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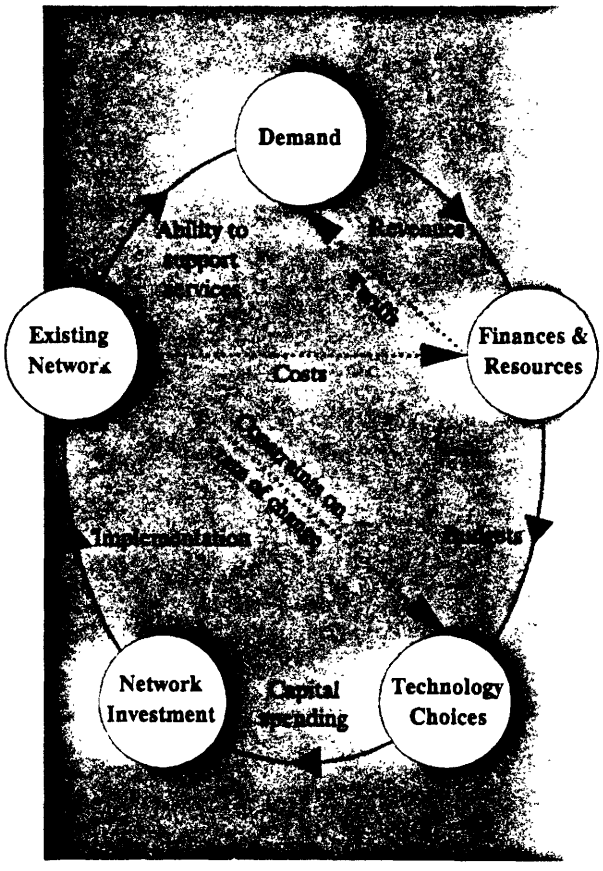
Performance of the Telecommunications Sector up to 2010 under Different Regulatory and Market Options

Analysys



Final Report to the Commission of the European Communities

Executive Report

Performance of the Telecommunications Sector up to 2010 under Different Regulatory and Market Options

Final Report to the Commission of the European Communities DGXIII/D2

Executive Report

This study, "Performance of the Telecommunications Sector up to 2010 under Different Regulatory and Market Options", has been prepared for the Commission of the European Communities. It has been commissioned as one of a series of independent studies to examine the long-term aspects of telecommunications development in the European Community.

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Summary

This study demonstrates that the European telecommunications industry faces an important choice in the first half of the 1990s. If action is taken now on regulation and reorganisation, the outcome will be continued market expansion, supporting Europe in the decade of the Single Market to the benefit of users and suppliers. If there is delay, the result may be relative stagnation.

The specific regulatory actions necessary for expansion are:

- Early licensing of competitive pan-European network operation and service provision, followed by the progressive introduction of competition in services and networks within Member States after 1995, with specific target levels and dates leading to competition throughout the EC by 2005. Competition to cover services (including voice, data, image and other new services) and networks (including fixed, mobile and satellite).

- Freedom for existing telecommunications operators (TOs) to compete in all market segments, with adequate measures (specifically interconnection and equal access) to enable competition to be viable.

- Restricted use of direct tariff controls on 'baskets' of services; the emphasis to shift to competition (through supervising interconnection agreements) and allowing tariffs to respond to market conditions.

- Genuine open procurement to increase economies of scale in equipment markets.

This study shows that these measures are financially sustainable by the existing TOs, although assistance from structural funds or other sources will be required in peripheral regions and in the countries of Eastern Europe.

The Opportunity for Expansion

The study results indicate that, given the right regulatory conditions, total revenues for the telecommunications sector in the EC (including services and CPE) will grow rapidly in real terms from ECU 90 billion in 1990 to ECU 320 billion in 2010 – a factor of 3.5.[1] Total annual investment will rise from ECU 33 billion to ECU 140 billion, and over the 20-year period will total more than ECU 1200 billion.[2]

The main projection is therefore an *Expansionist case*, in which rapid demand growth – particularly for mobile, advanced voice, video and data services – is matched by rapid and focused investment, whilst profit margins are allowed to move to meet most of the additional cash requirements. This case represents an innovative, highly competitive market in which telecommunications monopolies are removed, full service competition is allowed, and the TOs and the sector as a whole respond rapidly by becoming commercially-oriented.

In this case, the régime allows sufficient financial resources to be generated to enable forward-looking technology choices to be made, which in turn enable rapid development of the existing network and the generation of new revenues. Between 1995 and 2000 the sector's operating profit margins peak at 31%, and a cash surplus of ECU 29 billion is generated – 13% more cash than is required to fund investments. In the longer term the existing TOs' average market share falls, from an average of 95% today to around 70% by 2010 (with significant variations within this average). Nevertheless the revenues of the existing TOs still expand in real terms from ECU 85 billion to around ECU 235 billion. Operating profit margins are cut, but the TOs are still in a strong position to defend market share and expand revenues.

For the purposes of comparison, a second case (the *Minimum case*) is also presented. This represents the outcome of a regulatory policy which attempts to protect existing interests and does not promote the fundamental commercialisation which is needed in the sector. This case assumes slow or partial implementation of EC Directives and other liberalisation measures, delayed introduction and take-up of new services and applications, and cautious investment policies. Regulators impose tighter control of tariffs in an attempt to prevent abuse of monopoly power and to cut costs. Under these conditions, total sector revenues rise to only ECU 187 billion in 2010, whilst investment reaches ECU 76 billion, totalling only ECU 800 billion for the 20-year period.

1 These figures, like all the financial measures used in this report, are expressed in real terms (i.e. adjusted for inflation), in 1990 ECU.

2 These figures represent the capital outlay of all network and service providers in the EC; they exclude end-users' investment in CPE.

In this case, although there is sufficient cash flow to fund the slow expansion, the regulatory régime limits the size and resources of the sector and the attractiveness of innovation, and reinforces the slow pace of development.

The gap in benefits between the Expansionist case and the alternative Minimum case is striking. The difference in the net present value (NPV) of the Expansionist case over the Minimum case – calculated at a real rate of interest (i.e. allowing for inflation) of 4%, and before tax and dividend payments – is around ECU 130 billion.[3] This is without taking into account the wider economic benefits for users or spin-off from a strong, expanding and innovative telecommunications sector.

The Study Approach: Capturing Diversity and Forces for Change

There are significant differences between the national telecommunications sectors in Europe, in terms of services, costs, tariffs, networks, technologies, regulation, standards, and financial and operational performance. The diversity of Europe means that it is not possible to forecast developments simply by examining the experience of other countries and regions. The approach for this study has therefore been based on a detailed assessment of each individual country in Europe.

For a period as long as 20 years it is not possible simply to extrapolate past trends. In the short term (the first five years) investment requirements can be expected to be determined by the existing plans of the TOs; but beyond this there may be profound changes in the way investment develops. In particular, regulatory and organisational changes put into effect in the next five years will determine the extent of structural change and the rate of expansion well into the next century.

All aspects of telecommunications – network technologies, investment, demand, tariffs and revenues – will change substantially over the next 20 years. Digitalisation and the use of optical fibre will support new services and enable cost reductions. The fall in transmission costs relative to switching will promote a radical change in network architecture, with larger, more centralised switches and longer, higher-capacity transmission. Investment in transmission and processing will become increasingly significant. Rapid reduction in the cost of long-distance and international telecommunications will be possible; as a result, the local loop will come to dominate all telecommunications investment. Alternative technologies, particularly radio access, will become attractive,

3 Net Present Value (NPV) represents the value of an investment discounted at a particular rate, so that income in the future is worth less than income now. The discount rate used to calculate NPV is usually set equal to or greater than the rate of interest payable on the money market; it should also reflect the degree of risk of the investment with a high discount rate for higher risks. The interest rates used in this study are real interest rates, i.e. adjusted for the effects of inflation. NPV is usually quoted before tax and dividend payments; this represents the overall value to the sector. The value to the sector after tax and dividend payments is around ECU 50 billion.

and (together with cable TV systems) these could provide the basis for service and network competition in the local loop.

Changes in network architecture and technology will also reduce the sensitivity of network costs to the volume of traffic. It is then inevitable that tariffs for usage will decrease – whether through pressure from regulators or from competition – and that growth in traffic for basic services will bring only limited revenue growth. Detailed analysis shows that relatively high growth rates for services overall are required to off-set this effect. Conditions must be created for the rapid deployment of equipment capable of supporting mobile and advanced voice services if revenue growth is to be maintained during the critical second half of the 1990s.

Nowhere, however, can the existing pattern of behaviour and massive investment in telecommunications be changed overnight. Through the use of quantitative techniques to capture these complex interactions, this study examines within a coherent framework the financial implications of fundamental change. It compares the performance of the TOs under different regulatory options, taking full account of both the existing situation and plans, and the forces for change.

The Short, Medium and Long Term

Regulatory action taken in the short term will determine the medium- and long-term growth of European telecommunications. Analysis on a country-by-country basis shows that the likely development of the sector over the next 20 years can be divided into three broad stages. Differences between countries are evident in the timing of transition between stages, but not in the pattern of evolution nor in the critical importance of regulatory changes.

The short term (typically up to 1995)

The short term will be a period of apparent stability masking important underlying structural change as the sector increases its financial strength. TOs will focus on reducing investment levels and costs, whilst demand will continue its steady growth. Some TOs will generate large cash surpluses, whilst those with underdeveloped networks will still find it difficult to generate sufficient funds from operations. Equipment manufacturers will come under increasing pressure to deliver greater functionality at lower overall cost into a slowly growing market. The disparity in financial fortunes, together with commercialisation, competition and changes in investment patterns, will lead to increasing differences between telecommunications sectors in the EC Member States.

Because of the increasing financial health of the TOs and the changes in network economics, it will become feasible during this period to begin to remove existing monopolies in services and networks and to introduce widespread competition (though where peripheral countries lag behind, intervention will begin to be required). These regulatory changes will have little impact in the short term, but will have major consequences in the ensuing years, when the scale of structural change will depend on the policies put in place during this period.

The medium term (typically 1996-2000)

If these regulatory initiatives are carried forward and reinforced, the medium-term prospects are for continued growth and an expanding market, benefiting both users and suppliers. The TOs will generate large cash surpluses from basic operations as continued cost reductions limit the need for growth in investment. Advanced voice services, narrowband and broadband digitally-based network access (including ISDN), and mobile services will all become increasingly important sources of revenue; simple voice telephony will therefore become relatively less significant, although taking Europe as a whole it will still achieve positive growth.

A surge in competitive pressures can be expected, and those TOs which have not absorbed the implications of commercialisation will become increasingly disadvantaged. Nevertheless, the degree to which competition can capture market share will still be limited, partly because of the inherent advantages possessed by the incumbent TOs, and partly because of tariff régimes. In particular, TOs which have been able to invest in the network architectures and equipment capable of supporting new services will be at an advantage against competitors attempting to gain market share.

If, on the other hand, regulatory changes are not put in train early in the 1990s (and followed through thereafter), both competition and growth will be held back. In this event – represented by the Minimum case – the larger TOs will look elsewhere for returns on their capital. The regulatory authorities will then respond by imposing tariff restrictions to curb monopoly exploitation. The combination of slower demand growth, tariff constraints and cost reductions (as network technologies improve) would mean stagnant revenues for the TOs.

In either case, the peripheral countries will – despite major advances in penetration – tend to be left behind core countries in terms of usage, financial strength and the implementation of technology. They will therefore require assistance to manage this transition period; this assistance will need to be greater in the case of a rapidly expanding competitive market.

The long term (typically 2001-2010)

The first decade of the 21st century will see a continued acceleration in demand for new services, and (as usage charges decline and available bandwidth increases) an expanding market for new generations of customer premises equipment, offering significant revenue potential. This new wave of growth will require a further acceleration in investment, so that annual investment could be as high as 40%-45% of turnover, up from 30%-35% in the previous decade. During this period it will be feasible for the peripheral countries to complete their network modernisation and so reduce the divergence between Member States. However, the ability of the sector to deliver and sustain a high rate of growth and attain some degree of convergence depends critically on the reform process which will have been put in train years before.

Consequences for Policy

In September 1983 the Commission of the European Communities (CEC) put forward to the Council of Ministers the outline of six Action Lines in telecommunications. Since then, substantial progress has been achieved with the Green Paper, the Services and Open Network Provision (ONP) Framework Directives, procurement, STAR, RACE and standards (including the formation of ETSI); and the CEC has continued to monitor and promote telecommunications throughout the Community. Only in the development of transnational infrastructure has progress not matched the original intentions.

This progress must now be accelerated. Telecommunications is a vital part of the future Single Market in Europe, but within a few years the sector will be undergoing substantial change, and initially the differences between countries will grow wider, not narrower. Action is needed now in a number of critical areas:

Reinforcement of existing actions

The EC initiatives begun in the 1980s must be continued and reinforced. ONP is especially important, as it provides the only European-level regulatory framework; however it must be recognised that market and technological changes will require ONP to be amended. Another major issue relates to standards, procure-

ment and the open market: from the cost data for different TOs' investments it is clear that there is a long way to go before similar prices are being paid for telecommunications equipment across Europe. Action is required here to make existing policy effective. It will also become important to focus shared R&D initiatives on demonstrating the capabilities of the new technologies and on building European-level networks to support this.

Pan-European networks and services

Of the original Action Lines, only one remains relatively inactive – the development of pan-European networks and services. The early introduction of competitive, long-distance intra-Community network operation and service provision would be the single most effective measure to promote infrastructure development in support of the European economy, to provide a spur to the lowering and rebalancing of tariffs, and to accelerate commercialisation. Such an initiative should be combined with the definition of ONP conditions for carriers and service providers wanting to interconnect with national networks. Action on this can and should be taken immediately by Member States and the EC.

Tariffs

Tariffs for telecommunications between Member States are far too high and bear little (if any) relationship to the cost of providing the service. These tariffs could and should be reduced significantly. Whilst direct intervention is possible, the objective would best be achieved in the long run through competition – by licensing pan-European operations and providing fair and reasonable interconnection, whilst monitoring tariff changes in relation to cost.

Adjustment arrangements and peripheral regions

The opening of markets and introduction of competition is essential for ensuring a rapidly expanding sector, and is sustainable in most countries even in the short term. However, exceptions exist in the peripheral regions where networks are poorly developed or the TO is not fully commercial. In such cases assistance from structural funds (or other sources) should be stepped up to assist in the adjustment process. As an alternative, lengthy transition periods could be allowed, but delays would mean substantial costs in terms of higher prices and slower innovation.

Eastern Europe

The situation faced by the peripheral regions of the EC is directly paralleled in the countries of Eastern Europe. Here, too, assistance is required, both in terms of investment and in bringing about more competition; without such assistance, the transition to modern networks and fully commercial operations will be long and costly.

Removal of monopolies and reserved services

Having built up their national networks, the TOs in Europe will increasingly move into cash surplus. At the same time, developments in technology and improvements in efficiency will mean that previous arguments for retaining monopoly rights to the provision of telecommunications services will no longer apply. In future, networks will be capable of supporting multiple service providers, and changes in the technology for local access and the differentiation of the market into a wide range of services will mean that efficient market competition is both possible and desirable. The results of the study show that the progressive introduction of competition in services and networks is financially sustainable.

Observing enforcement of Directives and resolution of disputes

The authority and mechanisms to enforce regulatory change and compliance with Directives exist at the European level, but their operation can be slow - largely because inadequate emphasis and insufficient resources are devoted to this area. The recent challenge to the Commission's use of Article 90 took nearly two years to resolve through the European Court of Justice; as further action on regulation and the increasing pace of change in the sector inevitably give rise to further disputes, any further delays of this kind could seriously hamper the required structural changes. It will be important to ensure that the process of resolving disputes is considerably speeded up in the short term. This will not be achieved unless more resources are devoted to the area at a European level.

Social aspects

The economics of telecommunications networks are moving towards increasing the cost of connection and decreasing the cost of usage. This benefits larger customers who make intensive use of their network connections. For infrequent users, however, the cost of telecommunications will rise. Consideration will need to be given to obligations to provide service, and to the degree of cross-subsidy (if any) and other intervention which might be necessary to ensure access for all users at acceptable costs.

Main Conclusions

The main conclusions of this study are as follows:

- **Expansion is possible.** This study demonstrates that there is an opportunity for substantial expansion in the European telecommunications market over the next 20 years. Demand for basic voice, mobile, advanced voice, facsimile, data, video and image services will grow as a result of economic expansion, increasing intensity of use of information, and substitution for transport. Falling costs and improvements in technology will be major factors sustaining this growth. The detailed country-by-country analysis suggests that service revenues may rise by a factor of 3.5 and annual investment may quadruple in real terms.

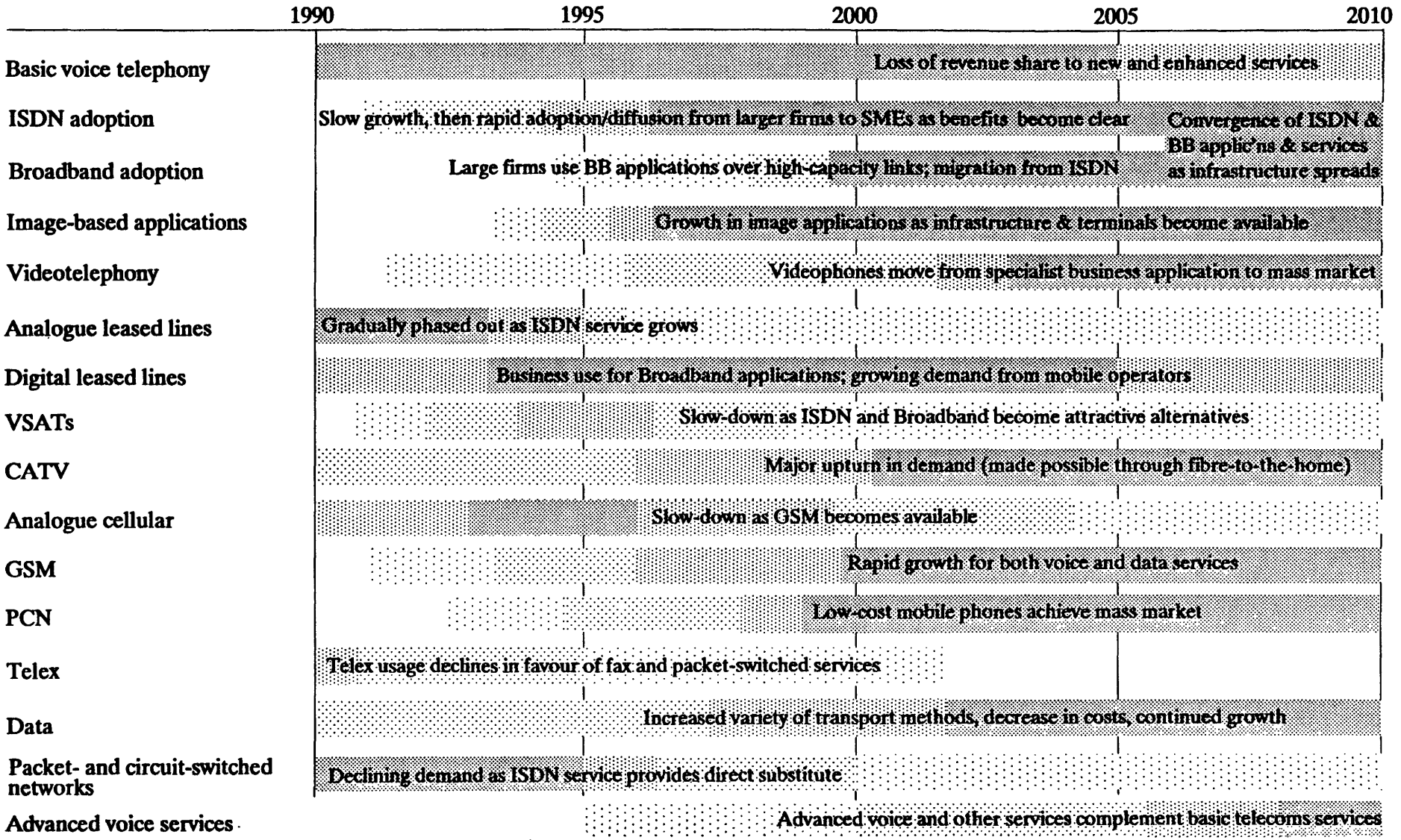
- **Liberalisation is necessary.** New developments will enable many services to be supplied on one network, and allow different networks to be used to provide services in different market segments. This, together with reductions in cost, increased profits and cash flow for incumbent TOs, and a rapid growth in the variety and scale of demand, mean that previously valid arguments for monopoly provision of telecommunications networks and services will no longer hold. Reinforcement of ONP and other EC actions is needed, but rapid expansion will only be possible if there is a policy for structural change that goes beyond existing EC actions. Specifically, this means the progressive introduction and enforcement of competition in services and networks (immediately in the case of telecommunications between Member States), restricted use of direct tariff controls on 'baskets' of services (the emphasis to shift to competition and allowing tariffs to respond to market conditions), genuine open procurement and diverse sourcing of equipment, non-interference in technology choices, and an increase in the resources available to Member State regulators.

- **Expansion and liberalisation are financially sustainable.** Given the right regulatory conditions, sufficient financial resources could be generated to enable forward-looking technology choices to be made, which in turn would enable rapid development of the existing network and the generation of new revenues. For the incumbent TOs, loss of market share is more than offset by the growth in revenues and profits from expansion of the sector as a whole.

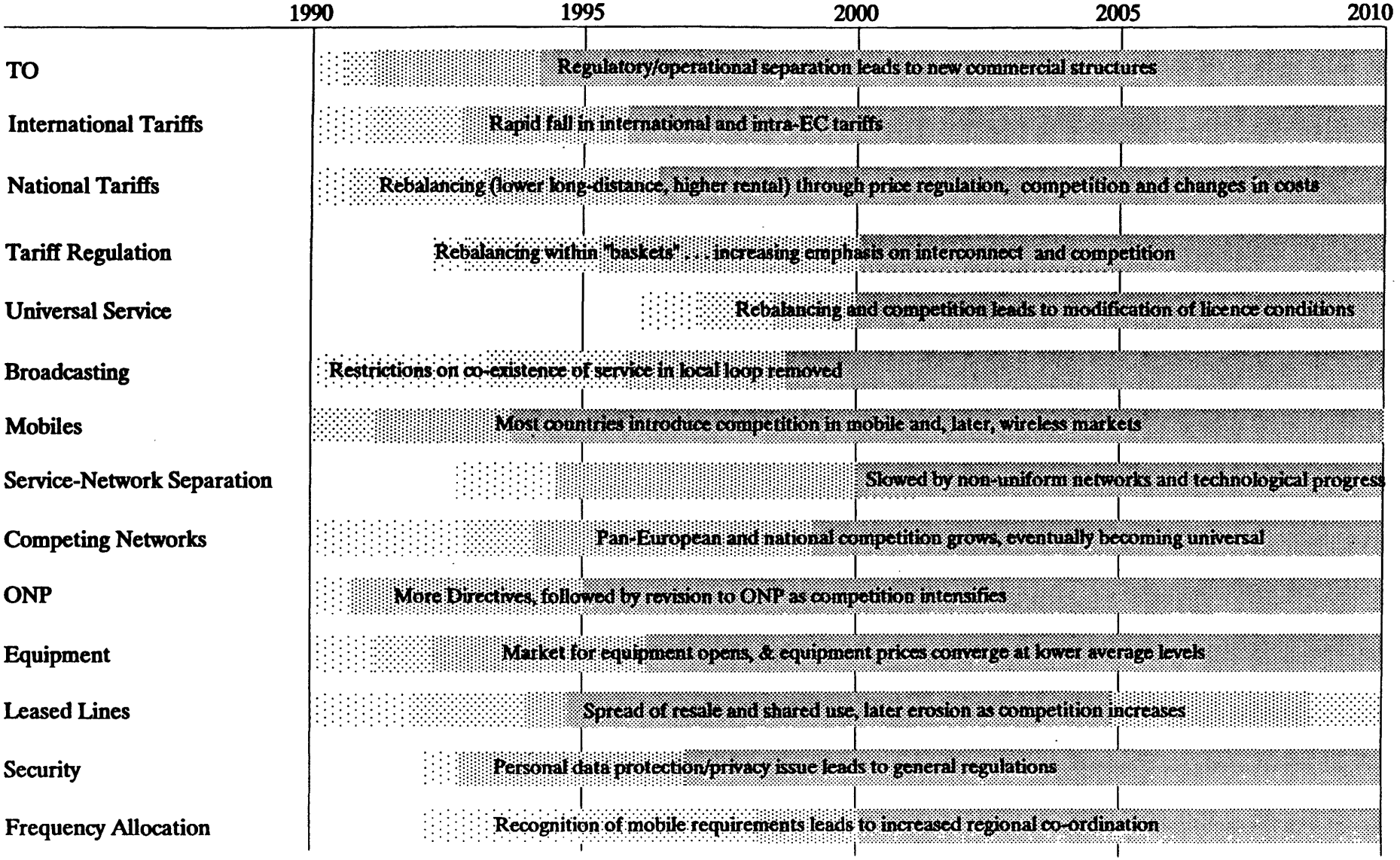
- **Additional assistance will be necessary. Investment requirements in the peripheral countries of the EC,** in order to keep pace with expansion in the rest of the Community, will need to be high – as much as ECU 145 billion up to the year 2000. This total cannot be fully covered by commercial operations; it is not until near the end of the decade that positive cash surpluses are being generated overall. Assistance will therefore need to be directed at specific regions where financing requirements are particularly burdensome. For **Central and Eastern Europe** (not including

the countries of the former Soviet Union) the projections indicate that investments will run to ECU 90 billion over the next 20 years and result in a borrowing requirement of up to ECU 20 billion. Although investment costs will be high, the benefits of falling equipment costs mean that Eastern European countries will in fact be able to modernise more cheaply than those Western countries who began their modernisation in the 1970s. The EC should consider annual assistance of ECU 100 million rising to ECU 500 million by 2000 (a total of about ECU 3 billion over 9 years from 1992 to 2000), so as to enable these countries to match the developments in Western Europe. **For low usage and remotely located customers** consideration must be given to continuing to provide access at an acceptable cost.

