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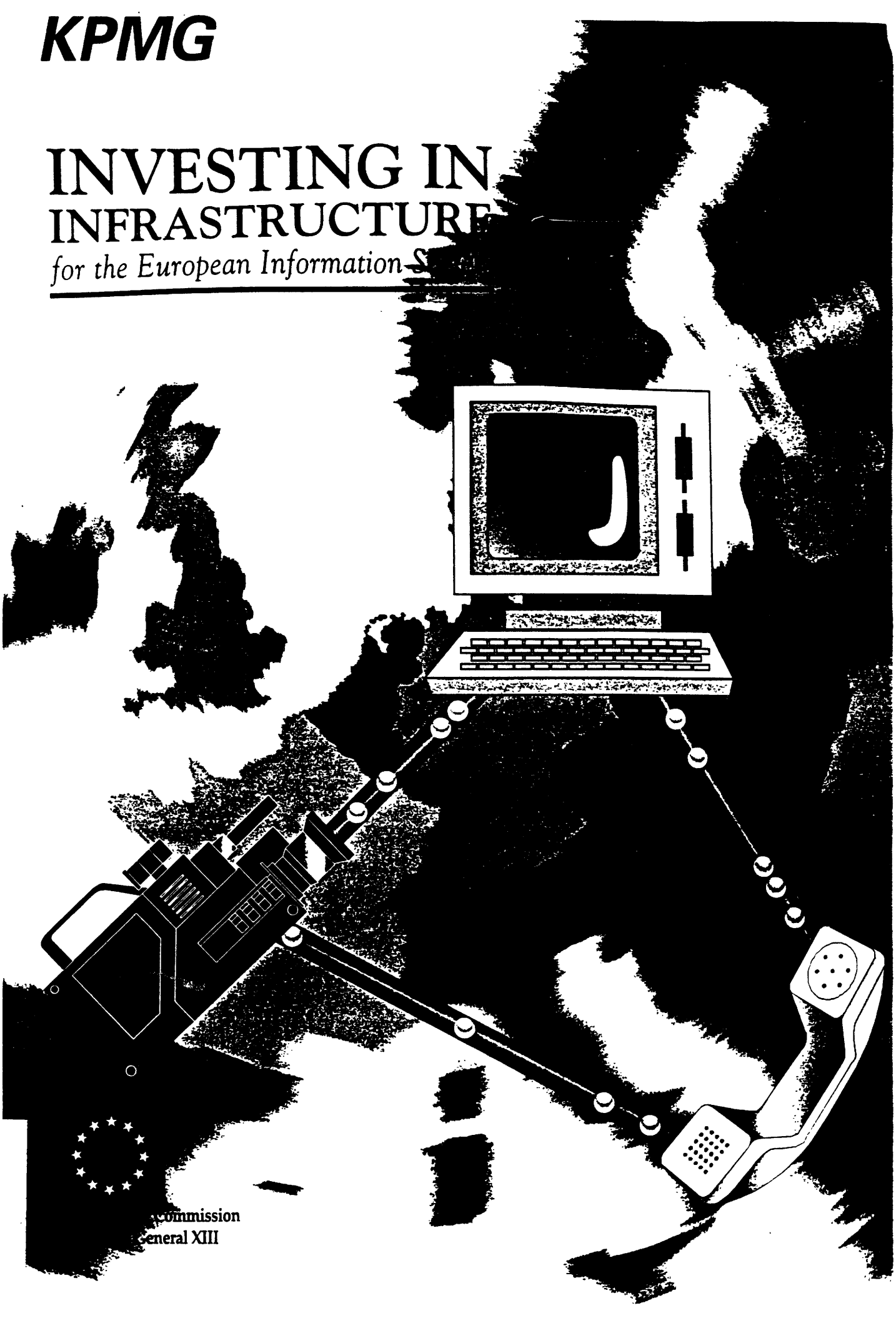
INVESTING IN INFRASTRUCTURE

for the European Information S



Commission
General XIII

Investing in infrastructure for the European information society

Final report

KPMG

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PREFACE

This report presents the findings of a study undertaken on behalf of the European Commission under contract number 48226.

The report is intended to support ongoing discussions on the future liberalisation of the provision and commercial exploitation of telecommunications and cable TV infrastructure currently underway in the European Union. It is presented to stimulate further public debate on the issue within the context of the Green Paper on telecommunications infrastructure and cable television networks recently published in two parts by the Commission. It is one of a number of studies in this area.

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We would like to take this opportunity to thank everyone who supported us in this study. Thanks are due in particular to the staff and advisers at the European Commission and to the representatives of the organisations who provided valuable inputs from which our findings are derived.

The views expressed in this report are those of the study team and are not necessarily those of the European Commission or of the individuals consulted in the course of our work. All the information has been assembled in good faith and to the best of the ability of the study team. The study intends to stimulate debate and our estimates of the levels of investment required are necessarily indicative. They should not be used as the basis of commercial plans without further professional advice. We cannot accept any responsibility for loss arising from decisions based on this study.

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Executive summary

Introduction

This executive summary presents the key findings and recommendations of KPMG's study conducted on behalf of the European Commission into the level and nature of investments in an infrastructure required to support multimedia services.

The liberalisation of telecommunications supply is occurring rapidly across all Member States. This KPMG study was commissioned as one of a series intended to stimulate debate on the mechanisms by which infrastructure liberalisation might occur, and in particular, how the Bangemann Committee's desired reliance on private investment and market forces could best be encouraged. The objectives of our study were to consider the overall level of funding required as well as the environment that would best encourage private sector investment.

We studied potential commercial and technical delivery systems for multimedia services. This drove the development of an investment model which was designed to produce country by country costs for providing infrastructure under a range of different scenarios. In addition to this model we conducted a selective but wide rangin interview programme. We analysed the findings of these interviews together with the results from our investment model to develop conclusions and recommendations on how Europe could best realise the necessary private investment in infrastructure for multimedia services.

Key Findings

There are two types of multimedia services: information (or content) services where information is provided to users in a variety of formats including text, video, image or audio; and communications services that allow the electronic conveyance of multimedia information. Communications services may be provided in their own right, for example, a multimedia e-mail service, or may be used by information service providers as a means of delivering products to their customers. Multimedia services of both types provide significant opportunities for users and suppliers alike and are fundamental to the realisation of the European information society.

Multimedia services have become feasible as a result of developments in both information technology and telecommunications. Much, however, still has to be done before services are widely available. The focus of this study is one of the key elements of this development plan - the provision of an infrastructure that will support multimedia communications services. This will require significant investment.

A new industry must be created to deliver the new multimedia services. This industry will result from the convergence and interaction of three historically distinct industries - telecommunications, media and consumer electronics (including in particular the personal computing industry). Major players in each industry view the development of multimedia services as a fundamental element of their strategy and are actively considering their response to the anticipated convergence. Alliances are being formed, trials are being planned and infrastructure requirements are being assessed. Nevertheless, there is still considerable uncertainty and as yet it is not possible to see

how the new industry will be structured. The uncertainty is exacerbated by as yet undefined markets and services. As a result detailed deployment plans do not currently exist and, as a consequence, investment requirements remain unclear. Our cost estimates are therefore provided for a range of implementation options.

Multimedia services will be delivered on broadband networks largely constructed from optical fibres. These fibres may eventually extend right into each business and home on the network. In line with the Bangemann report and the Green Paper on infrastructure liberalisation, competing networks will be developed and funded from private investments. These competing networks may be deployed in a variety of ways with differing commercial impacts. The early stages of development are likely to include:

- cable TV networks being enhanced to allow telephony and other interactive services. This would allow cable TV operators to broaden their service offerings especially to residential users;

- asymmetric digital subscriber line (ADSL) being used to increase the bandwidth of existing local loop used for telephony. This would allow telecommunications operators (TOs) to provide entertainment services;

- high value customers (for example large businesses) being targeted with new fibre based networks using synchronous digital hierarchy (SDH) transmission. This provides a low cost entry route for new competitors and is often facilitated by geographic concentration.

All approaches have an increased penetration of optical fibre in common.

Multimedia services will be provided to both residential and business users. The greatest investment in infrastructure will be required for the residential sector because of its size and because the present local distributions network requires major development. Cable TV networks provide some broadband services but even these will often require substantial upgrade before interactive services can be provided. Such networks are by no means widespread in Europe as is illustrated by the following diagram which shows the penetration of cable. The diagram indicates both the extent of the opportunity and the magnitude of the task. In most countries where it is provided, cable TV has been highly successful. These networks, nevertheless, often need upgrading, while many southern Member States remain largely uncabled. Addressing businesses will be cheaper - there are fewer of them - and also has greater revenue earning potential.

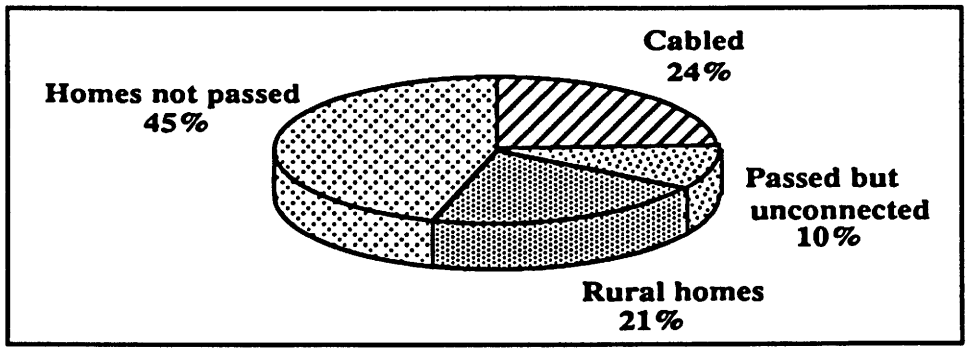

Figure 1 *The extent of cable TV in Europe*

The major element of cost in developing a multimedia communications infrastructure is the transmission network. The costs include civil construction (the largest part), fibre optic cables and transmission electronics; for both the trunk and the local access network. Added to these are the cost of storage devises as well as information and telecommunications processing equipment. These costs may result from equipment placed in the customer's premises (for example, a cable TV set-top box or a PC interface card), within the network (for example, switches) or as part of the content provider's systems (for example, a video server).

As previously noted, our costing model needed to estimate the investment required under different scenarios. These estimates (for the transmission components) are summarised in the following table.

Scenario	Cost (ECU bn)
Long term goal	
Green field provision of fibre through new duct to all homes and businesses	333
Cost of providing fibre to all homes and business if 60% of build was able to utilise existing duct	172
Green field provision of fibre through new duct to 90% of homes and all businesses	245
Cable TV network enhancements	
Enhancement of existing cable TV networks to allow 'limited' interactive multimedia capabilities (excludes set top box)	17
Expansion of cable TV networks through new duct to 90% of urban households	84
PSTN upgrades	
Cost of providing new fibre through new duct to all businesses (no homes connected)	67
Cost of providing new fibre through new duct to all large businesses only	13
Cost of providing new fibre through new duct to all city centre businesses only (large, medium and small)	11
Cost of providing new fibre through new duct to all homes (no businesses connected)	325
Cost of providing new fibre through new duct to all urban homes only	201

The figures are the total for 16 countries (the 15 members of the EU together with Norway). The table shows that to build a new fibre based, broadband network entirely from scratch and covering all homes and businesses in the 'sixteen' is estimated to cost ECU 333 bn. This figure is broken down as follows:

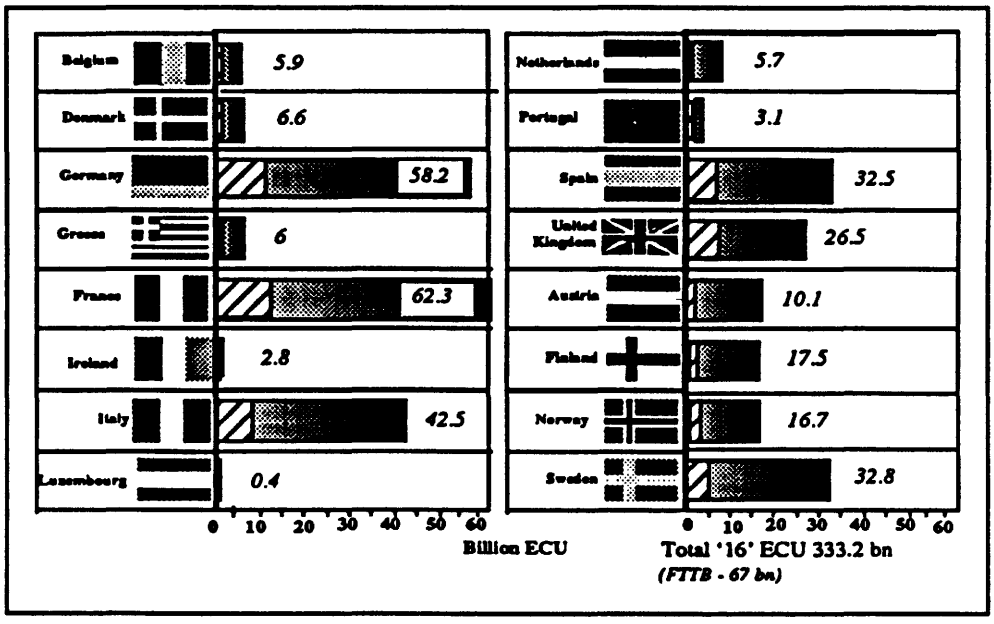

Figure 2 *Cost of universal fibre access*

The hatched area indicates the estimated investment that would be necessary if only businesses were addressed.

A mixture of debt and equity will be needed to fund this investment and we believe that investment will be forthcoming if certain conditions are met to reduce the inherent risk of infrastructure investment due to the long time frame and uncertainties about service revenues. Whether these conditions are met will depend in part on regulation.

The industry seems positive about the opportunities for attracting investment. However, the growth of telecommunications investment opportunities across the world, many of which may be judged to have a lower risk than mulitimedia, improves choice for investors. Investors may well choose to invest elsewhere than Europe. Any perceived protection of established TOs, which is seen to be a barrier to investment in new ventures within the EU, will exacerbate this problem. Availability of funds for multimedia development cannot therefore be assured. A favourable regulatory regime may ameliorate these concerns and it is therefore important that Europe takes the right decisions otherwise its ambition of a privately funded multimedia infrastructure may not be realised.

Recommendations

The regulatory environment should provide an environment in which new suppliers will prosper and new services will be developed while at the same time preventing anti-competitive behaviour. Often the two objectives may contradict. For example, an

alliance between content and distribution providers, each strong in their own field, may encourage investment and result in innovative services. Yet there is a danger that this combined strength could be abused in the longer term.

The appropriate balance between encouragement and control is likely to change with time. However, any measure aimed at supporting the development of the new industry by encouraging investment must be of sufficient duration to convince investors that a reasonable return can be achieved. This does not imply that regulatory controls should be unalterable, but it does means that the process of change must be transparent and acceptable to investors.

Areas that have the potential to make a significant contribution to investor confidence and infrastructure development but which do not endanger fair competition include:

- support to new entrants to help them develop a sustainable position in relationship to an existing monopoly achieved, in all likelihood, by imposing different restrictions and obligations on new and established operators;
- recognition of the short term benefits of collaborative ventures in a manner that prevents future development of anti-competitive behaviour;
- a regulatory framework that recognises the concerns of investors and in which changes are transparent;
- acceptance that deployment costs and user needs vary and that universal service obligations should not be applied too quickly;
- encouragement to share inactive physical resources thereby reducing overall deployment costs.

These areas, and others of lesser impact, are discussed fully in our main report. Key points on each, however, are discussed below.

Assistance to new market entrants

Motivation for policy

Existing operators may be so strong, and new infrastructure so expensive, that new investment will only be made if some advantage (over the incumbent) is provided to new entrants. This is particular true in the provision of local loop infrastructure to small and medium enterprises (SMEs) and residential users. For trunk services less investment is required, and for large businesses the potential revenues are greater.

Pros and cons

Organisations investing in UK cable television infrastructure have reiterated to us that they did so only because they:

- were protected against BT providing entertainment services;
- could supplement cable TV revenues with telephony revenues.

Prior to this stage of regulation, cable TV investment was slow in the UK and only large corporate accounts had competitive supply of local loop infrastructure.

However, such assistance to new entrants itself creates market distortions and may restrict development. Some argue that TOs are the organisations best able to invest in new infrastructure and that barring them from particular revenues streams will prevent new service development. They also express concern that denying established TOs new revenue streams will unacceptably weaken them - a particular concern where privatisation is planned or under consideration.

Generalisation from the UK example is difficult. Nevertheless, some likely conclusions from the UK experience can be drawn:

- provision of alternative wired local loop infrastructure to homes and SMEs will not be made for telephony services alone if the competitor has to build its own ducts;

- unless advantages over the TO are offered, significant risks exist that competitive supply of broadband infrastructure to homes and SMEs will not be made. Particular concerns include:

  - in a country like Greece or Portugal where the extent of cable infrastructure is now modest at best, the TO will have several years (because of derogations of EU policy) in which only it can install modern interactive broadband infrastructure to carry telephony as well as other services;

  - in a country like Germany, Ireland or the Netherlands which already has extensive cable television infrastructure installed by the TO there is little encouragement for new investment.

We recommend that the Commission should develop policies to address these risks. The challenge is to identify mechanisms that will give new entrants the necessary confidence to invest without precluding the development of new services by the TO.

KPMG sees two major alternative types of policy as being suitable:

- market entry assistance to new investors;

- resource sharing (see below).

Without either, strong risks exist that the Bangemann Committee's desired reliance on private sector investment and market forces will be undermined. The development of a multimedia service industry is then likely to rely on a single national infrastructure being operated under tight regulatory constraints to ensure operating efficiency. The development of Europe wide services would in turn require a strong European dimension to regulation.

Neither approach should be lightly dismissed, despite their obvious technical and political difficulties.

In this study we have developed models that allow the costs of alternative infrastructure provision models to be considered. But the economic feasibility of different competitive scenarios cannot be addressed without a simultaneous consideration of revenues. Informed debate and policy making can only occur if this action is progressed.

If market entry assistance to new investors is to be policy, then we recommend that a clear duration of any preferential treatment should be specified either in terms of a number of years or market circumstances (this is explored further below).

We therefore recommend the following.

> Recommendation - market entry assistance
>
> The Commission should evaluate the need for, and extent of, market entry assistance, and in particular asymmetric regulation, taking into account a full cost benefit assessment (costs are addressed in this study - the benefits still need to be quantified).

Collaborative ventures

Motivation for recommendation

Exclusive collaborative ventures may lead to vertical and horizontal integration, creating powerful new monopolies in the emerging multimedia industry and risking abuse of a dominant position. On the other hand such ventures may both simulate the development of innovative multimedia services and make infrastructure investment more likely.

Pros and cons

Collaboration between infrastructure and multimedia 'content' providers may facilitate the development of compatible services and stimulate innovation. For the content provider, collaboration gives more control over distribution channels that are fundamental to business success. For infrastructure providers new revenue streams become available and some of the risks of an uncertain market are reduced. Vertical integration reduces the risks of incompatibility between, or delays in, the simultaneous availability of new infrastructure investments and interactive services. An appropriate joint venture may find it easier to finance the required investment.

However, if such collaboration were exclusive (in other words if content were only available through one network) companies, each powerful in their own right, may be combined into an even more dominant force. Risks of abuse of dominant positions must be avoided, especially as the multimedia industry has the potential to create major new businesses and of significantly informing social and political debate.

Vertical integration through acquisition increases these risks. Media companies could exclude competition by having undue control of network distribution channels using broadband infrastructure. Network operators owning 'content' could give preferential treatment to it on their networks, or use it to command a price premium for their network

services. Vertical integration of this type would nevertheless ensure that service revenues were available to fund infrastructure development.

The balance between these concerns will change with time. Collaboration may be required to 'kick-start' the industry, yet in the longer term when the industry has developed it is essential to guard against abuse.

European Competition law is probably adequate to ensure that abuse does not occur. Legal procedures, however, are time-consuming and create uncertainty which risks undermining, or delaying, the positive benefits of properly structured collaborative ventures.

> Recommendation - collaborative ventures
>
> A permissive approach to collaborative ventures (including acquisitions) may be appropriate when considering the early development of multimedia markets. Decisions should take into account the extent to which a venture may stimulate the development of new multimedia services and the benefits this would bring to Europe. However, conditions should be applied that ensure early advantage does not translate into future anti-competitive behaviour.

General regulatory framework

Motivation for recommendation

Regulation has a major impact on a company's ability to attract external investment and to achieve an acceptable return. Investment in infrastructure for multimedia applications is considered to be risky and regulation may increase or reduce this risk.

Pros & cons

In the early stages of the development of a new competitive market, regulation may be required to compensate for weaknesses in competitive structures. In particular, protection may be required by new entrants so as to enable them to enter the market. This may require specific and detailed regulation.

In the longer term it is preferable to reduce regulation progressively and rely increasingly on the application of competition law. The process of change should be transparent.

Potential investors need certainty on the regulatory environment before they will commit financial resources. The period of certainty needs to match the pay-back period for the investment. However it is difficult to achieve a regulatory framework that is appropriate under changing and uncertain market conditions. The regulatory measures need not be unalterable, but any permitted changes have to be transparent. For example, it may well be defined that regulatory conditions would be relaxed when a certain market share is reached or where a particular revenue or profitability target is achieved. Provided that an investor accepts and knows these criteria assessment of risk and plans can be made

accordingly. This transparency will be important in convincing investors of a less risky future.

We therefore recommend the following.

Recommendation - Regulatory framework

- The long term goal should be to rely on competitive forces and competition law; regulation should only be used while competition in infrastructure is too immature to be fully effective and if historic structures prevent the development of competition.
- The licence for infrastructure provision should be based on a regulatory framework that is clear and certain to facilitate investment.
- Licence award procedures should not bias competition against new entrants. This should clearly identify changes that may occur and trigger points for these changes based on industry consensus.

Universal service obligations

Motivation for recommendation

Universal service is a desirable yet expensive requirement.

Pros & cons

Universal service obligations must be addressed and interconnection arrangements need to consider how such obligations can be equitably funded. Europe needs to ask itself whether it is appropriate to extend universal service obligations to multimedia services based on a consideration of the cost of universality. Chapter 8 shows that excluding the 10% of homes that are most expensive to service would, according to our model, reduce the investment cost from ECU 333 bn to ECU 245 bn (a 26% reduction). It would be an error to impose universal service obligations prematurely, since doing so could discourage the early investment and innovation needed to define service possibilities. As yet the commercial potential of multimedia is too poorly understood for a universal service obligation to be imposed. Nevertheless, it is worth noting that universal service is more easily afforded if physical structures (eg ducts or trenches) or transmission media (eg fibres) are shared.

