU, 1991–1997

Figure 16
Evolution of Average Selling Prices for PCs, Europe (ECU), 1991–1997

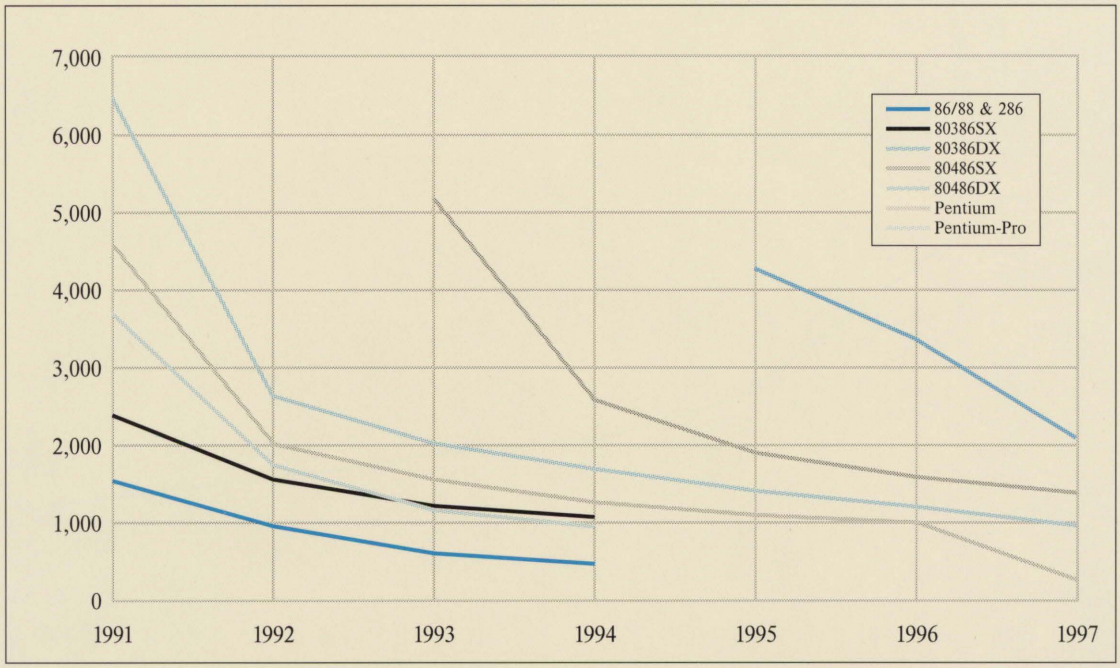


Table 102
Evolution of Average Selling Prices for PCs, Europe (ECU), 1991–1997

	1991	1992	1993	1994	1995	1996	1997
86/88 & 286	1,544	968	618	477	n/a	n/a	n/a
80386SX	2,373	1,561	1,208	1,051	n/a	n/a	n/a
80386DX	3,718	1,750	1,160	951	n/a	n/a	n/a
80486SX	4,559	2,008	1,536	1,265	1,097	997	n/a
80486DX	6,441	2,631	2,019	1,689	1,407	1,201	961
Pentium	n/a	n/a	5,151	2,569	1,888	1,577	1,381
Pentium-Pro	n/a	n/a	n/a	n/a	4,258	3,360	2,085