Demand Projection (Expansionist Case, Advanced Countries)



Regulatory Projection (Expansionist Case, Advanced Countries)



Analysys

Performance of the Telecoms Sector up to 2010 under Different Regulatory and Market Options

FINAL REPORT

EXECUTIVE REPORT

CONTENTS

1/ Introduction

This volume forms part of the Final Report from a study of the performance of the telecommunications sector up to 2010 under different regulatory and market options, produced by Analysys Ltd for the Commission of the European Communities. Using quantitative techniques, the study projects the financial performance of TOs and the telecommunications sector in the EC Member States, EFTA and Eastern Europe, and shows how this performance is affected by different regulatory choices.

This **Executive Report** sets out the findings of the study and gives recommendations for policy. It is supported by a **Main Report** which describes the general European projections for demand, technology and regulation, and presents detailed financial results (at the EC level) under the different regulatory options. The Main Report also summarises the results for EFTA and the East European countries, and outlines the methodology underlying the quantitative analysis.

A series of **Annexes** contain the country-by-country results of the study and full details of the approach and assumptions from which these results are derived. **Annex A** (the Technical Reference) explains in detail the methodology underlying the quantitative analysis. **Annex B** analyses each country in terms of a profile, assumptions (including the ways in which the individual country projections differ from the general European projections), and investment and financing implications. A standard set of quantitative results for each country appears in **Annex C**.

Following the present introduction, this Executive Report contains:

- An overview of the current diversity of European telecommunications in demand levels, technology and the financial performance of the sector (Chapter 2).
- An account of the basis for expansion, including a summary of the regulatory options considered (Chapter 3).
- An analysis of the main forces for change – demand, technology and regulation – which will determine the evolution of telecommunications, together with a projection for the action of these forces in Europe over the next 20 years (Chapter 4).

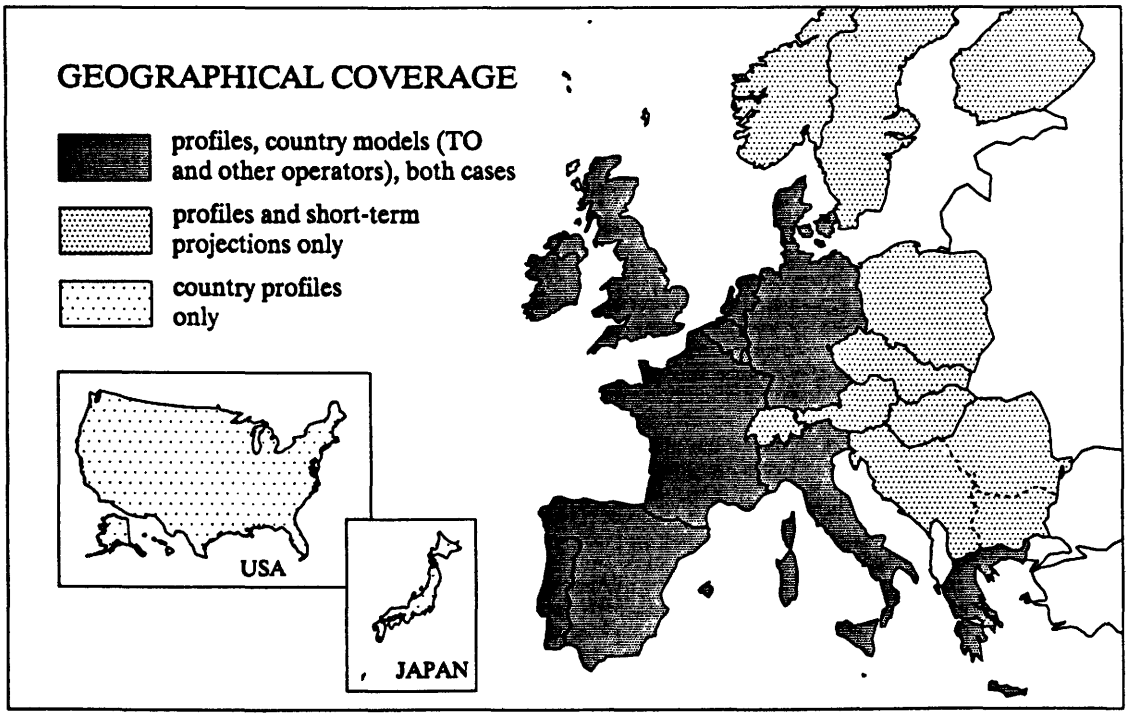
- The detailed results of the quantitative modelling, including investment, revenue and financial measures (Chapter 5).
- The main conclusions and action points arising from the study (Chapter 6).

1.1 Overview of Study Aims, Coverage and Results

The **aims** of the study are:

- to forecast the major developments in European telecommunications up to 2010, and produce quantitative projections for network investment and revenue country-by-country
- to assess in detail how different regulatory options – 'Expansionist' and 'Minimum' – will affect the market and the telecommunications operators' performance
- to demonstrate to what extent financing needs may be met from internal funds, and where assistance may be necessary.

Coverage: The study covers the 12 Member States of the European Community (EC) over the years 1990-2010. For each EC country separate quantitative models have been produced for the national TO and its competitors, to enable a distinction to be made between the financial health of the incumbent TO and that of the country's telecommunications operations as a whole. For each of these, results are generated for both the Expansionist and Minimum cases.



Other countries have also been studied (in less detail) in order to put the EC results in context: short-term projections, covering 1990-1995, have been made for each of the EFTA countries[1] and the countries of Eastern Europe.[2] For these countries only one set of results is generated, since no distinction is made between the TO and its competitors, and the two regulatory options are sufficiently close in the short term to make a comparison unnecessary. Country profiles have also been constructed for the USA and Japan, indicating the main points of difference and similarity vis-à-vis the EC.

The Expansionist and Minimum cases: The study finds that considerable expansion of the European telecommunications market is possible (and can be sustained by TO finances) over the next 20 years. This goal will, however, require action to be taken in the short term on regulation and reorganisation, and assistance to be made available to peripheral regions of the Community. The countries of Eastern Europe will also require financial assistance. The report therefore presents the financial consequences for the market and the operators of two different approaches – the 'Expansionist' option (in which these regulatory actions are taken) and the 'Minimum' option:

The **Expansionist case**:

- Represents an innovative, highly competitive market in which telecommunications monopolies are removed and competition is allowed in all services (including voice, data, image and other new services) and networks (including fixed, mobile and satellite). The existing TOs and the sector as a whole respond rapidly by becoming commercially-oriented.

- Assumes rapid demand growth – particularly for mobile, advanced voice, video and data services – matched by rapid and focused investment.

continued...

The **Minimum case**:

- Represents the outcome of a regulatory policy which attempts to protect existing interests and does not promote commercialisation. Assumes slow or partial implementation of EC Directives and other liberalisation measures, delayed introduction and take-up of new services and applications, and cautious investment policies.

- Represents relative stagnation in the telecoms sector, and illustrates the consequences of preserving the regulatory status quo.

continued...

1 With the exception of Iceland; also Liechtenstein is included with Switzerland, as the Swiss TO operates the network in Liechtenstein.

2 Except for Bulgaria, Romania and Yugoslavia, which are covered in a single aggregate model.

The **Expansionist case** (continued):

- The regulatory régime allows sufficient financial resources to be generated to enable forward-looking technology choices to be made, which in turn enable rapid development of the existing network and the generation of new revenues. Competitive pressures drive tariffs towards costs; this process stabilises after approximately 15 years.

- Total revenues for the telecommunications sector in Europe (including services and CPE) grow rapidly in real terms from ECU 90 billion in 1990 to ECU 322 billion in 2010 – a factor of 3.5.[3]

- Total annual investment rises in real terms from ECU 33 billion to ECU 142 billion, and over the 20-year period totals ECU 1277 billion.

- Between 1995 and 2000 the sector can be expected to generate a cash surplus of ECU 29 billion – 13% more cash than will be required to fund investments.

- Existing TOs' average market share falls from an average of 94% today, but their competitive response enables them to maintain their share at an average of above 70% in 2010. Though operating profit margins are cut (to an average of around 24%), the existing TOs are still in a strong position to expand revenues; over the 20 years their revenues expand in real terms from ECU 85 billion to around ECU 237 billion.

The **Minimum case** (continued):

- It is assumed that regulators impose tighter control of tariffs in an attempt to prevent abuse of monopoly power and to cut costs. Tariffs therefore become cost-oriented more rapidly than in the Expansionist case; driven by regulatory pressure, the process of cost-orientation stabilises after approximately 10 years.

- Total sector revenues rise to only ECU 188 billion in 2010 – a factor of 2.1.

- Total annual investment reaches ECU 76 billion, totalling only ECU 899 billion for the 20-year period.

- Cash flow is expected to be sufficient to fund investment, but the regulatory régime limits the resources of the sector and the attractiveness of innovation, reinforcing the slow pace of development.

- The average market share of existing TOs is gradually eroded as they fail to develop a commercial and competitive orientation, and falls to an average of around 75% in 2010. Although this is higher than in the Expansionist case, their revenues rise to only ECU 141 billion (in real terms) over the 20 years. TOs' operating profit margins are cut more severely than in the Expansionist case – down to 19% in 2010.

3 These figures, like all the financial measures used in this report, are expressed in real terms (i.e. adjusted for inflation), in 1990 ECU.

1.2 INPUT DATA SOURCES

Note that all financial data are expressed **in real terms**, that is, adjusted for the effects of inflation. The currency used is 1990 ECU; the conversion rates used are those published by the OECD and Economist Intelligence Unit.[4]

The starting-point for each country model is given by 1990 data. These data have been drawn from a range of sources, including TOs' own statistical data (both confidential and public), TOs' annual reports, and other published reports.[5] In some cases, 'start-data' information was not available for the correct year or half-year, and so had to be calculated. In other cases published data had to be adjusted and 'standardised' in format in order to conform with the requirements for consistent model input. Start-data for revenues used in the modelling were for the 1990 calendar year; where 1990 information was unavailable, the revenues were projected forward from earlier years. Start-data for lines and waiting lists were for mid-1990, and so sometimes differ from other published figures, which usually represent the year-end. Where mid-1990 figures were not available, estimates were obtained by extrapolation or interpolation. The table below summarises the starting-point for the modelling. It shows the 1990 values of certain key measures for the EC as a whole. For definitions of measures shown, see the Explanation of Financial Terms which appears towards the end of this volume.

Selected 1990 Data, Aggregated for the 12 EC Member States

Connections (thousands) by connection type[6] (estimated at mid-year)	Business Telephony	35689
	Residential Telephony	105389
	Mobiles	1862
	ISDN and Broadband	19
	Total (Main Switched Services)	142960
	Other Services	3606
	Total	146566
Population (est. at mid-year)	Millions	341
Financial - Revenue (MECU) by connection type[6]	CPE	16009
	Business Telephony	28968
	Residential Telephony	33392
	Mobiles	1718
	Other	10386
	(Total) Revenue	90472
	Telephony (Bus. & Resid.) as Proportion of all Revenue	69%

continued...

4 See Appendix to Annex B, Volume 1 for details of the conversion rates used.

5 See Appendix 1 to Annex A for details of data sources.

6 Note that connection types are referred to as 'bearer services' on the results graphs in the Main Report and in Annex C.

Selected 1990 Data, Aggregated for the 12 EC Member States (continued)

Financial - Costs	Capital Outlay (MECU)	33071
	Operating Cost (MECU)	66640
	Operating Cost per Connection (ECU)	455
Financial - Ratios	Operating Profit Margin	26%
	Long-Term Debt	82393
	Fixed Assets plus Net Current Assets	168695
	Long-Term Debt as a Proportion of Total Net Assets	49%
	Ratio of Fixed Assets to Turnover	1.99
TOs' Market Share	% Share of Turnover	94%
	% Share of Investment	95%

The projections for technology, regulation and demand used in the study take account of existing plans, and of expert opinion on likely developments over the 20-year period. They include the completion of digitalisation and the introduction of Synchronous Digital Hierarchies (SDH) and Asynchronous Transfer Modes (ATM); major restructuring of network architectures; the widespread installation of optical fibre in the local loop, beginning in core business areas and spreading to residential areas after 2000; major growth in ISDN, mobile, broadband and image-based services; increased competition; and tariff rebalancing. (The assumptions differ between the Expansionist and Minimum cases, as explained in Section 1.1 above.) Projections of demand take account of economic forecasts made in the first quarter of 1991.

One assumption worthy of special note is that governments do not interfere in the financial affairs of the TOs above and beyond the controls and levies that currently exist. It is recognised that in practice governments may intervene, for instance by instituting special tax levies on TOs to divert profits in line with social and political objectives. No account is taken of such interventions in the quantitative results presented here.

It should also be noted that activities or events outside of the operators' normal domestic business operations are not included in the financial projections. Care should therefore be exercised in comparing these figures with information published elsewhere about the organisations' financial performance.

1.3 Summary of Methodology

In order to achieve its aims, the study takes account of both the *diversity* of the current situation and the *complexity* of the interacting forces which will shape developments. Major differences exist between the national telecommunications sectors in Europe (in terms of services, costs, tariffs, networks, technologies, standards, and financial and

operational performance); the approach is therefore based on a detailed assessment of each individual country, starting from existing infrastructures and current plans. Future developments will be shaped by existing patterns of behaviour and by the dynamic interplay of demand, technology and regulation; the approach is therefore designed to capture the interaction of these forces in a structured and coherent framework.

The **methodology** therefore has the following main aspects:

- Building **profiles** of each of the countries studied, starting from 1990 data, a study of the telecommunications sector and the general economic situation, current plans and established trends. (See Annex B.)

- Making global **projections** for developments in demand, technology and regulation – issues which cut across all countries – supported by expert input. (See the Main Report.)

- Developing a **methodology to forecast demand** within the constraints imposed by economic factors, and using this to make detailed projections of demand for different services on a country-by-country basis. (See Annex A.)

- Constructing a **general reference model** framework capable of capturing these profiles and projections, and of quantifying the costs and funding implications of network investment to meet the forecast demand. (See Annex A.)

- Building and running **country-specific models**, which bring together the profile data, the global projections, and the demand forecasts within the quantitative framework, and generate the financial results. (See Annex C for country-by-country results, and the Main Report for aggregate results at the European level.)

The first stage in the quantitative modelling is therefore the **forecasting of demand**. From input on GDP growth, the elasticity of telecommunications spending with respect to GDP, usage patterns, tariff assumptions, demographic trends and the existing customer base, detailed demand forecasts are calculated in terms of the numbers of connections and the levels of usage. These detailed demand forecasts are then used to drive the **investment model**, which calculates the costs of satisfying demand, using input on the initial financial position of the operator, trends in capital, operational and maintenance costs for the main network elements, and the operator's network provision and depreciation policy. The results of the investment model include:

- the costs and quantities of equipment in the network
- the capital investment required
- cash flow, revenue and profitability
- the cost of providing services to customers

- financial information (summarised in the form of profit and loss account, balance sheet and source and application of funds).

Demand forecasts and the costs of service provision are fed into the **calculation of tariffs and revenue**, where account is taken of moves towards cost-oriented tariffs.

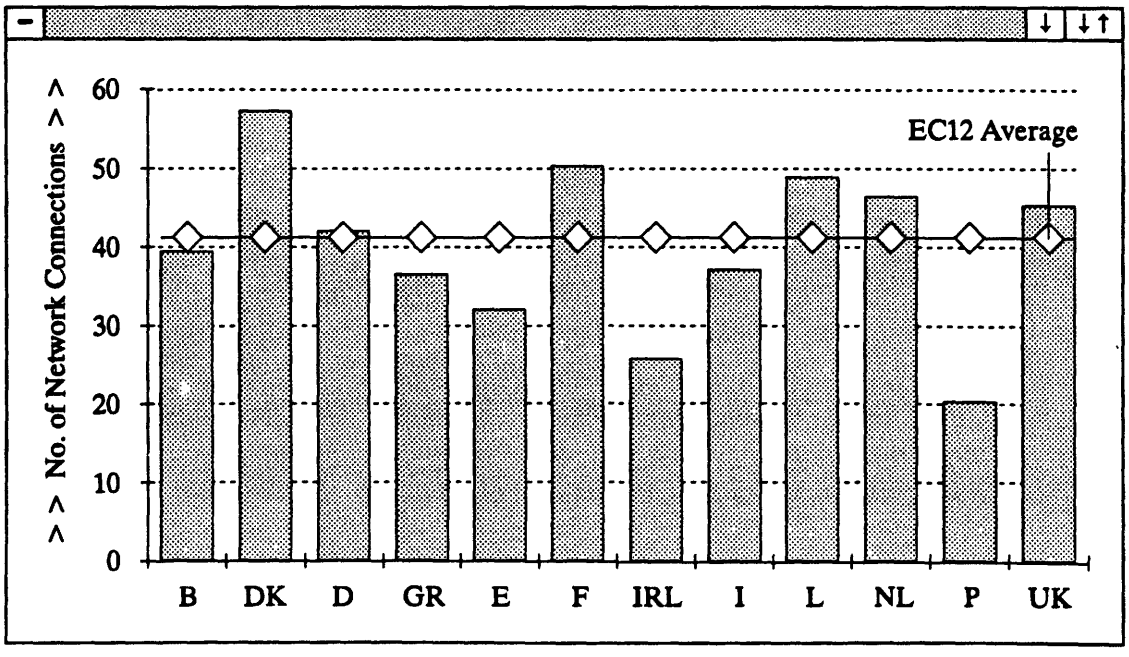
2/ The Diversity of European Telecommunications

Europe begins the decade of the Single Market with substantial differences between Member States in terms of the intensity of telecommunications usage, technology, and the financial well-being of the telecommunications operators. This section provides an overview of some aspects of this diversity.

2.1 Diversity in Levels of Telecommunications Demand

There is currently a wide variation in the levels of telecommunications development and usage across the Member States of the European Community (EC). Average EC penetration in 1990 was just over 40 connections per 100 population (see Exhibit 2.1).

EXHIBIT 2.1: *Number of Network Connections per 100 Population, 1990 (Main Switched Services, excluding Mobiles)*

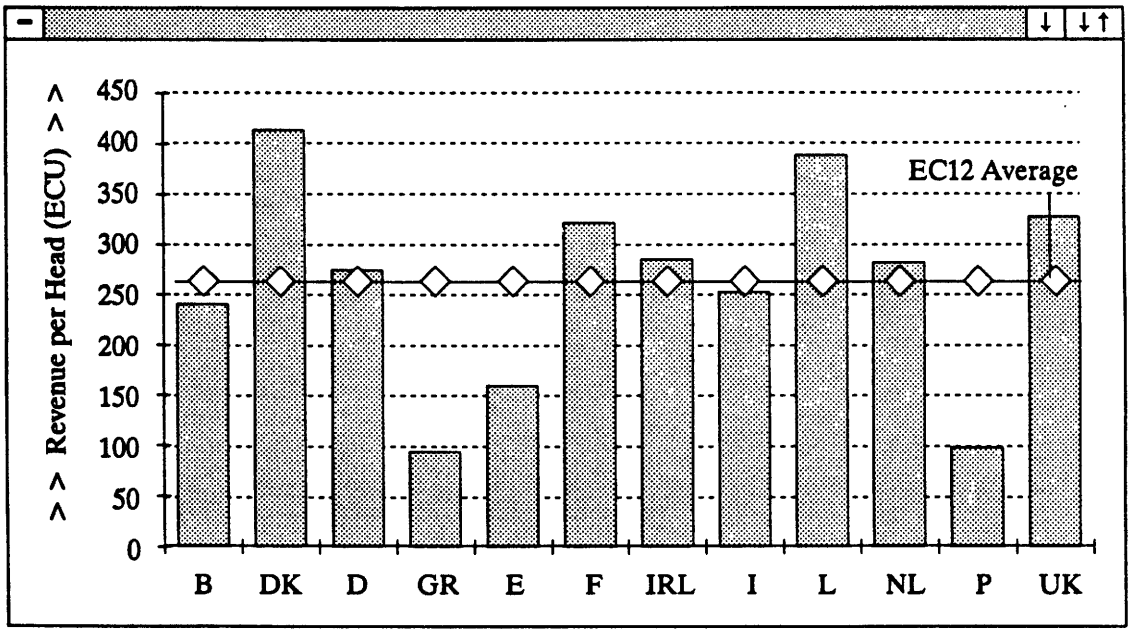


The EC Member States can be classified into two groups:

- countries with below average penetration: Belgium, Greece, Spain, the Republic of Ireland, Italy and Portugal
- countries with above average penetration: Denmark, Germany, France, Luxembourg, the Netherlands and the UK.

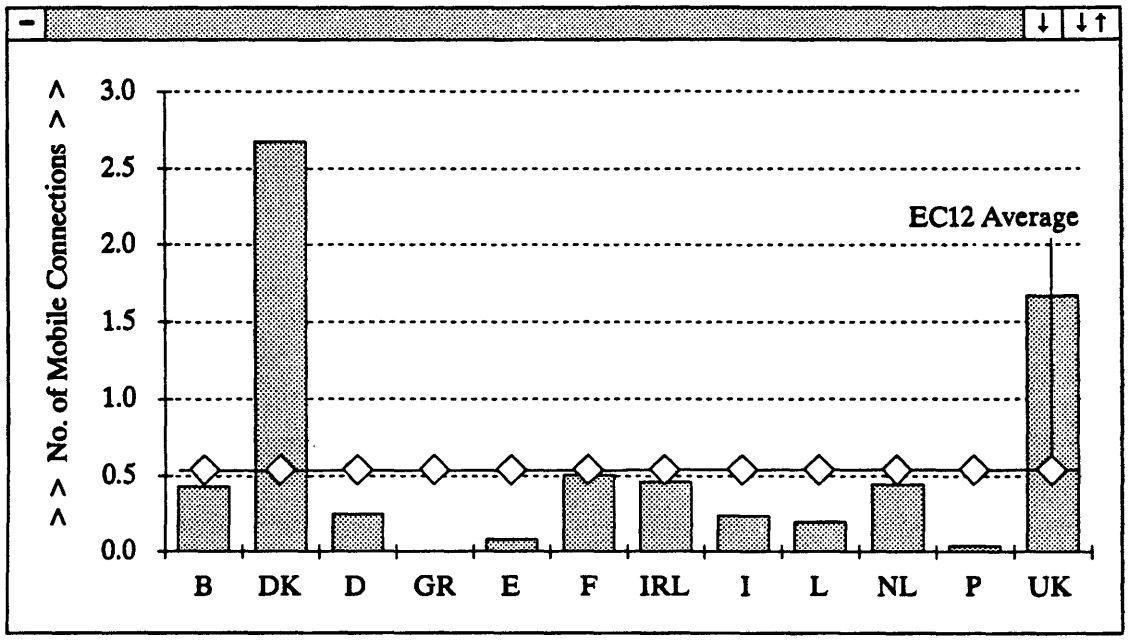
As would be expected, penetration and telecommunications-sector revenue per head are closely related. In fact, with the exception of the Republic of Ireland – whose revenue per head is above average – the groupings are identical, as shown in Exhibit 2.2.