The implications of establishing a universal service obligation (USO) on broadband services, and funding that USO via a "tax" on operators without a USO are complex. They depend timing and the nature of the process.

KPMG recommends that a "USO-tax" only be applied once demand for a service is shown to be universal, not specialist, and once the true additional costs of a USO on that

specific service are known. It is also important to understand clearly what a USO means in the context of multimedia service

> Recommendation - Universal service
>
> Universal service obligations should not be imposed on multimedia infrastructure until the commercial potential is better understood.

Resource sharing

Motivation for recommendation

This KPMG study shows that the physical ducts required to carry the transmission medium represent the largest percentage of the capital cost of a multimedia infrastructure. Chapter 8 shows that if a new network (including new ducts) were built the cost would be ECU 333 bn. If it were possible to avoid building 60% of these new ducts the cost would fall to ECU 172 bn - a fall of 48%.

Pros & cons

If any area of multimedia telecommunications has the characteristics of a natural monopoly it is the provision and operation of the physical infrastructure into (or onto) which transmission media are installed.

Although competition in telecommunication and transmission infrastructure services has been shown in many countries to have strong benefits to consumers, in terms of faster innovation and lower prices, it is far from clear that competitive provision of inactive, physical structures (for example poles and ducts) is necessary or desirable for competitive multimedia communication services.

Duplication of ducts has high capital cost; while their operation and maintenance is relatively inexpensive, so that sharing raises few risks that inappropriate allocation of shared costs will be a barrier to competition.

If ducts were shared, then the cost of network build could be substantially reduced - a saving of 48% would result from sharing 60% of ducts. Moreover the possibility of competition in multimedia transmission services to households and SMEs would be significantly increased, and universal service would be significantly aided. The creation of ducts also has the greatest environmental impact and unnecessary environmental impact should be avoided.

Inevitably, incumbent operators are likely to present many obstacles to duct (or pole) sharing. Sharing would make it much easier for new competitors to enter the market.

Arguments about difficulty are likely to include:

- the ducts are full and removing traditional transmission media is not justified in cost terms and risks damage or disruption to customer service;
- duct sharing poses risks to the safety and well-being of the transmission media;

- sharing imposes costs on the first operator which may be difficult to measure and recover.

Some of these arguments have validity, but can easily be exaggerated. Nevertheless serious consideration should be given to overcoming these difficulties so as to allow resources to be shared in view of the very significant benefits in terms of cost saving, feasibility of competition in transmission, universal service, and avoidance of environmental damage. The savings are very large, and a small proportion spent addressing the difficulties may facilitate technical solutions. This debate is fundamental and must be progressed.

Various means of addressing duct sharing exist. The following list is intended to show options and is not intended to suggest recommendations:

- central planning procedures to ensure coordination of duct installation (two or more ducts in one trench);
- obligations on builders of new ducts to ensure spare capacity of second duct;
- divestiture of physical infrastructure business into a new authority;
- regulatory obligation for competitors to cooperate;
- an obligation to quote prices for duct usage.

More controversial, and difficult to implement, would be for two operators to share a single transmission cable, for example, each having one pair in a multi-pair optic fibre cable. Nevertheless, the possibility would also result in significant cost savings and might make competition both in services and the operation of infrastructure more feasible.

Recommendation - Duct sharing

The desirability and feasibility of duct, or trench, sharing should be assessed based on a comprehensive cost/benefit analysis eg building on this study's cost model.

If for some countries or regions duct or trench sharing is appropriate regulatory controls must be identified to ensure that ducts are provided efficiently, in a timely manner and at low cost.

Further arguments supporting these recommendations are provided in our main report. In addition, we also discuss the following:

- the need for standards;
- the need for pilots and demonstrator projects;
- the possibility of using tax regimes to encourage investment.

1 Introduction

This report summarises the finding of KPMG's study on behalf of the European Commission into the level and nature of investments required to achieve convergence between telecommunications infrastructure and cable television (TV) networks and the emergence of multimedia services. The call for tenders was issued by the Commission in February 1994 and the contract number for the study is 48226.

1.1 Policy background to the study

Broadcasting and entertainment services, including copyright issues, have been subject to separate legislation from that applied to the telecommunications sector. Both legislative areas are based on foundations laid in the EC Treaty, including competition rules defined in Articles 85 - 90 and those relating to the creation of a common market.

In 1992 the Commission embarked on a major review on the provision of services in the telecommunications sector. This resulted in the Council Resolution of 22 July 1993 on *"The review of the situation in the telecommunications sector and the need for further developments in the market"* (93/C213/01). This resolution promoted the liberalisation of all telecommunications services by 1998 except for a limited number of derogations. Following on from this, the Green Paper on *"A common approach to mobile and personal communications in the European Union"* (COM(94) 145 final, 27 April 1994) also proposed to extend the principle of liberalisation to the mobile services and infrastructure.

In parallel, the Commission's White Paper on growth, competitiveness, employment (COM(93), 700 final) presented by President Delors to the Council at the end of 1993 highlighted the importance of the information society and the need to encourage private sector funding of the development of the trans-European networks.

In June 1994, the high level group chaired by Commissioner Bangemann recommended a number of specific measures in the areas of information infrastructures. A key message of the Bangemann report is that the best environment for the development of a new market is an open and competitive one.

In response to the Bangemann report, the Commission prepared its *"Communication on Europe's way to the information society: an action plan"* (Com(94) 347 final) that gave an overview of the various Commission initiatives relating to the Bangemann report. One of the main initiatives concerned the publication of a green paper on infrastructure (as had been requested by the 1993 Council meeting). Part 1 of the *"Green Paper on the liberalisation of telecommunications infrastructure and cable televisions networks"* was published on 25 October 1994. It advocated the liberalisation of these infrastructures while maintaining certain safeguards to ensure, for example, universal service. Part 2 of the Green Paper on infrastructure will address the safeguards and is due to be published early in 1995. The Council adopted the principles as set by Part 1 of the Green Paper in November 1994.

Liberalisation of the provision and commercial exploitation of telecommunications infrastructure raises a large number of issues for the European Union (EU). These include technical, commercial, policy and regulatory concerns of users and suppliers

alike. Fundamental to the debate are issues relating to the effectiveness of market mechanisms in realising customer benefits. There is a continuum of opinion, from those who believe that the market should be allowed to operate unfettered, to those who believe that the realisation of the social and commercial benefits of the information society will only occur as a result of directed intervention. The issues are complex and one solution cannot be categorically proven to be the best under the wide range of differing circumstances and objectives that exist in the Member States of the Union.

This study aims to consider one part of this broad spectrum of issues; it addresses the investments needed to realise the goals of the European information society. Other studies look at other sets of issues such as the service required, the size and nature of the market and the technology existing or planned. Some of these studies have aimed to complete comprehensive survey work. We have used these findings ourselves as inputs to our financial models.

We have considered the scale of investments needed in both the short and long term under a range of scenarios. We have endeavoured to develop realistic scenarios that will enable informed discussion of the benefits of different options to be discussed. We have also discussed the policy and regulatory environment that will best encourage the necessary level of private investment needed to complete the development in line with the recommendations and principles outlined in the Bangemann report.

Measures to liberalise the provision of telecommunications services are more advanced than those relating to the provision of infrastructure to support these services. Increasingly, however, regulators are realising the importance, and feasibility, of infrastructure liberalisation. It is our intention in this report to consider the investment requirements for realising the European information super-highways in the context of the Commission's proposals as laid down in the Green Paper on infrastructure.

1.2 Approach to the study

The stated terms of reference for the study comprised two elements, as follows:

- the general nature of investments: an assessment of the investments required to modify, upgrade or develop current networks (both telecommunications and cable TV) so as to provide multimedia services;

- the level of investment required: an assessment for each country of the level of investment needed taking due account of the current state of development.

In our analysis we have considered business and residential needs separately; our emphasis has been on network costs. Network architectures are changing and divisions between traditional network components are blurring. We explain our understanding of the scope of the network and of our investment study in chapter 7.

The stated scope of the study was to identify the type and level of investments required to complete the convergence of existing infrastructure and to allow, in the longer term, the emergence of fully interactive multimedia services. In addition to this stated objective we have also endeavoured to consider the environment in which these investments will occur. In particular, we have paid attention to policy issues and the

regulatory environment that will, in our opinion, best encourage the necessary levels of private investment to be made.

The study addresses both long term issues concerned with the development of infrastructure in support of fully interactive multimedia services and medium term issues concerning the convergence of two specific networks and services - cable TV and telephony. The issues and cost drivers of these two stages of development are different although it is necessary to ensure that medium term plans build towards, rather than contradict, longer term objectives. We have endeavoured to maintain the distinction between medium and long terms goals throughout our study.

Network investments alone are inadequate to realise the information society. New equipment will be needed to allow producers to offer multimedia services, new storage devices will be needed to hold and provide access to new services, while customer premises equipment will be needed in both the home and the office. Most of these equipment needs are dependent on the services to be offered which are largely undefined at present. It is therefore impossible to be precise on the level of investment required although we do consider some aspects where a degree of certainty exists.

In undertaking this engagement we were encouraged by the Commission to use as many results as possible from previous studies. Our brief was to take a critical look at the investments needed and the environment that would best encourage these to be made. A major component of our work was the development of a model that calculates the amount of equipment required and applies price assumptions to obtain an overall investment requirement. A detailed description of the model, the assumptions that drive it and the results generated is given in chapters 7 and 8 of this report.

When we commenced this study Austria, Finland, Norway and Sweden were in the process of joining the Union and these countries were therefore included in our analysis. Since then all but Norway have joined. Rather than excluding Norway from our financial analysis we have continued to present result for the 'sixteen' amongst whom we include the members of the EU and Norway. The 'twelve' refers to the members of the Union as of the end of 1994.

In addition to this modelling work, we undertook a focused interview programme. Our objective was to cover a broad range of interests rather than to provide comprehensive coverage in limited areas. A list of contacts is provided in Appendix B. We would like to express our thanks to all those who participated in the study.

Our purpose in undertaking interviews was to confirm the cost assumptions used in our model and to collect opinions on the developments needed or desirable and the concerns and objectives of key players. Based on the results of our modelling work and of the interview programme we have considered the extent to which different options may help to encourage private investments.

Finally we make a number of recommendations on the policy and regulatory options that appear to us to maximise Europe's ability to benefit from the competitive provision of infrastructure.

1.3 Report structure

Following on from this chapter, we present our analysis of the issues in chapters 2 to 7. These chapters specifically include:

- an overview of the commercial environment in which investments will be made (chapter 2);
- an overview of some of the forces that are driving change (chapter 3);
- key public policy and regulatory imperatives needed to create the environment that will encourage successful investment (chapter 4);
- a description of the current infrastructure that will form the foundation for development (chapter 5);
- an analysis of the technical developments that will be necessary to develop this foundation into a platform able to service the information society (chapter 6);
- a description of the investments that will be necessary to realise these developments and a description of the modelling approach used to determine the level of investment required (chapter 7).

In chapter 8 to 10 we begin to draw some key conclusions from this analysis, as follows:

- in chapter 8 we present our opinion on the likely level of investment required and highlight the major uncertainties;
- in chapter 9 we present our view on sources of investment and barriers to this being achieved;
- in chapter 10 we draw conclusions on what direction European policy should take to create an environment conducive to the achievement of the necessary investment and make a number of specific recommendations.

2 The industry structure and environment

2.1 Commercial overview

Three separate industries have developed in the provision, processing and dissemination of information, namely:

- telecommunications;
- media and entertainment, especially TV;
- electronics equipment, including consumer electronics, telecommunications equipment and computer hardware and software. The personal computing (PC) industry is potentially influential.

Traditionally, these industries have dealt with different aspects of information and communications and have evolved using specialised technology to meet customer demand. For example, the telecommunications industry concentrated on improving the quality and reliability of interactive narrowband voice communications while the media industry considered ways of improving the attractiveness of information in visual, audio and text formats. In recent years the divisions between them have begun to dissolve and they have started to show greater commonality to the extent that some people predict the emergence of a single, more unified information industry. The impetus behind this has been increased use of digital techniques to store and process information married with a growing awareness that this enables products and services to be mixed in new and more exciting ways.

Because of the specialised nature of the industries, trade investment for convergence will need to come from within these three, yet each has a different focus and commercial, as opposed to technical, convergence is not straight forward. A view that was widely supported during our interview programme.

The difference of focus is fundamental. From the buyer's perspective the telecommunications industry is concerned with transmission services; media with the content and format (delivery has been of secondary concern) and the electronics industry is concerned with physical product - the customer equipment required for delivery. The electronics industry also supports the other industries through provision of infrastructure equipment utilised by the communication services and to create the content. These differences require different strategies and each industry will have different investment evaluation criteria.

We will briefly consider historic developments in relevant sectors addressing the pressures players are under.

2.2 Services

To date each industry has provided distinct services. We highlight in particular the following:

- interactive person-to-person communication services, such as telephony and teleconferencing;
- entertainment, information and education services provided via cable TV,

consumer electronics and multimedia PC applications, including the use of CD-ROMs, in particular before interactive broadband networks emerge;
- transaction services such as home shopping.

Some of these have a long history others are only just beginning to emerge and continuing rapid change is anticipated. Other studies being undertaken for the Commission address how multimedia services are expected to develop.

An investment study of this type should ideally be based on forecast need, however, in such an uncertain market this is currently unfeasible. Faced with this conundrum, we needed to develop a model that uses a number of simplifying assumptions. Our approach is described in the chapters on our financial model. However, in the context of a commercial overview of the industry it is important to distinguish between:

- services that relate to 'content';
- services that are used to distribute these information services;
- those that provide communications services in their own right (such as multimedia e-mail).

The technical delivery of the last two services are likely to be similar although the customer base for the first will comprise service providers while that for the second will comprise individual consumers. The skills and competencies needs to address each service type will therefore differ. Many of our interviewees believe that it is this that will prevent a rapid full scale integration of the three industries. It is perceived that each will continue to focus on its core business. This does not exclude the formation of alliances which are expected to continue to occur over the next few years.

2.3 Industry structure

There is a hierarchy of value to the consumer:

- content (comprising information and applications);
- communications service (ability to convey information between source and sink);
- network service (the 'logical' means of conveyance);
- provision of infrastructure (the 'physical' means of conveyance);
- provision of rights of way, access to spectrum, etc.

At all but the lowest level equipment is needed to support the 'service'.

The broadcast TV and the telecommunications industries are structured differently with different (and changing) levels of integration.

A representation of the TV industry is provided below.

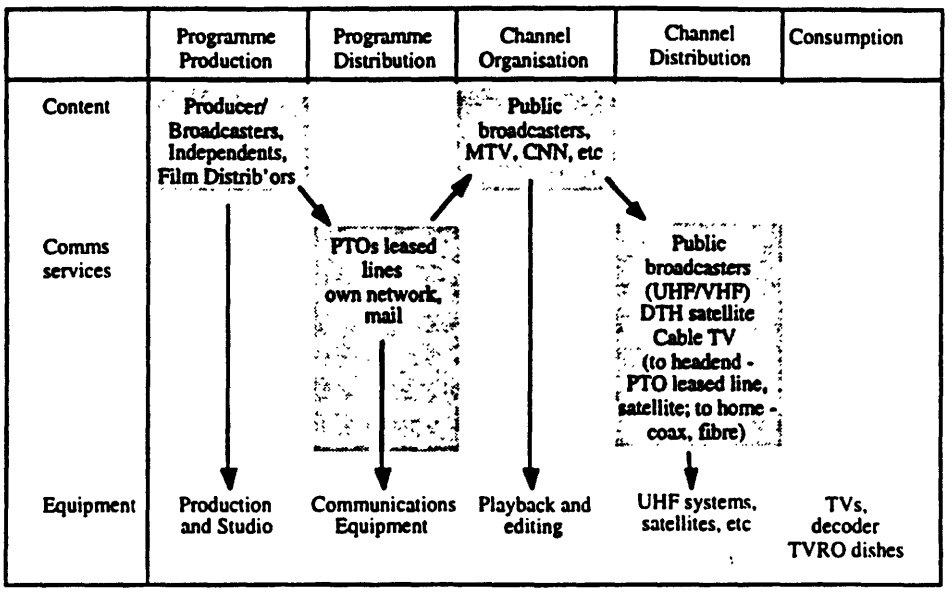

Figure 1 *Broadcasting industry structure*

A typical model for the communications industry is shown below. The diagram is based on a model developed through a number of ONP studies - it is highly suitable for considering organisation interfaces.

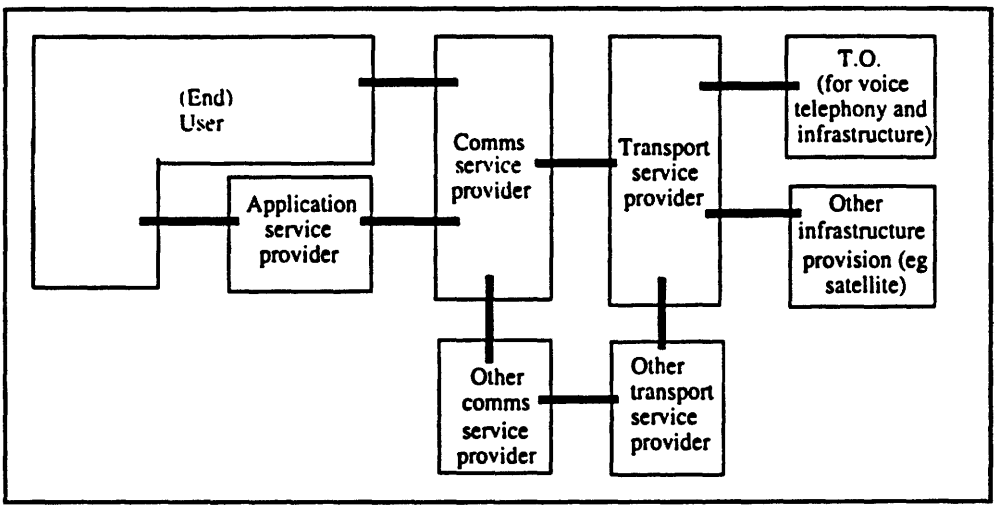

Figure 2 *Telecommunications industry structure*

The two different structures show how great the problems of integration will be.

2.4 Investments to date

As has already been mentioned the development of the European information society will be built from the convergence of three distinct industries: media and entertainment, communications and electronics. Cross divisional investment is only just occurring and, prior to this, each industry took a distinct view on investment. We consider in this sub-section some of the key issues associated with these historic investments.

Telephony

The telecommunications sector has historically been managed under state ownership. This has had a number of impacts, not least of which is the borrowing constraints imposed by national fiscal policy and influence on the level of re-investment of profits permitted. Balancing these borrowing constraints, terms are typically favourable with long pay back periods and relatively low interest rates. Under public ownership, a number of companies have become deeply indebted although the distinction between government and company debt is not always clear.

However, the investment demand for telecommunications has always been high and figures from the ITU indicate that the 'sixteen' invest between nearly ECU 60 bn in 1991. This figure represents about 2% of gross fixed capital formation across the 'sixteen'. This investment was made against a combined turnover in 1991 of ECU 156 bn.

A different effect has occurred in the US Regional Bell operating Companies (RBOCs). The RBOCs have retained local monopolies but have had restrictions placed on them in terms of the rate of return they can achieve on their investments. This has had an impact on the nature of their investments and has meant that they have become cash rich to the extent that they actively sought investment opportunities outside of their regulated activities. Our interviews suggested that this may be beginning to change.

Ownership structures are changing through privatisation. This has freed companies from borrowing constraints (often following a clarification of the debt position) but has required them to seek debt financing at less favourable commercial terms as well as pay dividends to investors.

Coupled with the privatisation trend, we have seen the introduction, or the threatened introduction, of increasing levels of competition. This has caused PTOs to examine their cost and their revenue base. On the cost side, particular emphasis is placed on efficiency and this has often entailed a review of staffing levels. On the revenue side, one key element is the re-balancing of tariffs to reflect the actual cost base. Often tariff distortions have been allowed to occur as, for example, high international prices are used to subsidise lower local tariffs. Competition has also prompted PTOs to re-examine their capital investment plans prompting faster investment in areas where there is greater exposure to competitive pressures. The introduction of competition can have a significant effect on cash flow and margins have been squeezed. However, efficiency gains and increases in revenues can more than compensated for this loss.

Before addressing other industries it is worthwhile considering the last major investment cycle that occurred in the telecommunications sector and which financed the conversion from analogue to digital switching and transmission systems. This investment was funded by TOs still largely in public ownership. It is interesting to consider whether there are differences between the situation then and now.

The commercial environment at the time was undoubtedly different to today's. Competition was much less of an issue, the investment was directed at the voice telephony service revenues for which accrued entirely to the telecommunications operator (information service providers take a much more significant role in a multimedia environment), there was no downward pressure on prices, growth was

projected to remain buoyant and timescales for development where more relaxed. Indeed, many countries have yet to complete their upgrade programmes.

Public networks benefited from a stable external network and typically enjoyed a regional or national monopoly. Risk was low and immediate returns were not expected. The low risk produced the added side benefit of cheap capital.

Turning now to the media and entertainment industry we have to consider them from two perspectives: as sources of investment (into new distribution channels for multimedia content) and as the provider of cable TV services.

Cable TV

Cable TV has, as was described above, followed noticeably different development paths in Europe. In a number of countries in the north of Europe, networks are older and penetration is high. In the south, developments have generally progressed more slowly. UK and France have seen rapid recent growth. The size of the cable TV industry, however, is small when compared to telephony.

UK history in cable TV is particularly interesting because it is the one market where voice telephony services may already be provided. Cable had a relatively slow start in the UK and little occurred until the mid-1980s, but investment has increased recently as indicated on the chart below. There is now considerable foreign investment in UK cable operations.