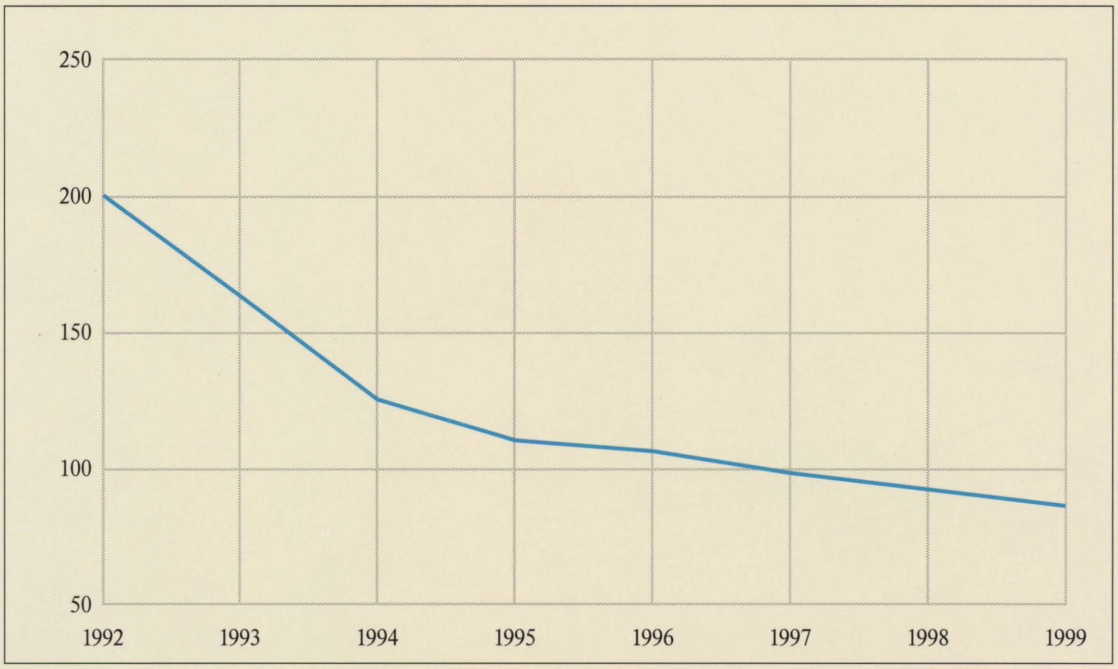


Figure 17
Evolution of PC NIC Average Selling Price, Worldwide (ECU), 1992–1999

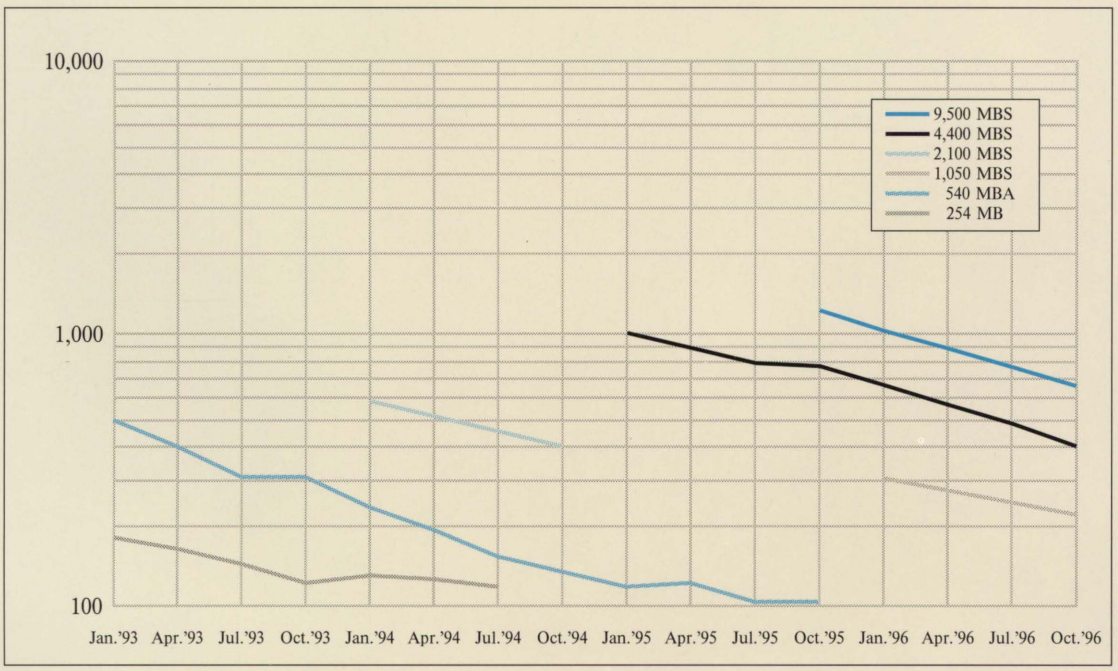


Figure 18
Hard Disk Drive Price Dynamics (ECU)

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. These definitions are outlined below.

Geographic coverage

The heading European Union (EU) refers to Belgium & Luxembourg, Denmark, France, Germany, Greece, Italy, the Republic of Ireland, the Netherlands, Portugal, Spain, the UK and the three new members – Austria, Finland and Sweden – which joined the EU on January 1, 1995.

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 and Slovak Republics, Hungary, Poland and Russia.

The Four Tigers refer to Hong Kong, Korea, Singapore and Taiwan.

Information technology

For the purposes of this study information technology refers to the combined industries of hardware for office machines, data processing equipment, data communications equipment, 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* 1994 ECUs, 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

DP 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.

Multi-user systems group all large-, medium- and small-scale systems (i.e., all computer systems except personal computers and single-user workstations). Multi-user computers are typically multi-tasking, multi-user systems which support and are principally marketed to support two or more users.

- *Large-scale systems* included in this class of systems are all high-end mainframes computers and supercomputers; typical products include IBM 3090 and ES/9021, Siemens-

Nixdorf H90, H120 and H130, Amdahl 5995, etc. These products are often - but not always - bounded at the bottom end by prices in excess of $1,000,000. They are almost exclusively used by large companies in data centres, although some of the most specialized systems are found in specialized smaller scientific and technical environments.

- *Medium-scale systems* included in this class of systems are all low-end mainframe computers and high-end midrange systems; typical products include IBM ES/9121, ES/9221 and high-end AS/400, Siemens-Nixdorf low-end BS2000 mainframes and RM600 Unix-based machines, Digital DEC 7000 and 10000, Tandem Cyclone/R and CLX, Groupe Bull's DPS/7000. These products are often, but not always, bounded at the top end by prices less than $1 million and at the bottom end by prices greater than $100,000. They are used by large and medium-sized companies in data centres, and by large companies in branch and departmental environments; some specialized systems are used in smaller scientific and technical environments.
- *Small-scale systems* included in this class of systems are all low-end minicomputers, workstation servers, and dedicated LAN servers; typical products include low-end IBM AS/400 and RS/6000, Digital's VAX 3000 and AlphaServer 1000, Siemens Nixdorf's RM400, low-end MX and 8860, Bull's DPS 6000, and DPX/20, ICL's low-end Teamserver and SuperServer, etc. These products are - but not always - bounded at the top end by prices lower than $100,000 and, at the bottom end, by the ability to support a minimum of two terminal devices (e.g. the systems must be primarily designed to be sold as a multi-user computer). They are used in a wide variety of environments from departmental computing in large and medium-sized businesses to corporate computing in small businesses.

Workstations: workstations include all workstations and personal workstations with the exception of NT/Pentium-based systems which are included in the PC segment. Traditional single-user workstations are defined by processor, operating system and typical price band. This includes typical workstation class processors, such as Sparc, MIPS, PA-RISC, Power, Clipper and MC680x0. Personal workstations represent the movement of PC vendors upward and workstations vendors "downwards". Personal workstations have the functionality, features, graphics and distributed computing together with the PC's buying patterns, price points and ease of use.

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.

- *PCs - portables:* portable and transportable machines are included in this category, but electronic organizers (such as the Psion Organizer products) are not counted. Sub-categories acknowledged include AC-portables, battery operated laptops, notebooks and sub-notebooks. Small hand-held products such as high-end organizers and palmtops are excluded from the portable definition.
- *PCs - desktops:* desktop and tower machines are included in this category, but dedicated games machines (such as Nintendo) are not included.

PC printers include models designed to be attached to PCs, not sold with the systems. These include dot matrix printers, thermal/ther-

mal transfer printers, non-impact page printers, ink-jet printers and colour printers.

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 POS, document filing (microfilm, 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 hardware required to link multi-user systems, PCs or workstations to a local area network; it does not include software (e.g., specialized 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.
- *Internetwork equipment* includes bridges and routers. Bridges connect two networks, operate at level 2 (data link) of the International Standards Organization (ISO) Open System Interconnection (OSI) model and are protocol-insensitive. Routers are devices that allow for multiple paths, providing two or more connections. They operate at Level 3 (network) of the ISO OSI model and are protocol-sensitive, which allows them to "intelligently" decide how to route data.