EXHIBIT 2.2: *Telecommunications Sector Revenue per Head of Population, 1990 (ECU)*



These differences between Member States are intensified for newer services. For these services, penetration and revenues per connection are influenced by a number of factors, including when the service was introduced, whether supply matches demand, tariffing policy and the state of competing or complementary networks. For example, Exhibit 2.3 opposite illustrates mobile connections per 100 population in 1990. The enormous variation in penetration levels is clear with Greece, Spain and Portugal being very low (or non-existent), and the UK and Denmark very high. Similar differences in usage and penetration can be shown for a wide range of new and advanced services.

EXHIBIT 2.3: Number of Mobile Telephony Connections per 100 Population, 1990



2.2 DIVERSITY IN TECHNOLOGY

In Europe the more advanced networks are characterised by high digitalisation levels, the rapid implementation of new technologies, the ability to provide new services quickly, high service quality, and high penetration. Having already established an adequate basic infrastructure, network planners are able to concentrate on rationalising and enhancing the existing network to support new services.

The less advanced networks are characterised by insufficient basic infrastructure to meet current demand, outmoded equipment, poor service quality, a high proportion of analogue switching, and few advanced services. Some or all of these characteristics are to be found in the peripheral and less favoured European regions. In these instances resources must be devoted to modernising and extending the basic network before new service development can take place on a wide scale.

In technology and network development, three groups are discernible:

- countries where digitalisation and modernisation lags behind the European average: namely Greece, Italy, Portugal and Spain
- countries around the European average: Belgium, Germany, the Republic of Ireland, Luxembourg and the Netherlands
- countries with relatively advanced networks: Denmark, the UK and most notably, France.

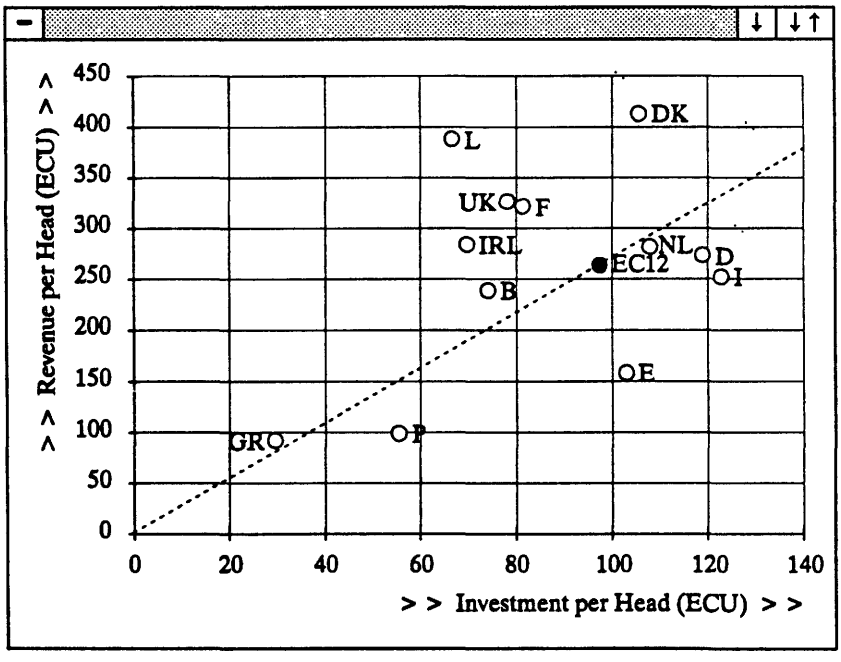
A number of the EC states plan to make, or are making, rapid strides in developing their networks. These include Italy, Spain, Germany and the Netherlands.

The pace at which technological change is implemented in these and other countries depends on a combination of market conditions and investment policies. In France, the policy of relatively early digitalisation has led to significant long-term gains in operating efficiency and the ability to support new services (including ISDN). Deutsche Telekom in Germany has decided upon a major implementation programme for Synchronous Digital Hierarchies (SDH) which will lead to advantages in cost reductions and flexibility. In all cases the situation is changing rapidly.

2.3 Diversity in the Financial Well-being of the Telecommunications Sector

Indicators of financial performance for the telecommunications sector show very great diversity between the EC Member States. For example, major differences occur in investment per head and in the relationship between this and revenue per head (Exhibit 2.4).

EXHIBIT 2.4: Investment per Head and Revenue per Head, 1990 (ECU)



In the area of financial performance there are two groupings, dividing the countries quite differently from the groups according to usage or technology:

- Countries whose revenue is high compared to their investment, namely Belgium, Denmark, France, the Republic of Ireland, Luxembourg and the UK. These

countries have been controlling investment levels, and investment is typically around 25% of revenue in these countries.

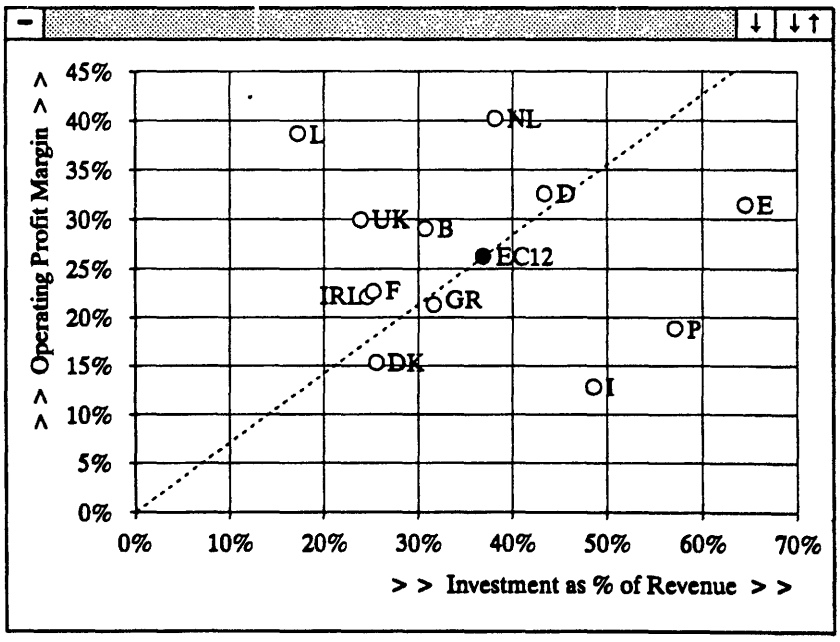
- Countries whose investment is relatively high compared to revenue: Germany, Italy, Portugal and Spain. In these countries investment is more than 40% of revenue, rising to over 60% in the case of Spain. In the case of Germany the already high ratio of investment to turnover for a relatively mature network is likely to rise further as a result of the investment required for the eastern Länder.

Greece and the Netherlands fall just either side of the line (with investment at around 35% of revenue), although the situation in each case is very different.

It will take time for this situation to change. Revenue growth and investment levels depend on the rate of growth of the network, and Italy, Portugal and Spain will all be expanding their networks faster than the European average.

Profits determine how fast a TO can change the existing situation, and high profits can compensate for high ratios of investment to revenue. As with the other indicators, profitability - as measured by the operating profit as a percentage of turnover (operating profit margin) - varies greatly between countries. Exhibit 2.5 shows this measure of profitability, and its relation with the investment/revenue ratio:

EXHIBIT 2.5: Operating Profit Margins and Investment as a Percentage of Revenue, 1990



Once again, there is clear diversity. Although not an exact relationship, high investment levels (relative to turnover) generally require a high operating profit margin in order to generate the required cash and to keep up debt repayments, yet no clear relationship exists between these measures in Europe. Some countries, notably Luxembourg, the

Netherlands and the UK have very favourable figures. Italy and Portugal on the other hand have very high levels of investment given their operating profit margins.

It is clear that considerable diversity exists in the financial situation of TOs in the EC, and that this diversity is evident across a wide range of measures covering investment, revenue and profitability.

2.4 DIVERSITY OF DEVELOPMENT PATHS

European telecommunications is highly diverse. The Member States differ widely in respect of networks, technologies, usage, financial conditions, the speed of reform and social and industrial policies. As a result each country has a different potential development path, and these differences prevent direct transfer of experience from country to country or region to region. At the same time, there are powerful forces driving telecommunications developments everywhere in a common direction. The effects of these forces are considered in Chapter 4.

3/ The Basis for Expansion

Realisation of the potential for telecommunications depends on the various driving forces – demand, technology and regulation – reinforcing each other. A critical element is the extent to which the sector can generate revenues and profits for further investment in support of growth in demand. Maintenance of this virtuous circle through changes in regulation forms the foundation for the *Expansionist case*. Expansion could, however, be stifled by delay and restraints on competition, tariffs and investment; the evolution of this vicious circle is represented by the subsidiary *Minimum case*.

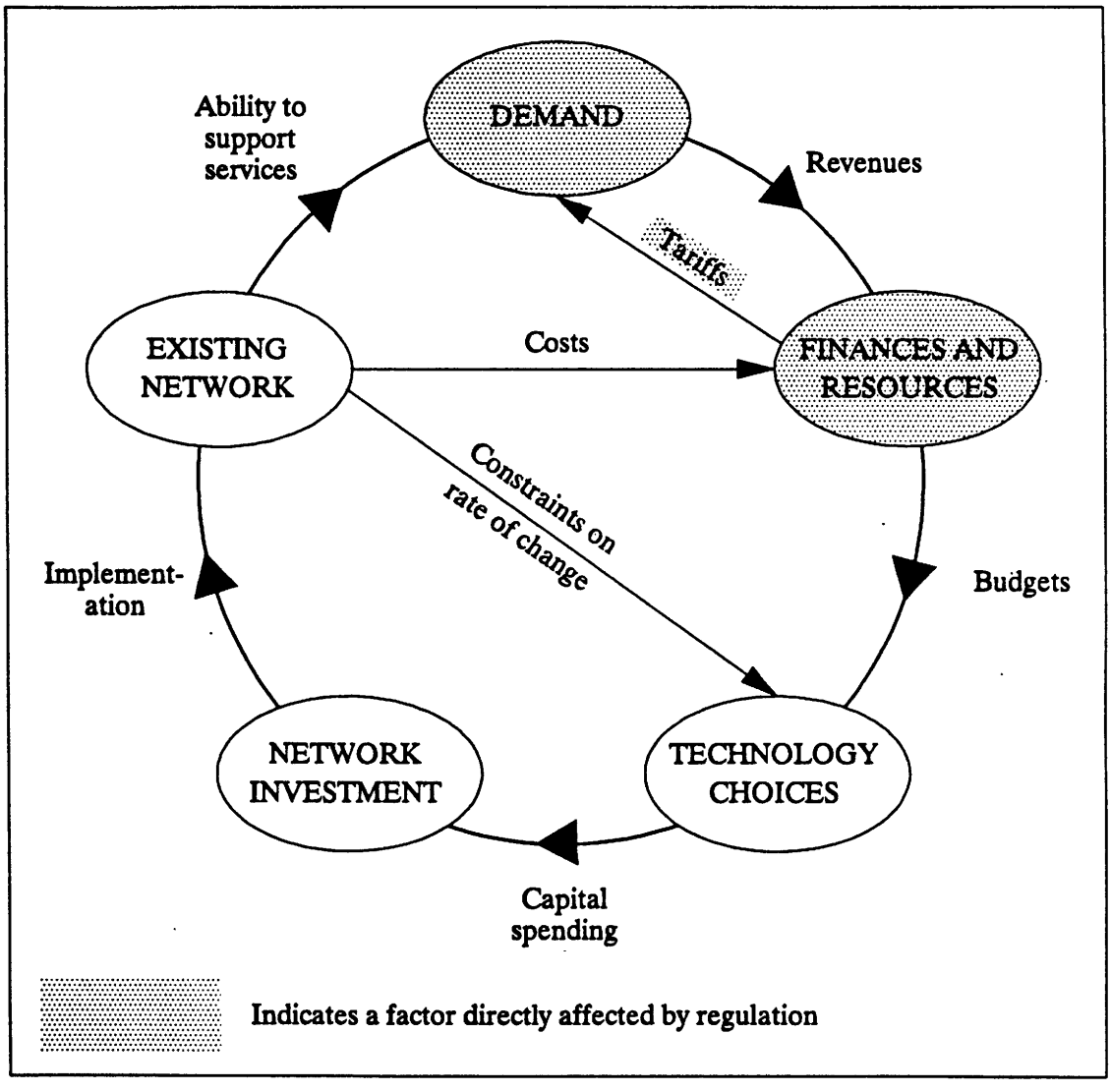
3.1 THE POTENTIAL FOR EXPANSION

Considerable potential exists for growth in revenue and investment in European telecommunications. This study addresses the diverse situations of telecommunications markets, infrastructures and policies across Europe, and projects how they might develop in the future – and in particular, examines whether expansion is affordable, and what policies can encourage it. This has involved detailed analysis of the situation in individual countries, and the use of quantitative techniques – including the Analysys STEM modelling system – to capture the complex interaction of these factors over time.

The interactions of regulation, demand, finance and resources, technology choices, network investment, and the current state of the network, all affect the rate at which a market can respond (in terms of both supply and demand). Exhibit 3.1 illustrates these interactions from the point of view of a service provider or network operator. The financial and other resources available depend on the level of demand and the tariffs or prices; these generate the revenues which meet the costs of running the existing network and determine the budgets for future investment. That future investment takes the form of (amongst other things) particular technologies, such as optical fibre. The choice of technology is determined not only by budget but also the state of the existing network; technologies which might be attractive for a 'green field' may prove unworkable in the short term if they have to interface with older technologies or be maintained and

operated by a workforce organised and trained to meet other requirements. Finally the existing network determines both the costs and the services which can be supplied.

EXHIBIT 3.1: *Interaction of the Main Factors Affecting the Evolution of the Telecommunications Sector (seen from the Point of View of a Service or Network Operator)*



The regulatory environment plays a critical role in determining the interplay of these factors and the evolution of the sector. Regulation affects tariffs, the introduction of new services, revenues, cross-subsidies and – through open procurement – the prices paid for equipment.

Regulation also has a number of indirect effects on technology choice and network investment. For example, if a TO is not permitted to distribute cable TV and telecommunications services then this may discourage the selection of optical fibre in the local loop and may ultimately affect the evolution of the network itself. Regulations affecting competition, service provision, tariffs and accounting practices (reflecting back on cost allocation and tariffing) can have profound consequences for the evolution of the sector.

Within a given regulatory environment a central issue for service and network providers is how rapidly they can implement effective technologies to reduce costs and support new services; the key to this is the generation of sufficient revenues and profits from the existing base.

The main limitations on the rate at which change can take place are:

- the level and rate of growth of demand for existing and new services
- the current cost structure
- the profit margin (determined by tariffs and costs) and the cash available
- the condition and rate of depreciation of the existing network
- the budget for investment
- the rate of improvements in performance and cost of technologies.

These factors form the main determinants for the evolution of any telecommunications sector in Europe. They require a country-by-country examination of current telecommunications networks, planned future technological advances, the current financial position of the TO and other operators, current and historical regulatory policies and the timing of future regulatory change, the current economic situation and likely future prospects, and current and expected demand trends.[1]

By projecting some factors (such as demand and technology) and analysing the impact on other factors (such as tariffs and finance), consistent feasible development paths for each individual country can be projected. Of the range of feasible paths, two have been chosen for detailed analysis:

- The *Expansionist case*, in which the sector develops through a self-reinforcing 'virtuous circle' of growth.

- A *Minimum case* – representing the continuation of the 'status quo' – in which restraints on competition, tariffs and investment contribute to a 'vicious circle' of slow growth.

1 Information sources for these 'country profiles' were primarily publicly available data, augmented by interviews with the incumbent TO and other market players.

The main assumptions for each of these cases are described in turn below; the consequences of each case for telecommunications revenues, investment and financing are described in Chapter 5.

3.2 CHANGE IN REGULATION IS NECESSARY FOR EXPANSION (THE EXPANSIONIST CASE)

In the *Expansionist case* projection, rapid demand growth – particularly for mobile, advanced voice, video and data services – is matched by rapid and focused investment.

Substantial regulatory change is projected for this Expansionist case. Widespread competition is introduced early on, stimulating innovation and exploitation of new services to provide growth in demand and revenues. It is assumed that competition is allowed for all services (including voice, data, image and other new services) and all networks (including fixed, mobile and satellite). However, the régime also allows sufficient financial resources to be generated through flexibility in tariffs and profit margins to enable forward looking technology choices to be made, which in turn enable rapid development of the existing network and the generation of new revenues.

The regulatory conditions therefore work to promote a virtuous circle of rapid dynamic growth.

The Expansionist case assumes:

- Sustained growth in applications demand across the board (with the exception of telex) as telecommunications becomes a more significant part of both commercial and personal activities. Total call minutes per head of population increase by a factor of five between 1990 to 2010.

- Especially strong growth in mobile telephony demand and advanced voice services. Mobile telephony reaches a penetration of 10-20 per 100 population; significant demand for advanced voice services begins in the mid-1990s, and these services are used by about 50% of connected customers by 2010.

- A rapid deployment of new technologies and the development of advanced network architectures and additional functionality, in step with the rapid growth in demand.

- A reduced market share for the incumbent TOs as a result of intense competition from new operators and service providers in market areas of rapid growth. It is assumed, however, that the TOs exploit their strengths to compete aggressively and so limit this reduction.

- A relatively long (15-year) transitional period for tariff rebalancing from 1995 to 2010, during which regulators tolerate higher sector profits and greater divergence between costs and tariffs in return for increased competition and sector expansion.

This last point, which relates tariff rebalancing, costs and profits to growth, is crucial in determining the resources available for the long-term development of the sector. Tariff rebalancing – whereby prices for the main services such as telephony more closely reflect the relative costs of international, national and local calls and connections – is inevitable.[2] This will take place either as a result of regulation or competition or both.

In the Expansionist case it is assumed that TOs attempt to satisfy the new demands which emerge as quickly as possible. Their investment requirements are therefore higher, as are their requirements for cash to finance the investment. It is assumed that the regulators' response is to allow operating margins to be higher and tariffing to be driven by markets rather than costs, in the interests of stimulating further competition and growth. Consequently, in this rapidly expanding market there is a relatively long transitional period during which tariffs are rebalanced.

The analysis indicates that, provided the conditions set out above are met, telecommunications in Europe can undergo rapid growth in service revenues from ECU 90 billion to ECU 320 billion in 2010, a factor of 3.5. Annual investment in the Expansionist case rises from ECU 33 billion to ECU 140 billion, and over the 20-year period totals more than ECU 1200 billion.[3]

3.3 EXPANSION COULD BE STIFLED BY DELAY AND RESTRAINTS (THE MINIMUM CASE)

For comparison purposes, a *Minimum case* has been generated. This represents the outcome of a regulatory policy which attempts to protect existing interests and does not promote the fundamental commercialisation which is needed in the sector. It assumes slow or partial implementation of EC Directives and other liberalisation measures, and represents relative stagnation in the telecommunications sector.

In this Minimum case the regulatory environment does not change radically. The emphasis is on controlling tariffs in relation to costs using regulation rather than allowing competition. As a result, the introduction and take-up of new services and applications lag behind the Expansionist case, and investments are conservative and

2 TOs have historically cross-subsidised local access through high call charges, specifically long-distance and international charges. In addition, some TOs have pursued a policy of discouraging the construction of private networks through high leased-line tariffs, and this has had a debilitating effect on the rate of innovation in use of telecommunications. Tariff rebalancing is essential for an efficient competitive environment and would enable the correct investment decisions to be taken in response to market demand.

3 These figures, like all the financial measures used in this report, are expressed in real terms (i.e. adjusted for inflation), in 1990 ECU.

technology- rather than market-driven, with a longer lead-time before they become effective and a longer pay-back period.

Under this environment, the sluggish response of the sector prompts even tighter regulatory control of tariffs, in an attempt to prevent abuse of monopoly power and to cut costs. Whilst there is sufficient cash flow to fund the slow expansion, the régime limits the size and resources of the sector and the attractiveness of innovation, and thus reinforces the slow pace of development. The regulatory assumptions therefore work to promote a vicious circle of sluggish growth.

The Minimum case assumes:

- Moderate increases in the rate of growth of demand, limited both by the rate of new network infrastructure investment and marketing of the benefits of telecommunications. Call minutes increase by a factor of only 2.5.

- Slower growth and delayed introduction of mobile telephony and advanced services compared to the Expansionist case.

- The relatively slow deployment of new technologies, as demand requiring these technologies is later in developing.

- A slower erosion of incumbent TOs' market share than in the Expansionist case (although, because demand grows more slowly, the TOs' overall revenue is much lower).

- A shorter (10-year) transitional period in which tariffs adjust towards cost (from 1995 to 2005), during which time regulators squeeze tariffs as a result of telecommunications becoming perceived as a slow-moving sector which generates large cash surpluses.

As in the Expansionist case there is an important link between growth and tariff rebalancing, costs and profits. Slow growth in demand leads to lower investment requirements and larger cash flows as telecommunications becomes a relatively slow-moving and mature sector. Cash surpluses then accumulate which are not used for further sector expansion but which generate investment income from outside the sector. The regulators can then be expected to react in order to control the 'excess' profits and cash surpluses and impose tighter control of tariffs. Ironically this leads to a shorter period for rebalancing than in the Expansionist case.

The overall result of this slow growth and tight regulation is that revenues for the Minimum case only rise to ECU 187 billion (in real terms) in 2010, whilst annual

investment reaches ECU 76 billion, totalling only ECU 800 billion for the 20-year period.

3.4 THE POTENTIAL FOR GROWTH IN DEMAND

Demand for telecommunications may be categorised from the point of view of *applications* (such as voice, video or mobile) or from the point of view of the *type of connection* which supports these applications (such as basic telephony or ISDN). This section considers the potential for growth in demand for different connection types, in terms of traffic volumes and the numbers of connections.[4]

Overall demand for both business and residential connections can be expected to grow strongly throughout the next 20 years. The number of connections and volume of traffic by service are summarised in Exhibit 3.2 overleaf, which shows both Expansionist and Minimum case assumptions for 1990, 1995, 2000 and 2010. Connections are shown for a number of different connection types; these are:

- Basic telephony (providing both current voice telephony services and access to advanced voice services when these become available)
- ISDN (providing enhanced integrated digital services in units of 2x64kbit/s for Basic-Rate access and 30x64kbit/s for Primary-Rate access)
- Switched broadband (providing a digital channel of at least 2Mbit/s)
- Mobiles (mostly providing the same features as basic telephony)
- Narrowband leased lines (capable of supporting one voice channel in either analogue or digital form)
- Broadband leased lines (providing a digital channel of at least 2Mbit/s).

In the **Expansionist case**, as Exhibit 3.2 shows, the following demand assumptions are made:

- **Between 1990 and 1995** the main growth is in basic telephony connections, with about 33 million lines added at an annual growth rate above 4%, although some significant growth in Primary-Rate ISDN occurs as larger establishments take this in preference to multiple basic telephony lines. Mobile connection numbers are still relatively small but growth is very strong at around 23% per annum.