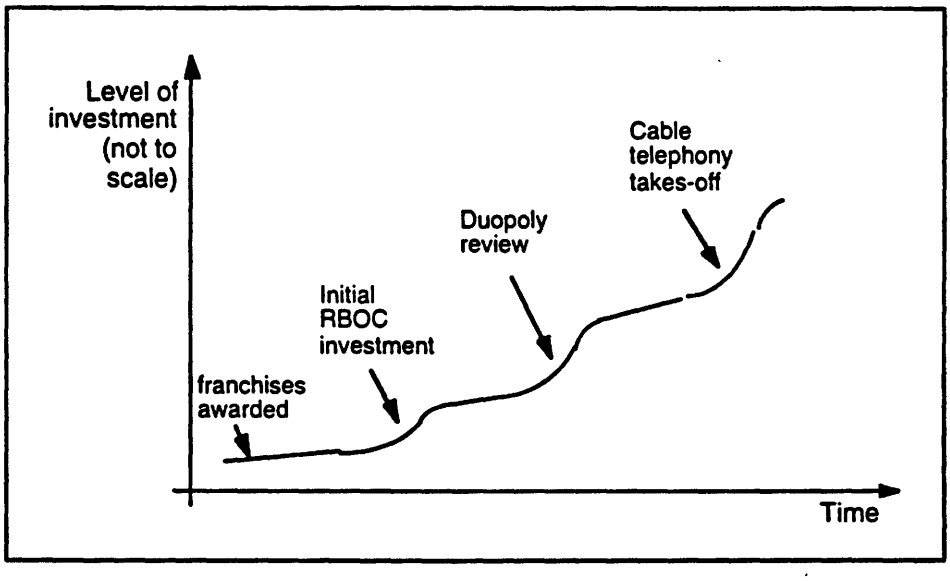

Figure 3 *Historic investment in UK cable TV*

The first sizable boost came when external investment was permitted and US RBOCs, precluded from provided entertainment in their home markets, sought to invest and develop experience building and operating the necessary infrastructure and services. A further boost occurred when UK regulation (the 'duopoly review' of 1991) was changed to permit the provision of voice telephony services over cable TV networks. As operators gained experience they recognised that the size of this opportunity was substantially greater than was originally anticipated. Indeed, many operators now

believe that their major revenue stream will come from telephony services. To an increasing extent they are adjusting their investment profile to reflect this.

The recent UK Trade and Industry Committee's report recommended that the preclusion on BT and other national PTOs from providing or conveying entertainment services should be lifted. The Government, however, chose not to follow this recommendation and the restrictions will remain in force until 2001 although this decision will be reviewed again in 1998.

Other networks

A number of other network provide interesting sources of comparison for investment history. Of potential interest are mobile networks and those provided by, for example, utility companies for internal or, where permitted by regulation, commercial purposes. Limited competition has generally been permitted in the mobile sector and there has been much cross-border investment as shown below.

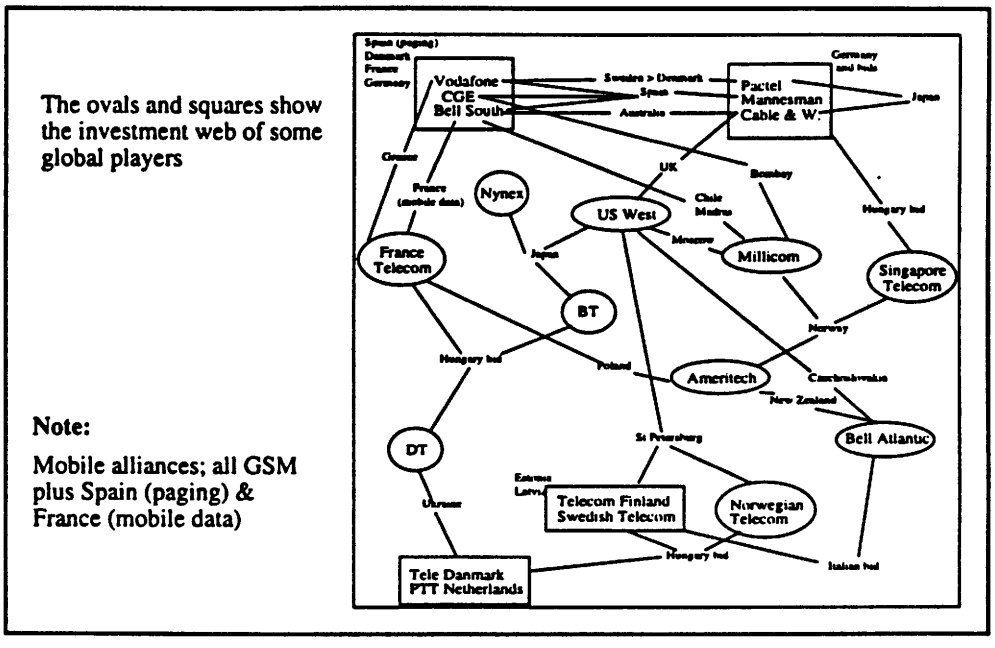

Figure 4 *Mobile industry investment web*

Although the traditional mobile infrastructure has limited application in a multimedia environment (because of bandwidth limitations) the investment web shown above illustrates the extent to which telecommunications organisations are seeking to grow from their traditional geographic and service base.

3 Forces for change

The emerging multimedia industry will address a market that will be subject to rapid and fundamental change in end-user requirements and perceptions: a market which is further characterised by considerable uncertainty. Changes in user needs are both enabled and stimulated by advances in technology. Developments in one area raises expectations, possibly in related areas. The industry then seeks to employ technology advances in line with their commercial objectives in a manner that enables these needs to be more fully met and hopefully allows operational efficiencies to be realised and synergies exploited.

Technical developments that cross over traditional boundaries between industries are particularly important in this respect. Such developments not only change the nature of the services offered but also the structure of the industry. In the medium term, a particular concern relates to the ability of cable TV networks to support voice telephony and for traditional telecommunications networks to convey video information. In the longer term, network boundaries between different information formats will be completely removed. The ability to exploit such technical advances by offering services in other areas of activity reduces barriers to entry and makes competition both more likely and more feasible.

In addition to technical advances, regulation will continue to have an important and changing influence. Changes may include, on one hand the imposition of additional constraints and obligations on operations (for example cost based pricing), and on the other liberalisation and the removal of regulatory barriers to entry. At the same time ownership structures may alter possibly as a result of government policy, and possibly as a result of alliances and purchases across geographic and service boundaries. Together these factors will affect the overall economics of the industry. In response to these external pressures as well as to the need to improve internal efficiency we will see the emergence of a highly dynamic industry as illustrated below.

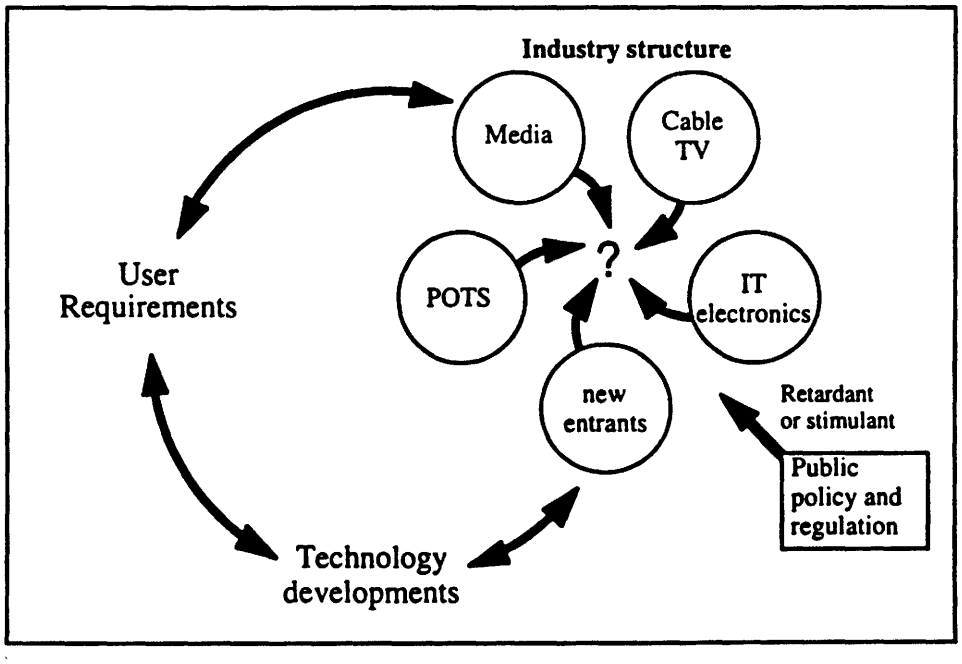

Figure 5 *A dynamic industry structure*

In this chapter we consider these major forces for change. We consider changing markets and end user requirements, the commercial impact of technical developments and changes to the commercial environment.

3.1 Changing markets and end user requirements

Provided quality and cost are acceptable, few end users are actually concerned with the underlying technology of a communications network. For the medium term development objectives of converging cable TV and telephony delivery mechanisms, customers' concerns will relate largely to price and quality. In the longer term, however, users will increasingly demand a wider range of services and continuing price reductions.

Both cable TV and telephony are mature products. Growth in basic telephony revenues is slowing yet new services, for example mobile communications, are entering high growth phases in their development cycle. For TV services the major development is the introduction in some markets of subscription TV (either on a channel or even individual programme basis) to supplement or replace advertising revenues. This is not a new information service but indicates the use of electronic communications facilities to realise a new distribution channel which allows customers to choose to view, say, a recently released film without going to the cinema or renting a video. The introduction of video-on-demand (or on-near-demand) is the logical next step in this trend.

Interactive multimedia services are seen as an option for building a new industry on this mature customer base building. There are two broad types of service:

- communications services using multimedia formats;
- multimedia information services.

The first type of service - multimedia communications services - includes those where end-users want to exchange multimedia information generated by themselves, between themselves. Such services can be considered as the extension of telephony to include other information formats. Examples include:

- video-telephony;
- multimedia e-mail;
- the provision of services that allow, for example, users to change cooperatively multimedia documents.

The second type of new services - multimedia information services - are those where users receive multimedia information (or access to a application such as a computer game) from information providers such as broadcasters and publishers. Here the content of the commercial service is as important as the medium. Examples include:

- video-on-demand services;
- access to and interrogation of multimedia databases;
- interactive games;
- multimedia training.

These services will in the future use multimedia communications services as the means of connecting information providers with their customers - the end users. Currently CD-ROMs can be used as a method of distribution for those services where levels of interaction are restricted. Indeed, there is considerable optimism within the CD-ROM publishing industry. According to one source sales of printed encyclopedias in the US fell by 50% last year although some press reports suggest that some major companies are managing to maintain sales. CD-ROMs are increasingly seen as a more convenient alternative.

For a large run (say 10,000 copies) CD-ROM can be published and packaged for a cost estimated to be about 0.4 ECU per copy. The CD can contain over 600 Mbytes of information. This is a very low cost per byte and it will be some time before telecommunications can compete with these prices. Furthermore, desk top mastering and printing machines are increasingly available at low cost, and the speed with which CDs can be prepared and printed is falling quickly. One interviewee believed that within eighteen months companies will be able to tailor CDs to customer requirements, prepare them, print them and dispatch them within a day. Thus for data that is frequently accessed data and/or not time critical a common industry opinion is that CD-ROMs will be the most significant method of distribution for at least the medium term. All large publishing houses are adopting the technology at a greater or lesser extent. While, at least the in the UK, PCs with CD-ROM readers have had more success in residential computing, there is an expectation that penetration in business is set to expand quickly.

Despite this optimism content providers are by no means excluding other options and there are a number of active trials being pursued. The success of homeshopping, which was mentioned to be a US$ 3 bn industry, is cited as an example of how the industry might develop. The belief is that niche areas would be targeted and gradually developed.

The market for multimedia services of all types is likely to be characterised by an increasingly sophisticated and demanding end user community. Moreover, the perceptions users have of the services market cannot be totally divorced from trends in IT and consumer electronics markets. In the IT market in particular the speed of change has for some time been very rapid and this has a strong influence on user perceptions.

Powerful desktop computing is becoming common in the business community, and increasingly such power is spreading to the home. According to a recent survey by Mintel, 50% of UK homes already have access to an electronic terminal providing computer games of some description. People accept the rapid development in processing power as the norm. They see prices continually falling and are much more comfortable with the use of computers. Stand alone multimedia capabilities (for example using CD-ROM[1]) are already taken for granted by many users. Users want and expect better graphics, an interface that better meets their needs and faster response times.

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1 80% of home computers shipments in the UK now are provided with a CD-ROM reader and the anticipation is that the installed UK based of CD-ROM readers will increase from 0.25 million to 1.0 million over the next year

Furthermore, electronic communications and the ability to share information have been widely adopted by businesses as local area and wide area networks are implemented. Internationalisation of trade and business means that companies require communications systems that transcend national boundaries. Information service companies, for example those providing financial service information, are increasingly looking to extend their portfolio of services in response to customer needs. It is believed that the business information market is growing at between 6% and 7% annually.

The desire to have access to systems with similar capabilities is beginning to be seen in the residential market. Modem sales are buoyant and on-line information service providers such as CompuServe are increasingly targeting the consumer markets across Europe. Minitel in France addresses personal as well as business needs. We are also being to see the entry onto the market of the first interactive and cooperative games (a modem is currently required to communicate with other users), and computer games companies are reported to be planning the introduction of interactive games channels.

As a result of this, information services of all types are no longer seen as innovative and fear and uncertainty about this technology is declining. Latent demand undoubtedly exists, yet the emerging multimedia industry must make a realistic assessment as to the overall size of revenues that can be realised. There is a belief by some in the industry that expenditure on leisure activities as a percentage of GDP is unlikely to increase substantially. It is, however, recognised that this expenditure may be reallocated. Education and training are also considered to be areas where there will be a gradual reallocation of expenditure.

A further consequence is that end-users expect, fuelled by analogy with the IT industry, that their expenditure on services should be made to go further. Increasing competition (realised through liberalisation or diversification facilitated by convergence) requires suppliers to respond to this pressure. We have found a general expectation that to survive and prosper companies will need to offer "more for the same".

There is a generally recognition of the huge potential of multimedia, yet there is uncertainty as to the manner in which this potential will be realised. There is a belief that the 'killer application' that will be the spur to rapid development of infrastructure provision will exists but has yet to be found.

3.2 Impact of new technology

As was mentioned in the introduction to this chapter, advances in technology both stimulate new user requirements and enable industry better to respond to these needs. A detailed discussion of the role of technology in the delivery of multimedia services will be delayed until chapter 7 - in this chapter we are more concerned with technology's influence on commercial aspects of the industry.

In the medium term the advantages being sought by companies operating in the sector are concerned with technical advances that improve operational efficiency by allowing the exploitation of synergies between cable TV and voice telephony networks. Both kinds of network involve the conveyance of electrical signals and, as will be discussed in chapter 6, convergence is possible. For companies operating in either field, this provides the potential to expand, albeit in a fiercely competitive environment, their possible

sources of revenue away from markets that are becoming saturated. Furthermore, this can be achieved from an investment that will be less than that of building a new network.

This convergence of technologies facilitates possible new competition as a result of organisations crossing over from one area of activity (eg entertainment distributed by cable television network) to another (eg telephony). "Convergence is another term for competition". By recognising the technical feasibility of combined networks and removing the regulatory barriers, organisations operating in either of the segments will be encouraged to explore the new opportunities that are created. Conversely, failure to do so might also leave them open to competitive threat as others enter their traditional markets.

In the longer term, advances in processing and storage technologies, in digital encoding and compression, optical fibre transmission and switching enables the possibility of producing multimedia information combining text, image, sound and video and distributing this information on a single network. This both creates new information and communications service opportunities and deepens the trend towards competition through convergence.

The new information services which will be offered in the long term, and the companies which will be involved in the production and supply of these service are not clear. Other studies being undertaken on behalf of the Commission are addressing this area.

Fibre has been, and will continue to be, installed in both the trunk and the local distribution networks. The levels of capacity being installed is immense and the owners of infrastructure will be looking to fill these systems with profitable services. Communications services provided to end users are generally recognised to be only part of the answer, at least in the long term. Supplementary revenues will have to come from information services, and infrastructure providers will have to set prices that balance the need to encourage the development of new services while providing sufficient revenue to meet their commercial objectives.

The overall message is that technology provides not only opportunity to exploit entirely new markets but also allows companies to compete in markets that have been closed to them with substantially reduced entry costs. Furthermore, failure to diversify could leave them open to attack in their traditional markets.

Companies, without exception, recognise this trend and we found considerable interest and concern about this matter. Even well established TOs recognise the absolute importance of making the correct commercial decisions in their response to the challenges of technical convergence; some believing such decisions to be fundamental to their future success.

Whilst there is uncertainty regarding the markets and the commercial responses that need to be made, there is universal recognition that the technology changes will occur. Nobody believes that technology will impede progress although there is a recognition that economics will influence adoption. The accepted view appears to be that adoption is limited to proven markets. Once demand is proven for new service, units prices are expected to fall through mass production encouraging even faster adoption within the market.

Potential competitors to TOs are waiting the removal of regulatory barriers so that technical convergence can be exploited. Utilities companies in particular are looking to gain value from their infrastructure assets particularly in long distance communications, and cable companies are well aware of the UK situation and are considering their options.

Another technology area of concern that was often mentioned is ownership of standards. There are two conflicting issues. Ownership of standards (and technology license fees or market control) are seen by the supply industry as the reward for innovation. Without care, however, the companies that creates such a standard can become a de facto monopoly. There are a large number of areas were this could potentially occur in the developing multimedia industry. For example set top boxes could be developed with a level of functionality that excludes competition. This is a concern for many in the industry.

3.3 Commercial environment

Given the background of a developing market and enabling technology, the commercial environment in which services will be offered is generally recognised to be subject to considerable change. We have already highlighted a number of concerns including the following:

- technical convergence may encourage competition;
- technical developments will, in the long term, facilitate many more new opportunities;
- some suppliers are seeing their traditional markets becoming saturated;
- spare capacity is likely, at least in some parts of the network;
- service providers are looking for new distribution channels;
- quality is seen as a vital element of competitive strategy;
- prices for network services are generally expected to fall.

These suggest an industry where there will be:

- a continuing downward pressure on margins especially for manufacturers or infrastructure providers;
- the need to enter new markets (geographic or service) to ensure continued revenue growth;
- a continuing need to reduce cost;
- entry of new competitors;
- the need to invest, not just to enable growth but to retain current position.

In this section we consider how industry may be required to respond to these pressures.

The liberalisation of telecommunications services in Europe has already created opportunities for new competitors who increasingly represent major customers for TOs. The business of these new competitors relies fundamentally on access to infrastructure and the prices that are charged for it. They understand the industry and will tend to demand much of their suppliers. Many will have the necessary competence to develop their own infrastructure, but even if they choose not to do so they will still be seeking to achieve the best terms for access. Their influence as a powerful customer will be strong.

Coupled with liberalisation is the increasing trend for Governments to privatise their TOs. This process will often drive the speed of liberalisation. Because of the size of the sales envisaged within the European Union, privatisation will be achieved through public flotation. Governments increasingly realise the value of these assets and are seeking to free the capital tied up in the TOs. In addition the following benefits of privatisation are often cited:

- to widen share ownership;
- to introduce efficiency through external scrutiny by shareholders;
- to allow companies to fund investment from a wider variety of sources and to break the link between telecommunications development and public sector borrowing requirement restrictions.

When a company is being prepared for privatisation, part of Government's aim will be to maximise the perceived value (including future cash flows) of the company at the time of flotation. To some extent this objective runs contrary to the introduction of competition although many argue that it is only through exposure to the discipline of a market economy that a telecommunications operator (TO) will realise is true value. It is generally agreed that preparation for competition requires a long term outlook while preparation for privatisation requires a more short term focus. A major challenge for the regulator is to balance such conflicting interests.

We now turn to the changes occurring in the structure of the industry. In the previous chapter we indicated the different starting points of the key players. Technology is converging and it is necessary to consider whether the industry itself will also become increasingly integrated.

This remains to be seen, although the consensus is that the differences between information services and communications services (and indeed sub-components of these) are so great that it is unlikely that the same organisation will have sufficient competencies to compete effectively in all areas. It is generally assumed that companies will have to focus on what they do best. While the industry does not generally anticipate the emergence of vertical integrated companies, they do not preclude the development of alliances or other cooperative arrangements to help in the development of a strong market. This allows infrastructure owners to create the necessary new demand for their resources and provides some level of certainty to content providers that the infrastructure will be available at the price, form and quantity required.

The timing of these alliances is crucial. Architectural and research decisions must be taken soon if Europe is not to fall behind other markets.

The climate is right for such alliances, as is reflected by the proposed Bertlesmann/Deutsche Telekom/Kirch link-up. This alliance was, however, blocked on the grounds of Union competition rules and merger policy. Although opinions are divided, the industry on the whole recognises the need for alliances of this type but also recognises the concerns that the proposed alliance was too strong in too many parts of the value chain. One of our interviewees indicated that the venture would have been good if it was intended to allow the companies jointly to expand into new markets, but would have been highly undesirable if it were conceived primarily as a defensive strategy in existing markets. Generally people remain concerned that the balance

between stimulating service development and avoiding abuse of a dominant position is very sensitive and must be constantly reviewed. To some extent there is a belief that the link up should have been allowed to progress so as to provide the necessary stimuli, but that a way should have been found of ensuring that others should in time have fair access to the network developments that might have resulted. The concerns are that content providers that also own networks should not restrict access to information not controlled by themselves.

Considerable uncertainty exists about market prospects and the planned commercial response. There is a degree of experimentation not just in services but also in distribution channels and alliances. Despite some media comment to the contrary, a common view was that any industry restructuring would be evolutionary rather than revolutionary and would continue over a relatively extended period.

4 Public policy and regulation

4.1 Introduction

This chapter addresses public policy and regulatory issues with a particular emphasis on how this is likely to impact the scale and form of investment.

Before doing so it is worth re-iterating, based on the discussion of earlier chapters, some of the points that are special to the multimedia environment. These include:

- investments will be made by across industries which have hitherto pursued separate development paths, have different expectations on investment performance and have different criteria for investing;
- investments are likely to occur across national boundaries and between major trading blocks;
- the size of the investment is substantial, the potential of infrastructure provision to achieve high margin is limited (service provision and content attract a higher value), the market outside of voice telephony and cable TV is very uncertain;
- these together mean that risks are high and pay back periods are likely to be long;
- these factors can be ameliorated, or exacerbated, through regulation.

In this section we consider these points in more detail. We begin, however, by providing a description of the regulatory starting point for this study.

4.2 The regulatory starting point

Broadcasting and entertainment services, including copyright issues, have been subject to separate legislation from that applied to the telecommunications sector. Both legislative areas are based on foundations laid in the EC Treaty, including competition rules defined in Articles 85 - 90 and those relating to the creation of a common market.

In 1992 the Commission embarked on a major review on the provision of services in the telecommunications sector. This resulted in the Council Resolution of 22 July 1993 on *"The review of the situation in the telecommunications sector and the need for further developments in the market"* (93/C213/01). This resolution promoted the liberalisation of all telecommunications services by 1998 except for a limited number of derogations. Following on from this, the Green Paper on *"A common approach to mobile and personal communications in the European Union"* (COM(94) 145 final, 27 April 1994) also proposed to extend the principle of liberalisation to the mobile services and infrastructure.

In parallel, the Commission's White Paper on growth, competitiveness, employment (COM(93), 700 final) presented by President Delors to the Council at the end of 1993

highlighted the importance of the information society and the need to encourage private sector funding of the development of the trans-European networks.

In June 1994, the high level group chaired by Commissioner Bangemann recommended a number of specific measures in the areas of information infrastructures. A key message of the Bangemann report is that the best environment for the development of a new market is an open and competitive one.