Other data communications hardware is for this project expressly limited to hardware and to the following categories, of which it will be the sum: modems, multiplexers, X.25 packet switching equipment, digital switching equipment, communications processors and channel extenders.

- *Modems* tracked are restricted to analogue and short haul modems, segmented 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 specialized and customized 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 telecom 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 authorization terminals, smart-card readers, factory data collection systems, numerical controllers for manufacturing equipment, cheque processing equipment, computer assisted publishing systems, and specialized 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 vendors and independent software vendors (ISVs), and do not include specially designed application software solutions added by turnkey systems houses 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 all revenue for packaged software, including fees partially earmarked for software maintenance, services and/or support.

- *Systems software and utilities* are software programs designed (1) to operate hardware through basic operating systems and programming languages, increase the efficiency of systems personnel through system per-

formance measurement tools, improve the operating capabilities of the hardware system by routing the flow of data among machine units and handle data entry and delivery, or (2) to ensure program integrity through maintenance and security programs, convert programs from one language to another, organize data resources through sort/merge products and monitor machine usage. Major components today include operating systems enhancements (e.g., MVS/ESA) and data centre management software, especially automated operations programs. However, because bundled software is by definition not a market from which users can choose to buy, and to avoid double-counting with systems categories, for Black Book purposes bundled operating systems are counted only in the hardware systems categories.

- *Application tools* are programs that allow users to retrieve, organize, manage and manipulate data and databases. This group is divided into four subcategories: data access/retrieval, data management, data manipulation and program design development. It includes all database management system (DBMS) software; decision support and executive information system (EIS) programs; spreadsheet programs, including Lotus 1-2-3 and Excel; front-end and back-end CASE tools; and emerging areas like co-operative processing and/or object management application development tools.
- *Application solutions* software includes programs designed to provide packaged software solutions for specific problems inherent in an industry or a business function. Such software can address "cross-industry" functions (e.g., accounting, human resource management, payroll, project management or word processing and other office activities) or specific industry solutions for vertical markets (e.g., banking/financial, manufacturing, health care, oil and gas exploration, etc.).

11.1.3. Services

Professional services

Professional services comprise procurements obtained on a customized or contractual basis for system and/or software development, systems design, integration, installation, related training/education, facilities management and consulting services for information technology purposes only (i.e. management consulting services are not included). The primary professional services activities can be divided into six categories:

- Requirements analysis, planning and strategy, as well as needs assessment for future IT services and equipment. It typically includes audits of hardware, software, personnel, security, work flow etc.
- Systems design represents the detailed deployment plans for the development of a coherent information technology systems out of set resources.
- Contract programming and custom software development represents services (not products) offered on a fixed-fee, cost-plus, or per diem basis for application design, development, integration, and documentation.
- Systems and network implementation and integration includes physical systems integration, migration, system installation, "glue-code", cabling, subsystems integration, tuning, testing, and "burn-in".
- Management and administration constitutes charges for managing and administering a large services contract (e.g. project management for systems integration, or systems and/or network operations in facilities management). It includes overhead costs not captured elsewhere (e.g. human resources in a facilities management contract would be counted, but not the cost of system hardware or packaged software, which would be countered in the proper market category).

- Education and training includes course work and training (both on- and off-site) related to 1) systems and/or network installation and/or 2) software and programming, expect as provided for within a vendors service contract counted within software services above. Excluded from education and training are books and other published material and course work offered through public schools, colleges, universities and non-profit private institutions

These six categories of activity can be variously applied in a number of ways, including business process redesign, systems integration and facilities management contracts. However, professional services do not include data processing that a vendor may resell from the client's site to a number of unrelated users at other sites, not does it include traditional time-sharing services or so-called processing services. To avoid double-counting with the package software category, for this project, support services excludes software support contracted as part of long-term update and support agreements.

Processing services

Processing services comprises bureau type services which can be classified under two further sub-headings; problem solving and transaction processing. Problem solving covers the provision of charged time on systems providing access to computer software tools, models or applications. Transaction processing covers access to specific applications programmes with charges often based upon the number of transactions processed.

Network services

Network services are defined as chargeable value-added services, and comprise: managed network services, network processing services, network messaging services. E-mail, EDI and Value added transport services are typical examples.

Hardware maintenance and support services

comprise, for the purpose of this study, the repair or replacement of components of computer systems hardware (including data communications equipment, but not industry specific terminals like ATMs) and other hardware services, namely: disaster recovery, site planning, installation and relocation. Maintenance revenue may be generated by on-site maintenance, time and materials, parts for self-maintenance and/or depot services, in each case on a service contract or non-contract basis. To avoid double-counting, for this project, support services specifically excludes all software support.

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 telecom 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 (e.g. Transpac) circuit switched networks, value added networks (e.g. GEIS), 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. 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. Data for the US, Japan and EFTA countries is also based upon data held by Eurostat, but in these cases the original source of the information is the appropriate national statistical office. 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 has been selected based upon standard sub-headings of the Combined Nomenclature as listed below.

Data until the end of 1994 relates to the previous boundaries of the European Union. Austria, Finland and Sweden were outside the European Union and are defined within EFTA (as are Norway and Switzerland).

The reported areas (or grouping 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 one reporting/trading country in the European Union and one reporting/trading partner outside the EU), EFTA, US, Japan, 4 Tigers.

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 following analysis is broad, embracing the European Union, the major EFTA states, the US and Japan.

In reporting intra-EU trade it is usual to report the country of consignment as the source of the goods even where this differs from the country of origin. For extra-EU trade the source is generally reported as the country of origin.

Please note: descriptions have been abbreviated. Product codes have been stated to indicate the level at which data was 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 Harmonized System Nomenclature, pub. 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. More information is expected from 1996 onwards.

An approximate relationship is therefore applied to compute production values:

production = market value + exports - imports

where market data is based upon IDC data, and trade data is based upon appropriately adjusted statistics.

For IT and telecommunications hardware this relationship is relatively straight forward to calculate, since data is 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. For example, the figure reported for the leader's share of hardware market in a particular country is in fact an aggregate of the market shares of the individual leaders of each of the standard IDC hardware market sectors.