4 The meaning of a connection in 1990 is clear; the number of voice circuits or channels is nearly identical to the number of connections, because a connection is usually a copper pair carrying one voice circuit. But by 2010 this relationship will have been broken. A Primary-Rate ISDN connection provides 30 voice circuits but is still one connection. Connections capable of carrying the equivalent of many voice circuits will form an increasingly important part of the market, and so the growth in numbers of connections hides a far greater increase in the capacity of access to the network.

EXHIBIT 3.2: Numbers of Connections and Traffic, Minimum Case vs Expansionist Case

	1990		1995		2000		2010	
	Min. Case	Exp. Case	Min. Case	Exp. Case	Min. Case	Exp. Case	Min. Case	Exp. Case
Connections (Thousands):								
Basic Telephony Res.	105389	105389	120851	125224	133421	142327	144689	159433
Basic Telephony Bus.	35689	35689	47600	49475	54949	66043	43968	81535
ISDN Basic-Rate	17	17	646	711	2973	3731	22285	31476
ISDN Primary-Rate	2	2	99	103	530	629	3771	6663
Broadband Switched	0	0	0	0	63	81	1209	2119
Mobiles	1862	1862	4804	5200	8922	11513	31220	42538
N/Band Leased Lines	1586	1586	1920	1974	2172	2404	1709	2287
B/Band Leased Lines	21	21	69	70	131	141	325	451
Originating Traffic (millions of B-H Erlangs)								
Telephony	6.91	6.91	9.08	9.67	11.16	14.86	11.91	26.05
ISDN	0.01	0.01	0.53	0.57	3.11	4.00	27.52	53.76
Broadband Switched	0	0	0	0	0.35	0.48	8.24	16.20
Mobiles	0.04	0.04	0.11	0.12	0.25	0.36	1.21	2.73
TOTAL	6.96	6.96	9.72	10.36	14.88	19.70	48.88	98.73

- **The period 1996 to 2000** marks the beginning of a major change, as growth in basic telephony connections slips to 3.5% per year and ISDN connections grow five- or six-fold (or about 40% per year). The mobile market shows signs of slackening as penetration levels rise towards 4 or 5 per 100 population, but growth is still strong at around 18% per year. Broadband begins to make its first real appearance with numbers of connections comparable with those for ISDN five years previously.

- **From 2001 to 2010** the major change can be clearly seen. Growth in basic telephony connections slackens to just over 1% per year, whilst ISDN shows growth rates of 25% p.a. and broadband expands at over 35% p.a. (albeit from a low base). A true mass market develops for mobiles; growth rates of 14% per year mean that penetration reaches 12 per 100 population by 2010. The availability of flexible, high-capacity digital switched services means that these substitute increasingly for leased lines after 2000.

The major growth, however, is in traffic. Stimulated by the effects of competition – including tariff changes – this is projected to grow 14-fold over the period (an annual growth rate of 14%). In the first ten years the traffic growth rate is 10%; most of total growth is concentrated in the second ten-year period and comes from new services such

as ISDN, mobiles and broadband. The majority is carried via ISDN connections, reflecting an increased intensity of business use of telecommunications applications.

The **Minimum case** differs from this in three important respects. Firstly, growth in basic telephony connections slows to a standstill between 2000 and 2010. Secondly, overall growth in connections is much lower (especially for business applications). Finally – and most importantly – traffic levels are only half those in the Expansionist case. This relatively low growth in traffic reflects both the lower overall usage and also the higher overall tariffs in the Minimum case.

4/ The Forces for Change

The interaction of three forces – demand, technology and regulation – will determine the future development of telecommunications. Despite their different starting points, all countries in Europe are subject to these same forces. Their effect has been summarised in this study as a *General European Projection*,[1] as described in this Chapter. This projection represents the Expansionist case view of the scale and timing of different events for demand, technology and regulation in the more advanced countries.

4.1 DEMAND FOR SERVICES WILL GROW IN VOLUME AND VARIETY

It can be expected that demand for telecommunications over the next 20 years will be marked by a growing range of new services, as a result of:

- substitution to telecommunications from other modes of communications (for example, videoconferencing will replace some of the need for business air travel; telecommuting will replace some daily commuting to the office)
- additional demand created by the increased cross-border communications requirements resulting from the Single Market
- the economy (and society in general) becoming more information-based.

The evolution of this pattern of demand is shown in the 'timeline' on page 27. In this diagram, the degree of shading indicates the relative importance of the particular service. Heavy shading indicates that the demand levels and revenues form a significant part of total demand and revenues. (Note that shading can become lighter, indicating loss of share without absolute revenue levels falling.)

1 The projections for demand, technology and regulation are based on expert input from within Analysys and from outside. They are described in more detail in the Main Report, Chapters 1 to 3.

The main elements of this evolution are as follows:

Basic Voice Telephony

Basic voice telephony – that is, the simple voice service accessed by fixed links – currently accounts for over 85% of revenues. Growth in other services can be expected gradually to erode that market share, although total growth in volume terms (connections and traffic) is still likely to be substantial in the short to medium term. In the longer term there will be two competing effects determining the growth in demand and revenues. Firstly, price compression effects (whereby the tariffs reflect more closely the very low cost of carrying simple voice traffic), together with alternative network access and competing services such as mobile, will erode the revenue share of basic voice telephony. On the other hand, developments in personal numbering and other advanced voice services will make it easier to make calls, improve their chances of success, tend to generate follow-on calls, and generally increase the opportunity and scope for voice telephony. The outcome will be a significant increase in demand for basic telephony which will partly off-set the long-term trend towards loss of revenue share as prices decline. Nevertheless, growth in demand for new services and low prices will result in basic telephony becoming less important in revenue terms in the long run.

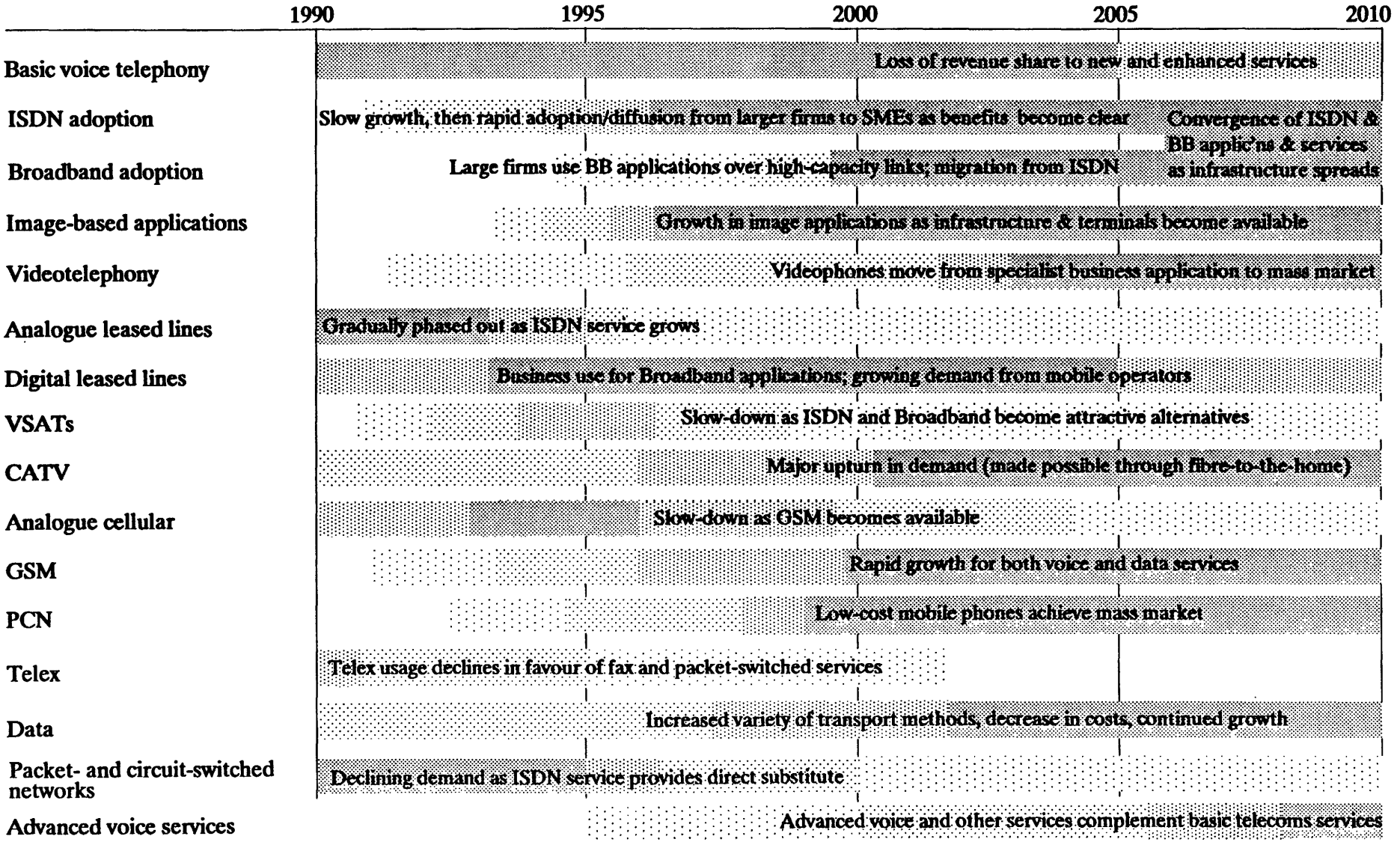
ISDN

Demand for ISDN has been slow to materialise, and competitors to ISDN service (including data services and leased lines) will remain dominant in the short term. Initially take-up of ISDN is projected to remain slow, but after 1995 a much wider understanding of ISDN will develop. New applications and cheaper CPE will become available, and it is expected that demand will accelerate in the last years of the decade. Analysis of costs indicates that ISDN will then be attractive to a very wide range of users, and demand will continue to accelerate beyond 2000.

Broadband

The current markets for high-speed leased lines and increasing demand for LAN-LAN interconnection are early signs of the potential demand for a switched broadband service which is projected to be introduced towards the end of the 1990s through interlinking broadband 'islands'. Initially demand will be concentrated in large organisations, but towards 2010 smaller organisations will migrate from narrowband ISDN to a switched broadband service.

Demand Projection (Expansionist Case, Advanced Countries)



Videotelephony and image-applications

After 2000 it is assumed that image-based terminals – primarily videotelephones and PCs – will be in widespread use, having dropped in price very rapidly during the previous years. Deployment of digital (ISDN) networks, the falling cost of videophones, and an increase in disposable income, will mean that videotelephony service moves rapidly from the business to the residential market.

Analogue and Digital Leased Lines and VSATs

Demand for analogue leased lines is projected to fade gradually as better-quality, higher-capacity and cheaper digital alternatives become available. Demand for digital leased lines will eventually come under similar pressure, and demand will depend crucially on tariffing policies and the availability of high-capacity switched services. However, it can be expected that additional demand will be generated from mobile and other operators wishing to interconnect with other networks. In the short term VSAT demand will grow as users seek to avoid paying high international tariffs and are frustrated by the limited availability of alternatives such as ISDN. In the late 1990s, however, the availability (and pricing) of ISDN and broadband will result in a slow-down in VSAT demand growth.

Cable Television

Cable television is currently characterised by substantial differences in penetration across Europe: from 90% penetration in Belgium to less than 2% in France. The reasons for this divergence are complex and involve regulation, cultural diversity, dates of original implementation, geography, technical standards and costs. In the longer term, however, it is likely to become economically feasible (in terms of costs and tariffing) to deliver telecommunications and television services to the home over the same access links. Demand will be determined by regulatory changes and the deployment of fibre-based systems allowing competing operators to offer a wide range of services – specifically telecommunications services – over cable TV networks. It is projected that developments in the mid-1990s will enable demand growth to become substantial towards the end of that decade.

Analogue Cellular, GSM and PCN

It is assumed that during the next ten years, mobile services will diversify and become more widely available to both residential and business users and will – when penetration becomes relatively high – provide a partial substitute for fixed connections. The range of mobile services will grow as costs continue to

fall rapidly, driven both by technological developments and economies of scale and integration; the services will become steadily more tuned to specific market segments. Together with advanced voice services they will provide a major area of revenue growth through the provision of integrated personal communications (including personal numbers). Revenue growth will be realised not only as direct demand for these services; they will also generate additional revenue for basic telephony through overall increased usage. By 2010, major advances in the spread of mobile communications can be expected; small, cheap handsets which access networks through a dense radio infrastructure will be part of a mass market.

Telex and Data

A wide variety of data services are projected to become available, including fast packet, frame relay and other services capable of supporting large-scale data and image transmission. These advances – including ISDN – will hasten an erosion of the low end of the market. Telex has already declined due to the effect of fax, electronic mail and electronic data interchange (EDI); its extinction is likely to be a complex process as it is so widely used, but in advanced countries separate networks are likely to be replaced by gateways to what is left of the telex network at the beginning of the next decade.

Advanced Voice Services

With the modernisation of networks (covered in the technology projection – Section 4.2 below) will come the development of a number of advanced voice and other services, including superior call-forwarding capabilities, and the maturing of 0800 and 0900 services. These complement basic services by providing greater user freedom and individual control. Increasing use of these services will lead to greater use of transmission services, including mobile communications. It is projected that such services will start to become popular during the second half of the decade; around 50% of connected customers will subscribe to them by 2010, providing a major source of revenue.

4.2 TECHNOLOGY WILL CHANGE THE ECONOMICS OF SERVICES AND NETWORKS

Technological change will be the driving force behind a range of major developments over the next 20 years – bringing major cost reductions, enabling radical changes in network architectures, changing the relationship between services and networks, and lowering the sensitivity of network costs to the volume of traffic.

The evolution of network technology follows a logical progression which builds on preceding developments. Digital equipment replaces older analogue systems; optical fibre can then be implemented; this allows new transmission techniques, which in turn lead to further changes. The evolution of technology is shown in the 'timeline' on the following page, in which the degree of shading indicates the relative importance of the particular area.

The main elements of this evolution are as follows:

Digitalisation

Digitalisation of the network is being driven by cost savings and the ability to support new and additional services (as well as ISDN). For many countries in Europe this digitalisation will be largely completed by the end of this decade.

Optical Fibre

Optical fibre is already widespread in international and long-distance national routes, and deployment in the inter-exchange network is becoming more common. It is assumed that optical fibre in the access network will initially be for specialised connections such as large business customers or metropolitan area networks (MANs) in major European urban areas. In the second half of the 1990s, however, more rapid deployment of optical fibre will begin, and optical fibre will have become the main method of fixed access to telecommunications by 2010. This change will have been propelled by advances in techniques for providing access at low cost, particularly Passive Optical Networks (PONs) which broadcast signals through an optical-fibre 'tree'. From 2005 all new CATV and residential telecommunications will be based on optical fibre, with additional radio-based solutions for final distribution where appropriate.

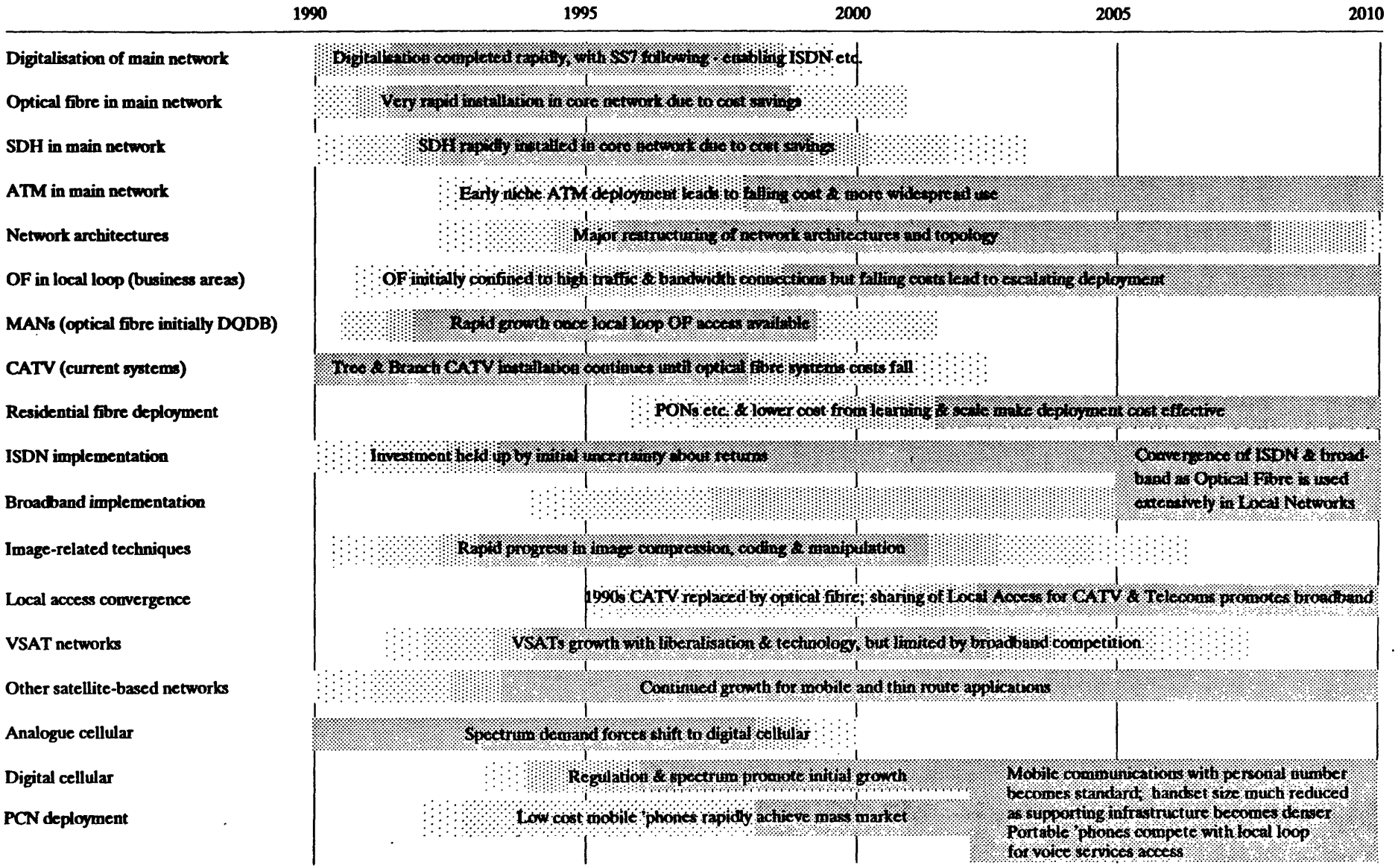
Synchronous Digital Hierarchy (SDH)

It is projected that the deployment of optical fibre will enable Synchronous Digital Hierarchy (SDH) to be used, driven by substantial cost savings in transmission and operations and maintenance. SDH will provide a substantial increase in the capacity, quality and robustness of networks at very low cost. Once in place, it will provide a platform for the economical supply of high bandwidth and new service offerings.

Asynchronous Transfer Mode (ATM)

Once optical-fibre systems are deployed and low-cost transmission and network management can be delivered through SDH, ATM (Asynchronous Transfer Mode) will provide a flexible – though initially quite costly – means of offering variable bandwidth 'on demand'. It is expected that the mid-1990s will see the

Technology Projection (Expansionist Case, Advanced Countries)



first applications of ATM as a transmission technique and its selective use in switching for data and related services. Initially, the more widespread application of ATM will be hampered by standards issues, as well as its complexity and cost, but by the end of the decade ATM will become increasingly important and provide the basis for flexible service provision, particularly in the local loop.

Network Architectures

Digitalisation, the deployment of optical fibre, and the introduction of SDH and ATM will all change the balance of costs in the network. It can be expected that the falling cost of transmission relative to switching and the ability to support sophisticated network management functions will cause the number of switching points and levels in current switching hierarchies to be reduced. Connections between nodes and to customers will no longer be stars but meshes, rings and buses, and it will be possible to provide switching, ISDN services and Intelligent Network features at sites far removed from the customer at little extra cost. These changes in network architecture will have four important effects:

- there will be an overall reduction in the cost of telecommunications services
- the costs of carrying traffic will fall relative to the cost of connection
- it will be possible to introduce new services and facilities rapidly at low cost
- it will be possible to provide these services and facilities by operators being given access to the network from remote points, thus enabling separation of the service provider from the network infrastructure provider.

ISDN and Broadband Implementation

The digitalisation of the network, the deployment of optical fibre and advanced transmission techniques, and the corresponding changes in network architectures will enable the cost-effective deployment of ISDN and eventually the ability to supply broadband services cost-effectively. The application of these techniques and the network restructuring will allow digital access to a wide range of capacity, and digital access using common standards will enable ISDN to be merged with broadband.

Image Handling and Videotelephony

Image transmission and storage require high-capacity systems, but compression techniques are advancing rapidly and penalties in cost and time delay are reducing. It is projected that the availability of a digital telecommunications infrastructure – particularly as variable-bandwidth services become available – will enable image transmission and videotelephony to be supported economically from the mid-1990s onwards.

Satellites

Satellite technology will continue to improve and costs will continue to fall, but neither are likely to match the rate of change in terrestrial systems. The role of satellites will therefore be confined to distribution, specialised services such as global mobile communications, or thin-route applications.

Mobile and Radio Systems

It is projected that rapid progress will be achieved in mobile and radio systems. The 1990s will mark a transition from analogue to digital cellular and by 1995 PCN systems aimed at mass markets will be well established. Thereafter separate networks aimed at different market segments and offering varying degrees of functionality (including fixed as well as mobile links) will be developed. After 2000 intelligent networking will bring the ability to integrate the fixed and mobile networks into one seamless service. It will then be possible to communicate with people based on their personal number rather than their location.

4.3 REGULATION WILL BE THE ENABLING FACTOR

The 1990s will see the gradual lifting of significant regulatory barriers to competition (initially through international services), enabling the potential of telecommunications to be realised.

Although competition in networks and services will progress at different rates in different Member States, by the late 1990s the economics of network provision – encompassing both costs and tariffs – will have changed, so that incumbent telecommunications operators will potentially face competition even in the local loop from both cable and radio. In spite of the fact that competition is likely to be introduced at a different pace in different parts of the network in different Member States, by the beginning of the next century competition in services and networks should be widespread.

The regulatory timeline overleaf therefore represents a particular policy of liberalisation – that assumed in the Expansionist case for the most advanced countries.

Regulatory and Operational Split

The split between regulator and operator is the fundamental change of the early 1990s which sets the scene for regulation over the next 20 years. By the mid-1990s it is assumed that regulators will have moved from supporting the dominant TO against 'unfair competition' to preventing abuses of monopoly power (e.g. by setting precise performance targets). It is projected that the TOs themselves will respond by implementing new commercially-oriented organisational structures.