In response to the Bangemann report, the Commission prepared its *"Communication on Europe's way to the information society: an action plan"* (Com(94) 347 final) that gave an overview of the various Commission initiatives relating to the Bangemann report. One of the main initiatives concerned the publication of a green paper on infrastructure (as had been requested by the 1993 Council meeting). Part 1 of the *"Green Paper on the liberalisation of telecommunications infrastructure and cable televisions networks"* was published on 25 October 1994. It advocated the liberalisation of these infrastructures while maintaining certain safeguards to ensure, for example, universal service. Part 2 of the Green Paper on infrastructure will address the safeguards and is due to be published early in 1995. The Council adopted the principles as set by Part 1 of the Green Paper in November 1994.

The agenda outlined in Part 1 of the Green Paper includes the following:

- the underlying motivation for infrastructure liberalisation is its ability to support new services;
- that developments should be funded through private investment reflecting the revenue potential;
- that this private investment will only be forthcoming if a stable regulatory framework is established;
- that the definition of universal service obligations should be extended to include multimedia services;
- that existing network infrastructure investment (for example by utility companies) should be exploited when developing the infrastructure.

Among the benefits of deregulation the Green Paper cites the following:

- overcoming existing bottlenecks in the availability of high capacity infrastructure and stimulating public and private investment;

- faster adjustment of pricing structures to bring tariffs in line with costs and lower leased line charges.

The position put forward in part 1 of the Green Paper is that it is necessary and desirable to remove immediately restrictions on the use of own or third party infrastructure in the following areas:

- for the delivery of satellite communications services;

- for the provision of all terrestrial telecommunications services already liberalised;

- to provide links within the mobile network for the provision of mobile communications services;

- within the timetable for the full liberalisation of voice telephony and subject to the necessary safeguards, for the provision of voice telephony services for the general public.

4.3 The environment for investment

4.3.1 The need for private investment

As was mentioned in chapter 3, network infrastructure used to distribute cable TV and to an even greater extent telephony has consumed large capital sums and will continue to do so even for modest upgrade programmes. Traditionally, public networks were state-owned and their investment was, as discussed above, strongly influenced by central/local government and therefore investment decisions often incorporated public policy as well as commercial concerns.

The investment required to upgrade networks to enable the provision of universal access to multimedia service will be huge (see chapter 8). A partial investment will not fully realise the objectives of European users or information providers and any delay would put Europe at risk of not being able to keep up with development in other major trading blocks. A relatively compressed investment period is therefore felt to be desirable.

The high annual level of investment implied would, if funded entirely from public sources, have a material impact on the borrowing requirements of fiscal policy of national governments, potentially increasing national debt at a time where many are trying to reduce it. Other sources of funds are therefore likely to be necessary.

Most TOs in the EEA tend to work in markets where their mainstream service (public telephony) is fully mature, and they no longer expect the high revenue growth achieved in the past. Revenues, and debt secured against these revenues, is unlikely to be as forthcoming as it was in the past. Furthermore, TOs need to seek new markets so that they can continue to grow and prosper. The telecommunications industry is shadowing the commercial world it serves by becoming increasingly global and foreign expansion is often seen as a key strategy. This, coupled with pressures to modernise (so as to meet subscriber demands and counter the threat of competition) and the need to enter the market for new services, means that many European TOs are increasingly short of investment capital.

Attracting new private equity or venture capital will certainly provide access to a substantially larger pool of financial resources. Furthermore, these new investors will be looking for currently unexploited revenue streams to help them service the additional financing required. There is historic evidence that opening up investment opportunities has the potential to generate more revenue, result in more considered and better investment decisions and ensure tighter and more efficient project control reducing the overall cost.

However private investment will only occur if the conditions are right. This means that an acceptable return without excessive risk should be realisable. The rest of this chapter considers what these conditions might be.

4.3.2 The relationship between services and infrastructure providers

We discussed in earlier chapters a fundamental difference between services and infrastructure provision. The perceived value to a consumer is often in the information content of a multimedia service, not in the physical means of conveying an electronic representation of that information. Infrastructure provision is a utility service. However, the investment in infrastructure will be substantial and may only be recouped over an extended period. Previously this long pay back period has been offset by lower risk. However, since the demand for multimedia services is uncertain the risks of investment remain high.

The situation is different[2] where part of this investment has already been made, either in an existing telecommunications system, or in one that can be modified for a different purpose to that for which it was intended. This is the case for those cable TV companies many of which can modify their networks from broadcast use to the provision of voice telephony services. Sometimes this is easy and inexpensive. Even when the transmission infrastructure is unsuitable, conduits or poles can significantly reduce investment.

Many utility companies throughout Europe also have well developed telecommunications capabilities, or have the ability and resources to build a network cheaply. Energis in the UK, for example, has found that it can wrap fibre optic cable around the earth wire of overhead power distribution network much more cheaply than it could bury cable in the ground. Indeed we heard of some power distribution cables available on the market that have integral optical fibres provided in the same sheath. It is clearly economically inefficient not to maximise the use to which different resources are put. Many of our interviewees were fully aware of the problems and benefits associated with the entry of utility companies into the market, and they believe that is only a matter of time (and the removal of regulatory restrictions) before this occurs, at least for long distance telecommunications services.

COLT (a UK company offering voice and data services to businesses initially in the City of London) had no previous infrastructure and even Mercury had limited coverage. Yet both perceived that the highly lucrative business communication needs of their target markets were sufficient to justify the provision of a new network.

By comparison to infrastructure provision, information services is seen to be much more varied in character with a great range in the size of opportunity provided. The scale of investment is likely to be lower overall, while the services may be priced at a premium that reflects their perceived value[3]. The potential for high or early returns on investment counteracts the potentially high risk and/or short life cycle of many opportunities. An

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2 the scale of the difference is demonstrated in chapter 8.

3 For example, in chapter 8 we estimate that the cost of providing multimedia servers (the most expensive element of the processing equipment needed to support a video on demand service) is a little over ECU 5 bn. Whilst this is considerable, it is small when compared to the investment required to upgrade and extend cable TV networks - ECU17 bn and ECU 84 bn respectively.

investor looking at the Information Society is, therefore, more likely to be attracted to the service/information side of the industry. However, gains will be maximised, and the service industry grow most rapidly, where cheap, reliable and controllable access to infrastructure is available.

In illustration of this point, information service providers are looking to enhance their distribution options and broaden access to their products. Content and distribution are considered to be inextricably linked and the distribution is seen as a fundamental element of the overall product proposition.

The conditions under which cheap infrastructure will be available include:

- a regulatory regime that keeps prices low;
- price competition in the provision of infrastructure services;
- rights to share existing physical infrastructure (for example conduits);
- self ownership of infrastructure.

Service providers will have greatest control in the last case. Two types of service providers can be conceived: those who are concerned only with having access to low cost delivery systems and those who see the delivery system as an integral part of their overall service. The first type are unlikely to be direct investors, while the latter group may seek infrastructure control through alliance or direct investment. The general consensus is that content providers are not currently expected to invest directly in infrastructure although the option to do so later is not excluded.

The preceding discussion essentially recognises a synergy between service and infrastructure provision. The multimedia industry will develop more quickly if the value of this synergy is recognised and a means is found of ensuring that revenues from content services are available to finance the construction of the pre-requisite infrastructure. The concern is that this must occur in a manner that does not restrict freedom of access to information or create excessively strong vertical integration.

Synergy also exists between services; cable TV and telephony being a particular example. The distinction between cable TV and PSTN is, as result of technical advances, becoming increasingly artificial. The two networks have followed different evolutionary paths with each providing distinctively different services. As a consequence, cable TV networks have been designed to broadcast TV channels and have developed the complementary commercial activities such as programming and advertising that are a natural adjunct to television distribution. The PSTN, on the other hand, has developed as a narrowband two-way distribution systems with a very complex tariff structure that offers dedicated facilities to customers. The separation between the two networks has been as much a historical development as a deliberate policy - television distribution was simply considered to be a different industry to telecommunications. Within the constraints of satisfying other public objectives, each network has managed to give an adequate commercial return.

UK experience with the introduction of telephony into cable TV networks indicates the advantages of removing these barriers and the extent of the synergy achievable between cable TV and telephony services. The advantages to cable TV operators include:

- telephony doubles their revenue;

- telephony reduces churn;
- telephony penetration has proven to be much higher than previously expected;
- telephony can be provided at a relatively low marginal cost and therefore the addition of telephony improves profitability;

However, it is universally recognised that the award of exclusive franchises and the prohibition on BT from offering entertainment services have been key factors in attracting investors.

4.3.3 Competition in infrastructure provision

The opening of infrastructure provision to competition will affect all players to some extent. To the users of infrastructure (consumers and content service providers) the effect of competition is anticipated to be greater availability and lower price for access. For end users this should entail greater range and choice of information services being made available in a shorter time.

The effect of competition (or regulatory control aimed at achieving similar effects) on infrastructure providers is likely to be pressure to reduce overall charges, which in turn means that payback periods may increase and the already high risks of infrastructure investment will grow. Infrastructure investment may become an even less attractive proposition unless the investor can achieve other benefits. These benefits will necessarily come from the ability to provide lower cost or higher value services or to exploit synergy with other operations such as the provision of public utilities.

The degree to which circumstances change for the monopolist and opportunities can be adequately exploited by new entrants will depend largely on regulation. There is a concern among industry observers that in a newly opened market, embryonic competition is not likely to endure or grow unless there are adequate safeguards to protect it against the monopolist exerting its massive market and financial muscle. This requires asymmetric regulation. Even in markets where competition is established, anti-competitive behaviour and abuse of dominant position need to be guarded against.

Views on asymmetric regulation are divided. Many who know the UK market believe that asymmetric regulation played a vital part in attracting the necessary investment in cable TV and that future investment from the private sector elsewhere in Europe will not occur without it. On the other hand concerns also exist that asymmetry prevents the development of a true competitive market while others are concerned that excessive constraints on the dominant operator could occur and would result in the slower development of the sector as a whole.

What has become clear to us in the course of our investigations is that a distinction needs to be drawn between market entry support and ongoing regulation in a more stable environment. In more established markets the arguments in support of moving towards minimal regulation other than existing EU competition legislation appear more persuasive.

4.3.4 The interests of the parties

Public policy not only needs to encourage the development of an environment conducive to infrastructure investment but must do so in a manner that balances often contradictory interests. Many of these have already been mentioned but are brought together below.

Users

The over-riding concern for users is to have access to a range of services at an affordable price. Service availability concerns the type of services, their quality, the way they interwork and the extent to which a harmonised service is available across the Union. These needs will be meet by an environment in which service providers prosper and are able to bring new service to market rapidly. Users in less favoured regions should not be precluded from being part of the information society.

Users benefit from a market that operates without distortion and where price reflects cost. They require that artificial boundaries between services are removed, that there is no unnecessary investment in infrastructure, that synergies and economies of scale are exploited and that prices are brought quickly into line with costs.

Information providers

Information providers require a cost effective electronic distribution mechanism for their services which allows them to address a broad market. They require a stable and understood platform on which they may build applications. It needs to be future proof while allowing them freedom to choose between competing infrastructures. They require non-discriminatory access to this infrastructure and protection from abuse by dominant operators of infrastructure.

National and European interests

Member States and the Union as a whole need a sound telecommunications infrastructure that is able to meet social, cultural and commercial obligations and aspirations on a national and regional basis. Regulators need to ensure that these vital requirement can be met.

Countries will also need to ensure that their telecommunications and service industries are able to build on traditional European strengths. Europe needs to attract inward investment and ensure that revenues and experience are retained within Europe. Reciprocity of access into foreign markets will also be a key requirement.

Investors' interests

Investors in infrastructure will require assurance from the regulator because of the high capital sums required, the long pay back period and the uncertainty of the revenue streams. For many investors concern would concentrate on the following:

- transparency of regulatory policy: clear expression of regulatory policy including competition, measures to protect against abuse of dominant position, exclusivity of licences;

- certainty of future regulatory regime: what safeguards are there to protect future prospective cash flows;

- access to policy makers.

Without clarity in these areas the risk to investors is likely to outweigh the potential returns.

4.4 The regulatory requirement

The regulatory requirement can be summarised as the need to define an environment that exploits available resources, balances the interests of users, providers and investors, yet which provides a stable environment in which investment may occur recognising that the investment in infrastructure may be risky and needs stimulating. These issues are pursued in the final chapters of this report

5 The existing infrastructure

This chapter summarises the level of investment in telecommunications infrastructure in Europe. The coverage and capabilities of existing cable TV and PSTN networks are key to understanding the amount of investment required to expand and enhance these networks in order to provide multimedia services on a competitive basis in a liberalised environment.

5.1 Historical perspective

Historically there has been separate development of PSTN and cable TV networks in EU Member States. Sometimes however (for example in Germany), these infrastructures are owned and operated by the same company, the national TO. In this case, ducts and buildings may be shared for the co-location of plant and equipment for these networks. Yet even in this instance, the two networks, one carrying switched, narrow-band voice telephony services, the other carrying broadcast broadband television signals, are logically distinct. The two have developed separately because each needed to meet the needs of two very different kinds of service: switched voice and broadcast television.

These two different services place different requirements on the network infrastructure. PSTN requires the ability to switch narrowband signals transmitted in both directions between many individual subscribers. Broadcast TV, however, requires much higher capacities but in one direction only. The signal is not switched. Instead the same signal is, in effect, shared or broadcast to a number of subscribers. These networks also differ in a number of operational aspects including their capacity to support billing and reliability. Being primarily an entertainment service, cable TV networks have not traditionally been designed with the high degree of reliability as the PSTN network which is used as a means of communication sometimes in the event of an emergency.

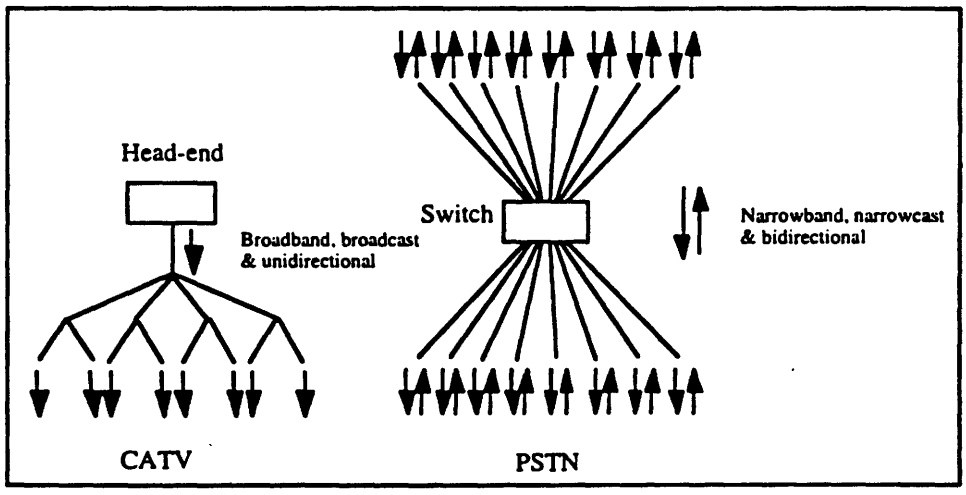

Figure 6 *Differences between cable TV and PSTN infrastructures*

The people, skills and support systems required to operate these two types of network are also very different. Telephone operators usually provide a whole range of communications services to residential and business customers with differing service

characteristics and tariffs dependent for example on usage and distance. Pure cable TV operators however provide usually only a very small number of packages of programming to the residential market. With the advent of digitisation and the technical convergence of these networks towards interactive multimedia networks, a large degree of investment will be required in human resources in order to effect the convergence of these services.

5.2 Classification of current network infrastructure

A challenge for this study was to balance a well structured and transparent investment model against the reality of a highly complex situation on the ground, where there are many national variants in network coverage, demographics, technology and operating performance. We therefore sought to identify classes of network against which subscriber populations may be matched. We then use a sampling approach to determine a 'typical' network and to define an average representation of these classes. The first classification is to consider different component parts of the network of which we believe three are relevant.

- Access

The access network connects a local public switched telephone network (PSTN) or multimedia switch to a subscribers set-top box or, as appropriate other customer premises equipment (CPE). The network technology used to perform this function can vary from that of broadband analogue coaxial cable used for the transmission of analogue TV signals, to twisted copper pairs used in a standard PSTN network supporting 'plain old telephone service' (POTS). It is the access network and the technology it uses which limits the amount of capacity in either direction and therefore the services can be delivered to the customer. In the classification of existing networks, the split between providing access to residential and business customers needed to be made. The capacity and technology used to access high-use business customers can vary significantly from that provided to lower usage residential customers.

Using optical fibre to provide broadband two-way services into every home and business is recognised as the ultimate in infrastructure capacity and performance. Fibre to the home (FTTH) however is still expensive compared to other access technologies and the demand for high bit-rate services which make use of optical fibre capacities all the way to the customer is uncertain. A number of sources in the industry believe that FTTH is a certainty - the question is 'when?'. The penetration of optical fibre at higher levels in the access network however, fundamentally affects the performance of the physical access medium which makes the final connection to the home. Conventional twisted copper pairs and coaxial cable are limited in their bandwidth carrying capability by their physical length, which is required to connect a telephone exchange or cable TV head-end to individual customers. By using optical fibre for part of this distance (eg fibre-to-the-street or fibre-to-the-kerb) and then using conventional copper (or radio) access technologies over the shorter distances to the customer, endows an existing local drop infrastructure with the higher bandwidth carrying capability which is required to make multimedia service provision possible. The penetration of fibre in the local distribution network and how fibre is shared between multiple users is key in determining how much an existing networks infrastructure needs to be upgraded to convey broadband, interactive multimedia services.

It is the access network which dominates the cost of building a network infrastructure. The proportion of duct or cable required increases enormously the closer it gets to the home. The diagram below shows how the costs of providing a network is weighted very heavily towards subscriber access.

The graph shows the hypothetical situation of changing the number of subscribers connected to a 'trunk'[4] exchange. As the number of connected subscribers decreases, so the 'trunk' network increases in size while the 'access' network decreases. The graph shows the percentage of the total cabling requirement (in terms of cable lengths) for a country represented by the 'trunk' network. Thus, if a typical 'trunk' switch serves 2500 subscribers only 3% or so of the total cabling requirement is included in the trunk network. Even when a 'trunk' switch serves only 100 subscriber the 'trunk' network still only represents about 10% of the total cable requirements.

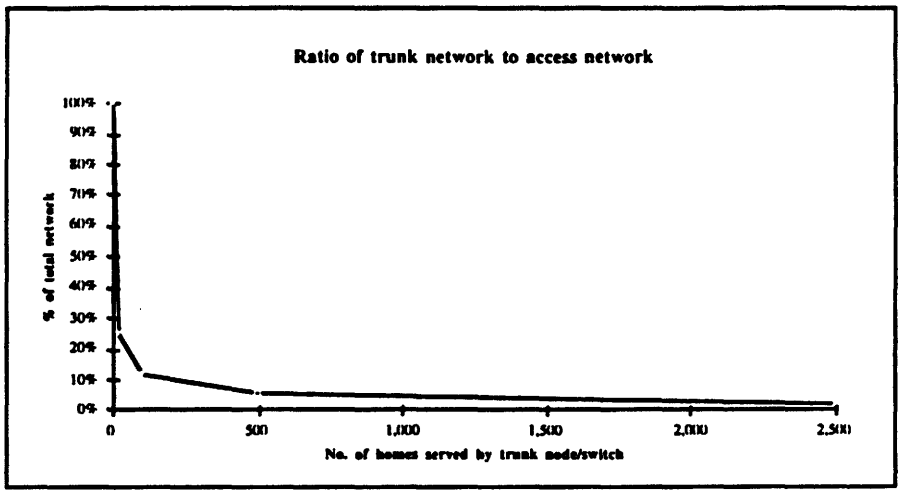

Figure 7 *Ratio of trunk network to access network*

- Switching

Switching in a European PSTN network is primarily that of 64kbit/s telephone channels. Some cross-connects do exist that can route chunks of capacity at the 2Mbit/s level. The evolution to broadband interactive multimedia network will require the switching of various services at a number of different bit-rates. Asynchronous Transfer Mode (ATM) is the likely technology on which these switches will be based.

Cable TV networks have historically required little in the way of switching functionality. TV signals are broadcast to many homes and individual users simply 'select' from a number of channels. The small amount of switching that does exist occurs on the customers premises. With the advent of many hundreds of TV channels and different multimedia services, switching will be required to 'tailor' existing capacity to the needs

4 more accurately we should refer to a network concentration devise. This could be a remote concentrator unit or an add-drop multiplexer on a synchronous digital hierarchy (SDH) ring. The introduction of SDH is blurring traditional divisions between trunk and access networks.

of individual customers rather than broadcasting every signal to all customers. Digital compression will allow many more channels to be squeezed into the existing infrastructure, however it is likely that switching in a cable TV environment will also be based on ATM, allowing multiple services with different bit-rates (including voice) to be transmitted over the same network.

Migration to an ATM switching platform however will take time and is very dependent on the demand for the new multimedia services. Large investments have already been made in digital switch technology which switches voice telephony, very cost-effectively. This investment needs to be recouped. ATM switching technology will need to demonstrate significant cost-functionality benefits over established technologies.

- Trunk

The trunk or high speed backbone network connects local exchanges, trunk exchanges, international exchanges and cable TV head-ends to each other. Presently, trunks utilising optical fibre using synchronous digital hierarchy (SDH) or plesiochronous digital hierarchy (PDH) technology, microwave and coaxial cable are in existence across Europe. In a broadband multimedia environment it is hard to imagine that high-speed backbone networks will employ any technology less than SDH or a combination of SDH and ATM.

Technology is developing such that ever increasing bit-rates can be provided over existing optical fibre. Once a fibre trunk network is installed, the marginal cost of providing transmission circuits over that network is very small indeed.

In competitive telecoms environments (eg the UK and US) competition has increased very much in trunk network provision. This is because of the lower costs to entry in building a trunk infrastructure (when compared to an access network). Long distance telecoms revenues have traditionally been high for trunk providers not least because of cross-subsidisation by expensive trunk calls of cheap local calls. A subscriber is more willing to pay a premium for a long distance telephone call, than one which is terminated locally, however the incremental cost of providing long distance infrastructure is very small.

Installed capacity versus latent capacity

In our assessment of the present state of the European telecommunications network infrastructure it is important to differentiate between the capacity of the different networks as they are being used and the network capacity which is actually installed but not utilised. This will be important in determining whether TOs will have to deploy for instance new fibre cable in their trunk or access networks as they would do if their existing optical cables were fully utilised (ie no dark fibre). Technology progression however - for example, better lasers, modulators optical amplifiers - means that, if required, much more capacity can be made available from fibre currently operating. For this reason it is probably safe to assume that if optical fibre is installed on a route then there is sufficient capacity, even in the long term, to provide a whole range of bandwidth hungry services. No further investment in capacity on these routes needs to be made.