11.3.4. Industry Concentration

As for the industry leader's (sic) market share (see above), industry concentration is an aggregate market share statistic. In this case, the market positions of the top 10 vendors in each of IDC's primary categories are used to compute the degree of concentration.

11.3.5. Inflation

All forecasts and historical figures include inflation.

11.3.6. Exchange Rates

All *market* data and forecasts are presented in constant 1994 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.

For Eastern European research the peculiarities of that region have in the past dictated that research be 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 is 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, sheetsize =<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 1994

(Units per ECU)

Austria	13.60
Belgium	39.83
Denmark	7.57
Finland	6.21
France	6.61
Germany	1.93
Greece	288.33
Ireland	0.80
Italy	1920.24
Netherlands	2.17
Norway	8.40
Portugal	197.62
Spain	159.52
Sweden	9.19
Switzerland	1.63
UK	0.77
US	1.19
Japan	121.2
Source: OECD	
Local commercial rates	
Czech Republic	33.6 Crowns
Hungary	126.1 Forints
Poland	27,203.4 Zloties
Russia*	2,559.0 Roubles
Slovak Republic	37.1 Crowns

* 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, rouble to ECU exchange rate was 7,140 roubles to the ECU).

Alphabetical Index

A

ACTS (Advanced communication technologies and services in Europe) 54

ADSL (Asymmetric digital subscriberloop) 152

Alliances 56ff

Amadeus 157

Analogue systems 147

APC (Advanced process control) 132

API (Application programming interface) 111

Application
- A. and technology push 80f
- A. programming interface (API) 111
- A. software in EU banks 205, 207f
- A. tools 101-104

Architecture(s) 115f, 197f

ARP (Adress resolution protocol) 121

ARPANET 65, 117, 121

ATM (Asynchronous transfer mode) 74f, 108, 111, 143, 150, 152, 202

ATM (Automated teller machine) 166, 190

Audiotex 144

Austria
- ICT market value 287
- IT hardware shipments (units) 310
- Market structures and penetration of ICT 327
- Trade in ICT hardware 319

Automated teller machine (ATM) 166, 190

B

Bangemann Report 134, 141

Banking and financial services in Europe 176-217

Banking requirements 212-217

Belgium/Luxembourg
- ICT market value 288
- IT hardware shipments (units) 310
- Market structures and penetration of ICT 327
- Trade in ICT hardware 319

Bibliography 132

BIOS (Basic input/output system) 93

BLOB (Binary large object) 102

BOC (Branch operational centre) 196

BOOTP (Bootstrap protocol) 122

BPR (Business process reengineering) 116, 127

BSS (Broadcast satellite service) 115

Business
- B. arena 84ff
- B. confidence indicators 26
- B. process reengineering (BPR) 116, 127

C

CAFE (Conditional access for Europe) 210

Cassandra's syndrome 83f

Catenet 120

CATN (Computer aided technologies network) 129

CATV (Cable TV) 115, 140f, 151f

CCIR (Comité consultatif international des radio-communications) 89

CCITT (Comité consultatif international de téléphonique et télégraphique) 89

CDRAM (Cached dynamic random access memory) 91

CD-ROM (Compact disk read only memory) 95f

CEN (Comité européen de normalisation) 89, 144

CENELEC (Comité européen de normalisation electrotechnique) 89, 144

Channel(s)
- C. conflict 248
- C. model of the future 247-251
- C. players 227-232
- C. structure 221
- Distribution c. 220-265
- EITO standard for c. definition 222f

CIE (Computer integrated enterprise) 130

CII (Computer integrated industry) 130

CIM (Computer integrated manufacturing) 127f, 130

CIO (Chief information officer) 76

CISC (Complex instruction set computing) 89, 92

Client/server 109
- C./s. computing 30, 37, 72

CMOS (Complementary symmetry metaloxide semiconductor) 90, 92f

Combined market share 49

Competition in TLC 52

Computer technology 92ff

Concentration in the IT market 49ff

Conditions 87

Consumer 86
- C. market 30

Content 173

Contents industry 14f, 18, 159

Convergence 244f
- C. of average selling prices 334

Cordless telephony 74

CPU (Central processing unit) 90f

CRS (Computer reservation service) 157

CSTA (Computer supported telephony application) 111

CTI (Computer telephony integration) 80, 111f

Customers 247

Czech and Slovak Republics 62
- IT market value 303
- IT hardware shipments (units) 315

D

DARPA (Defense advanced research projects agency) 117

Data
- D. communications 50
- D. processing outsourcing 197
- D. storage 96
- D. warehouse 70f, 103f

DCE (Distributed computing environment) 100f, 115

DCS (Distributed control system) 130f

Definitions 222, 233, 253, 337-345

Denmark
- ICT market value 289
- IT hardware shipments (units) 310
- Market structures and penetration of ICT 327
- Trade in ICT hardware 319

DHCP (Dynamic host configuration protocol) 122

Digicash 159, 166

Digital
- D. systems 147
- D. TV 114f

Direct
- D./indirect supply levels 232ff
- D. response 241-244
- D. versus indirect channels 221f
- D. versus indirect supply 237

Distribution channels 220-265

DME (Distributed management environment) 101

DNS (Domain name system) 122

DRAM (Dynamic random access memory) 90

DSP (Digital signal processor) 91f, 95

DTD (Document type definition) 125

DTH (direct to home) satellites 114f

DTMF (Dual tone multifrequency) 144

DTTB (Direct terrestrial television broadcasting) 114

DVB (Digital video broadcasting) 115

E

Eastern Europe 61ff
- Country market comparison 62ff
- ICT market value 309
- IT hardware 61
- IT hardware shipments (units) 317
- Software and services 61

ECB (European central bank) 177

ECL (Emitter coupled logic) 92

ECMA (European computer manufacturers association) 111

Economic
- E. background 273-276
- E. growth 78f, 273f

EDI (Electronic document interchange) 155f, 245

EDORAM (Extended data out random access memory) 90

EDP (Electronic data processing) systems 92-98

EDRAM (Enhanced dynamic random access memory) 91

EDTV (Enhanced definition TV) 114

Education 38, 45

Edutainment 69

EEPROM (Electrically erasable programmable read only memory) 91

EFT-POS (Eletronic fund transfer from point of sale) 155ff

E-ISDN (Euro-integrated services digital network) 44, 145

EITO standard for channel definition 222f

Electronic
- E. banking 166
- E. commerce 84
- E. distribution 245f
- E.-mail 155f
- E. marketing 80f
- E. purse 210
- E. trading 245f