International and National Tariff Rebalancing & Regulations

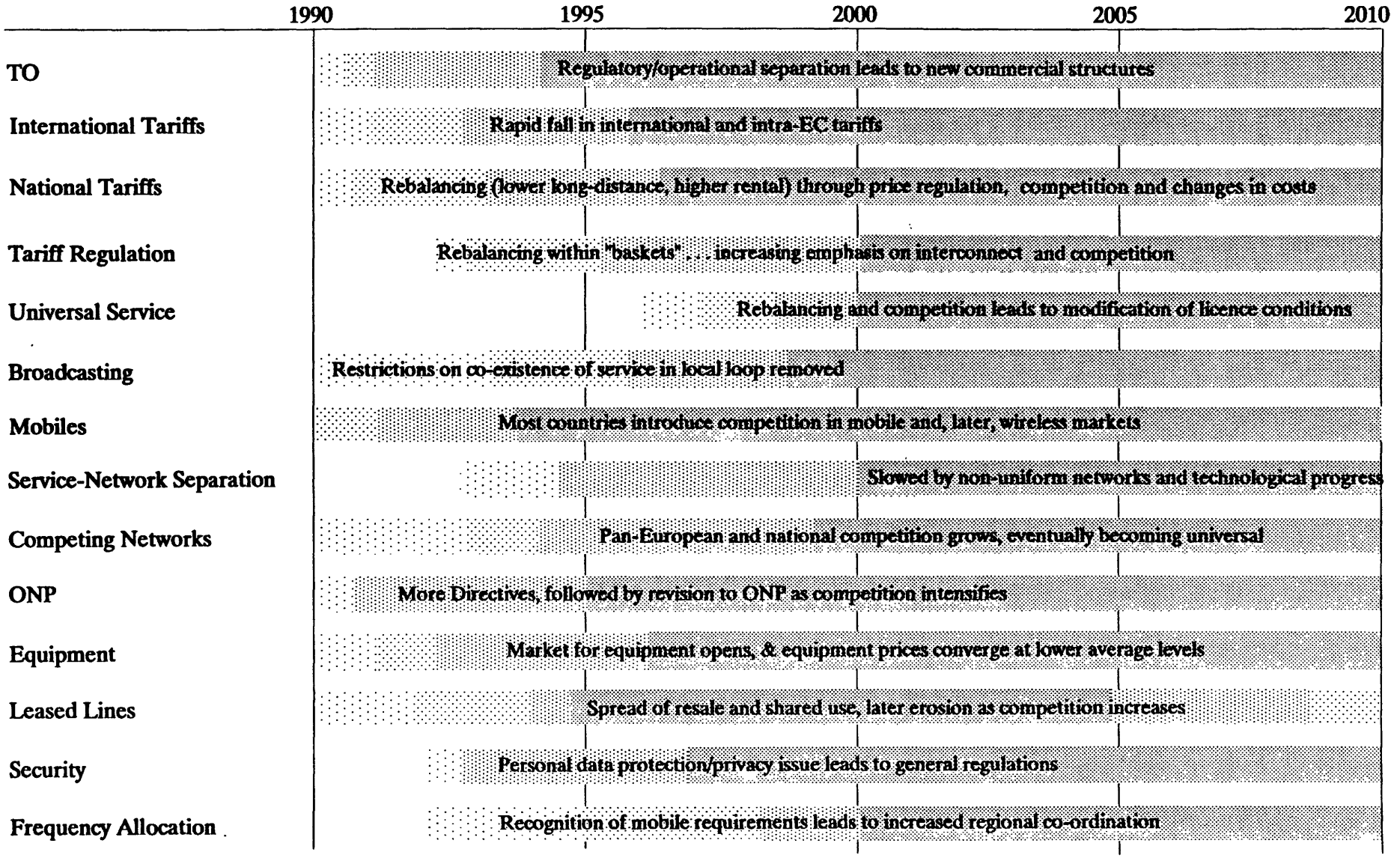
Tariffs throughout Europe are out of line with costs. Such imbalances prevent fair competition either by allowing new entrants to make high profits (as in international and long-distance transmission) or by preventing entry by charging less than cost (as in local access). In the long run these imbalances must be removed if competition is to be possible in telecommunications. Initially rebalancing will mean a significant fall in international and long distance tariffs.

It is assumed that rebalancing will be achieved both through direct tariff controls (such as have been introduced in Denmark, Germany and the UK) and the introduction of competition (at first in international services across Europe and in national services in some countries). However, in a competitive market there would not necessarily be a perfect relationship between the tariff and cost of a given service. Where many services share the same infrastructure and different use is made of these services by different subscribers, providers will set up elaborate pricing packages to maximise revenue. In the Expansionist case it is assumed that regulators will minimise direct tariff controls through the use of overall tariff changes for 'baskets' of services, and emphasise competition through supervising interconnection agreements whilst at same time allowing tariffs to respond to market conditions rather than costs.

Universal Service Provision

There is likely to be considerable pressure for a change in the system of universal service provision during the 1990s, as the incumbent TOs face competition in all parts of the network. These developments may lead to a re-defined (if not wholly replaced) system of licensing to ensure access to basic telecommunications services on acceptable terms for customers.

Regulatory Projection (Expansionist Case, Advanced Countries)



Local Loop, Broadcasting & Cable Television

In the short term, competition in the local loop from alternative cable-based networks will be limited. It can be expected that policies will start to change in the medium term, as more liberal countries allow the sharing of local access links between CATV and telecommunications. After 2000, following general acceptance of the principle of common carriage of TV and telecommunications, it is assumed that Passive Optical Networks (PONs) will be deployed more widely for residential users. In the long term, the main aim of regulators will be to ensure equitable sharing of infrastructure costs between services.

Mobiles

Mobiles will be at the forefront of competition in telecommunications; they are important because they also provide the possibility of competition in the local loop. In the short to medium term it is expected that this competition will encourage the rapid growth of digital cellular systems and the use of fixed-link radio. In the long run agreements on frequency use and management will be required at the European level.

Separation of Services and Infrastructure

The development of new services supported by advanced network architectures will enable services and infrastructure to be provided by different operators - including multiple service providers using the same network. New regulatory régimes will then be needed; the timing of their introduction will depend on how simply the potentially very complex regulations can be drawn up, and on the technical progress made in network implementation. Separation for some services is possible now (as with Minitel in France), but more widespread application of this principle is unlikely before the late 1990s.

Competing Networks

It is assumed that network competition will begin in some Member States, and at the European level in pan-European networks. Technological change and growth in demand for new services will result in new networks being introduced throughout the EC.

CEC Directives

Efforts to encourage regulatory change at the European level will be spearheaded by the CEC - including the application of EC competition rules partly in response to pressure for a more open environment from the GATT framework. It is assumed that ONP will be applied to leased lines, packet-switched data, satellites and voice telephony. ONP Directives on both ISDN and Intelligent Networks (IN) will set down some minimum standards of open

access to network signalling and software-defined features; this will stimulate competition and innovation in VAS. ONP will need revision to deal with interconnection charges, equal access and competition.

Equipment

It is projected that true open procurement and purchase of equipment from diverse sources will result in prices converging at lower 'European' levels. At present, some countries with restrictive purchasing policies are paying up to three times more than others for the same equipment.

Leased Lines

At present there are differing national regulatory stances in Europe regarding the conditions for resale of leased-line capacity. In the short to medium term, it can be expected that unrestricted resale and shared use of leased-line capacity will gradually spread across Europe. Eventually conditions for the interconnection of private networks to the public network are likely to converge under the influence of ETSI's work (Network Code of Practice) and common standards (such as those recommended under ONP). The opportunity for exploiting tariff anomalies through the use of leased lines will gradually disappear in the long run as competition increases.

Security

Security, privacy and data protection will become increasingly important as telecommunications networks become more sophisticated and capable of offering services based on information about individuals (for example their location) as well as accessing and transmitting information about individuals. The increasing communication of information between Member States and potentially outside the EC is likely to lead to action at the European level on these issues.

Frequency Allocation

It is assumed that increasing demands for frequency capacity and the use of mobiles throughout the EC will lead to frequency allocation issues being discussed and co-ordinated at the European level.

5/ Consequences for Telecommunications Revenues, Investment and Finances

The expansion of the telecommunications market will lead to increased revenues and investment requirements, and will have significant consequences for the financial state of the telecommunications sector in Europe. In this section the demand assumptions which have been projected are linked through tariffs to revenues, and through costs to investment requirements. Finally the financial consequences are analysed.

5.1 MAJOR REVENUE GROWTH

5.1.1 Total revenues grow strongly

Given the right regulatory conditions, total revenues for the telecommunications sector in Europe (including services and CPE) can be expected to grow rapidly in real terms from ECU 90 billion in 1990 to ECU 320 billion in 2010 - a factor of 3.5.[1] If these conditions are not met, revenue is projected to double to ECU 187 billion in 2010. Revenues are the product of tariffs and demand; both of these will be changing rapidly over the next 20 years, and the dynamic interplay of the two factors will cause significant variations in the overall levels of revenue, the sources of revenue, and rates of growth.

Between 1995 and 2000 revenues are projected to grow in the Expansionist case from about ECU 120 billion to ECU 154 billion (as shown in Exhibit 5.1). This represents an annual growth rate of 5.1% (as shown in Exhibit 5.2), slightly lower than the previous five-year average annual rate of 5.9%. The slow-down occurs as the falling costs of telecommunications - specifically voice telephony - are reflected in tariffs, and growth in demand is insufficient to compensate fully for these changes. This point of 'price

1 These figures, like all the financial measures used in this report, are expressed in real terms (i.e. adjusted for inflation), in 1990 ECU.

EXHIBIT 5.1: *Revenue for Total EC Telecommunications Sector, Minimum and Expansionist Cases (in Real Terms – 1990 ECU billions)*

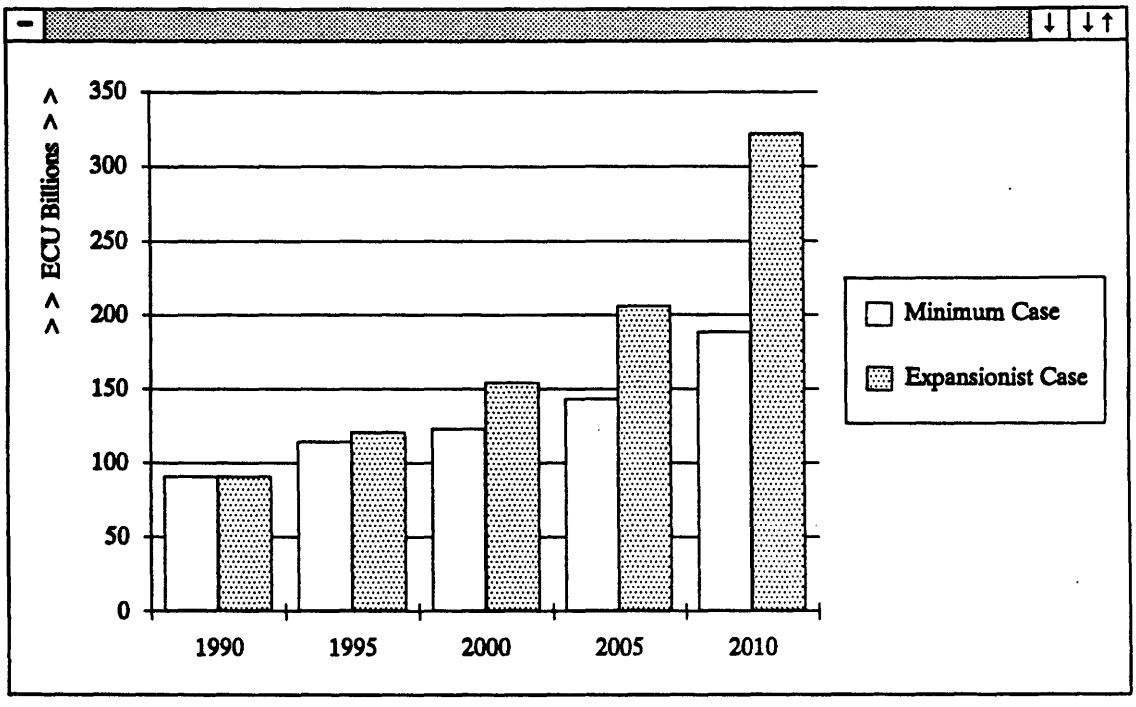
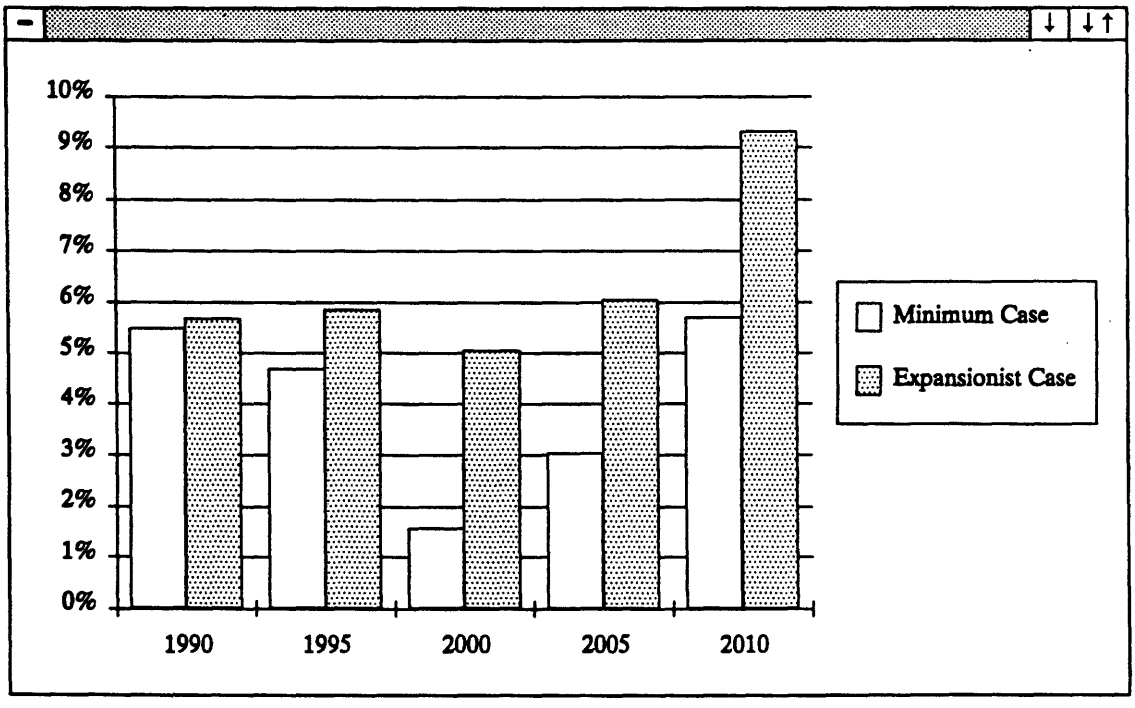


EXHIBIT 5.2: *Average Rate of Change of Turnover for Total EC Telecommunications Sector, Minimum and Expansionist Cases (in Real Terms)*



compression' occurs at a critical juncture in the development of European telecommunications: strong demand growth is needed during this period to maintain revenue growth.

From the year 2000, market expansion in the EC telecommunications sector as a whole is strong because demand growth is very strong. From 2005 to 2010 revenue growth accelerates markedly, rising from ECU 206 billion to ECU 320 billion over the five years, a real annual growth rate of 9.3%. Total revenue per connection grows from ECU 617 in 1990 to ECU 980 in 2010.

In contrast the annual revenue growth rate in the Minimum case falls to only 1.6% between 1996 and 2000 and only just reaches 5.7% in the following decade; as a result total EC revenues reach only ECU 187 billion, just under 60% of the Expansionist case levels.

Revenue growth will not be uniform across countries. For some countries development of the network to levels already seen in the more advanced states in Europe will bring substantial increases in turnover, particularly where there are currently long waiting lists; correspondingly some advanced networks will see lower growth rates in overall revenue than the average.

5.1.2 Revenue growth differs between applications

Demand for different telecommunications applications and services will also grow at different rates. Demand may be categorised from the point of view of applications (such as voice, video or mobile) or from the point of view of the type of connection which supports these applications (such as basic telephony or ISDN). In this section growth of demand in terms of applications is discussed; in Section 5.1.3 below demand for connections and traffic volumes is described.

Demand for new applications can be expected to grow more rapidly than demand for existing applications, but the impact of these developments only becomes significant in terms of revenue towards the end of the 1990s (as shown in Exhibits 5.3a and 5.3b).

The following points can be observed from these Exhibits:

- Revenue from non-voice services – including data – grows steadily, but not as rapidly as the overall level of revenue growth. This is because the very substantial growth in volume of traffic is not fully reflected in revenues (as a result of cheap high-capacity transmission being available and the use of encoding techniques for limiting bandwidth requirements).

EXHIBIT 5.3a: *Sources of Revenue in terms of Applications for Total EC Telecommunications Sector, Expansionist Case (in Real Terms - 1990 ECU billions)*

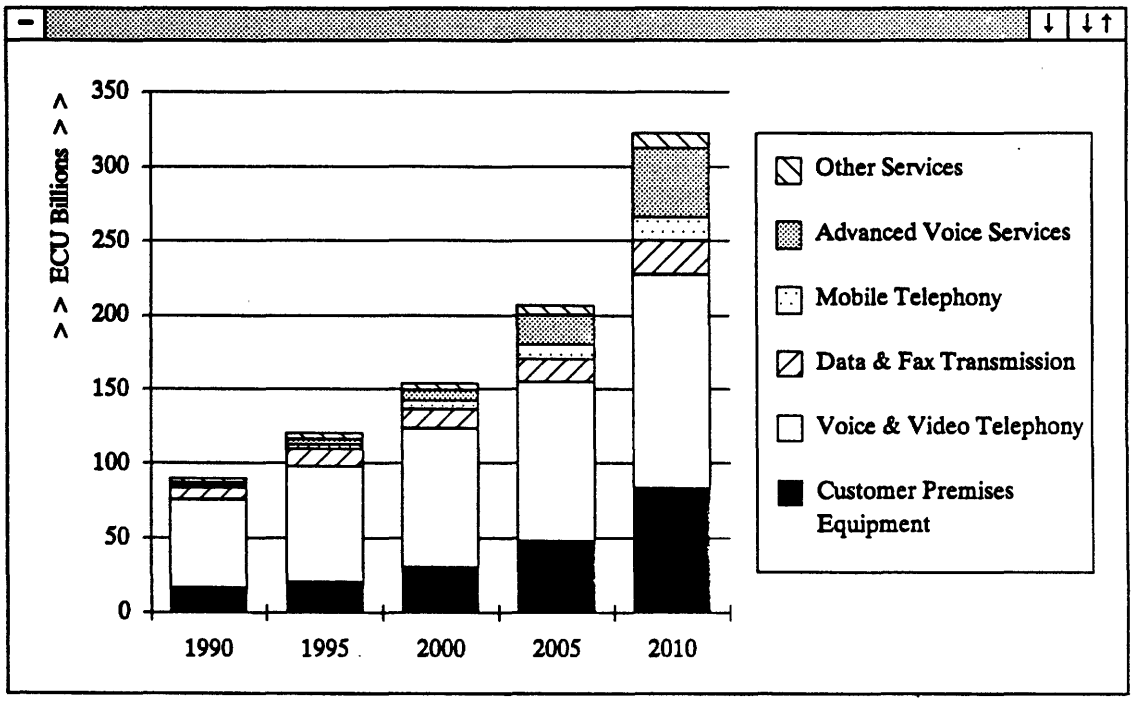


EXHIBIT 5.3b: *Sources of Revenue in terms of Applications for Total EC Telecommunications Sector, Expansionist and Minimum Cases (in Real Terms - 1990 ECU billions)*

Application	*1990*	*1995*	*2000*	*2005*	*2010*
Expansionist Case					
Customer Premises Equipment	16	20	30	48	83
Voice and Video Telephony	59	78	93	107	144
Data and Fax Transmission	8	11	13	15	23
Mobile Telephony	2	3	6	10	16
Advanced Voice Services	2	4	7	20	46
Other Services	3	4	5	6	10
Total	90	120	154	206	322
Minimum Case					
Customer Premises Equipment	16	19	26	36	53
Voice and Video Telephony	59	73	74	79	95
Data and Fax Transmission	8	11	10	11	14
Mobile Telephony	2	3	4	7	11
Advanced Voice Services	2	4	4	6	11
Other Services	3	4	4	4	5
Total	90	114	123	143	188

- Encouraged by competition and open networks, advanced voice services provide a significant area of growth; this is one of the major differences between the Expansionist and the Minimum cases.

- Revenue from mobile telephony grows rapidly compared to other applications.

- Revenues from voice telephony continue to grow steadily, but its share of the revenues declines in relative terms. (Videotelephony begins to generate a small but significant share of revenues after 2000.)

- Users increase their spending on customer premises equipment very substantially in order to take advantage of the increased capability and capacity of networks.

5.1.3 Revenue growth differs between connection types

The growth in applications will be matched by growth in the various different types of service connections which support them.

Over the period 1990-2000 major changes can be expected in the way in which different connection-types are used to support different applications. The most significant of these is the growth of digital ISDN and broadband connections, replacing the existing copper pairs and providing lower-cost high-capacity access:

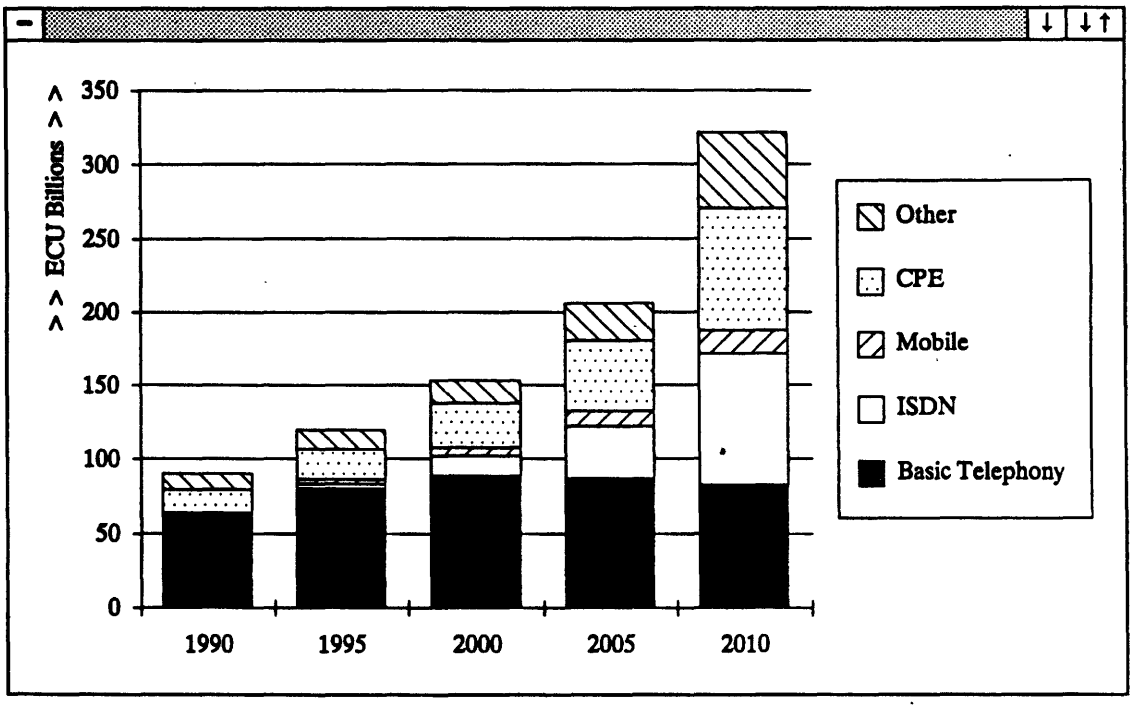
- Revenue from ISDN connections (including both broadband and narrowband) increases from 8% of total revenue in 2000 to around 27% in 2010.

- The share of total revenue from basic telephony connections (including both residential and business) declines from almost 60% in 2000 to less than half this percentage in 2010, reflecting the replacement of analogue transmission over copper pairs.

- There is a substantial growth in 'other' connection-types – broadband and radio-based connections – particularly after 2000.

These changes are shown in Exhibit 5.4 overleaf.