5.3 State of infrastructure in EU member countries

Telecommunications infrastructure across Europe consists primarily of the existing PSTN and cable TV networks. Large corporate companies and utilities additionally have their own networks which in the past have been used for internal use, but these networks are relatively small compared with the mainly state-run national telephone and either state or privately owned cable TV networks. More importantly, these and other companies (e.g. electricity, water and railways) own ducts and wayleaves which enable a new telecommunications infrastructure provider to much more cheaply install communications capacity.

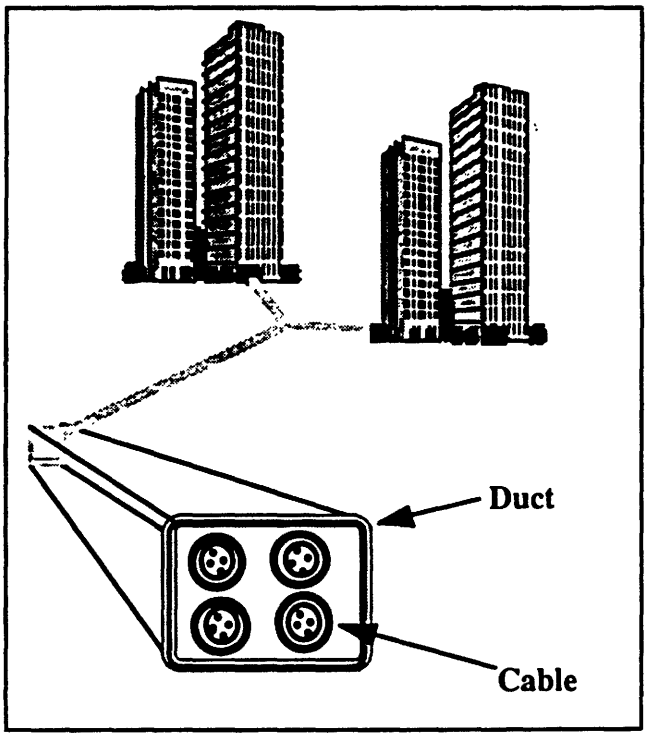

Figure 8 *Ducts and cabling*

The costs associated with installing a fixed telecommunications network are dominated by the requirement to bury cable in the ground. Typically up to three-quarters of a new transmission link's cost is associated with civil works and with burying cable ducting in the ground. Any resource which allows a company to reduce this cost (for example, existence of easily accessible rights of way, ducts, poles or overhead electricity cables which may make the installation of fibre easier) has a large economic impact when it comes to becoming a new competitor in this market place. For this reason utility companies such as electricity and water are likely to be significantly involved in the provision of alternative local loop infrastructures.

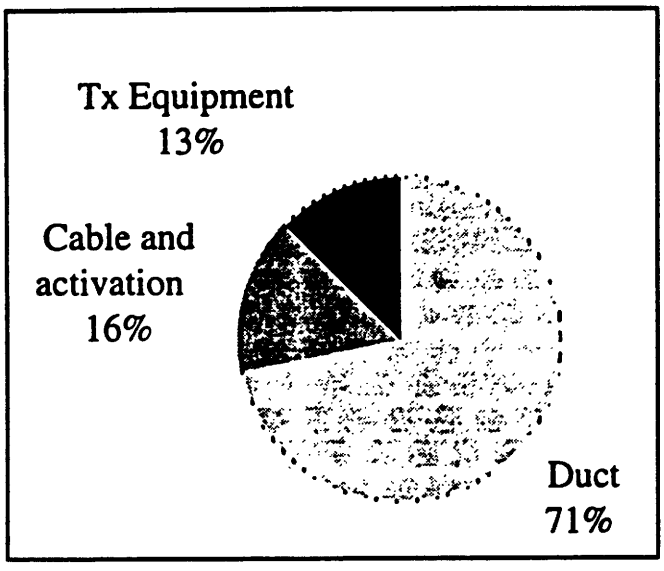

Figure 9 *Typical infrastructure cost components*

5.3.1 PSTN in Europe

The penetration of telephony lines per population across Europe is shown below. The average penetration is raised by the inclusion of the Scandinavian countries which generally have much higher levels of telephone penetration. Little comprehensive information exists regarding the state of PSTN infrastructure in Europe.

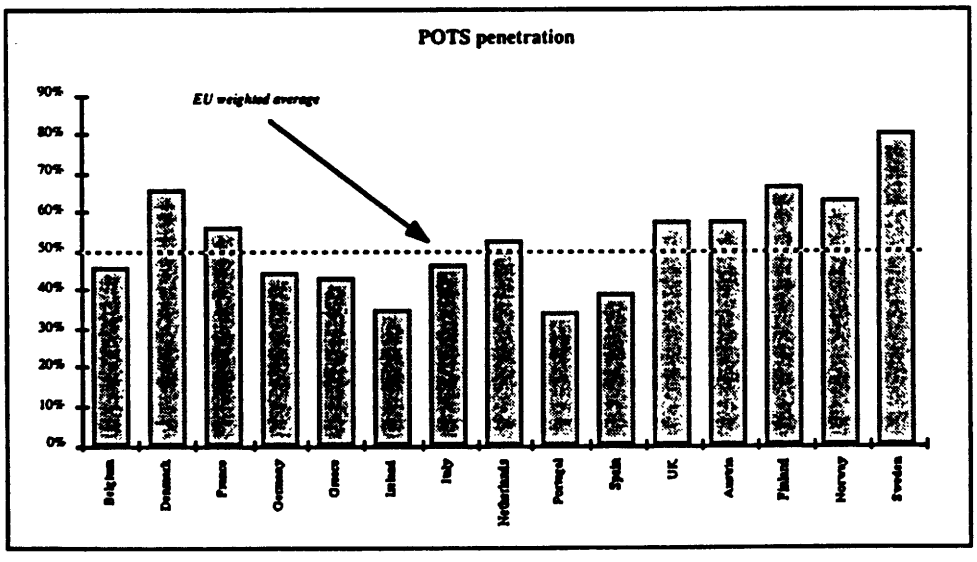

Figure 10 *POTS penetration in Europe*

5.3.2 Cable TV in Europe

The graph below shows the penetration of cable TV services to residential homes in each EU member state. It can be seen that penetration levels vary dramatically across these countries. The Benelux countries have very high levels of cable TV penetration indicating well established cable TV networks. Conversely, the Mediterranean states, with very low levels of cable TV penetration, have very little in the way of wired broadcast networks.

There are effectively three models of European cable TV infrastructure development:

- "greenfield" countries, where there is little or no broadband infrastructure to the home - Greece, Italy, Portugal and Spain
- "fast developing" countries, where there is relatively little broadband infrastructure to the home, but significant investment and installation of advanced modern systems - the UK, and perhaps France
- "widespread mature system" countries where installation of broadband to the home is extensive, but would require upgrading to facilitate two-way interaction, required for some multimedia services - Benelux, Denmark and Germany

Ireland is probably best considered as a special case where the cities represent a "widespread mature system", however Ireland's large rural population means that overall cable TV penetration is much lower.

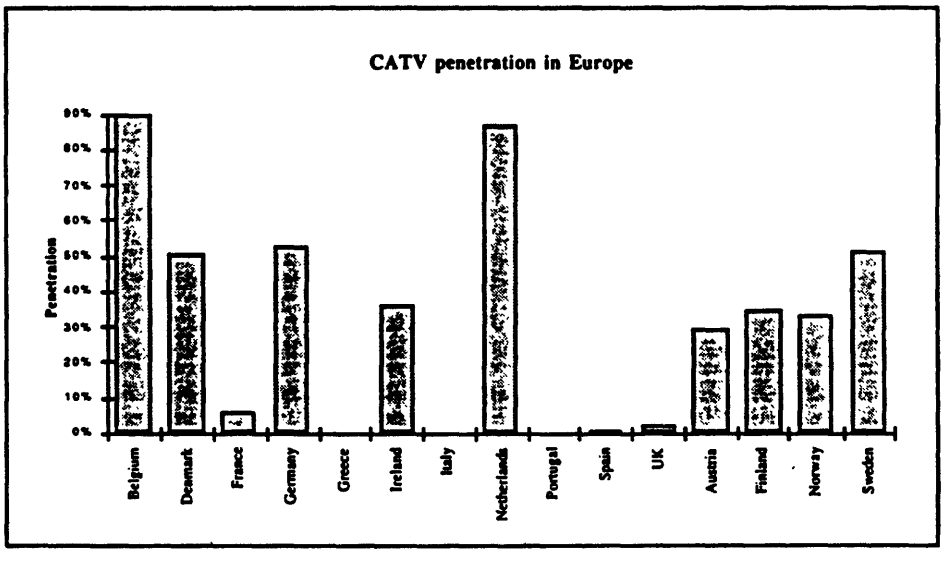

Figure 11 *Cable TV homes penetration in Europe*

The diagram above shows, the different levels of cable TV penetration across the EU. Due to demographic variations across different countries it is sometimes difficult to picture the overall extent of European cable TV infrastructure. The following diagram

shows for the 'sixteen', the population adjusted state of cable TV infrastructure in Europe.

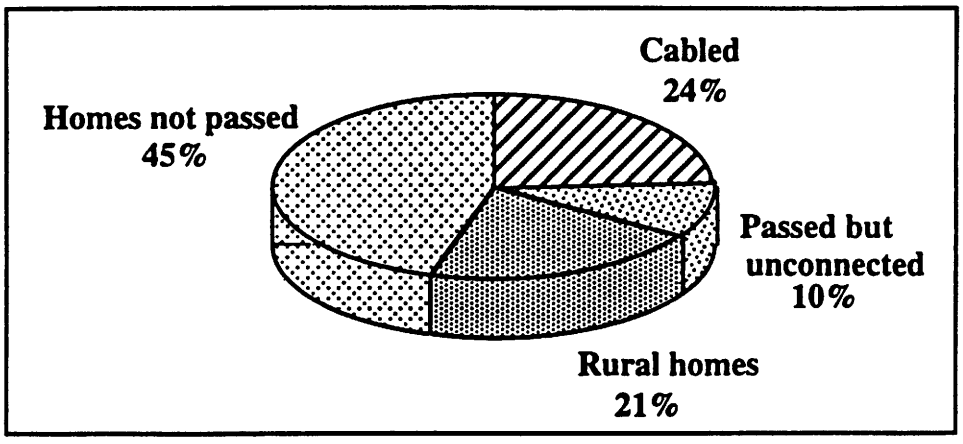

Figure 12 *The extent of cable TV in Europe*

It can be seen that in total, 24% of homes in Europe receive some sort of cable television service. A further 10% of European homes are passed by a cable TV network but choose not to be connected to a cable TV service for whatever reason. Approximately 21% of homes in Europe are classed as being in rural areas. It is unlikely that these rural homes would be economically addressable by a cable TV network infrastructure so they are excluded from the total number of homes which are 'not passed'. These homes are likely to be better served by terrestrial broadcasting channels or satellite TV distribution. The remainder, some 45% of European homes, (65 million; two-thirds of which are in Spain, Italy, Portugal and Greece), predominantly in urban areas, do not have access to a cable TV service. Alongside the upgrade of existing ageing cable TV infrastructure to support multimedia type services, it is the greenfield construction of a fixed cable TV infrastructure to connect these totally unaddressed homes that represents the largest part of the investment required in cable TV in Europe. Our model (see Chapter 8) estimates the required size of that investment.

6 Multimedia provision - technical requirements

The purpose of this chapter is to consider the technical developments that are needed to allow multimedia services to be provided and to indicate the way in which the required technology may be deployed From this description we develop a number of scenarios that we cost using our model. Chapter 7 explains the general investment types and the workings of our cost model. Chapter 8 presents the results of our analysis based on the scenarios outlined in this chapter. We commence the section by discussing the scope of the future multimedia network.

6.1 Network model

An interactive multimedia delivery network comprises a number of components including, for example, the following:

- video server(s);
- network and customer management systems;
- network intelligence;
- switching;
- routing and multiplexing (in head end or local exchange);
- backbone or trunk network (to link geographically dispersed video servers);
- access network (from head-end/local exchange to the home or business;
- customer premises network (within a business customer eg hotel);
- set-top units that receive, demodulate, decode and convert the video signal for television playback (set-top units are also known as subscriber terminals).

Service providers seeking to offer profitable services will select carefully from the different choices within each category for the right technology, features, performance price, reliability and ease-of-use.

In the last chapter we split the network components into local access, trunk and switching components. Some generalisation of this division needs to be made to make the model more applicable in the future multimedia environment. Changes reflect the generalisation of switching with the introduction of ATM for example and an increasing difficulty to distinguish between trunk and local transmission.

We propose to split costs into distinct areas as indicated below:

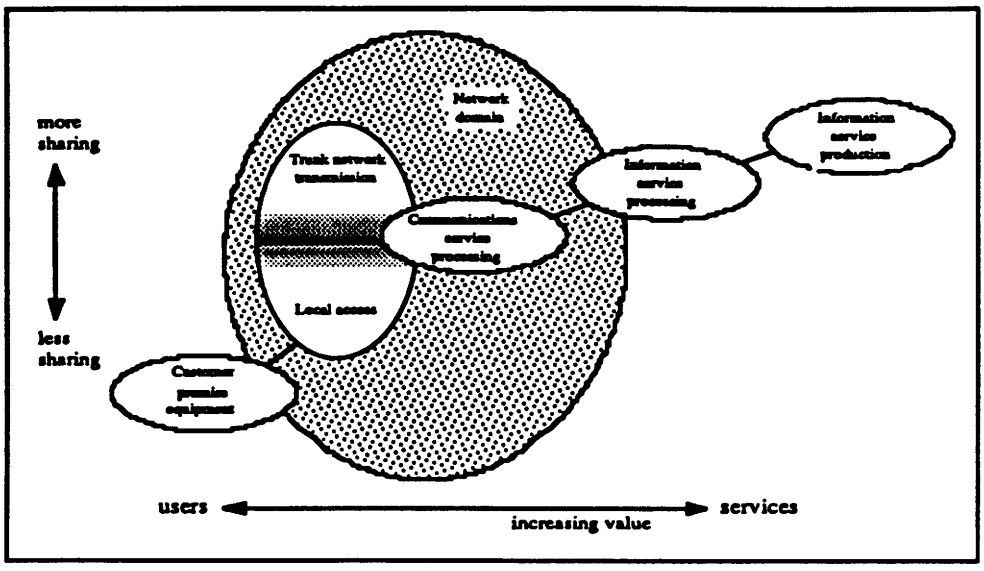

Figure 13 *Network infrastructure - key elements*

The diagram is structured so that its two dimensions have significance. Telecommunications network will only be cost efficient where network resources are shared whenever possible. The trunk part of the network demonstrates a high degree of sharing; the local loop becomes more specific to the customer. The vertical axis broadly indicates the level of resource sharing. The horizontal access broadly indicates a value chain with the consumer on the left and information service providers on the right.

Costs associated with transmission include rights of way, ducts as appropriate, the cables and the transmissions systems (for example SDH systems)

Communication service processing, concerns the functions of establishing a communications path and managing the network. For voice telephony this includes basic switching and IN capabilities if appropriate; for cable TV it includes those elements of the 'head-end' that relate to the combination of video signals into a form suitable for presentation to the local access network; in the future this will include ATM switches. These processing functions also include customer management and billing functions that relate to the communication element of the service.

Information service processing is concerned with the information content. They may include, for example, a database and interrogation system or a video server. Processing functions include customer management and billing relating to the content rather than its distribution for example pay-per-view systems of database usage (time on-line, items retrieved). Production concerns all functions relating to creation of the multimedia service in a suitable electronic format. It could include studio capabilities in the case of video information or could include a workbench for developing a multimedia database.

The diagram indicates what we consider to be the scope of the network. We have taken this to include transmission and communications service processing resources. In addition it includes those elements of CPE and information service processing resources that allow interaction with the network to occur.

As an illustration we consider what is traditionally referred to as a cable head-end. This includes for example video play-back facilities as well as the electronics needed to drive the passive coaxial cable network which distribute the signals to subscribers. The head-end is an example of an information service processing resource. The video play-back element is not a network resource but the electronics that drive the signals are.

6.2 Technology trends

Digitisation

One of the chief drivers towards multimedia is the digitisation of video signal formats. Voice and data have been transmitted over telecommunications networks in digital format for a number of years, however TV channels are traditionally broadcast in an analogue format over terrestrial broadcast or via cable TV networks. The digital transmission of video signals allows the signal to be integrated with data and sound to provide new multimedia services.

Transmission

The advent of digital transmission allowed data to be transmitted over much longer distances than was previously possible because '1's and '0's are used instead of analogue waveforms which are more difficult to detect. The invention of the optical fibre and laser allowed unrepeatered transmission distances to increase even more dramatically. With the recent invention of the optical fibre amplifier it is possible to transmit huge amounts of data over thousands of kilometres whilst remaining entirely in the optical domain. The net effect of this is that transmission has now become very cheap.

Processing

Data processing has developed rapidly as integrated circuitry has become ever more powerful. This not only allows programs to run more quickly but also allows new architectures to be considered which are more appropriate to the task in question and are less concerned with optimising the use of the underlying hardware. Among the many impacts we note:

- the ability to perform more complex tasks in a short time allowing time critical functions (such as switching) to be performed with ease. This means that boundaries between telephones switches and computers are blurring;
- the implementation of client-server architectures. This is relevant to this study as it relates to the division of functionality between CPE and central processing resources and influences the demands placed on the communications network. Changes in this area are changing perceptions of the division between centralised and distributed processing;
- the ability to deliver multimedia services and manipulate data at the desk top;
- increasingly sophisticated production capabilities and reducing costs for multimedia services.

Compression

When TV signals were first digitised it was thought that a full motion colour video signal would require large bandwidth in order to be transmitted effectively (about 100Mbit/s). Recent developments in the field of digital signal processing and image compression now allow a full motion colour video signal to be transmitted at bit-rates as low as 1.5-2Mbit/s. These compression techniques however require the latest in very fast digital processors to be able to manipulate these signals in real time. A trade-off is made between the bandwidth requirements of these signals and the processing power required to squeeze these signals into smaller more manageable bandwidth.

Storage

The storage of video data formats also presents considerable challenges for the new multimedia service provider. Traditionally video footage has been stored on magnetic tapes. These tapes however were prone to wear out but more importantly had to be physically re-wound in order to get to the start of the programme. This process is timely and although acceptable for watching home videos is unsuited to real time memory access required by interactive services. Even though video films can be compressed to around 2Mbit/s, 90 minutes of film footage requires approximately 1.3 Gbytes of storage capacity. This level of storage is larger than typical hard disc drives for computers. The development of optical CD-rom storage however allows these large amounts of data to be stored on a single disc with very fast access and download times. Originally the price of these CD players was high relative to the cost of associated equipment (eg PCs) but with volume production the price of these drives has fallen such that a large proportion of PCs presently being shipped contain CD Rom drives. A recent Toshiba product offers a random access time of 150ms and a sustained data rate of 600 kbytes. Price at launch in Japan was about 700 ECUs.

CD-Roms are gaining significant market penetration. In the UK 80% of home computer sales now have a CD-Rom reader included meaning that the installed base is likely to increase from 0.25m currently to 1m within a year. The catalogue of titles is growing rapidly and prices are falling.

In addition CD-Rom production costs are falling all the time. A CD-Rom can contain 660 Mbytes and for a large run (10,000 copies) can be printed for only 0.4 ECU per copy. At the more specialised level individual CDs can be printed on relatively inexpensive equipment. Industry sources indicate that within eighteen months it will be possible to master, print and dispatch a tailored CD to a customer within a day.

6.3 Multimedia infrastructure requirements

The requirements placed on a telecommunications infrastructure are dependent on the types of services which are to be conveyed by that network. The public switched telecommunications network was developed to meet the requirements of narrowband, bidirectional plain old telephony services. This network is entirely unsuited to the broadcast delivery of a large number of analogue television channels as performed by a cable TV network.

The multimedia network of the future will need to combine the properties of both these networks. It needs to be able to support asymmetric broadband digital delivery and the ability to have simultaneous two-way communication. The degree to which the multimedia network adopts the characteristics of either network or characteristics of its own however is dependent on which services customers will want and pay for. One can envisage a small number of multimedia network scenarios which are capable of conveying services which require increasingly demanding network capabilities.

These will be addressed in section 6.5 below. Before doing so we consider some of the major technology options that exist.

6.4 Main technology options

There are a number of different network technology options which can be adopted to provide a multimedia type video service over a cable TV or a conventional PSTN network. The chosen solution depends very much on the starting point of network development. Conventional telecoms operators are anxious to exploit their existing base of copper in the ground and will favour a solution where they can make use of their existing plant, rather than building a completely separate or overlay network.

There is a consensus within the industry that there are no technological stumbling blocks to the provision of interactive multimedia services. It all depends on economics. Questions being asked include whether there is a large enough demand for the volume production necessary to reduce the price of the equipment and whether people are willing to pay enough money to make the provision of such a service economically justifiable.

The main technology options open to prospective providers of infrastructure and multimedia services are listed below. We consider transmission and service processing issues separately.

6.4.1 Transmission options - access

The access network connects a multimedia server or switch to the subscriber (eg. set-top equipment, PC or telephone). This network infrastructure requires a large investment by the network operator in order to upgrade it to allow it to carry multimedia services. This investment is often justified by operational savings alone. The replacement of numerous strands of twisted pairs with a single strand of optical fibre gives significant savings in reliability and maintenance.

Cable TV coax with analogue modulation

This is the traditional method of delivering analogue television programmes. These systems usually have around 450Mhz of bandwidth with a few systems up to 1.5GHz., split into around 6MHz bands each containing a single analogue TV channel. An on-demand video channel would be carried in a 6MHz broadcast channel below 450MHz. Network topology is traditionally tree-and-branch.

A reverse channel (4 x 6MHz) is allocated in cable TV systems but is rarely supported in the more normal tree-and-branch network's unidirectional amplifier chains; there is also no standard for the sharing of bandwidth among multiple subscribers. Reverse

bandwidth is probably acceptable for limited signalling in video-on-demand applications, but not suitable for higher reverse requirements in the future.

Hybrid fibre and coax

Some cable TV operators have installed fibre to home nodes serving a few hundred homes in order to improve system reliability. A tree-structured coaxial cable network is used to carry an analogue signal over the shorter distance to the home. Fibre uses same multi-carrier video spectrum used by the cable TV industry and therefore no complex signal format conversion is required at the fibre-coax interface. This system is being widely adopted in new networks and is considered an important option for the phased development of existing networks where main distribution cables may be replaced leaving existing coaxial cables in place to serve the final customer drop.