EMI (European monetary institute) 177

Employment 53f, 135f, 194ff

EMU (European economic and monetary union) 177

Enhanced
- E. fax 144
- E. interactive services 160f

ESPRIT 54

ETACS (Extended total access communication system) 147

ETSI (European telecommunications standards institute) 89, 144

EU (European Union)
- Evolution of average selling prices 335
- ICT market value 307
- IT hardware shipments (units) 316
- Trade 58
- Trade in ICT hardware 324

EUC (End-user computing) 92

EUROBIT 21

Europe 245f
- E. as consumption area 46-52
- E. as production area 53-58
- ICT market in E. 23-87

European Commission
- Business confidence indicators 26
- E. C. on ICT in Europe 12-16
- High level advisory group 144

Evolution of ICT distribution channels in Europe 220-265

Exchange rates 281, 345

F

Fast packet switching networks 150f

Fax machine 73

FDD (Floppy disk drive) 95

Finance 37, 45

Finger 123

Finland
- ICT market value 290
- IT hardware shipments (units) 311
- Market structures and penetration of ICT 328
- Trade in ICT hardware 320

Firewall 109, 206

Four tigers
- ICT market 24

Fourth framework programme 54

FPM (Fast page mode) 90

FR (Frame relay) 147, 150

FRAM (Ferroelectric random access memory) 91

France 137, 153, 158, 256f
- Banking sector 181ff
- ICT market value 291
- IT hardware shipments (units) 311
- IT trends 28
- Market structures and penetration of ICT 328
- TLC trends 40
- Trade in ICT hardware 320

Frequency analysis tables 253-265

FSS (Fixed satellite service) 115

FTP (File transfer protocol) 123

FTTC (Fibre to the curb) 153

FTTH (Fibre to the home) 114, 153

Fuzzy
- F. control 106
- F. logic 105
- F. model 106
- F. set 105
- F. systems 105-108

G

Galileo international 157

Germany 153, 158, 258f
- Banking sector 183ff
- ICT market value 292
- IT hardware shipments (units) 311
- IT trends 27f
- Market structures and penetration of ICT 328
- TLC trends 39
- Trade in ICT hardware 320

GII (Global information infrastructure) 21, 134, 141

Gopher 123

Government 37, 45

Greece
- ICT market value 292
- IT hardware shipments (units) 312
- Trade in ICT hardware 321

G7 conference on the global information society 12, 17, 21, 134, 141f

GSM (Global system for mobile communications) 147

GUI (Graphic user interface) 92

H

Hardware
- H. equipment and installed base in banking 198ff
- H. products 92ff
- IT h. 30-33
- IT h. shipments (units) 310-317
- LAN h. market 33
- Multi-user h. 31f
- Trade in ICT h. 318-325

HDTV (High definition television) 114

Health 45

Hedge 106

High capacity mass storage technology 94-98

High level strategy group 21

High-speed networks 143

Home
- H. banking 166f, 191
- H. market 38, 45, 235ff
- H. office 170
- H. shopping 165f

HSM (Hierarchical storage management) 95, 97f

HTML (Hypertext markup language) 125f

HTTP (Hypertext transfer protocol) 126

Hungary 62
- IT market value 304
- IT hardware shipments (units) 315

I

IAB (Internet architecture board) 118

ICMP (Internet control message protocol) 121

ID (Internet datagram) 120ff

IEC (International electrotechnical commission) 88

IEEE 802 109f

IETF (Internet engineering task force) 118, 127

Impediments to growth 82ff

Import/export codes 345

IN (Intelligent network) 74, 143ff

Indirect
- I. channel structure 225f
- I. channel member 223, 228-232

Industry
- Contents i. 14f, 18
- I. leader's market share 327-331
- ICT i. on ICT in Europe 17-22

Inflation 26

Info 2000 15

Information
- Global i. infrastructure (GII) 21, 134, 141, 152
- I. infrastructure 54ff, 141ff
- I. system (IS) 75f

Information and communications technology (ICT)
- Current economic situation in Europe 25-46
- Evolution in ICT 88f
- ICT market in Europe 23-87
- ICT market in Europe's banking and financial services 176-217
- International ICT markets 277-317
- Market size 23f
- Market value 285-309
- Mergers, acquisitions, cooperation 56ff
- Trade flows 318

Information society 12-16, 17-22, 134-173
- I. s. forum 16
- Social challenge of the i. s. 15f
- Social expert group 16

Information Technology
- Current economic situation 25-46
- IT driving forces 66-72
- IT market size 23f
- IT consulting 34
- IT hardware 30-33
- IT hardware shipments (units) 310-317
- IT penetration 46-49
- IT trends 27-38
- IT user perspectives 36ff

Infrastructure harmonization and security 82

Ink jet market 33

Integrated
- I. broadband digital networks 152f
- I. voice response 74

Interactive
- I. digital network technologies 75
- I. TV 75

Internet 12, 23, 40, 57f, 65f, 82, 84, 98, 109, 117-127, 158f, 168f, 206
- I. address 119f
- I. architecture and standards 117f
- I. drafts 118, 127
- I. experts 77f
- I. opportunities 79f
- Software and tools for the I. 69

Internetwork 120f

InterNIC 119f

Interconnectivity 143

Interoperability 143

Interworking 143

Investment 26

IP (Internet protocol) 120ff

IP (Internet protocol) address 119f

IRC (Internet relay chat) 123

Ireland 27
- ICT market value 294
- IT hardware shipments (units) 312
- Trade in ICT hardware 321

ISDN (Integrated services digital network) 44, 46, 145f, 202
- E- (Euro-) ISDN 44, 145

ISO (International standards organization) 88, 118

ISOC (Internet society) 118

Italy 153, 260f
- Banking sector 185ff
- ICT market value 295
- IT hardware shipments (units) 312
- IT trends 28f
- Market structures and penetration of ICT 329
- TLC trends 40f
- Trade in ICT hardware 321