EXHIBIT 5.4: Sources of Revenue by Service Connections for Total EC Telecommunications Sector, Expansionist Case (in Real Terms - 1990 ECU billions)



5.2 HIGH INVESTMENT REQUIREMENTS

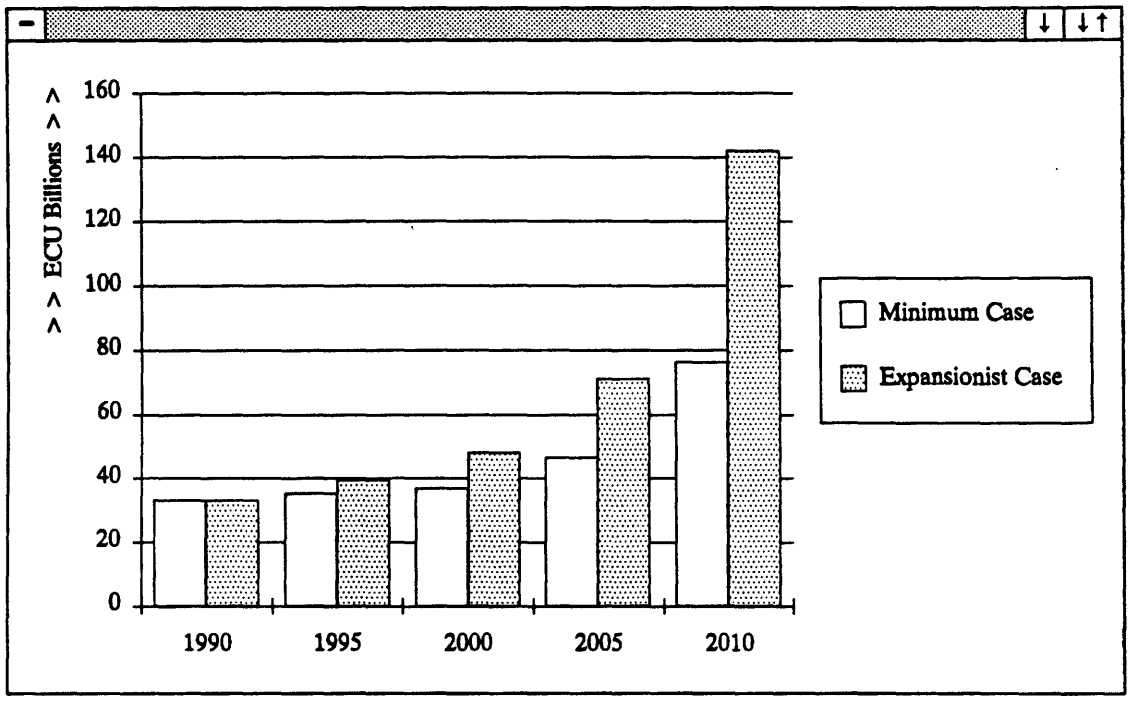
The study results show investment levels rising substantially, though initially this rise is greatest in the peripheral regions of the EC and in Eastern Europe. In the longer term, increased demand for new applications and services will mean a reacceleration of investment in countries with relatively mature markets.

5.2.1 Total EC annual investment rises from BECU 33 to BECU 140

The rapid growth in demand projected in the Expansionist case requires major increases in investment levels, from ECU 33 billion per year today to just over ECU 140 billion in 2010, a cumulative total of more than ECU 1200 billion over 20 years.[2] The restrictive regulatory assumptions in the Minimum case lead to lower demand levels and less rapid take-up of advanced applications and services; as a result investment grows much more slowly to ECU 76 billion per year. These figures are illustrated in Exhibit 5.5.

2 These figures represent the capital outlay of all network and service providers in the EC; they exclude end-users' investment in CPE.

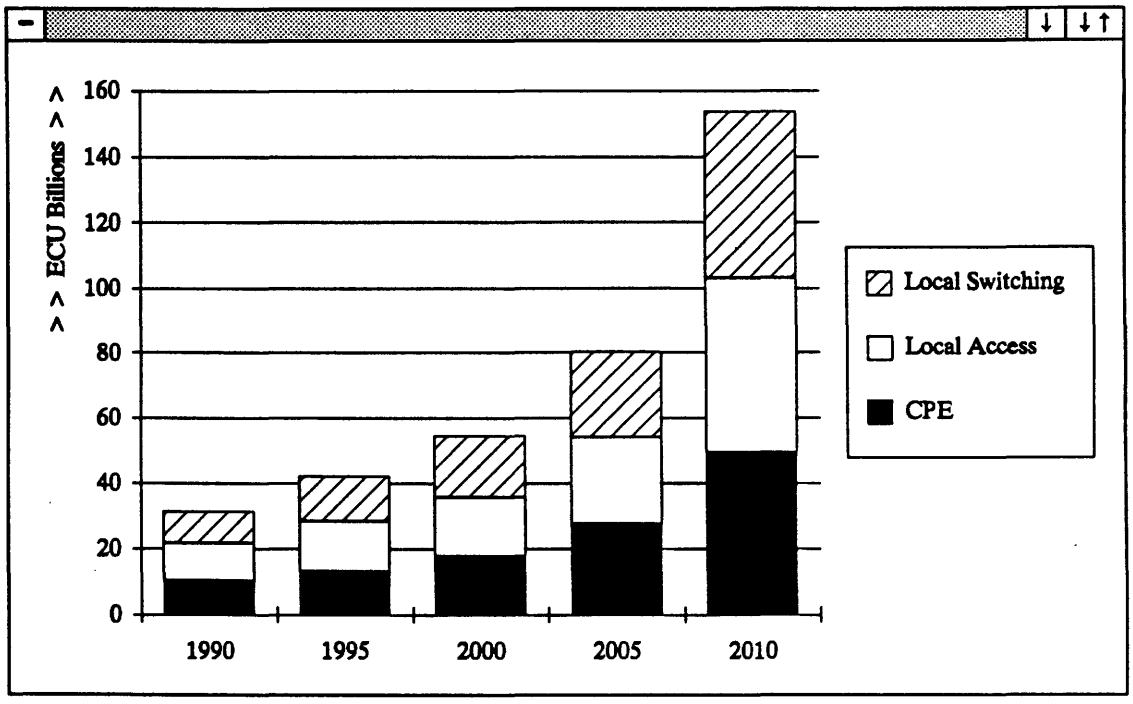
EXHIBIT 5.5: *Investment for Total EC Telecommunications Sector (excluding CPE), Minimum and Expansionist Cases (in Real Terms - 1990 ECU billions)*



As this graph shows, investment grows slowly at first and remains fairly similar in the two cases for the first five years; the difference between the two cases emerges thereafter. In the Expansionist case, annual investment increases at a faster rate, so that in 2000 investment is about ECU 48 billion (compared to about ECU 37 billion in the Minimum case). By the year 2010 investment in the Expansionist case is over 80% higher than in the Minimum case. It is important to note that the investment is peaking towards the end of the study period due to the requirement for investment in new services (such as switched broadband), and that investment levels could be expected to level out after 2010.

From ECU 10 billion today, annual EC investment in local access is projected to almost double by 2000, and continues to grow very rapidly; its share of total investment rises from 30% in 1990 to 40% in 2000. Together with local switching - the entry point into the main network - this represents the overwhelming majority of telecommunications investment. (See Exhibit 5.6.) With the accelerating deployment of fibre in the local loop after 2000, local access outlay continues to be significant throughout the study period.

EXHIBIT 5.6: *Investment in Local Access, Local Switching and CPE for Total EC Telecommunications Sector, Expansionist Case (in Real Terms - 1990 ECU billions)*

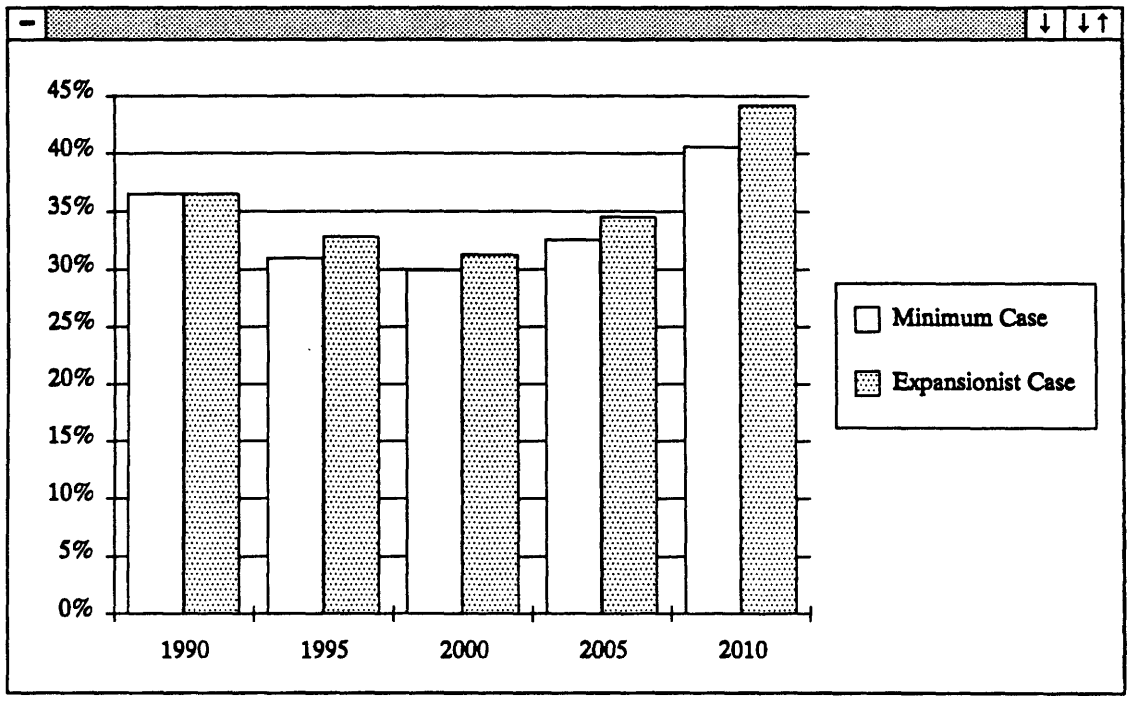


CPE spending (also shown in Exhibit 5.6) increases substantially during the course of the study period as a result of a number of interacting factors - including the widening of the terminals market and increasing demand for new terminals which can make use of the capacity of the new networks.

Curbs on investment represent a significant means of cutting costs and cash spending. As the attention of the TOs in Europe becomes more focused on profitability, the rate of growth of investment can be expected to slow; this effect will be reinforced by decreasing cost of telecommunications equipment in relation to capacity and performance. As a result, investment levels can be reduced as a percentage of turnover in the short term, and will only begin to rise again significantly in the long term as investment for new services becomes a major factor. The high investment levels projected for 2010 - at nearly 45% of turnover - cannot be maintained indefinitely: they represent a peak as new networks and technologies are deployed (partly in advance of new-services demand growth).

There are exceptions to these general trends, most notably in countries where the network is less developed. In such cases the investment costs of developing networks may continue to increase even in the short term before stabilising.

EXHIBIT 5.7: Investment as a Percentage of Turnover for Total EC Telecommunications Sector, Minimum and Expansionist Cases (in Real Terms)



5.2.2 Investment requirements are higher in peripheral regions

The major increases in investment levels described in Section 5.2.1 can be expected to be particularly marked in those areas of the EC where the development of infrastructure is already lagging behind – the so-called 'Objective 1' regions, which are situated on the periphery of Europe.

Because the present study is based on the modelling of countries (rather than regions within countries), it is necessary to define a group of countries as a 'proxy' for the Objective 1 regions.[3] In three countries (Portugal, Greece and the Republic of Ireland), all regions fall into this category; in addition, most of Spain and a large part of Italy are included under Objective 1. Together, these countries represent all but a few of the Objective 1 regions in the Community; they have, for example, received 92% of the STAR Programme budget.[4]

[3] The Objective 1 regions are those where development is lagging behind (i.e. where per capita GDP is less than or close to 75% of the Community average).

[4] The STAR Programme draws on Structural Funds which are made up from the European Regional Development Fund (ERDF), the European Social Fund (ESF) and the European Agricultural Guarantee and Guidance Fund (FEOGA), and is used to target assistance at specific qualifying regions. STAR is a Community Initiative which predates the current Sectoral and Regional Programmes within the Community Support Framework.

Because of the concentration of Europe's Objective 1 regions within this group of countries, it is possible to use their investment requirements and other financial indicators as approximations for the peripheral regions themselves, and to draw some general conclusions as to the situation in peripheral regions of the Community as a whole. Exhibit 5.8 compares the investment requirements for these countries (hereafter labelled 'Peripheral EC') with the investment requirements for other countries and for the EC in total.

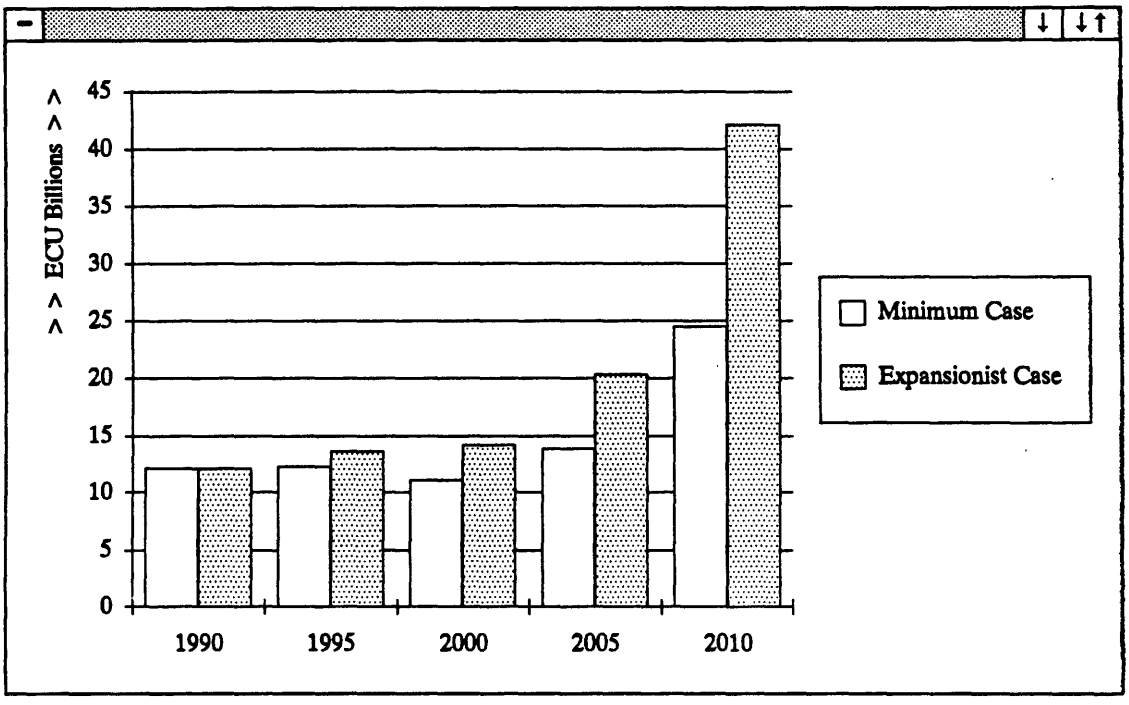
EXHIBIT 5.8: *Investment Requirements for Telecommunications Sector in Peripheral EC, Non-Peripheral EC, and EC Total, Expansionist Case (in Real Terms)*

	1990-1995	*1996-2000*	*2001-2010*
Non-peripheral EC Investment (BECU)	140	150	599
as % of turnover	31%	31%	37%
as % of EC total investment	65%	68%	71%
Peripheral EC Investment (BECU)	74	71	243
as % of turnover	42%	33%	38%
as % of EC total investment	35%	32%	29%
EC total Investment (BECU)	214	221	842
as % of turnover	34%	32%	37%
as % of EC total investment	100%	100%	100%

As this Exhibit shows, the need for network expansion and modernisation in the 'Peripheral EC' countries means that investment levels over the next five years are projected to be high: investment between 1990 and 1995 totals ECU 74 billion, and as a proportion of turnover, investment during this period averages 42% (compared to the EC average of only 34%).

Much of this high investment requirement for the peripheral regions can be attributed to the costs of expansion, as shown by the fact that between 1990 and 2000 the additional investment required in the Expansionist case compared to the Minimum case is over ECU 17 billion. By 2010 this cumulative figure rises to over ECU 100 billion. The extra investment in expansion is also illustrated in the annual figures shown in Exhibit 5.9. In contrast (as the same Exhibit shows), the Minimum case shows flat investment with no real growth until well into the next century. This reflects the low rate of service innovation and development of new networks that would be expected in this case.

EXHIBIT 5.9: *Investment for Telecommunications Sectors in EC Peripheral Regions, Minimum and Expansionist Cases (in Real Terms - 1990 ECU billions)*



5.2.3 Eastern Europe requires investments of BECU 16 between 1990 and 1995

The countries of Eastern Europe have suffered from chronic under-investment in telecommunications. They are now faced with large investment requirements in order to overcome the deficiencies in their networks, to replace obsolete equipment and to meet the hitherto suppressed demand for telecommunications.

From the current annual ECU 700 million, investment in the Eastern European countries is projected to rise steadily, reaching ECU 4 billion per year in 1995. The cumulative total investment over the period 1990 to 1995 is ECU 16 billion - roughly equivalent to 7% of EC investment (see Exhibit 5.10 overleaf). Investment levels are projected to continue to rise, and peaking at the equivalent of 10-12% of EC investment during 1996-2000.[5]

5 As explained in Chapter 1, detailed results for Eastern Europe have only been produced for the period 1990-95. Figures quoted beyond these dates are the result of additional aggregated model runs, and represent broad estimates only.

EXHIBIT 5.10: Investment Requirements for Telecommunications Sector in Eastern Europe (in Real Terms)

	1990-1995	1996-2000	2001-2010
Eastern European Investment (BECU)	16	-	-
as % of turnover	53%	-	-
as % of EC total investment	7%	-	-

This implies a substantial burden on the sector compared to its resources. Average investment runs at 53% of turnover between 1990 and 1995, and peaks at around 60% during the second half of the 1990s – levels not seen in the EC since France undertook its telecommunications development programmes in the 1970s.

5.3 Improvement in the Financial Strength of the Sector

The telecommunications sector in the EC can be expected to grow substantially over the next 20 years. This growth can be sustained by the sector alone. There are, however, specific exceptions in the peripheral regions and in Eastern Europe. Each of these is considered in turn below.

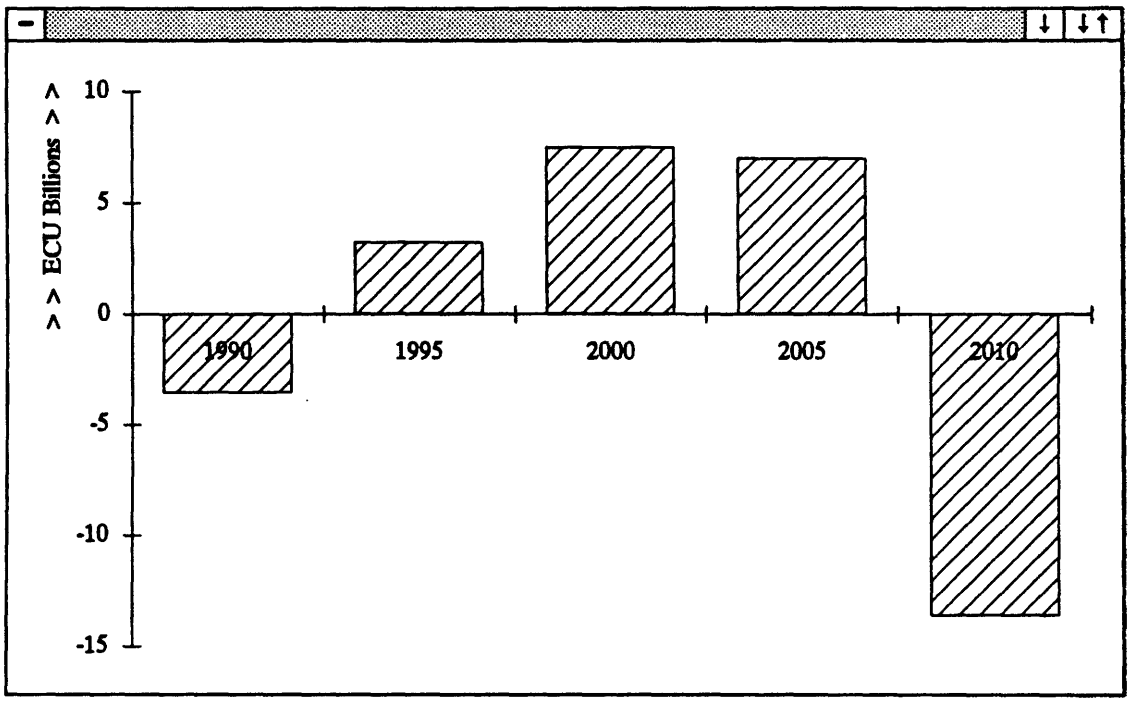
5.3.1 The telecommunications sector in the EC as a whole can afford expansion

Cash flow has historically been a factor determining the rate at which telecommunications can grow.[6] Cash flow in telecommunications is very sensitive to the rate of growth, and rapid expansion quickly raises the requirements for investment and borrowing, and consequently increases costs.

In 1990 total cash flow in the EC telecommunications sector is negative (by ECU 4 billion), indicating that profit is insufficient to cover the gap between investment and depreciation. However, this is expected to recover rapidly and markedly in the short term as profitability improves and investment growth slows (see Exhibit 5.11).

6 Cash flow is the net amount of cash generated during a year having allowed for operating expenditure and investment. Strictly, therefore, it can be called 'Net Cash Flow'. If an organisation is profitable, cash flows are generally positive if investment is less than depreciation. Negative cash flow occurs either if there are losses or if investment is greater than depreciation (or both).

EXHIBIT 5.11: Cash Flow for Total EC Telecommunications Sector, Expansionist Case (in Real Terms - 1990 ECU billions)



The study results show that in the six years between 1991 and 1995 the telecoms sector in Europe generates a net cumulative cash flow of over ECU 3 billion (as shown in Exhibit 5.12). By 1995 total net annual cash generation reaches ECU 3.4 billion and is positive everywhere except Germany (where Deutsche Telekom faces a major network building programme) and some of the peripheral countries.[7] Between 1996 and 2000 - the peak years - an additional ECU 29 billion is generated, and the Self Financing Ratio[8] is 113%, indicating that, on average, the telecoms sector is generating about 13% more cash than it requires for its investments. Operating profits peak at this time as changes in tariffs lag behind the rapidly falling costs, and the full effects of competition are still to be felt.

7 See Section 5.3.2 below.

8 Self Financing Ratio (SFR) is a measure of the ability to finance investment from internal resources. SFR is calculated as the ratio of cash generated before investments to the amount required for investment. An SFR of 120% indicates that 20% more cash is generated than is needed for investment.

EXHIBIT 5.12: Cash Flow and Financing Requirements for Total EC Telecommunications Sector, Expansionist Case (in Real Terms)

	1990-1995	*1996-2000*	*2001-2010*
Cash Flow (1990 BECU)	3	29	23
Cash Flow as % of Turnover	0%	4%	1%
Capital Outlay (1990 BECU)	214	221	842
Capital Outlay as % of EC total	100%	100%	100%
Average Self Financing Ratio	101%	113%	106%
Average Operating Profit Margin	29%	31%	26%

The study results show that by 2000 the TOs in Europe have accumulated substantial financial strength. The benefits of this strength then become apparent, as from that point on investment requirements begin to accelerate again relative to turnover, and this growth has to be backed by substantial financial reserves. By 2010 investment requirements are expected to increase to 40-45% of turnover (from around 30-35% in 2000), and cash flow to turn negative, reaching a net outflow of nearly ECU 14 billion. But the Self Financing Ratio is 106% on average during the preceding ten years, and in 2010 is at the same level as in 1990.

The pattern of cash flow varies between the Expansionist and Minimum cases due to the rate of growth and the profit margins achieved. Early on, the Minimum case generates slightly more cash because investment levels are lower, but later the Expansionist case tends to generate more cash because profits are greater and more revenue is being obtained from each unit of investment. Eventually the two cases diverge substantially because investment requirements for the new wave of growth in the Expansionist case are so much greater.

Competition can be expected to have an increasingly important effect as the incumbent TOs' share of revenues in the Expansionist case declines to close to 70% overall, and operating profits as a percentage of turnover move lower than at any time since the 1980s (as shown in Exhibit 5.12). But the strength built up during the preceding years – in terms of cost, efficiency and finances – enables the TOs to support the required additional investments.