Cable TV coax with digital modulation

New cable TV systems with higher bandwidth, or ones which have upgraded the upstream part of their network with optical fibre, can make use of analogue and digital modulation in different channels of the same cable. Multimedia on demand type services can be carried in a digitally modulated 6MHz channel between 450 and 750MHz. A 6MHz analogue channel can be modulated to carry up to 30Mbit/s or up to fifteen 2Mbit/s compressed signals.

Twisted pair

Digital subscriber line (DSL) technology has advanced rapidly since being used to provide basic rate ISDN over installed copper plant. High bit-rate digital subscriber lines (HDSL) can provide 784kbit/s full duplex per twisted pair, with two pairs providing 1.5Mbit/s within an exchange serving area up to distances of 2.7-3.6km depending on wire gauge. Asymmetric digital subscriber lines (ADSL) can provide in its initial form - ADSL I -1.5Mbit/s in one direction over a single twisted pair plus providing a 16kbit/s data channel and analogue POTS service. A later version - ADSL II - uses discrete multi-tone (DMT) technology to provide a 6.4Mbit/s downstream plus a full-duplex data channel up to 384kbit/s, 16kbit/s of control and analogue telephony.

The distances that are supportable by ADSL II are only half of those for ADSL I. Both forms are attractive as they make use of existing twisted pair, but are viewed by many as only an interim solution. However in many situations ADSL meets short-term needs, and in combination with fibre may prove an effective long term solution. The duration of its usefulness will depend on the rate of installation of fibre all the way to the home.

Passive optical networks (PONs)

When fibre goes all the way to the home, all the switching of traffic for the different homes can be done at the telephone exchange. Fibre is the ultimate delivery vehicle for delivery of broadband services to the home and has recently become an effective and economic method of trunking to small community distribution nodes. PONs have been trialled in the UK by BT, and deployed in large volumes in the former Eastern Germany. Interlinked cost, standards and technical barriers nevertheless prevent the widespread introduction of fibre to the home. A large amount of work has been done by RACE on this subject [eg Project R2024]. Over about the next five years it is likely that high-

speed fibre feeds will be shared among multiple subscribers. It will then become more practical for fibre to be installed all the way to the home.

Hybrid fibre and twisted pair

DSL is a distance limited technology and frequently cannot be implemented all the way from the local exchange to the home. However, if fibre is used to connect to a local neighbourhood node (for example an SDH multiplexer) then DSL can be used on the shorter distance copper cables that remain. It is highly conceivable that even 20Mbit/s HDTV could delivered in this way.

Current industry thinking is that ADSL is only a short term solution and is unlikely to see widespread adoption. However if a huge surge in demand for multimedia services occurs, a hybrid fibre/ADSL solution, which will make use of some of a TO's existing infrastructure, is much more likely to be implemented.

Hybrid fibre and wireless

Advances in millimetre wave technology together with the availability of spectrum at these wavelengths make it possible to develop hybrid fibre and wireless distribution networks. Such a solution would be desirable in areas without any copper wires or where the existing plant is in poor condition or where physical access for wiring between a local distribution point and the subscriber premises is restricted or costly, such as may occur where a service provider owns a fibre infrastructure but not the copper wires to the home.

Trials include BT's Millimetre wave multichannel multipoint video distribution service at 29 GHz or CellularVision's commercial offering in the New York area under a US FCC pioneer licence in the 27.5 to 29.5 GHz frequency band.

Unlike the hybrid fibre coax network, there is currently no way to maintain the signal structure in the transition from fibre to wireless. Both the BT and CellularVision systems use wideband frequency modulation for the radio TV channel transmission. Neither provides a wireless return channel (although CellularVision plans to do so). It is not clear that the required asymmetric duplex operation will be cost-effective compared to other solutions, except in particular cases of difficult and costly wiring access. However new advances in wireless access may change all this.

6.4.2 Transmission options - trunk network

Optical fibre cable is the preferred transmission medium for long distance communication, however microwave systems are very important in the options open to a telecoms service provider. Satellite can also be used as a trunking system and it is presently used as such by cable TV operators which receive films and programmes to a cable TV head-end via a satellite service provider (eg BSkyB), and also by conventional telephone companies for voice transmission on long distance routes. Satellite is particularly suited to point-to-multipoint distribution and so has the potential for multimedia content providers to distribute output to local network operators.

6.4.3 Processing options

Present telephony switching is based on a bit-rate of 64 kbit/s. In order to get higher bit-rates services multiple channels can be joined together (n x 64 Kbit/s; eg H.261) to provide higher capacity for multimedia applications.

Switching, or cross-connection as it is called at higher bit-rates, is available in SDH networks. SDH cross-connects or add-drop multiplexers in a ring behave in this way. However they only handle channels of at least 2Mbit/s bandwidth.

ATM is the technology on the horizon which will enable different services of any bit-rate to be switched on the same platform. Digitisation allowed the successful transmission of multimedia formats. It is ATM which will allow these services to be switched independently and will allow full technological convergence of PSTN/cable TV and computer networks to take place.

6.4.4 Key trade offs

A large number of engineering trade-offs will need to be made, and furthermore, these will change as technology develops. In this section we consider what we believe to be some of the more important.

Switching versus transmission

In the past due to technology reasons, ie the transmission distance limitations of copper twisted pairs, switches were placed quite close to the customer to overcome this limitation. Each local switching centre would typically serve a catchment area covered by the extent of its longest copper line, perhaps 3 or 4 km. Transmission over longer distances was difficult, requiring costly repeaters for signal amplification. Numerous 'cheap' switches were installed to minimise the requirement for 'expensive' transmission facilities.

Centralisation versus distribution

The deployment of optical fibre in the local access network removes the distance-expense limitation on the local access network. Optical signals can readily be transmitted over distances over 40-50km without the need for regeneration. With the advent of ever cheaper and astonishingly more powerful computer processors, the trade-off between transmission and switching is becoming much less important as both diminish in price. Switches can be located anywhere in the network from a transmission point of view. It is entirely conceivable that all local switches in a national network could be replaced by one or two very large network processors.

Somewhat contradictory is the position that the distributed bandwidth management functionality of a fibre ring system with add-drop multiplexers is often described as having the same functionality as a switch itself, except being distributed across a wider area. These SDH fibre systems presently handle bandwidth in chunks of 2Mbit/s capacity which means that these 'distributed switches' will not replace PSTN switches operating at 64 kbit/s, however with ATM switching, and the ability to switch services of varying bandwidth, a distributed switching architecture becomes even more feasible. Such a network would be akin to 'client-server' network technology rather than a

'mainframe' model. The complexities however on managing such a system carrying numerous servers may act to drive the trend back in the direction of centralisation.

Either way, with new technological developments and increasing competition in the provision of telecommunications equipment in Europe the costs of both switching and transmission are reducing.

Transmission/switching versus storage

A new trade-off which is likely to become very important over the next few years is that of storage. The provision of interactive multimedia servers, requires access to vast repositories of multimedia data or content. As previously discussed, even with the latest compression techniques, a full length video film still requires in excess of 1Gbytes of memory. Optical compact disc storage techniques solve the fixed storage problem and the ability to quickly access this data; however archives for video-on-demand services are likely to require a large amount of very expensive high speed RAM memory in order to serve large amount of customers in real time. These servers will be located to optimise costs by ensuring that sufficient users share facilities. The location of these 'multimedia servers' in the network will be determined by the most economic trade-off between local and remote storage and the transmission and switching capacity required to access the two.

Penetration of fibre in the local loop

As fibre penetrates the local loop to a greater extent, more and more capacity can be used on the existing copper infrastructure whose performance improves when the copper link's length is reduced and when upstream electronics generating noise and interference are removed. The question then becomes, 'how far does fibre need to go?'. There is a consensus in the industry that fibre will, one day, go all the way into every home. However, there is no consensus whatsoever as to when this is likely to happen. The closer and closer fibre gets to the home, the more and more bandwidth its presence allows. However do we need all this bandwidth? 'Not yet, but one day' seems to be the answer.

Symmetry of network bandwidth

Another issue is the symmetry of the bandwidth provided. Is full two-way (bidirectional) bandwidth required in both directions or is it sufficient for most uses to have large bandwidth going into the home and only a small reverse channel for signalling purposes in the reverse direction. It is likely that residential customers will be satisfied by an asymmetric service, primarily due to services such as video-on-demand or home shopping where the information flow (ie pictures) is mainly in the outward direction. The degree of asymmetry required in service will greatly effect the type of technology implemented. ADSL provides ample capacity for a VOD service however it is more likely that an optical fibre-based solution would be required for full two-way video.

6.5 Multimedia deployment scenarios

The manner in which the technology options described above will be deployed is far from certain. It is not clear which will be implemented, when and by whom. Indeed in the emerging competitive environment, different organisations will choose different technical solutions depending on, for example:

- whether the company is a TO, Cable TV provider or new entrant into the telecommunications market, their choices being dictated by the infrastructure already available to them;
- the geographic coverage envisaged and topography of the service region, including environmental issues;
- the type of users to be addressed, for example a large business user or a low volume residential user;
- the services to be provided, for example delivery of a video signal (largely one way transmission) or a full interactive service.

The services that will eventually be provided on the infrastructure have yet to be fully defined and the level of demand is consequently unclear[5]. However, any investment study cannot ignore services as it is their revenues that will repay the investment. In the uncertain multimedia environment greater attention will be paid to those services that are already established. Basic voice telephony and cable TV (and potentially video on demand) services will be the major initial source of revenue.

Infrastructure investment decisions should be based on both the services themselves (how much bandwidth is required by each application of the services) and the demand for each service. To obtain accurate costs and to be assured of adequate returns, networks should be designed to meet the likely demand in terms of size and location and take into account the extent of existing infrastructure. Unfortunately, the level of uncertainty about the market makes this approach impracticable for this study. This fact by itself highlights the high risk nature of early infrastructure investment.

Telecommunications investment decisions are different to those made in many other industries. Elsewhere the typical product development life cycle starts when a potential market need is identified, a product is designed and is then built. A telecommunications network is, by its very nature, a shared resource, and investment decisions will frequently be based on one service although subsequently the network may carry other services as well. The problem is further complicated by the apparent linkage of supply and demand which frequently develop together as a new capability stimulates a new application. Many designers of early LANs found that the mere availability of the network stimulated users to communicate more and many designers significantly underestimated network growth as a result. Road designers face similar problems where there is an increasing recognition that new roads stimulate traffic growth.

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5 Multimedia services are being addressed in a separate study commissioned by the Commission from Devotech.

In developing our cost model we have therefore decided to take a view on the networks that may be developed rather than the services that will drive them. This reflects the current reality of an industry where technology has such a dominant influence. In defined development scenarios we need, therefore, to consider what the networks supporting the Information Society may look like given the commercial realities of competitive supply of telecommunications services and infrastructure.

A clear driver will be the ease of infrastructure deployment and the rate of return on investment for the proposed user community. The economics of telecommunications are fundamentally related to the need to share resources where possible. This suggests that in order to provide the greatest benefit the initial investments will first be directed towards those elements of the infrastructure where there is greatest resource sharing - in other words the 'trunk' element of the network. This has been demonstrated by the competitive entry in the US and UK by long distance trunk service providers.

We use the word 'trunk' in quotation marks to emphasise the uncertainty, initially discussed in section 5.2, that is blurring the distinction between traditional views of trunk and local access networks.

Commercial realities mean that the next stage is likely to be investment in those areas which require the lowest level of investment, and therefore risk, and has the best chance of generating the most money. This requires infrastructure to be provided either to address users who either generate large revenues or are concentrated into a small areas. This process is illustrated below.

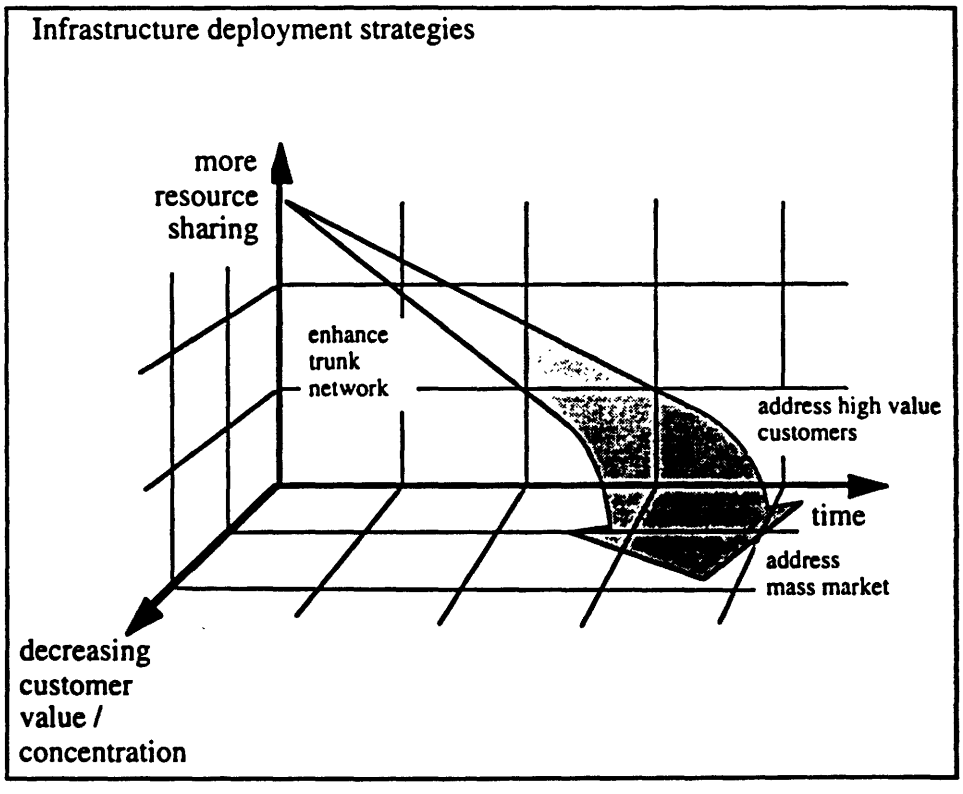

Figure 14 *Infrastructure deployment strategy*

This view demonstrates another dilemma of the telecommunications industry. Historically, prices have been consistent across an entire country and any differences between residential and business tariffs have tended to be small; indeed business users have generally faced higher rental charges. Such a pricing policy does not reflect the cost of provision. Price rebalancing will be necessary before a completely open market in telecommunications supply can emerge, but there are major social and political concerns that will needs to be overcome before rebalancing can be occurred.

The effect of this means that under the current system opportunities to 'cream-skim' can be identified. To ameliorate this concern, measures such as the levying of access deficit charges[6] may be introduced to protect the 'hard to serve' user. The role of access deficit charges and the financing of universal service obligations is very complex and is being considered throughout the Union. It is not the role of this study to consider an appropriate policy, but such a policy will have a significant affect on the manner in which investments will occur and be judged by investors. Furthermore, the development of, for example, wireless delivery mechanisms[7] may have a fundamental impact on the cost of serving remote or low volume users and may make universal services obligations easier and more cost effective to fulfil.

Given these concerns, new investors are likely to seek to exploit these more attractive targets first. Service deployment therefore is likely to follow the following path.

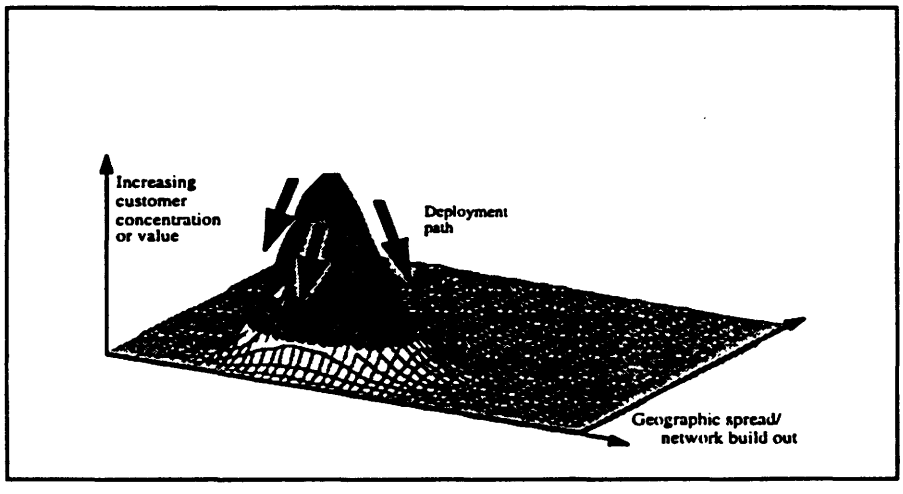

Figure 15 *Network development path*

6 an additional charge levied as part of the interconnect arrangements that ensures that new-entrants (providing partial coverage only) recompenses the dominant operator for the costs incurred in meeting any universal service obligations places on that dominant operator.

7 unlike cable technology where the final subscriber drop will always be unique to the customer wireless delivery takes resource sharing all the way to the customers' equipment.

This study concerns the costs of progressing down the arrows. Ideally we would understand precisely where the arrows lead and the key steps along the route. This is not practical so to discuss the scale of investments, we have defined a number of scenarios. These scenarios are not intended to be a prediction of the likely development path, but they are realistic and tangible possibilities. We consider both the long term objectives and the path followed to progress towards this goal.

The ultimate objective is to provide fibre (or possibly sufficient capabilities delivered through a wireless solution) into every home and office in the Union. Such a network would provide ample capacity for most applications. If the transmission network was supplemented by ATM switching, capacity may be assigned on demand.

Our model, which is described in the next chapter, considers the cost of providing a full broadband fibre network from scratch. This would be the cost of providing a single comprehensive network that took no account of the redeployment of existing infrastructure resources.

The cost to a company that has usable resources (including, for example electricity companies) of building such a network will be reduced. In this respect the headline figures quoted in chapter 9 represent an upper bound. On the other hand, competing companies may decide to build their own alternative infrastructure. This may duplicate certain resources increasing the total investment that will be made in the Union. This is discussed further in chapter 9.

This long term aim is a distant goal and we cannot predict precisely how it will be achieved. However, there are a number of short term measures that can reasonably be considered. These measures will be taken by different types of organisations.

First we consider the expansion of cable TV networks. The expansion may relate to expanding the user base and/or the services delivered. As a minimum we would expect the addition of a 'return path' between the user and the network, to allow some degree of interaction, for example for a home shopping service. We also assume that a voice telephony service will be provided.

Next we consider the enhancement of existing PSTNs (or the development of new PSTNs) to allow greater bandwidth to be provided. Different types or timing of development are likely for residential and business customer.

Business users typically represent only 20% of subscriber lines for a PSTN operator but may account for 50% of call volumes. Business users tend to be targeted by new entrants and place greater demands on service providers. Provision of fibre all the way to large business users will generally be the priority of established TOs and is likely to be the focus of many new entrants.

However, since business and residential geographic areas overlap, a network designed for businesses will have the potential to address some residential users as well and a sensible network plan will address long term potential and will aim to reduce future costs through judicious planning of initial resources. Hence concentration on a business market does not exclude the residential market, although improvements for business users will generally occur over a shorter period.

In addition to this potential to gain from infrastructure enhancement aimed at the business community residential users will targeted in their own right. Two factors in particular are important. First is an increasing use of fibre in at least part of the local loop[8]. Second is the potential deployment of ADSL to provide, for example, a video on demand service.

These define a number of interim development scenarios as follows:

- cable TV network enhancement: expansion of cable TV networks to provide broader coverage and the ability to offer interactive and telephony services;
- fibre to businesses: provision of fibre to business (large, medium and small) in city centre locations and across the country:
- fibre to residential customer: provision of fibre to the home in urban areas;
- provision of ADSL on residential subscriber lines: the provision of ADSL on all existing residential lines.

These scenarios, as stated above, are not intended to be predictions and indeed are not mutually exclusive. Realistically a combination of elements of each will be progressed. Nonetheless, providing costs for each will demonstrate the relative scale of investment for the different areas and how they relate to the headline greenfield cost of building a multimedia infrastructure from scratch.

The technical and commercial impact of the different scenarios is given below.

Cable TV enhancement

The coverage of cable TV networks needs to be developed from the existing base. In Belgium and the Netherlands, for example, coverage is already good and little new build is required. We have restricted the development of this interim stage to the customers that may most easily be served. This we have interpreted as 90% of urban populations. Urban populations represent 76% of all homes in the 'sixteen'. Taking 90% of this means that we have considered the most easily served group to comprise 71% of homes. This new build will employ fibre to the street with the final drop using co-axial cable.

In addition to this new build we also need to include the cost of upgrading existing systems to cater for telephony services. This can be done in two ways: either by providing a twisted pair overlay network or by employing fibre in part of the network. The costs quoted are for an overlay solution.

These developments will provided 71% of homes with the ability to receive broadcast TV via cable and telephony services from a network other than that of the established TO. It would potentially also allow suppliers to offer limited interactivity to support, for example, home shopping.

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8 in particular replacement of large copper cables in the'distribution network' in highly urban communities by SDH fibre rings.

Given the necessary regulatory freedom, this scenario would allow customers to choose to acquire basic telephony services from established cable TV operators (assuming they are separate from the TO) as well as the TO. It would also represent the situation where new entrants choose to address both the telephony and cable TV market. As explained elsewhere in this report, this combination is regarded by many as a highly effective way of introducing competition into the residential market, and one which is considered by many to have the best potential to attract the required level of investment.

Fibre to Businesses

This scenario relates to the implementation of fibre rings employing SDH technology and 'customer drops' (from the ring to customers' premises) also using fibre. Initially this will allow high quality multiple voice channels or more likely ISDN access (basic or more likely primary) to be provided. H.261 systems may be used to combine 64 kbit/s channels if bandwidth between 64 kbit/s and 2 Mbit/s is required[9]. The fibre may also be used as the physical delivery mechanism for the company's leased lines.

We have considered the cost of building such a network from scratch and have addressed separately the cost of addressing large businesses from small and medium enterprises (SMEs); and in city centre from urban areas and rural areas. This shows the benefit of concentrating investment on a limited sector.

These costs are indicative of those that a new entrant without infrastructure available to it would need to incur in addressing the business community.

Fibre to residential customers

Although, it is unlikely that a company will target fibre deployment solely on the residential community it is nevertheless useful to consider this cost relative to that likely to be incurred by cable TV companies to upgrade their networks to a level suitable for telephony and home shopping and to that likely to be required to install fibre for the business community.

We calculate the cost of providing fibre to the street addressing the 90% most easily served homes in urban locations (ie 71% of homes). The fibre to the street solution involves the cost of installing a SDH fibre ring. It is assumed that the final subscriber drop will be copper. This scenario represents a platform upon which an operator may provide full multimedia capabilities once the development of multimedia applications and customer premises equipment is widely available.