ITU (International telecommunication union) 88, 118

J

Japan 140, 171f
- Economic developments 275
- Information infrastructure 143
- ICT market 24
- Trade 58
- Trade in ICT hardware 325

Java 127

L

LAN (Local area network) 109, 111, 147, 150
- LAN hardware market 33

Large-scale systems 92f, 100

LDTV (Low definition television) 114

Leased circuit prices 44

LEO (Low earth orbiting satellites systems) 147

Liberalization 54f, 58
- Agenda for L. 81
- L. of telecommunication 13, 20f, 38ff, 134-143
- L. push 81f

M

Magnetic media and devices 95

Mainframe 92, 269

MAN (Metropolitan area network) 150

Manufacturing 36, 53f

MAP (Manufacturing automation protocol) 131

Market(s)
- Consumer m. 30
- ICT m. in Europe 23-87
- Ink jet m. 33
- LAN hardware m. 33
- M. perspectives 78-87
- M. structures and penetration of ICT 327-332
- Network m. 23
- Office equipment m. 33
- Printer m. 33

MEDIA 15

Medium-scale systems 93, 100, 198

Memories 90f
- Main m. 90f
- Non volatile m. 91
- Video m. 91

Mergers and acquisitions 56ff

Methodology 217, 252, 268f

Micro
- M. electronic components 89-92
- M. processor families 89f
- M. kernel 99

Middleware 33

Mobile telephone networks 147

MO (rewritable magneto-optic) disks 96

Mondex 210

MPEG (Motion picture expert group) 89, 114

MPP (Massively parallel processing) 93

Multidimension database 104

Multimedia 57, 167
- M. hardware technologies 68
- M. software technologies 68

N

National information infrastructure (NII) 141

NCP (Network control programme) 124

Netherlands
- ICT market value 296
- IT hardware shipments (units) 313
- Market structures and penetration of ICT 329
- Trade in ICT hardware 322

Network(s)
- N. managers 77
- N. market 23
- N. services 35
- New n. services and applications 134-173
- Private n. 42

New services and applications 116-132

NIC (Network information centre) 125

NIST (National institute of standards and technology) 109

NITS (Network independent transport service) 124

NFS (Network file system) 123

NII (National information infrastructure) 141

NMS (Network management system) 101

NMT (Nordic mobile telephone) 147

NNTP (Network news transfer protocol) 123

Norway
- ICT market value 297
- IT hardware shipments (units) 313
- Market structures and penetration of ICT 329
- Trade in ICT hardware 322

NOS (Network operating system) 92, 99

NSP (Nature signal processing) 91f

Number of PCs installed per white collar worker 47, 64

NVoD (Near video on demand) 114, 153, 162

O

Object
- O.-oriented CASE 34
- O.-oriented technology 34
- O. technology 76f, 102

OCR (Optical character recognition) 94

OCS (Open control systems) 131f

OFDM modulation 114

Office equipment market 33

OLAP (On-line analytical processing) 104

OLE (Object linking and embedding) 100, 102

OLTP (On-line transaction processing) 104

On-line service 57f

ONP (Open access network provision) 137

OOA (Object-oriented analysis) 102

OODBMS (Object-oriented database management systems) 34, 98, 102

OOP (Object-oriented programming) 34, 102

Operating systems 33

Optical media 95

OSI (Open systems interconnection) 101, 115

Outsourcing 197f, 212f, 244

P

PABX (Private automatic branch exchange) 42

Patterns of trade 269

Payment systems 190, 209f

PC 91ff, 99, 111, 200, 235, 242, 269
- PC-centric 111, 113
- PC market 32, 68
- PC NIC average selling price 336
- PC penetration 203

PCI (Peripheral component interconnect) 94

PCN (Personal communications network) 147

Penetration
- IT p. 46-52
- TLC p. 51f

Performance measures 343ff

Peripheral devices 94

Phone
- P.-centric 111f
- P. banking 166f, 191

PID (Proportional, integrator, derivator) 132

PLC (Programmable logic control) 132

Plug and play 93

Point of sales 190

Poland 63
- IT market value 305
- IT hardware shipments (units) 316

POP (Post office protocol) 123

Portable market 32

Portugal
- ICT market value 298
- IT hardware shipments (units) 313
- Trade in ICT hardware 322

PPP (Point-to-point protocol) 120

Price(s)
- Convergence of average selling p. for 386SX PCs 334
- Convergence of average selling p. for 486DX PCs 334
- Evolution of average selling p. of PCs, Europe 335
- Evolution of average selling p. of PCs, US 335
- Evolution of worldwide PC NIC average selling p. 336
- Hard disk drive p. dynamics 336

Pricing 83

PRIMA (Process industries manufacturing advantage) consortium 129

Printer market 33

PRML (Partial-response maximum-likelihood) 95

Production
- Europe as p. area 53-58
- P. of ICT hardware 318

Productivity applications 69

Professional services 34f, 50, 71

PSTN (Public service telephony network) 144f

R

RAD (Rapid application development) 101f

RAID (Redundant array of inexpensive disks) 97

RAM (Random access memory) 91

R & D (Research & development) 54

RDBMS (Relational database management software) 69f

Regulatory Framework 14, 137-141

Relational databases 69f

Residential information services 168

Retail 240f
- R./wholesale 36f, 44
- R. banking 191-196

RFC (Request for comment) 118

RISC (Reduced instruction set computing) 89, 92

RPC (Remote procedure call) 123

RTF (Rich text format) 125

Russia 63
- IT market value 306
- IT hardware shipments (units) 316

S

Sample sizes 252

SCSI (Small computer system interface) 94

SDH (Synchronous digital hierarchy) 108

SDRAM (Synchronous dynamic random access memory) 91

SDTV (Standard definition television) 114

Security 101, 144

Self service banking 191

Server-centric 111f

Services 34ff
- Data network s. 44
- Education and training s. 71f
- Integration, management and support s. 72
- Mobile voice s. 44
- Network s. 35
- Professional s. 34f, 50, 71
- Support s. 35
- Telecom s. 43f
- Voice s. 74