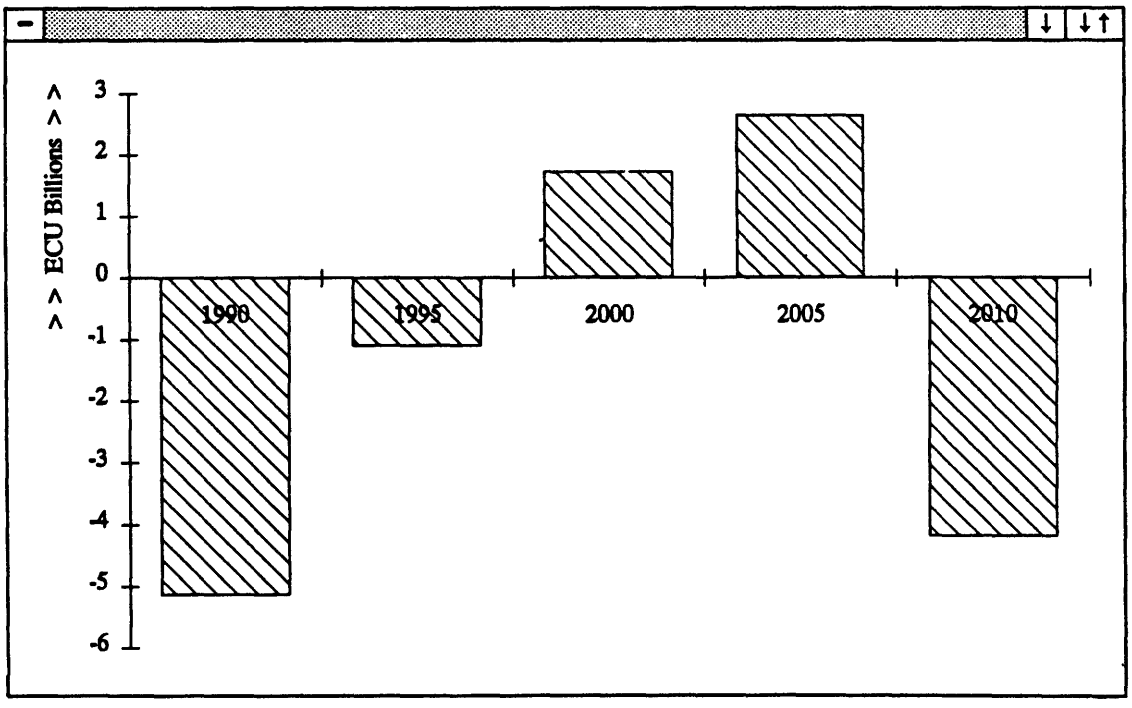
Meeting the appropriate regulatory conditions has substantial long-term benefits. An evaluation of the differences in cash flow between the Expansionist and Minimum cases and the total assets over the 20 year period indicates that the Expansionist case generates a much larger total of cash plus net assets than the Minimum case. The difference in the net present value (NPV) of the Expansionist case over the Minimum case – calculated at a real rate of interest (i.e. allowing for inflation) of 4%, and before tax and

dividend payments – is around ECU 130 billion.[9] This is without taking into account the wider economic benefits for users or spin-off from a strong, expanding and innovative telecommunications sector.

5.3.2 Cash Flows in peripheral regions are negative until 1998

Whilst cash flows in the rest of the EC are positive after 1990, cash flows in the 'Peripheral EC' group of countries (Italy, the Republic of Ireland, Spain, Portugal and Greece)[10] remain negative until 1999. Exhibit 5.13 shows the development of this cash flow between 1990 and 2010 (in the Expansionist case). The trend is upward sloping, reflecting the drive by this group of countries (particularly Spain) to curb investment levels, which were high in relation to turnover and profit during the network modernisation programmes of the late 1980s.

EXHIBIT 5.13: Cash Flow for Telecommunications Sectors in EC Peripheral Regions, Expansionist Case (in Real Terms – 1990 ECU billions)



9 Net Present Value (NPV) represents the value of an investment discounted at a particular rate, so that income in the future is worth less than income now. The interest rates used in this study are real interest rates, i.e. adjusted for the effects of inflation. NPV is usually quoted before tax and dividend payments; this represents the overall value to the sector. The value to the sector after tax and dividend payments is around ECU 50 billion.

10 This group of countries is used as a proxy for the peripheral regions of the EC, as explained in Section 5.2.2.

Exhibit 5.14 shows the figures for cash flow and financing requirements for the 'Peripheral EC' countries, for comparison with the EC total figures shown in Exhibit 5.12.

EXHIBIT 5.14: Cash Flow and Financing Requirements for Peripheral EC Telecommunications Sector, Expansionist Case (in Real Terms)

	1990-1995	*1996-2000*	*2001-2010*
Peripheral EC			
Cash Flow (1990 BECU)	-15	1	13
Cash Flow as % of Turnover	-8%	<1%	2%
Capital Outlay (1990 BECU)	74	71	243
Capital Outlay as % of EC total	35%	32%	29%
Average Self Financing Ratio	79%	101%	109%
Average Operating Profit Margin	27%	35%	29%

In the short to medium term, the cumulative cash deficit worsens, reaching almost ECU 17 billion in 1998 for the Expansionist case. It is estimated that this financing requirement represents a 50% increase in the total debt burden carried by the TOs within Peripheral EC countries in 1990 and is unlikely to be sustainable without significant financial assistance.

The more advanced regions within the Peripheral EC countries can be expected to generate cash surpluses (in the same way as the core Community regions) long before 1998. If these surpluses are not directed towards the less-developed regions then the latters' funding requirements will be even larger.

The growth rates in the Expansionist case impose considerably greater cash requirements than the Minimum case in the medium term. The additional investment in the period to 2000 – ECU 17 billion more than in the Minimum case (see Section 5.2.2) – increases the maximum deficit in 1998 by almost ECU 4 billion. The cost of this additional borrowing, in terms of interest paid, amounts to ECU 2 billion in the year 2000 (based on a real interest rate of 4%).

This additional burden may be difficult to justify in immediate financial terms, even though the overall long-term benefits of expansion are substantial. Compared to the Minimum case, the Expansionist case yields an additional net present value – calculated at a real rate of interest (i.e. allowing for inflation) of 4%, and before tax and dividend payments – of nearly ECU 50 billion. Realisation of this return, however, depends on increasing the level of debt in the short to medium term.

5.3.3 In Eastern Europe investment runs close to the maximum sustainable rate

Investment in Eastern Europe will be running at close to the maximum sustainable rate for the next ten years.

By 1995, the study results show a rise in the total borrowing requirement to ECU 3 billion (Exhibit 5.15 below). By itself, this increase is sustainable; the projected Self Financing Ratio for 1990-95 is around 94%. By 1995, however, the Self Financing Ratio is down to 67%, and indications are that it could fall further before climbing back to around 75% by 2000.[11] This deterioration in the Self Financing Ratio is explained by the fact that the borrowing requirement is increasing at the rate of around ECU 1.5 billion per year, potentially leading to a long-term total borrowing requirement of up to ECU 20 billion for Eastern Europe as a whole.

EXHIBIT 5.15: Cash Flow and Financing Requirements for Eastern Europe Telecommunications Sector (in Real Terms)

	1990-1995	*1996-2000*	*2001-2010*
Eastern Europe			
Cash Flow (1990 BECU)	-3	-	-
Cash Flow as % of Turnover	-10%	-	-
Capital Outlay (1990 BECU)	16	-	-
Capital Outlay as % of EC total	7%	-	-
Average Self Financing Ratio	94%	-	-
Average Operating Profit Margin	62%	-	-

In the long term Eastern Europe has a major advantage in that the costs of expanding the network will be less in real terms than those incurred by other countries – such as France – over the past 20 years. This is because of the extent to which the costs of technology have fallen, and the fact that these networks are being built on effectively 'green field sites'. By 2010 it will have been possible to have replaced the existing obsolete equipment with modern efficient networks using advanced technology for much less total investment than the equivalent older networks in Western Europe.

Despite these lower costs, however, between 1990 and 2000 Eastern Europe can be expected to invest over ECU 37 billion in telecommunications. By 2010 this figure could be as high as ECU 90 billion, allowing for population growth from 120 million in 1990 to

11 As explained in Chapter 1, detailed results for Eastern Europe have only been produced for the period 1990-95. Figures quoted beyond these dates are the result of additional aggregated model runs, and represent broad estimates only.

130 million, the provision of more advanced networks and services, and the very significant amounts of money required to replace existing equipment and for equipment depreciation during that long time period. It will be well into the next century before annual cash flows in Eastern Europe become positive, and debts for funding expansion are likely to continue to grow for the next 20 years.

The projected growth path is feasible, provided that the costs of funding the investment are not too high. This means that:

- sufficient funds must be made available to the sector through revenues, to keep a relatively high Self Financing Ratio, to limit borrowing requirements and to service debts
- external sources of funds must be made available on reasonable terms.

The study results suggest that the total borrowing requirement for Eastern Europe as a whole can be expected to be up to ECU 10 billion in 2000 and ECU 20 billion in 2010. The cost of this borrowing (in terms of total interest paid) is projected to rise from ECU 200 million in the short term to over ECU 1 billion by the end of the 1990s.

5.4 Three Distinct Phases in the Development of the Sector

The study results show that telecommunications in Europe over the next 20 years can be expected to evolve through three distinct phases – short, medium and long term – as a result of a combination of trends. The major trends are as follows:

- The cost of providing telecommunications will fall substantially as a result of greater efficiency, economies of scale and substantial improvements in technology.

- New network architectures, techniques and technologies will enable the increasing separation of network operations from service provision. It will be possible for additional services to be provided separately from the existing network providers; eventually it will also be possible for new infrastructure to be provided economically in competition with existing providers, even in the local loop.

- Demand will rise rapidly, especially the demand for new services. This demand growth will accelerate in the medium to long term as new networks and services become available.

- Greater regulation of prices, and the introduction of competition, will encourage tariff rebalancing. As the cost of connections to the network increases in relation to the cost of handling calls, rebalancing will favour reduction in charges for calls and

increasing charges for rental and connection; as a result, the growth in traffic demand will have a less significant effect on revenues and profits.

- Reduction in costs – both equipment and operating costs – in the short to medium term will improve profitability and cash flow and give many TOs very strong balance sheets.

- Pressure for tariff reductions, particularly for telephone calls, will reduce the long-term revenue potential from basic services and may depress revenue growth in the medium term if new services and networks are not available.

The study results indicate that the combination of these trends will result in a three-phase pattern of development over the next 20 years. Except where otherwise indicated, the comments below apply to the Expansionist case – that is, they assume that the right regulatory conditions are put in place for encouraging growth.

The short term (typically the first half of the 1990s)

In the short term, the telecommunications sector is expected to focus increasingly on cost reduction and greater efficiency. Networks will not yet be sufficiently developed for sustaining major growth in new services, but growth in demand for basic telephony will, in general, enable continued growth in revenue. Where cost-cutting measures are introduced there are likely to be substantial improvements in profitability and cash flow, but TOs with underdeveloped networks will still find it difficult to generate sufficient funds from operations to cover cash spending. Investment relative to turnover will fall in many countries and equipment manufacturers will come under increasing pressure to deliver greater functionality at lower overall cost into a slowly growing market. Increased competition and open procurement will mean that in markets such as Germany equipment prices will begin to fall substantially towards a 'European' level.

Because of the increasing financial health of the TOs and the changes in network economics, it will become feasible during this period to begin the process of removing existing monopolies in services and networks and to introduce widespread competition (though where peripheral countries lag behind, intervention will begin to be required). Competition can be expected to emerge, but it will be focused on specific areas such as long-distance and international services where large differences exist between tariffs and costs. The regulatory changes will have little impact in the short term, but will have major consequences in the ensuing

years, when the scale of structural change will depend on the policies put in place during this period.

Increasing differences are likely to emerge between telecommunications sectors in the EC Member States, as those with less well developed networks will still require large investment levels, whilst the more developed networks will be moving into a virtuous circle of improved financial performance, lower cost and higher demand. In Eastern Europe investments will result in substantial cash deficits.

The medium term (typically the last half of the 1990s)

The medium term represents the turning point for European telecommunications. During this period it will become clear (from decreasing costs and the pressure for tariff rebalancing) that the long-term growth of the sector depends on new services rather than continued growth of basic fixed telephony.

Competition is expected to increase, but its impact will be limited, partly because of the inherent advantages possessed by the incumbent TOs, and partly because of tariff régimes. TOs which have been able to invest in the network architectures and equipment capable of supporting new services will be at an advantage against competitors attempting to gain market share, and most TOs will continue to improve their financial positions, despite competition becoming a significant factor throughout Europe.

The study results show that advanced voice services, narrowband and broadband digitally-based network access (including ISDN), and mobile services will all become increasingly important sources of revenue. Simple voice telephony will therefore become relatively less significant, although taking Europe as a whole it will still achieve positive growth.

The rate of growth of the market hinges on regulatory reform, particularly the introduction of competition. If, on the other hand, regulatory changes are not put in train before 1995 (and followed through thereafter), both competition and growth will be held back. In this event – represented by the Minimum case – the combination of slower demand growth and cost reductions (as network technologies improve) would mean stagnant revenues for the TOs, but relatively high profits. The regulatory authorities can then be expected to respond by imposing tariff restrictions to

curb monopoly exploitation, and the larger TOs will look elsewhere for returns on their capital.

In either case, the peripheral countries will – despite major advances in penetration – tend to be left behind core countries in terms of usage, financial strength and the implementation of technology. They will therefore require assistance to manage this transition period; this assistance will need to be greater in the case of a rapidly expanding competitive market.

The long term (typically the first decade of the 21st century)

The long term will see an acceleration in the demand for new services and the widespread exploitation of new technologies. Costs for TOs, including equipment costs, will continue to decline as a result of technological progress and economies of scale, and price differences between Member States for similar equipment will have largely disappeared. The decline in usage charges and increase in available bandwidth will offer significant revenue potential and also provide an expanding market for customer premises equipment. This growth will require the development of new network infrastructure, some of it ahead of actual demand, so that annual investment in the 12 states of the EC could be as high as 40%-45% of turnover, up from 30%-35% in the previous decade.

Competition will begin to intensify and TOs will begin to find their overall share of revenue dropping to close to 70% overall. Competition through targeting high volume users – so called 'cream skimming' – will have become increasingly more difficult as the process of tariff rebalancing will be largely complete. Basic voice telephony will have become a low price commodity, and the TOs will have developed new voice, data, video and mobile services to compensate. Even though profitability in general will be good, the high levels of investment for developing these new networks – particularly broadband networks – will require additional borrowing or reduction in cash reserves. However, substantial market growth from the mid-1990s and general financial health will mean that this spending will be sustainable and such investment will only be required for a relatively short period whilst the new network infrastructures are put in place.

A high rate of growth and convergence of the sector in the Member States will depend on the regulatory conditions – specifically the introduction of competition in the mid-1990s –

having been put in place. Long-term growth will result from the reinforcing interaction of demand and supply – the growth in demand generating revenues, profits and cash flows, which in turn will enable the development of new networks and services capable of meeting that demand at a reasonable cost. The difference between the Expansionist and Minimum cases – 71% higher revenue and 84% higher investment – is a result of the long-term effect of this reinforcing interaction.

European telecommunications faces an important choice in the first half of the 1990s – and the choice which is made will determine the structure of the market for many years to come. If action is taken now on regulation and reorganisation, the outcome will be continued market expansion, supporting Europe in the decade of the Single Market to the benefit of users and suppliers. If there is delay, the result may be relative stagnation.

6/ Main Conclusions and Actions

The main conclusions of this study are that significant expansion of the telecommunications sector in Europe is possible – provided specific liberalisation measures are taken – and that the growth will more than compensate for any erosion of the incumbent TOs' market share, enabling them to become strong financially. Additional measures will be required for peripheral regions, Eastern Europe and for protecting disadvantaged members of society, but the costs of this will be more than offset by the expansion of the sector as a whole.

Telecommunications is a sector where long-term strategic decisions are part of normal planning. At the beginning of the 1970s, for example, it was decided in France to adopt a new, digitally-based architecture for telecommunications; benefits from this decision are still being realised in terms of lower costs and the ability to support advanced services. But European telecommunications, with its diverse networks, is faced with strategic decisions of an even greater magnitude today. All aspects of telecommunications – network technologies, investment, demand, tariffs and revenues – will change substantially over the next 20 years. *The key influence on demand, tariffs, finances and resources, and technology choices will be regulatory action; decisions on regulation in the near future are therefore vital to the long-term development of the telecommunications sector in Europe.*

6.1 EXPANSION IS POSSIBLE

This study concludes that rapid expansion of the EC telecommunications sector over the next 20 years is made possible by a number of mutually reinforcing factors in both demand and supply of telecommunications. In particular, telecommunications usage can be expected to grow rapidly across a wide range of services, while equipment and operations costs will fall rapidly, and new network technologies will enable new services and widespread competition.

6.1.1 Telecommunications use will grow rapidly across a wide range of services

The potential demand for telecommunications can be expected to grow at a very rapid rate as a result of expansion in trade and income levels,[1] increased emphasis on information in the economy as a whole, and substitution of telecommunications for travel. This potential demand will be the result of a wide variety of applications and network services becoming available at sufficiently low tariffs for widespread use. It is projected that:

- **basic voice services** will continue to grow in line with economic expansion and will benefit from increased reliability of networks and supporting advanced voice services
- **advanced voice services** will grow very rapidly once network development has progressed sufficiently
- **mobile services** will continue to experience rapid growth as they become available at lower cost to wider markets
- **facsimile and data usage** will grow as networks offer greater capacity at lower tariffs, and as terminal and other customer premises equipment becomes more widespread
- **videotelephony and image communications** will become extremely important in the long term as applications and equipment develop to support multimedia services.

Growth in telecommunications will of course be driven by natural growth in the economy, but changes in economic structure and substitution combined with the proliferation of services will lead in the long term to telecommunications usage increasing faster than historical rates.

Demand growth over the next 20 years will therefore not be a simple extrapolation of current trends. Many new services will become available, making it easier and cheaper to communicate in a variety of different ways, based on different networks and services each suited to the particular application or circumstance of the user.

6.1.2 Equipment and operations costs will fall rapidly, and new network technologies will enable new services and widespread competition

The increase in telecommunications usage will be supported by developments in technology, enabling the use of advanced networks at low cost. Digitalisation and optical fibre will allow new services to be supported, produce substantial savings, and allow the separation of service provision and network operation. Cost reductions can be expected to arise both through technological progress and more open procurement.

1 Historically, spending on telecommunications has grown on average between 20 and 60% faster then the economy as a whole.

Currently the prices paid by different TOs for effectively the same equipment vary by up to a factor of three across Europe and significantly add to the cost of some networks. A major factor in this variation is the lack of diversity of supply; frequently TOs buy over 90% of their equipment from one or two national suppliers. In the medium term open procurement, the Single Market and pressure to cut costs are likely to lead to more diverse sourcing of supply and reduce this variation in price. Such developments will have a major effect on the cost of telecommunications investment, and will tend to strengthen global suppliers, leading in turn to long-term structural change in the supply industry.

In the long run technological progress will result in continually decreasing costs – particularly in transmission and radio systems – both for capital expenditure for a given capacity and for operations and maintenance. Technological progress will also significantly affect the economics of access to telecommunications. It will enable many services to share the same access links at low additional cost, and will allow specialised networks (such as radio access in the local loop) to compete economically against more general networks based on optical fibre. This change in network economics will make possible competition in both networks and services.

The decline in unit costs for telecommunications services – a combination of technological progress and rapidly diminishing marginal costs for supporting additional usage – is expected to continue at a rapid rate for at least the next 20 years.

6.2 Liberalisation is Necessary and Timing is Critical

The comparison between the Expansionist and Minimum cases which is central to this study highlights the key role of regulation and liberalisation in releasing the forces of expansion. This comparison also shows that actions taken within the next five years will have profound effects over the whole of the next two decades. Liberalisation must take two forms – the re-inforcement of existing actions, and the instigation of additional and more wide-ranging changes.

6.2.1 Liberalisation is necessary

Changes in telecommunications demand and supply are making possible substantial growth in the potential range of services and networks available to the user. At the same time, however, they are strengthening the positions of the incumbent TOs, for the following reasons:

- cost reductions will increase the profitability of basic voice services in the short term
- the maturity of the sector will lead to generation of large cash flows

- demand will increase in terms of volume
- the technologies will be available to meet this demand at low cost.

The rate of innovation is the key to realising the potential demand for a wide variety of services and applications. But if the TOs remain unchallenged in the market place, then self-interest will prompt them to use their pre-eminence to preserve existing revenue streams at the expense of encouraging innovation. For example, they could be expected to manipulate relative tariffs to encourage or discourage migration as they have done in the past with leased lines.

Obviously specific regulatory steps could be taken to prevent this, including price controls. In the long run, however, this provides neither the incentive nor the resources (through profits and cash flows) for the TOs to innovate rapidly, and as the complexity of the market grows such regulation will continually lag behind. The central issue will be how rapidly new offerings can be brought to market and how responsive the suppliers will be to market needs.

In the future the economics of networks will change, enabling multiple services to be supplied over one network and different networks to be constructed to supply services aimed at specific market requirements. A simpler and more efficient approach, therefore, would be to allow the markets in networks and services to be contested by new entrants. These new entrants would continually be seeking to exploit new opportunities which the TOs would otherwise ignore in favour of existing approaches or larger-scale initiatives. Developments in technology and demand will make it feasible to implement such a policy; the potential benefits of liberalisation make it necessary, and the rate of change in the sector means that the timing is critical.

6.2.2 Current actions should be reinforced

Actions are required both to reinforce the existing initiatives and to take further regulatory measures. In the first place, EC initiatives begun in the 1980s must be continued and reinforced.

- **Open Network Provision** (ONP) is especially important, as it is focused on the separation of networks and services and provides the only European-level regulatory framework. Inadequate resources are devoted to ONP at the CEC. Moreover, the complexity of telecommunications is increasing rapidly and specific ONP measures with limited scope (such as the Leased Line Directive) will quickly become outdated and ultimately unworkable. ONP should therefore become more market driven, and focus on interconnection, equal access and the introduction of competition in services and networks.

- **Standards** in Europe are evolving as part of the increasing regionalisation of the telecommunications standards-formation process. Reinforcement of ETSI would assist in the long term in overcoming the substantial differences that exist between telecommunications networks in Europe, and would lead to lower costs.

- **Open procurement** is another area in which there is considerable progress still to be made. Many TOs still pursue a rigid policy of own-country procurement. From data for different TOs' investments it is clear that equipment prices vary substantially across Europe, significantly adding to costs.

- **Accelerated and simplified approvals processes** could also make a major contribution to reducing costs.

- **R&D initiatives** should focus on demonstrating the capabilities of the new technologies and on building European-level networks to support this.

6.2.3 Additional actions are required

During the 1990s it can be expected that technical and economic progress will make it feasible for operators to use different technologies, directed at specific market requirements such as mobile, advanced voice services or video communications, to compete for local, national and international business. This could lead to a much wider choice through service and network competition.

New actions must be directed at creating an environment where the potential created by demand on the one hand and technology on the other can be realised. The intersection of these two elements is in the market, where tariffs provide the guide for future investment – if tariffs are distorted, it is impossible to allocate investment resources efficiently.

Tariffs must change in order to enable fair competition. TOs have historically cross-subsidised local access through high call charges (specifically long-distance and international charges). In addition, some TOs have pursued a policy of discouraging the construction of private networks through high leased-line tariffs, and this has had a debilitating effect on the rate of innovation in use of telecommunications. Under such circumstances, if they were to persist, any new competition would be focused on the highly profitable parts of the market (leased lines, long-distance and international) leaving the unprofitable local access to the incumbent TO.

Tariff rebalancing is therefore essential for an efficient competitive environment, and would enable the correct investment decisions to be taken in response to market demand. Rebalancing tariffs would also have a significant beneficial effect for business

and residential users across Europe by encouraging local, long-distance and international communication through lowering the cost per call.

The early introduction of competitive, long-distance intra-Community network operation and service provision would be the single most effective measure to promote infrastructure development in support of the European economy, to provide a spur to the lowering and rebalancing of tariffs, and to accelerate commercialisation. The initiative should comprise the following:

- Licences should be granted unless there are specific reasons for not doing so – these reasons to be clearly stated in advance.
- Service should be provided between at least two Member States.
- There should be no restriction on who could be granted a licence unless the applicant's country of origin applies restrictions on ownership or operation of services which are more restrictive than those applying in this case.
- There should be no restriction on the technology used.
- There should be no restrictions on cabotage (transport of traffic across a Member State would not be subject to special taxes or conditions).
- There should be no restrictions on tariff levels but tariffs must be published.
- There should be no restriction on the services which may be carried.
- Operators in Member States should be required to provide interconnection on fair and reasonable terms. ONP conditions should be drafted for this.
- There should be no restriction on the resale of capacity for existing or new operators or users.
- Implementation of equal access within a pre-determined time period not to exceed ten years.
- Data protection and privacy terms should be clearly stated under ONP conditions.