We have also considered the cost of extending the fibre ring to these addressable homes. This is not intended to represent a realistic scenario but does show the relative size of the distribution network to the overall fibre provision cost and also allows the residential market to be compared to the business market.

9 By itself this would not allow a full bandwidth on demand service; to do this ATM transmission and switching would be required.

This scenario relates to the ability of TOs to provide some form of entertainment services most likely in the form of a video on demand (or near demand) service by implementing ADSL.

6.5.1 Convergence

Convergence is a much used term it is interesting to ask when it will occur in the above scenarios. The answer to this question is not a single point in time or network development but a gradual process. All the scenarios have one thing in common - they gradually extend the penetration of fibre towards the customer. Fibre can be used as a transparent transmission media, and once it has reached the subscriber it may be used for the conveyance of any service irrespective of the original reason for its provision.

Current networks have different characteristics in terms of the penetration, level of interactivity provided and the bandwidth available to users. In the diagram below we show how this differs for the PSTN and cable TV networks and how this may evolve towards the interim scenarios and the final fibre to the home option.

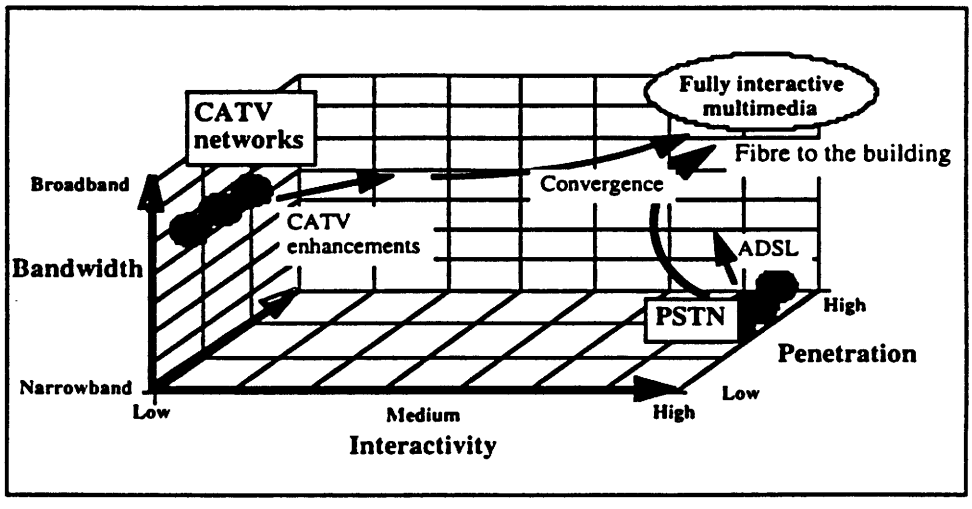

Figure 16 *Multimedia infrastructure scenarios*

6.5.2 Migration strategies

Each of the deployment scenarios discussed above can be realised in a variety of ways. The choice of migration or development strategy for an existing network will very much depend on the state of the existing infrastructure. There are three main strategies for developing an existing network for the provision of multimedia services:

- rebuild;
- overlay;
- upgrade.

We discuss each in turn below.

Rebuild

Parts of the existing PSTN and cable TV networks will have to be rebuilt in the course of moving to the broadband multimedia network of the future. Ducts in city areas of a number of countries are becoming congested and in need of repair. Optical fibre will increasingly be used to replace existing copper links once their economic life has been fulfilled. For cable TV networks, unidirectional amplifiers will have to replaced with bidirectional amplifiers which allow the two-way transmission of information on a network designed for unidirectional broadcast services. Large amounts of transmission equipment and processing equipment will need to be replaced to provide the capacity and functionality to convey the services of the future. In many countries the existing national telephone operator would have a substantial network of ducts already in place.

Overlay

Some existing networks (eg cable TV operators) will build overlay networks to provide new services to customers (eg POTS to cable TV customers). Optical fibre cables have been mainly deployed to date as overlays on bandwidth intensive routes and then evolving to the routes themselves over time.

Upgrade

Where infrastructure already exists, it may be more economically feasible to upgrade rather than rebuild or build an overlay network. Increasing the penetration of fibre in a cable TV network allows shorter lengths of coaxial cable to carry more video services.

Costing migration strategies

Our model aims at calculating the rebuild cost of networks but does so in a modular way so that we can comment on the extent to which other migrations options will result in lower costs. These issues and their impact are discussed in chapter 8 were we discuss results.

7 General classes of investment

7.1 Introduction

This section describes the cost model developed during this study in order to estimate the magnitude of the investment required in competing telecommunications infrastructures in Europe. The model uses demographic data, information regarding the state of existing cable TV and PSTN infrastructure in Europe, costs and a network planning guideline to provide an estimate of the scale of investment required to achieve varying penetrations of network infrastructure in each Member State under a number of different infrastructure scenarios.

The model is structured as shown below.

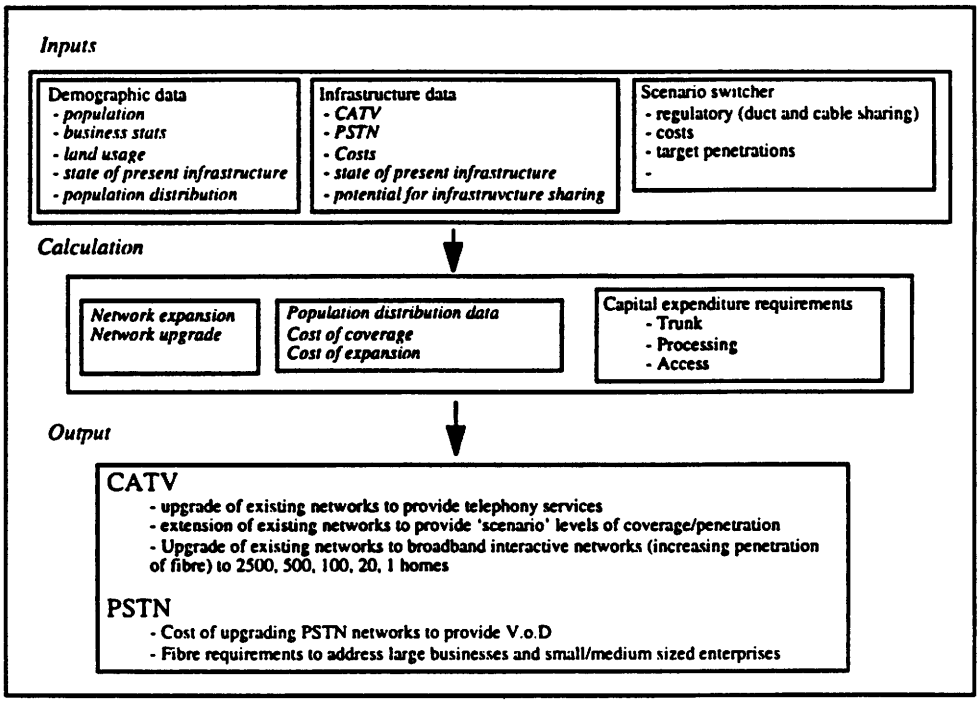

Figure 17 *Model structure*

7.2 Investment types

Using the network investment requirement model of 7.1 we consider main areas of investment under a number of different development scenarios.

R&D, standardisation, industry restructuring and network planning are also costs which will effect the likely introduction of these multimedia networks, and need to be addressed on a top-down basis.

7.3 Variations (by Member State) affecting network build costs

A number of factors will affect network build cost and that vary by country. The most important are described below.

Network development starting point

Data regarding the present state of the communications infrastructure (both cable TV and PSTN) in Europe has been collected from a number of sources[10].

These sources contain information regarding numbers of telephone lines/homes passed etc. but little data exists regarding the exact composition of each infrastructure element (e.g. how much optical fibre is used as opposed to copper or how old the network is). With this in mind, our financial model makes it possible to vary the level of optical fibre penetration in each country as a sensitivity analysis on the investment required.

Cost of labour

A relative cost of labour for each member state has been calculated with respect to a European average. This relative cost is used to evaluate the effect of variations in the cost of labour for building telecommunications infrastructure across the EU. This variation across the community mainly applies to the civil works component of network build cost. The labour element of network build costs is multiplied by the relevant relative labour cost to account for these variations across the 'sixteen'.

Geographic variations

The extent of urbanisation in each Member State is an input to our investment requirement model. Our model further distinguishes between city centres, densely populated by large businesses and SMEs, and ordinary urban areas in which most people live but which do not have such high concentrations of businesses. (We have assumed a city centre area, equal in size to 10% of a country's total urban area). The economics of providing high capacity telecommunications services in city centres are very different from serving large urban areas. This has been demonstrated in the UK where a number of operators have been actively building networks in the City of London. The cost of providing network infrastructure in more sparsely populated rural areas is also calculated.

Different penetration rates

As a base case, the penetration rate in each country has been assumed to be independent of population distribution (ie the penetration rate of PSTN per pop. in cities is the same as that in rural areas. We consider this a reasonable assumption given the highly developed state of most of the economies of the countries studied.

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10 - ECCA: European cable TV statistics
- ITU PSTN statistics
- Mercer Consulting study for the EC
- Industry consultation

For cable TV we have only costed the infrastructure required to provide a service in city centre and urban areas. We assume that rural dwellers will be more economically served by terrestrial or satellite broadcast services.

Variation in equipment costs

Telecommunications equipment costs (e.g. switching and transmission) have been assumed to be equal across the EU. This is not presently the case but is likely to become increasingly more so with free trade, increasing competition and market liberalisation.

7.4 Methodology used

The diagram below illustrates the scope of the model. It is restricted to cover network components only.

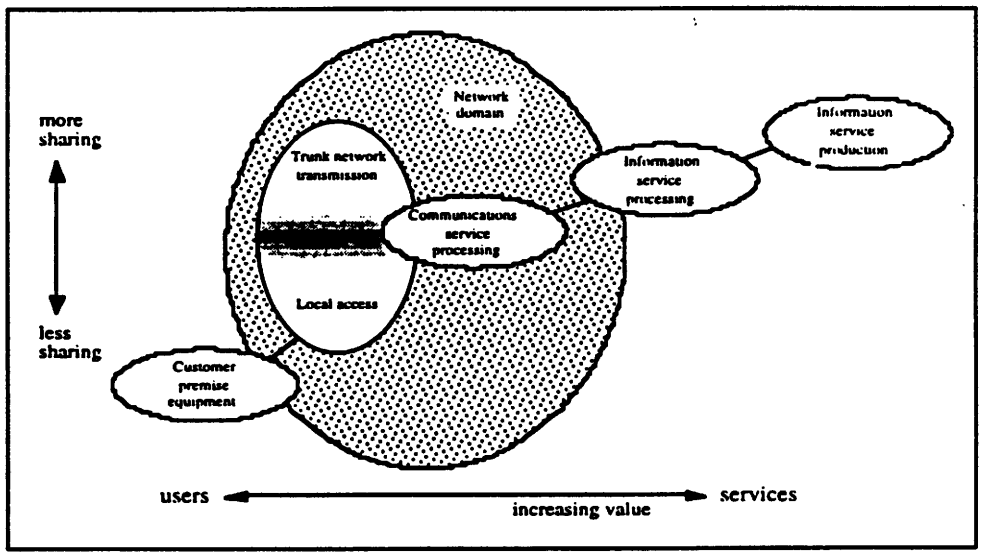


Figure 18 *Network infrastructure - key elements*

We calculated the network infrastructure investment required to address multimedia service scenarios in each member country using the following approach:

- consider the split between city centre, other urban and rural communities;
- consider the split between customer type (residential; small, medium and large businesses);
- calculate cabling requirement;
- compare to what is already in existence;
- calculated incremental investment required.

Each major element is considered below.

1. Split each country's total geographic area into three segments by land usage:

   - rural;
   - urban;
   - city centre.

   This split was chosen to reflect the variations in the needs of telecommunications customers in these areas and the technologies that are likely to be adopted to economically address these customers.

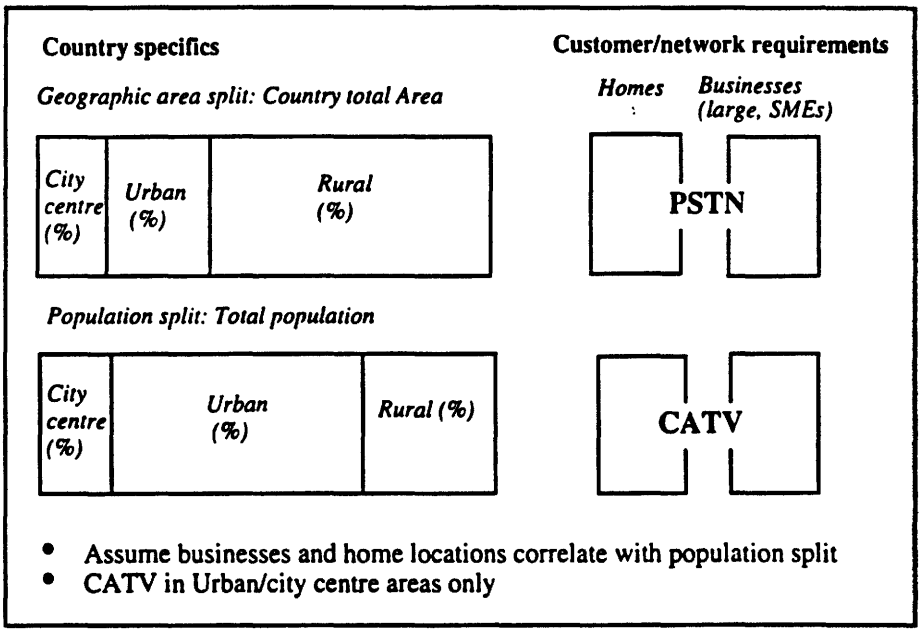


Figure 19 *Country demographics*

2. Segment customers of multimedia services according to demand (raw bit-rate) and geographical location. The customer segmentation chosen was:

   - large business customers
   - small and medium sized enterprises (SMEs)
   - residential/home subscribers

   Numbers of each type of customer in each geographic region were calculated from the base data available (Appendix B).

Country	Rural	City centre	Urban
Population	*By geographical area*		
Area (km^2)	*Useage of land*		
No. of homes	*By geographical area*		
Businesses: Large SMEs	*No. of business (sites) by size and by geographical area*		
State of present infrastructure: PSTN CATV	*Penetration* *Homes passed* *Average copper loop length*		
Relative labour rate	*Calculated with respect to a European average*		

Figure 20 Data requirements for each country

People, and therefore residential homes, are highly clustered within a given geographic area. This has the effect of increasing the effective population density in a certain proportion of that area, thereby reducing the amount of communications infrastructure required on a per line basis. A significant portion of an urban area is made up of parks, roads, businesses and public spaces in which no people live. The degree to which this 'clustering' of people takes place was estimated in our model by examining the distribution of telephone line lengths in a selection of EU member countries.

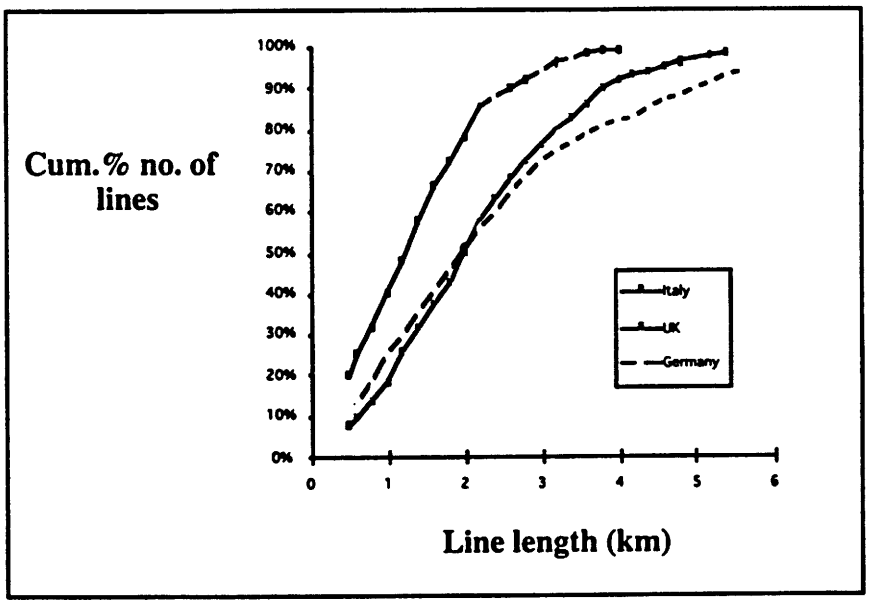


Figure 21 *Telephone line length distribution in Italy, UK and Germany*

Using a country's telephone line length distribution yields a measure of how telephone handsets and therefore people are distributed within that region. Italy for instance has a telephone line length distribution which implies that on average approximately 90% of the population served by a given switching exchange are reside within 40% of the total area served by that exchange (i.e. within a circle of radius of that country's maximum line length). The UK's line distribution statistics by comparison yield the result that 90% of the population served by a switching exchange are concentrated within 50% of that exchanges service area. This indicates that the UK population is more dispersed (for a given density) than the Italian population. In Germany the population is even more dispersed than in the UK.

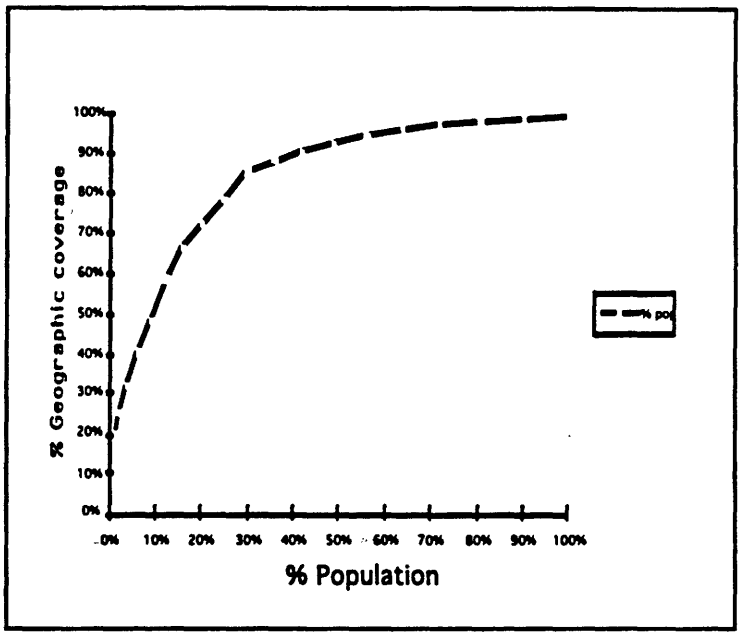


Figure 22 *Italy's PSTN line length distribution*

The model developed takes into account population distribution by calculating separately the infrastructure required to serve the 90% majority of the population in any geographic area, and then the last 10% of the population which are more dispersed. This allows us to identify the costs associated with serving residential customers in outlying geographic areas.

PSTN line length distributions were readily available for the US. Germany, Italy and the UK. A weighted distribution of the line lengths in these three European countries yielded the simplifying result used throughout the model that 90% of the population within any geographic area in an EU country will reside in approximately 50% of that area. Variations will of course exist throughout the Community but this measure was adopted for simplification purposes. Increasing layers of sophistication could be used in taking account of the effect of population distribution. However these refinements depend on the availability of data of sufficient quality to make these calculations worthwhile. For the purposes of our study, the 90% and 10% of population was assumed distributed evenly throughout its geographic area. This will tend to

underestimate the tendency of people to cluster in residential areas, thereby slightly overestimating the infrastructure requirement figures produced by our model.

3. For each customer type (business, residential) in each geographic region (rural, urban and city centre), the minimum length of network cabling (km) required to interconnect all customers to a trunk transmission system was calculated. The basis for this calculation is shown schematically in the figure below. The algorithm used to calculate the amount of cabling required is based on interconnecting N customers (businesses, homes or cable TV nodes) which are evenly distributed within a land area of size A (km^2). The algorithm used minimises the infrastructure required whilst maintaining a degree of route diversity.

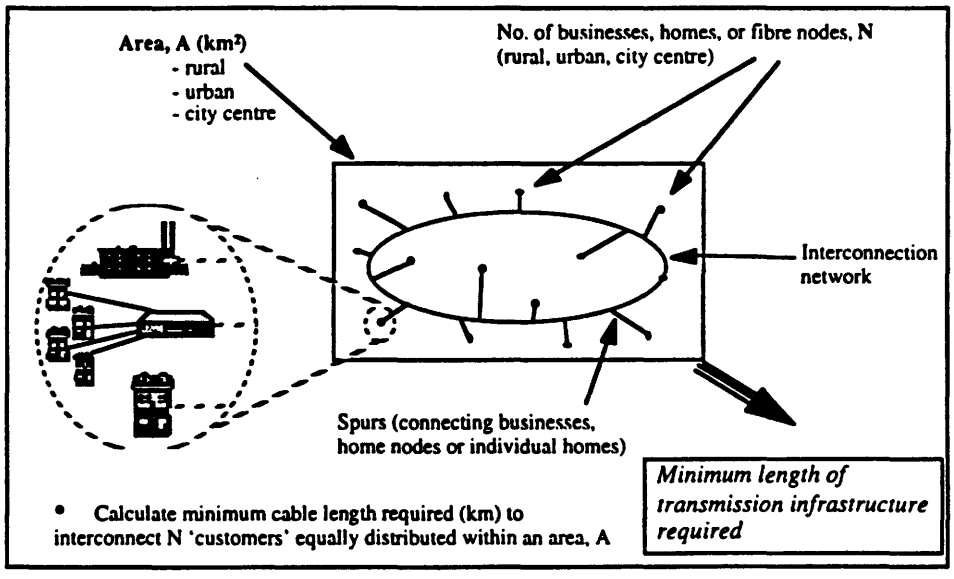


Figure 23 *Minimum cable length calculation by customer and geographic region*

4. The cable length required to interconnect the different customer segments in the different geographic regions in each country is compared with the state of the existing PSTN and cable TV network infrastructure in each of these countries. The incremental build and replacement network costs required to address different penetrations of customers with 'pipes' of varying bandwidth characteristics (according to the scenario chosen) are calculated. Different penetrations of fibre and copper cable can be modelled. Cost of labour variations between different EU member states are taken into account in these costings.

From these calculations the incremental build costs in addressing large business customers, and then smaller businesses, and eventually individual houses in each region can be calculated.