SGML (Standard generalized markup language) 125

Signal processing 91

SIMM (Single in-line memory module) 91

SLIP (Serial line internet protocol) 120

Small office/home office market (SOHO) 235f

Small-scale systems 93, 198

SMATV (Satellite master antenna television) 115

SMTP (Simple mail transfer protocol) 123f

SNMP (Simple network management protocol) 101, 124

Software 50
- Packaged s. 33
- Relational database management s. (RDBMS) 69f
- S. agents 69
- S. market taxonomy 70
- S. products 33f
- S. support 77
- S. technologies 98-108
- Strategic s. 33

Spain 262f
- Banking sector 187f
- ICT market value 299
- IT hardware shipments (units) 314
- IT trends 29
- Market structures and penetration of ICT 330
- TLC trends 41
- Trade in ICT hardware 323

SRAM (Static random access memory) 91

SSL (Secure sockets layer) 127

Standard(s) 88-133, 222f

Standardization 14, 21, 144

Statistical outlook 268-345

Storage management 96ff

Structural changes in banking 187

STT (Secure transaction technology) 127

Sweden 26
- ICT market value 300
- IT hardware shipments (units) 314
- Market structures and penetration of ICT 330
- Trade in ICT hardware 323

Switzerland
- ICT market value 301
- IT hardware shipments (units) 314
- Market structures and penetration of ICT 330
- Trade in ICT hardware 323

System(s)
- Computer s. 50
- S. management 73, 101
- S. software and utilities 98-101

T

TAPI (Telephone application programme interface) 111

Tariffs 55, 159

TBT (Technology-based training) 199

TCP (Transmission control protocol) 117, 121f, 124, 127

TCP/IP (Transmission control protocol/Internet protocol) 65, 93, 101, 117, 119, 123, 159

Technology
- Key technological trends and standards 88-133
- Object-t. 76f, 102
- Software t. 98-108
- T. integration 83
- Technological improvements 89

Telecommunication(s) (TLC) 108-115
- TLC driving forces 72-75
- Liberalization of T. 13
- T. driving forces 72-75
- T. equipment 42
- T. penetration 51f
- T. services 43f
- T. trends 38-46
- T. trends by country 39-42
- T. trends by product segment 42ff
- Users perspectives 44ff

Teledensity 51f

TELEMATICS 54

Telephone subscribers 148f

Teleworking 169f

TELNET 124

Terminal equipment 42

Théry report 136, 153

3D RAM (Random access memory) 91

Tools 34

TOP (Technical and office protocol) 131

Trade 58ff, 269
- ICT t. flows 318-325
- Patterns of t. 269
- T. in ICT hardware 319-325

Transport, communication, utilities 36

Trends
- IT t. 27-38
- T. by country 27ff, 39-42
- T. by product segment 30-38, 42ff
- TLC t. 38-46

Troff 125

TSAPI (Telephone service application programme interface) 111

U

UDP (User datagram protocol) 117, 122

UMA (Unified memory architecture) 94

United Kingdom 137, 264f
- Banking sector 179ff
- ICT market value 302
- IT hardware shipments (units) 315
- IT trends 28
- Market structures and penetration of ICT 331
- TLC trends 40
- Trade in ICT hardware 324

United States 18f, 139ff, 171f
- Economic developments 18, 275
- Evolution of average selling prices of PCs, US 333
- IT and ICT market 24
- Trade 58
- Trade in ICT hardware 324

Unix 99f

URL (Uniform resource locator) 125f

USB (Universal serial bus) 94

User
- U. access 57
- U.-interface 56f
- U. perspectives 36ff, 44ff

Utilities 33

V

Value-added
- V. versus volume indirect channel members 224f
- V. services 147, 154-160

Videotex 158

Virtual phone service 74

VOD (Video on demand) 114, 152f, 162ff

Voice
- V. server 111, 113
- V. services 74

VPN (Virtual private network) 145

VRAM (Video random access memory) 91

VRML (Virtual reality modelling language) 126

W

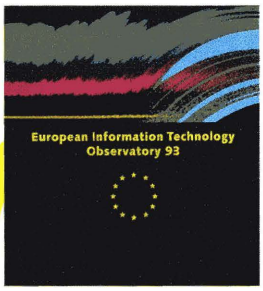
WAIS (Wide area information server) 124
Web 122
WHOIS 125
Worldwide markets 278-281
Workstation 32, 199
WORM (Write once read many) 96
WRAM (Window random access memory) 91
WWW (World wide web) 66, 125, 127, 159, 166

X

X.25 147, 150
X 400 155
XDR (External data representation) 123
X modem 123

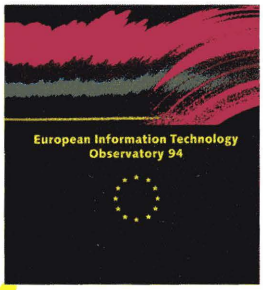
European Information Technology Observatory – EITO Previous editions with the following special studies

EITO 93



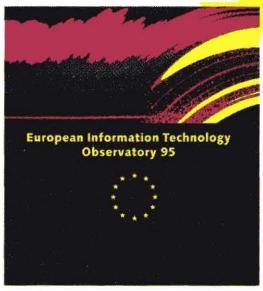
- Information Technology Standardization
- The European Software and Services Marketplace
- Environmental Achievement in Information Technology

EITO 94



- The Information Technology Markets of Eastern Europe
- Mobile Computing and Communications in Europe: Towards a Digital Wireless World
- The Information Technology Market in Europe's Public Administrations

EITO 95



- The European Information Infrastructure and the Convergence of Information Technology, Telecommunications and Media
- The Home and the Small Office/Home Office Markets for IT in Europe – The Importance of Information Highways
- Mobile Computing and Communications in Europe: Towards a Digital Wireless World

Copies still available. Apply to EITO members or sponsors.

Order addresses on front or back cover page.