However, in the long run changes in network architecture and technology will further reduce the sensitivity of network costs to the volume of traffic. Detailed analysis shows that if tariffs move towards costs then relatively high growth rates for service demand overall will be required to maintain revenue growth. Conditions must therefore be created for rapid innovation and the rapid deployment of equipment capable of supporting mobile and advanced voice services if revenue growth is to be maintained during the critical second half of the 1990s.

Developments in technology and improvements in efficiency during the 1990s will mean that previous arguments for retaining monopoly rights to the provision of telecommunications services will no longer apply. In future, networks will be capable of supporting multiple service providers, and changes in the technology for local access and the differentiation of the market into a wide range of services will mean that efficient market competition is possible.

In the medium term the objective should be to introduce competition across all aspects of telecommunications throughout Europe. By that time the implementation of pan-European networks will have had a significant impact on the commercialisation of TOs, the tariffs and investment decisions. Within an agreed timetable, Member States should then move to introducing licensing for competing operators on similar terms to those introduced for pan-European networks.

The authority and mechanisms to enforce regulatory change and compliance with Directives exist at the European level, but their operation can be slow because insufficient resources are devoted to this area. The recent challenge to the Commission's use of Article 90 took nearly two years to resolve through the European Court of Justice. Further action on regulation and the increasing pace of change in the sector will inevitably give rise to further challenges, and any further delays of this kind could seriously hamper the required structural changes. It will be important to ensure that the process of resolving disputes is considerably speeded up in the short term. This will not be achieved unless more resources are devoted to the area.

At the national level, separation of the operators from the regulatory function and from obligations for subsidising postal services or other activities will need to be used as the primary mechanism for implementing change. Because of the different state of development of networks and markets in Member States it is unlikely that liberalisation would be sustainable at the same pace throughout the Community; thus it will be appropriate for regulators in Member States to take on responsibilities for interpreting and implementing regulatory changes and for engaging in bilateral and multilateral discussions at the European level to achieve this where appropriate. It will therefore be essential to re-inforce the regulatory functions in the various Member States.

Liberalisation will not mean the absence of a need for intervention in the market. In the years ahead there are numerous crucial issues to be addressed by regulators – including tariff reform, competition policy, and market access reciprocity. Moreover, increasing pressure will be put upon regulators to act quickly as the pace of technological change and modernisation accelerates. If the regulatory response is too slow, market players may be prevented from capitalising on the opportunities arising from innovation. The regulator must act to ensure that the correct market signals are being given thus encouraging innovation and growth.

6.2.4 The timing and intensity of regulatory action is critical

Expansion in the sector depends on the development of new applications and services and the networks to support them. This in turn depends on action by the regulators to introduce competition to stimulate innovation and rebalance tariffs, and on a positive response from the existing TOs and new entrants. The Expansionist case shows how this

would be achieved: growth in demand can be supported by network modernisation and produce lower costs for customers whilst the TOs and the sector as a whole can improve their financial position.

Regulatory action is needed now because of the long lead times in the telecommunications sector. Regulatory changes take many years to take effect; there is great technical inertia inherent in a system with large infrastructure and long-term investment horizons, and large organisations effectively take a generation to change their 'culture'. Time is also required for innovations by leading-edge users to diffuse to the mass of customers.

Detailed country-by-country analysis of telecommunications throughout the EC indicates that expansion is possible if specific regulatory measures are taken. Without these measures, however, it is not certain that demand will grow substantially faster than the reduction in costs and prices in the medium term, and there is a significant risk – as shown in the Minimum case – that stagnation in revenues could set in during the late 1990s.

Timing is also crucial because of the accumulation of large cash surpluses by the TOs during the 1990s. TOs will be looking for opportunities: there must be some positive indication that future investment in European telecommunications promises high returns.

Deregulation and competition mean that the TOs must be free to invest where they wish. In the long run the strategic goal of TOs must be to provide networks and services and to own all or part of these facilities; if the rates of return in the telecommunications sector in Europe are not attractive then this cash will flow elsewhere, either into other parts of the world or into other sectors. Only early and comprehensive introduction of competition will ensure that attractive investment opportunities are created.

This gives little time for action. By 1996 most of the basic framework should be ready, with implementation completed during the second half of the decade. Furthermore the quicker and more intense the actions the greater the benefit for European telecommunications – including the TOs.

6.3 Expansion and Liberalisation are Financially Sustainable and the Benefits are Substantial

The study results indicate that, given the right regulatory conditions, telecommunications service revenues in Europe will grow rapidly, and that sufficient financial resources can be generated to enable forward-looking technology choices to be made, which in turn enable rapid development of the existing network and the generation of new revenues.

For the TOs in Europe expansionist regulatory policies offer potential for growth in profits and revenues. TOs' share of total revenues could fall from an average of 95% today to perhaps 70% by 2010 and in some cases could drop towards 50%. Nevertheless TOs' revenues can still be expected to expand (in real terms) from ECU 85 billion to around ECU 235 billion, above the level which might be expected if more restrictive policies were pursued.

Competition will obviously put pressure on operating profit margins, but only in the longer term. During the 1990s cost reduction measures should raise the operating profit margins from an average of 29% between 1990 and 1995 to 31% in the last five years of the decade. As the regulatory changes affect the market, average margins will fall – perhaps eventually below 25%. But TOs (and the new entrants) will have gained considerable financial and commercial strength, and will have considerable scope to price according to market requirements and obtain higher margins in specific areas.

The alternative to promoting competition is closer regulation and price control to offset the increasing dominance of the TOs. The Minimum case shows that this – like the Expansionist case – is a sustainable alternative in terms of cash flows and profitability, and even leads to lower tariffs in the short run. But the levels of revenues and profits for TOs are substantially reduced and the sector would become sluggish. Slow revenue growth and rising productivity through technology change could have severe employment effects.

The gap in benefits between the Expansionist case and the alternative Minimum case is striking. The difference in the net present value (NPV) of the Expansionist case over the Minimum case – calculated at a real rate of interest (i.e. allowing for inflation) of 4%, and before tax and dividend payments – is around ECU 130 billion. This is without taking into account the wider economic benefits for users or spin-off from a strong, expanding and innovative telecommunications sector.

Clearly the expansion and liberalisation are sustainable and the benefits are substantial. Telecommunications services serve as a means of increasing productivity, efficiency and quality, and thereby increasing returns and profitability. This is particularly so in the services sector which now dominates European business in terms of income and employment. In non-business activities, telecommunications adds a new dimension to the quality of life. On this basis higher economic growth and an improved quality of life in Europe through rapid expansion of the sector should be expected. It is essential that the right conditions are created for European telecommunications to seize the opportunities now before it.

6.4 SPECIAL MEASURES WILL BE NECESSARY TO ASSIST IN THE TRANSITION

The opening of markets and introduction of competition is essential for ensuring a rapidly expanding sector, and is sustainable in most countries even in the short term. However, exceptions exist in the peripheral regions, Eastern Europe and for low-usage customers.

6.4.1 Customer rights must be safeguarded and account taken of social policy

Low-usage and remotely-located customers are likely to face increasing disadvantages, because rising rental and connection charges relative to call charges will increase their bills. Business economics dictates that innovation in services and networks will be targeted initially at centrally-located higher-income customers; and in the long term cumulative advantages will accrue to those with access to cheap or new services and networks.

Any intervention needs to be carefully targeted. A framework of measures will need to be agreed which:

- balances the rights and obligations of operators through requiring equivalent levels of service to customers
- sets availability levels for new services in terms of geographical spread and proportion of population
- states the kinds of access which would be eligible for support (for example rural public telephones or low-calling-rate lines)
- establishes the grounds and scope for cross-subsidies or other intervention
- provides for the use of local government, national government and EC funds.

Early work will be needed on these issues in order that rapid movement towards competition in telecommunications is not impeded.

6.4.2 Assistance for peripheral regions will be necessary

The benefits of expanding markets and of improved communications will be widely shared only if assistance is provided to peripheral regions. Peripheral regions suffer from specific disadvantages: provision costs are higher, the infrastructure is less well developed, the quality of telecommunications is poor, and revenue levels – especially for new services – are low. Overcoming these disadvantages requires investment which

is high relative to revenue. As Section 5.3.2 shows, the burden of financing the investment required for expansion in the 'Peripheral EC' countries is substantial.[2]

Left to themselves, TOs cannot be expected to accelerate investments in peripheral regions in line with the Expansionist case, especially as telecommunications becomes more competitive. These investments are likely to yield a low or negative rate of return in the short to medium term, and adversely affect the operators' cash flow. The amount and cost of funds available to the peripheral regions are therefore critical factors in determining whether these regions can meet the rates of growth set out in the Expansionist case.

In the long run – beyond 2000 – the Expansionist case shows significant benefits for the peripheral regions. Compared to the Minimum case, the Expansionist case yields an additional net present value – calculated at a real rate of interest of 4%, and before tax and dividend payments – of nearly ECU 50 billion. Such benefits will only be realised, however, if the costs of additional borrowing can be met, for example from EC structural funds.

An alternative to structural fund assistance would be to allow lengthy transition periods, but this would be costly in terms of forgone growth. Direct assistance can compensate for additional costs in the short and medium term, lead to an acceleration in the rate of growth of the sector, and provide wider economic benefits – thus enabling the peripheral regions to match more closely the level of competition, innovation and growth of the core regions.[3] Assistance from structural funds (or other sources) should therefore be stepped up to assist in the adjustment process and to enable these long-term benefits to be realised.

6.4.3 Assistance for Eastern Europe will be necessary

Eastern Europe can be expected to invest over ECU 37 billion in telecommunications within the next ten years, and is unlikely to see positive cash flows until well into the next century.

These investments can be expected to lead to a long-term total borrowing requirement of up to ECU 10 billion by 2000 and ECU 20 billion by 2010 for Eastern Europe as a whole. Interest payments in such circumstances would rise from ECU 200 million in the short term to over ECU 1 billion by the end of the 1990s.

2 This group of countries (Italy, the Republic of Ireland, Spain, Portugal and Greece) is used as a proxy for the peripheral regions of the EC, as explained in Section 5.2.2.

3 These effects are well documented in the literature, including several studies undertaken for the CEC within the ORA and STAR Programmes. See, for example, *Study of the Economic Implications of Stimulating Applications of IT&T in Rural Areas*, Analysys Reports for CEC DGXIII/F, Phase 1 (September 1989) and Phase 2 (April 1990).

A number of important factors mean that this increase in borrowing is likely to be sustainable:

- the telecommunications sector is lagging so far behind demand that initially premium tariffs can be charged to help fund investment
- targeting of service provision at high-spending business customers can considerably shorten pay-back periods
- foreign participation and privatisation is being considered at an early stage to provide a source of funds.

These factors will help to offset what would otherwise be a very difficult financial situation and cash flow requirement.

However, the same factors which make the expansion sustainable will also restrict investments to the most profitable areas. Potential therefore exists for conflict between narrow financial and broader social and economic goals. If these are not managed correctly there is a danger that investment requirements may outstrip the financial resources of the sector.

An opportunity therefore exists for EC funding to be directed at preventing this conflict of goals, by providing assistance to areas where funds would not otherwise be readily forthcoming. This would have a direct benefit in ensuring that the sector does not accumulate a debt burden which would slow up longer-term growth.

The EC should consider annual assistance of ECU 100 million rising to ECU 500 million by 2000 (a total of about ECU 3 billion over 9 years from 1992 to 2000). This figure represents about 30% of the total borrowing requirement over the period, or about 8% of the total investment requirement.

This assistance could be used to:

- offset the costs of specific investments using the additionality principle
- underwrite loan guarantees so as to limit debt interest
- fund training and raise awareness
- assist with organisational changes and financial management
- fund international communications and applications
- enable participation in EC programmes such as RACE
- implement EC regulatory principles.

This type of assistance would make a significant difference in enabling these countries to match the developments in Western Europe; without such assistance, the potential for conflict between financial and broader economic and social goals will be significant, with

a corresponding risk to the ability of the sector to maintain the necessary rapid growth in the longer run.

Explanation of Financial Terms

Below, we present an explanation of financial terms used in this volume.

Capital Outlay — Capital Outlay is calculated as Net Expenditure on Tangible Fixed Assets plus CPE Sales Expenditure.

Cash Flow — The Cash Flow profile is the direct consequence of the pattern of network investment and operations modelled. In the results graphs presented in the Main Report (for the EC as a whole) and Annex C (for individual countries) it is, therefore, referred to as 'Network Cash Flow'.

Cash Flow can also be strictly described as 'Net Cash Flow', since it is the difference between the cash coming into the business as the result of its operations, and the cash going out in the course of those operations.

Depreciation — Depreciation is the sum of all capital charge payments from previous capital investments which fall due in the current year.

Fixed Assets — Fixed Assets in the current year are calculated to be the sum of Fixed Assets in the previous year plus Net Expenditure on Tangible Fixed Assets less Depreciation.

Investment — Investment is Net Expenditure on Tangible Fixed Assets. It excludes investment by users on CPE.

Investment as a Percentage of Turnover — Investment as a Percentage of Turnover is Net Expenditure on Tangible Fixed Assets expressed as a proportion of Turnover (revenue).

Long-Term Debt

Long-term Debt is taken to be equal to the operator's long-term debt in 1990, and is the same as 'Creditors (amounts falling due after more than one year)' used on the account sheets of the Main Report and Annex C.

Net Current Assets

Net Current Assets are the sum of Stock, Debtors and Cash, less Short-Term Creditors.

Net Expenditure on Tangible Fixed Assets

Net Expenditure on Tangible Fixed Assets is total capital expenditure in the year, excluding CPE sales expenditure.

Net Present Value

Net Present Value (NPV) represents the value of an investment discounted at a particular rate, so that income in the future is worth less than income now. The interest rates used in this study are real interest rates, i.e. adjusted for the effects of inflation. NPV is usually quoted before tax and dividend payments; this represents the overall value to the sector.

Operating Costs

Operating Costs are the sum of Depreciation charges occurring during the year and all Running Costs (all current account expenditure including operations and maintenance, administration, service provision and overheads) but not Interest, Tax or Dividends.

Where figures are shown for individual bearer services (as in Graphs 35 to 40 for the EC in the Main Report, and for individual countries in Annex C), the term Operating Charge is used instead of Operating Costs, since this is a more appropriate term for the individual services where the total cost is allocated to each one.

Operating Profit before Interest

Operating Profit before Interest is calculated as Turnover less the sum of Operating Costs in the year.

Operating Profit Margin

Operating Profit Margin is calculated as the Profit on Ordinary Activities before Taxation divided by Turnover in the year.

Profit Margin

Profit Margin is calculated as the Profit on Ordinary Activities after Taxation divided by Turnover in the year. It is also referred to as Net Profit Margin.

Revenue per Connection

Revenue per Connection is total revenue divided by the number of connections. Note that although a telephony connection in 1990 is usually a copper pair carrying one voice circuit, a connection not necessarily the same as a voice circuit. For instance, a Primary-Rate ISDN connection provides 30 voice circuits, but is still one connection. The sum of connections for Business Telephony, Residential Telephony, Mobiles, ISDN and Switched Broadband is described as the Total for Main Switched Services.

Self Financing Ratio

This ratio is a measure of the ability to finance investment from internal resources. It is calculated as the ratio of cash generated before investments to the amount required for investment. A ratio of 120% indicates that 20% more cash is generated than is needed for investment.

Turnover

Turnover is the sum of all revenues generated by the service and product sales during the year.

Glossary and Abbreviations

3D	Three Dimensional
ANI	Automatic Number Identification
AON	Active Optical Network
Application	A task that a user performs using telecoms. A number of different attributes are used to distinguish applications – type of information to be communicated, mobility of user, speed of transmission, etc.
ASST	One of the three TOs in Italy, which is responsible for the long-distance national network between major cities, and the international (European and Mediterranean basin) telephony services
ATC	The Association of local Telephone Companies in Finland, representing the interests of the companies in dealings with the government and the TO
ATM	Asynchronous Transfer Mode
AV	Audio-Visual
BABT	British Approvals Board for Telecommunications, responsible for equipment type approval in the UK
Bearer Service	Types of connection either offered at present or expected to become significant in the future. They may also be referred to as 'connection types'
BECU	Billions of ECU
BeNeLux	Belgium, the Netherlands and Luxembourg
bn	Billion
BT	The trading name of British Telecommunications plc
BTN	Basic Telephony Network
BTS	Base Transceiver System (part of PCN)
CAA	Autocommutateur à Autonomie d'Acheminement, a primary level exchange in France
CATV	Cable Television
CCIR	International Radio Consultative Committee
CCITT	International Telegraph and Telephone Consultative Committee
CEC	Commission of the European Communities
Centrex	A service offering a user organisation the functionality of a PABX from the local telephone exchange
CL	A local switch in France
Class	In STEM, *Classes* are the functional blocks which make up the network architecture; each includes several kinds of equipment (modelled as *Specifics*)
CLI	Calling Line Identification
CO	Central Office

COCOM	The organisation responsible for determining the security export control system for NATO countries and Japan
Connection Type	The type of access to the network used for a communication (e.g. Public Payphone, Narrowband Leased Line,Basic-Rate ISDN)
CPE	Customer Premises Equipment
CPRM	Companhia Portuguesa Radio Marconi, which provides a satellite and continental cable service in Portugal
CSA	An independent commission in France which controls all TV and radio broadcasts
CSDN	Circuit-Switched Data Network
CT2	Cordless Telephony 2
CTP	A tertiary level exchange in France
CTS	A secondary level exchange in France
CTT	Correio e Telecomunicaceos de Portugal, the former name for Telecom Portugal
Cu	Copper
DCC	Digital Cross-Connect
DCS	A packet-switched service introduced by RTT, the Belgian TO
DCSR	Direzione Centrale Servizi Radioelettrici, a body in Italy responsible for radio services, particularly marine communications
DCST	Direzione Centrale Servizi Telegrafici, a body in Italy responsible for telex and telegram services and the Telex-dati data network
DDD	Direct Distance Dialling
DEC	Digital Equipment Corporation
DECT	Digital European Cordless Telephone (CEC standard for digital cordless telephones)
DEL	Direct Exchange Line
DOS	Disk Operating System
DRG	Direction de la Réglementation Générale (French regulatory body)
EBRD	European Bank for Reconstruction and Development
EC	European Community
ECU	European Currency Unit
EDI	Electronic Data Interchange (generic term for the electronic transfer of invoices and other commercial documents)
EFT	Electronic Funds Transfer
EFTA	European Free Trade Association
EFTPOS	Electronic Funds Transfer at Point of Sale
Email	Electronic mail
EMS	European Monetary System
ERM	Exchange Rate Mechanism
ETSI	European Telecommunications Standards Institute
FCC	US Federal Communications Commission
FDDI	Fibre Distributed Data Interchange
FT	France Telecom; also Fyns Telefon, one of the four regional operators in Denmark, responsible for the Funen area
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GNP	Gross National Product
GOS	Grade of Service
GPT	GEC Plessey Telecommunications
GSM	Groupe Spéciale Mobile (the CEC/CEPT-initiated future digital pan-European mobile telephone system)
HDTV	High-Definition Television

HRC	Hungarian Radiotelephone Company
HTC	Hungarian Telecommunications Company, the Hungarian TO
IBC	Integrated Broadband Communications
IBCN	IBC Network
IBT	The new Belgian Institute for Telecommunications
ICP	Instituto das Comunicacoes de Portugal, the independent regulatory body in Portugal
IFC	International Finance Corporation
IMF	International Monetary Fund
IN	Intelligent Network
INTUG	International Telecommunications Users Group
IPSS	BT's international data transmission network
ISDN	Integrated Services Digital Network
ISO	International Standards Organisation
ISPT	Instituto Superiore delle Poste e Telecommicazione, the body responsible for equipment type approval in Italy
IT	Information technology
ITU	International Telecommunication Union
IXC	Inter-Exchange Carrier in the USA
JTAS	Jyosk Telefon Aktie Selskab, one of the four regional operators in Denmark, responsible for Jutland
KDD	Japanese international carrier
KTAS	Københavns Telefon Aktie Selskab, one of the four regional operators in Denmark, responsible for Zealand, Lolland-Falster, Moen and Bornholm
LAN	Local Area Network
LATA	Local Access and Transport Area, in the USA
LEC	Local Exchange Carrier
LEX	Local Exchange
MAN	Metropolitan Area Network
MDNS	Managed Data Network Services
mE	milli-Erlang (1/1000th of an Erlang)
MECU	Millions of ECU
MES	Master Earth Station
MFJ	Modified Final Judgement
MS	Market Segment
Mux	Multiplexer
NB	Narrowband
NCC	New Common Carrier
NET	Norme Européenne de Télécommunications
NMS	Network Management System
NT	Network Termination
NTT	Japanese domestic carrier
NY	New York
O&M	Operations and Maintenance
OECD	Organisation for Economic Co-operation and Development
OF	Optical Fibre
OFTEL	Office of Telecommunications (UK regulatory body)
ONA	Open Network Architecture
ONP	Open Network Provision
OSI	Open Systems Interconnection
OTE	Hellenic Telecommunications Organisation, the Greek TO
PA	Primary Access
PBX	Private Branch Exchange
PC	Personal Computer
PCM	Pulse Code Modulation
PCN	Personal Communications Network

PNC	Personal Number Calling
PON	Passive Optical Network
POTS	'Plain Old Telephony Service'
PPTT	The Polish Post, Telegraph and Telephone Organisation
PSDN	Public Switched Data Network
PSO	Private Service Operator
PSTN	Public Switched Telephone Network
PTO	Public Telecommunications Operator
RACE	Research into Advanced Communications Technologies for Europe (CEC Programme)
RBHC	Regional Bell Holding Company
RBOC	Regional Bell Operating Company
RCU	Remote Concentrator Unit
RDSI	Red Digital Servicios Integrados, an integrated ISDN service being planned by Telefónica in Spain
RFD	Rete Fonia-Dati, the lower layer of the CSDN in Italy
RPI	Retail Price Index
RPT	Rom-Post-Telecom, an autonomous state-owned company in Romania, with a monopoly over the supply of basic services
RSS	Remote Subscriber Switch
RTT	Régie des Télégraphes et Téléphones, the Belgian TO
SDH	Synchronous Digital Hierarchy
SFR	Self Financing Ratio
SIP	One of the TOs in Italy, which is responsible for the local network and for some long-distance national networks
SLIC	Subscriber Line Interface Card
SONET	Synchronous Optical Network
Specific	In STEM, *Specifics* represent the various technological options for implementing the network function of a particular *Class*
SS7	CCITT Signalling System No. 7
STEM	Analysys STEM™ Strategic Telecommunications Evaluation Model
STF	Statens Teleforvaltning, a regulatory authority in Norway responsible for type approval and the award of operating licences
STORE	Analysys STORE™ database management and model annotation system
TEX	Transit Exchange
TLP	Telefones de Lisboa e Oporto, responsible for the telephone network of Lisbon and Oporto (Portugal)
TMN	Telecommunication Management Network
TO	Telecommunications Operator
TP	Telecom Portugal
TPON	Telephony Passive Optical Network
TS	Søndis Telefon, one of the four regional operators in Denmark, responsible for southern areas of Jutland
UK	United Kingdom
UMTS	Universal Mobile Telephony Service
UPT	Universal Personal Telecommunications
USO	Universal Service Obligation
VADS	Value-Added Data Service
VANS	Value-Added Network Service
VAS	Value-Added Service
VCR	Video Cassette Recorder
VLSI	Very Large-Scale Integration
VPN	Virtual Private Network
VSAT	Very-Small-Aperture Terminal (for satellite communications)
WAN	Wide Area Network
WDM	Wave-Division Multiplexing