European Information Technology Observatory – EITO

Members

eurobit

EUROBIT · European Association of Manufacturers
of Business Machines and Information Technology Industry
Lyoner Straße 18, D-60528 Frankfurt am Main
Tel. + 49-69-66 03 15 30, Fax + 49-69-66 03 15 10
Internet: http://www.fvit-eurobit.de/eurobit

ECTEL

The European Telecommunications and Professional
Electronics Industry · c/o ZVEI/FV K
Stresemannallee 19 · D-60596 Frankfurt am Main
Tel. + 49-69-63 02 21 3, Fax + 49-69-63 02 28 8

CeBIT HANNOVER

CeBIT · Welt-Centrum · Büro · Information · Telekommunikation
Deutsche Messe AG, Messegelände, D-30521 Hannover
Tel. + 49-5 11-8 90, Fax + 49-5 11-89 32 62 6
Internet: http://www.cebit.de

SIMO TCI
FERIA INTERNACIONAL DE INFORMATICA, MULTIMEDIA Y COMUNICACIONES.

IFEMA - SIMO TCI
Parque Ferial Juan Carlos I · E-28067 Madrid
Tel. + 34-1-7 22 50 00, Fax + 34-1-7 22 58 07

smau

Esposizione internazionale dell'information
& communications technology
Corso Venezia 47/49, I-20121 Milano
Tel. + 39-2-76 06 71, Fax + 39-2-78 44 07
Internet: http://www.smau.it/magellano

Sponsors

SICOB

ASSOCIATION SICOB du Salon International d'Informatique,
Télématique, Communication, Organisation du Bureau et
Bureautique · 4 Place de Valois, F-75001 Paris
Tel. + 33-1-42 61 52 42, Fax + 33-1-42 61 21 27

KONTOR OG DATA

KONTOR OG DATA
Computers, Software,
Office Machines,
Office Furnitures
Post Box 25 68 Solli, N-0202 Oslo
Tel. + 47-22-55 82 20, Fax + 47-22-44 59 45
Internet: Per-Morten.Hoff@kdl.telepost.no

SYS SYSTEMS

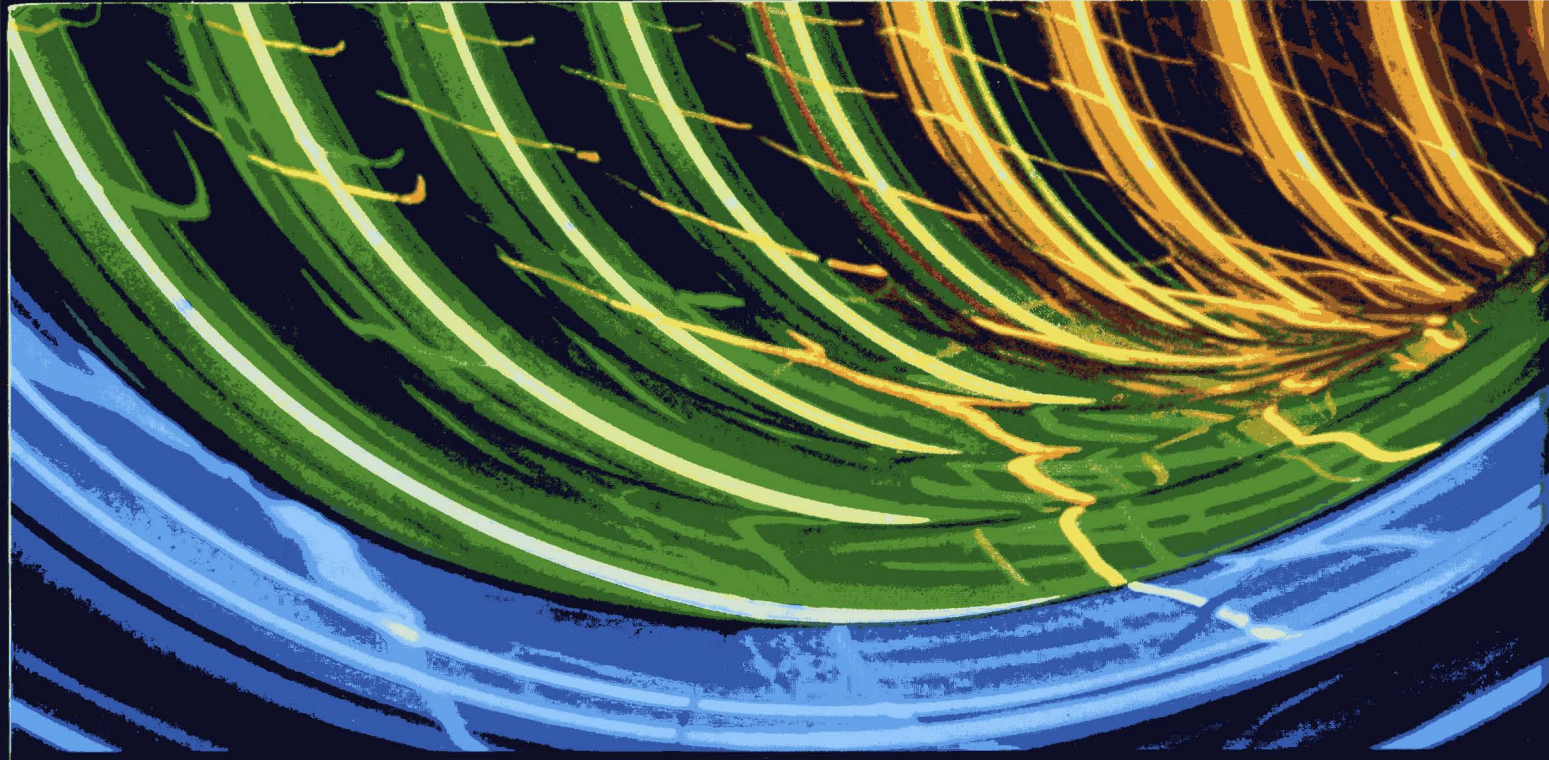
Computers, Software, Communications
Messe München GmbH, Messegelände, D-80325 München
Tel. + 49-89-510 70, Fax + 49-89-510 75 06
Internet: http://www.messe-muenchen.de

With the Support of

European Commission
DG III · Industry
Rue de la Loi 200, B-1049 Brussels
Tel. + 32-2-2 99 11 11, Fax + 32-2-29 50 13 8

OECD OCDE PARIS

OECD
Directorate for Science, Technology and Industry
2 rue André-Pascal, F-75775 Paris Cedex 16
Tel. + 33-1-45 24-82 00, Fax + 33-1-45 24-85 00
Internet: http://www.cs1-hq.oecd.org/dsti



ISSN 0947-4862