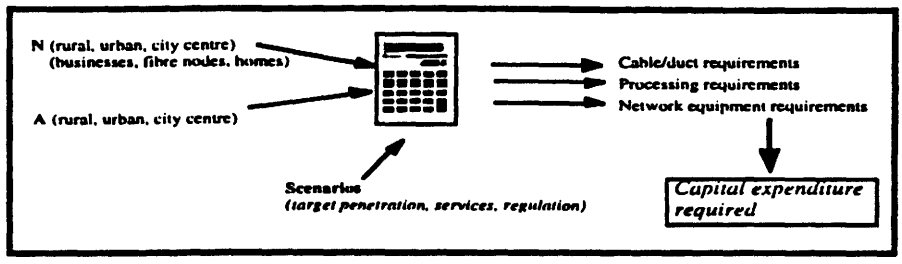


Figure 24 Network infrastructure investment required

'Greenfield' construction of these networks can be compared with the upgrade cost of existing networks. The potential to reduce new network build cost by the sharing ducts and fibre cable (regulatory conditions allowing) is built into this model. The degree to which there is potential to share common resources with other infrastructure providers can be varied on a country-by-country basis. Chapter 8 discusses the effect of infrastructure sharing between operators in detail.

5. Processing equipment costs are calculated as appropriate on a per customer basis according to the type of services/bandwidth provided to the different customer categories in each region.

7.5 Model outputs

The model produces overall network costs for each Member State by geographic region and customer segment. The model also allows input parameters to be varied allowing considerable flexibility in the analysis that may be performed. These results are discussed in the next chapter.

8 Investment requirements

This section summarises the results from our financial analysis of the investment requirements in competing European broadband telecommunications infrastructures. We emphasis again that these figures are indicative only, although they reflect our current understanding of likely costs using the methodology and assumptions provided in chapter 7. In this section we quantify the costs of implementing the various scenarios outlined in chapter 6. These scenarios broadly relate to:

- the 'green field' provision of a fibre network to all homes and businesses in the 'sixteen';
- costs relating to the upgrade and expansion of cable TV networks;
- costs relating to the progressive expansion of fibre to different customer groups.

Unless otherwise stated the costs relate to largest single element - the provision of transmission capabilities (fibre and systems). Comments are made throughout the section on other costs relating to CPE and processing equipment.

The costs, unless otherwise stated, represent a complete rebuild cost of a single network in each country. Often infrastructure resources will be available which will reduce these costs and comments are made throughout the section on what proportion of the total may be realistically avoided.

Europe is heading for a competitive environment for the supply of telecommunications. Different organisations will make different decisions on the extent to which they will build infrastructure (as opposed to acquiring capacity from a 'carrier's carrier') to support the services they offer. This is likely to lead to a duplication of infrastructure. However this duplication is not total and we consider this effect in section 8.6.

In addition to decisions on whether or not to build infrastructure, competitors will also have to consider the extent of their networks. Some customer groups can be addressed more cheaply than others, and the different scenarios reflect these different groups. Furthermore, some customers within a group will be cheaper to serve than others - a fact that is embedded in our modelling approach. This effect is considered in section 8.5.

8.1 Summary of investments required

The table below summarises the cost of building new transmission infrastructure under a range of different circumstances. The costs cover the 'sixteen' (the EU and Norway).

Scenario	Cost (ECU bn)
Long term goal	
Green field provision of fibre through new duct to all homes and businesses	333
Cost of providing fibre to all homes and business if 60% of build was able to utilise existing duct	172
Green field provision of fibre through new duct to 90% of homes and all businesses	245
Cable TV network enhancements	
Enhancement of existing cable TV networks to allow 'limited' interactive multimedia capabilities (excludes set top box)	17
Expansion of cable TV networks through new duct to 90% of urban households	84
PSTN upgrades	
Cost of providing new fibre through new duct to all businesses (no homes connected)	67
Cost of providing new fibre through new duct to all large businesses only	13
Cost of providing new fibre through new duct to all city centre businesses only (large, medium and small)	11
Cost of providing new fibre through new duct to all homes (no businesses connected)	325
Cost of providing new fibre through new duct to all urban homes only	201

The individual component costs are described in more detail in the following sections. Nevertheless, the table is presented here to show the overall cost of building the infrastructure to support the Information Society and the relative size of investment needed for the different scenarios.

The headline figure of ECU 333.2 bn for the provision of a new fibre network to all homes and businesses in Europe represents an upper bound for investment in a comprehensive transmission infrastructure needed to support the European Information

Society. As indicated on table, infrastructure re-use, substantially reduces this cost to ECU 172 bn (48% saving on the headline cost). Excluding the most expensive homes also reduce costs substantially (26% saving on the headline cost).

Before continuing it is worth briefly noting a key uncertainty inherent in the cost model. A number of the technologies and products being considered for use in the evolution to a multimedia network (eg ADSL on PSTN networks and cablephone on cable TV networks) are presently at the trial and development stage. Because these technologies have yet to see volume deployment, it is very difficult to estimate what the costs of these technologies might be, once full production runs have been established. It is therefore increasingly difficult to predict the definitive migration path of the multimedia network of the future and precise implementation costs.

8.2 The cost of providing universal fibre access

The figure and the table below shows the investment required to provide an entirely new transmission infrastructure using optical fibre cable exclusively. It assumes no re-use of any existing resources. The network it represents would provide fibre access to all business and homes allowing the potential for all Europe's citizens and businesses to access the fully interactive broadband services that may emerge in the future. On the diagrammatic representation the hatched area indicates the investment necessary if only business were to be addressed. This cost is discussed further in section 8.4.

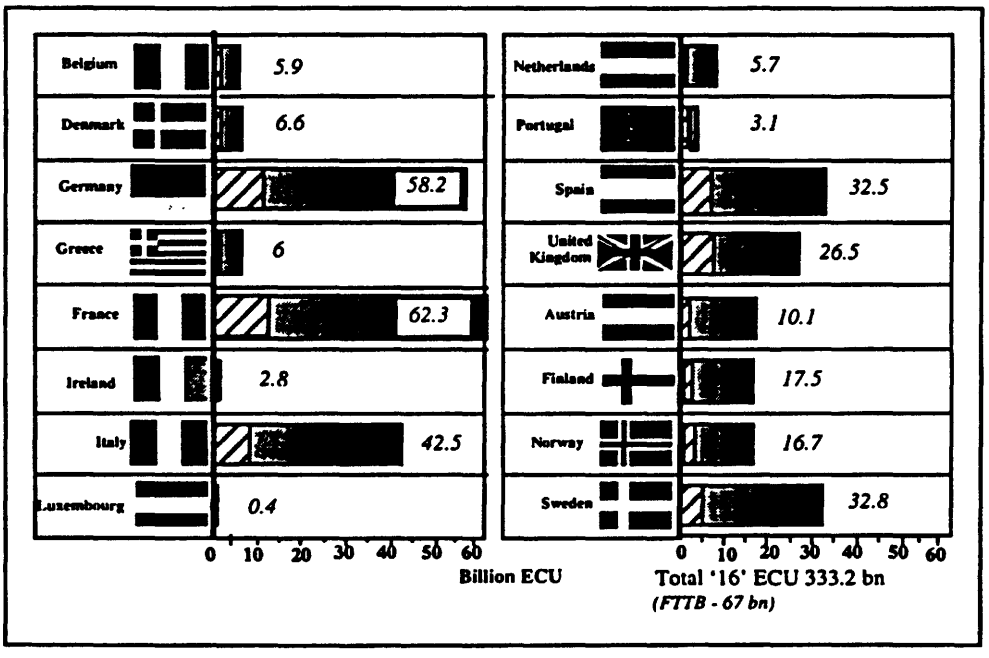


Figure 25 *Cost of universal fibre access*

FTTH & B	*Total* (M ECU)
Belgium	5,900
Denmark	6,600
France	62,300
Germany	58,200
Greece	6,000
Ireland	2,800
Italy	42,500
Luxembourg	400
Netherlands	8,100
Portugal	4,300
Spain	32,500
UK	26,500
Austria	10,100
Finland	17,500
Norway	16,700
Sweden	32,800
Total	333,200

Figure 26 *Fibre to the home (100%) & business (100%)*

Once the additional expense of processing and customer premises equipment are taken into account, the magnitude of these calculated investment requirements compares favourably with the size of some of the figures for broadband network developments being talked about in a number of EU member states. BT has announced that an investment of ECU 19 bn is required to provide broadband to the home in the UK. A recent report on Information Superhighways in France[11] stated that it would require between ECU 22 and 30 bn to provide fibre to all of French homes. Both BT and France Telecom have extensive existing networks which act to reduce the total investment required by these companies.

These costs assume the provision of fibre to all homes. Uneven population distributions and topographic variations mean that it will cost different amounts to serve different users.

Using the PSTN line length distribution of a country (the UK is used in the following analysis) as a proxy for population distribution, the model was run to calculate the level of incremental infrastructure required that is directly attributable to incremental coverage. The results are represented in the following diagram.

[11]Les autoroutes de l'information: Gérard Théry

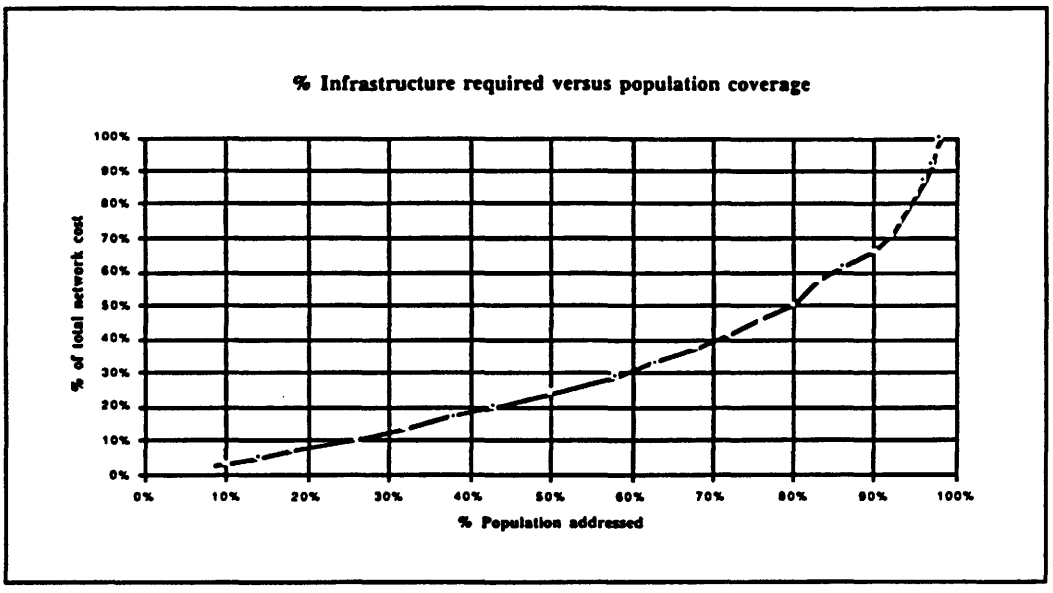


Figure 27 *Infrastructure size versus population coverage*

The curve indicates that 90% of the population in a given geographic area can be served by a network comprising around 70% of the total physical infrastructure (ducts, cables etc.) required to serve the entire population. The steepness of this curve for a given country clearly depends on the population distribution within that country.

This overall effect is that by excluding the most expensively serviced parts of the community, considerable savings can be made in the overall network build cost. For example, excluding the 10% of homes that cost the most to serve, results in a network investment of ECU 245.3 bn - a saving of 26%. Although our model makes reasonable averaging assumption in this context, geography will create a number of significant local variations. Particular care should therefore be applied when applying similar percentage savings to particular countries, regions or user groups.

The ECU 333.2 bn investment represents an upper bound for the cost to Europe of building an infrastructure that will support the Information Society but not all of these costs will necessarily be incurred. The bulk of this cost is expended as a result of the building of the physical infrastructure (for example, the ducts in which cables are laid) as opposed to the cost of fibre and electronics. This is discussed below in section 8.5.

8.3 Cable TV infrastructure

We turn our attention now to the development of the existing cable TV infrastructure. This is a very likely first step towards the creation of an infrastructure able to support the demands of residential customers for multimedia services.

As discussed in Chapter 6 of this report, the penetration of cable TV network infrastructures vary greatly throughout Europe. The extent of deployment in Europe is shown below.

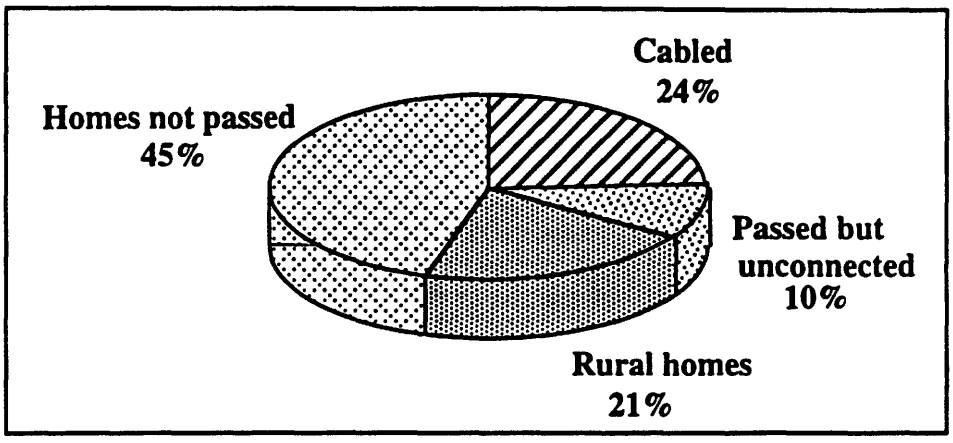


Figure 28 *The extent of cable TV in Europe*

There are two broad areas to consider as follows;

- the expansion of networks to achieve higher penetration so as to address the 45% of home not currently passed;
- enhancement of networks and service potential to those 34% of homes currently passed.

Each of these areas are considered below.

8.3.1 Expansion of cable TV network coverage

The following table shows the costs of physical infrastructure (ducts, cables and basic transmission) required to form a network capable of extending cable television coverage. The infrastructure that has been costed would allow broadcast TV as well as a narrowband, two-way interactive services to be offered. We have considered expansion so as to achieve two levels of coverage - 50% and 100% of addressable homes passed. The addressable market relates to the most economically addressable (90% of total) urban/city centre homes in each of the 'sixteen'. As urban homes represent 79% of all homes in the 'sixteen' the addressable market is therefore assumed to be 71% of homes.

These build costs assume that cable will be entirely buried in the ground. This reflects the stringent public requirements in a number of EU states not to have overhead cabling.

The results of this analysis are shown below. The hatched area indicates the proportion of the total cost that would be incurred if only a 50% coverage of the addressable market was achieved. It is noted that in some countries, this level of coverage has already been attained.

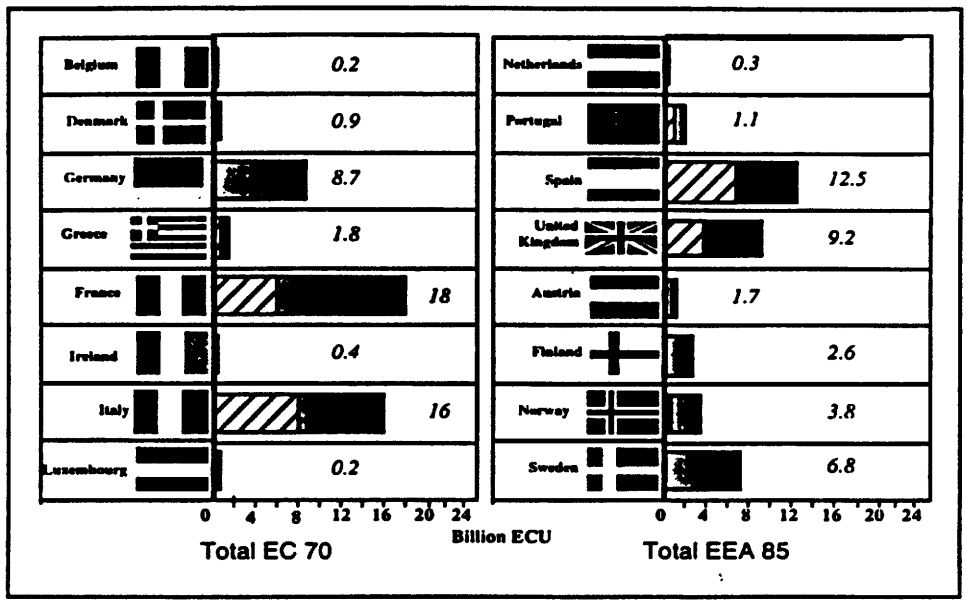


Figure 29 *Cable TV figures*

As expected, due to high existing levels of cable TV penetration, little investment in network expansion is required in the Benelux countries, Denmark and Ireland. Greece and Portugal, even though they have no existing cable TV networks require only approximately ECU 3 bn of investment between them by virtue of their small and concentrated urban populations. France, Italy, Spain and the UK, all require a large amount of investment to reach 50% coverage. The UK figure of ECU 9.2 bn compares favourably with recent industry estimates that an investment of ECU 8.7 bn (£6.8 bn; source: UK CCA) is required to reach at least 14 million homes in the UK. The Scandinavian countries (Finland, Norway and Sweden) also require significant investment to reach full target penetration levels.

The following table presents the same figures in tabular format.

CATV	Target penetration		Total
	50%	*100%*	(M ECU)
Belgium	0	200	200
Denmark	0	900	900
France	6,200	11,800	18,000
Germany	0	8,700	8,700
Greece	900	900	1,800
Ireland	0	400	400
Italy	8,000	8,000	16,000
Luxembourg	100	100	200
Netherlands	0	300	300
Portugal	600	600	1,100
Spain	5,800	6,600	12,500
UK	3,900	5,300	9,200
	0	0	0
Austria	0	1,700	1,700
Finland	0	2,600	2,600
Norway	300	3,500	3,800
Sweden	0	6,800	6,800
	0	0	0
Total (M ECU)	25,700	58,400	84,200

Figure 30 *Expansion of cable TV networks investment requirements*

In total, we estimate that ECU 84 bn is required to expand Europe's existing cable TV networks to reach 90% of Europe's the 'sixteen') urban population. This figure include transmission elements only and does not include set top boxes or any PSTN switches that would be needed if a voice telephony service were to be provided.

8.3.2 Upgrade of existing cable TV networks

In addition to the new build cost required to address previously unserved homes there is a requirement to upgrade the existing (in some cases quite old) cable networks in Europe so that their channel capacity and quality can be expanded to support new interactive multimedia services which require a return communications path.

Limited data exists regarding the true physical state of these networks, the extent of optical fibre deployment and the amount of work required to upgrade them to networks capable of carrying interactive multimedia services. The UK cable Communications Association (CCA) estimates that a further ECU 20 billion is required to upgrade the existing 35 million cable TV households in Europe.

We estimate that it would cost ECU 19.6 bn to upgrade existing cable TV networks in the 'twelve' (EU countries in 1994) and ECU 22.4 bn to upgrade up the 'sixteen'. The bulk of this upgrade cost is in Germany, Netherlands and Belgium - countries in which cable TV networks are presently well developed but which need substantial upgrading to provide two-way, interactive multimedia services.

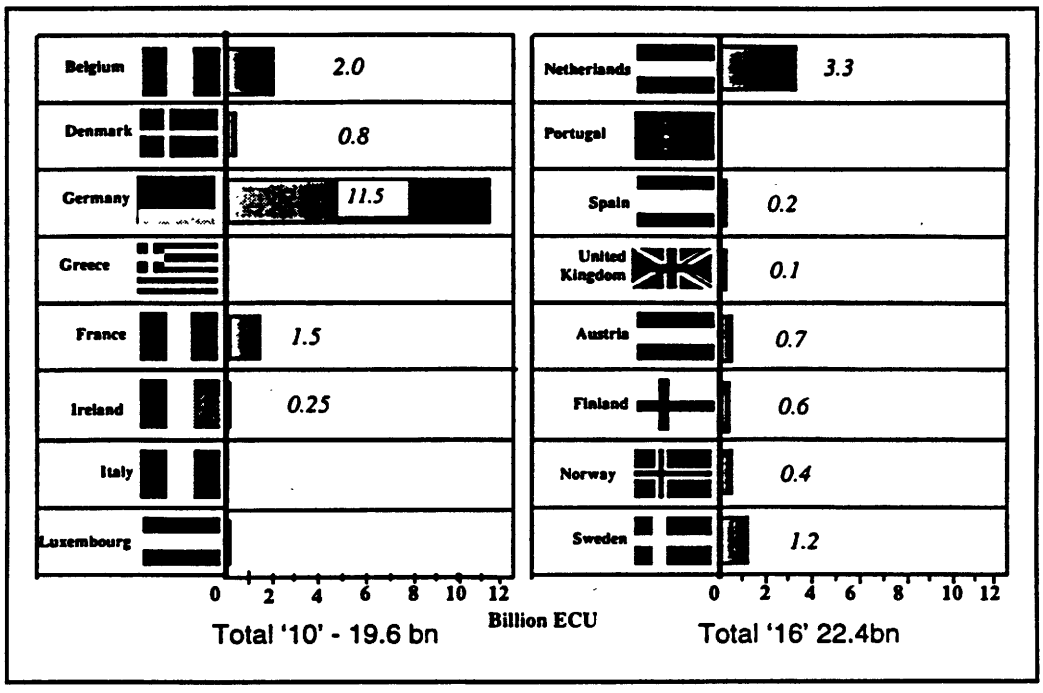


Figure 31 *European cable TV upgrade costs*

The principal assumptions we have assumed in calculating these upgrade costs are as follows:

- approximately 60% of existing ducts in the current networks can be re-used with only minor repair, the rest will need to be re-built;
- optical fibre is provided to the 500 home level;
- the scrap costs of the redundant cable and equipment is sufficient to pay for their removal;
- all set-top converters are replaced;
- the network is equipped so that it can supply all cable TV connected homes with a telephone service.

These assumptions are believed to be a reasonable base case.

Our figures include the cost of upgrading set top boxes which are fundamental to service. However, in the interest of comparison with other estimates, where no CPE is included, we have re-run our models excluding these costs. This has the effect the reducing the cost for the 'sixteen' from ECU 22 bn to ECU 17 bn as is explained in the following section.

8.3.3 Other cable TV investment requirements

Set top boxes

Substantial investment is required in set-top boxes/converters in the home to allow TV and multimedia services to be accessed. There is presently an industry wide debate as to who will own the set-top box. Some sources believe that eventually the set-top box will be incorporated into television sets and personal computers. The consumer would then bear the cost of the set-top box within the total cost of his or her, integrated multimedia system.

Industry consensus is that the cost of stand-alone boxes will mean that initially they will have to be either rented or heavily subsidised to achieve adequate market penetration. They could be owned by the cable TV infrastructure provider or alternately owned by the provider of a service which is being used by the subscriber, but it is unlikely that consumers will tolerate a different set-top box for each service purchased.

Assuming an indicative set-top box cost of around ECU 140, an estimate of investment required to provide existing subscribers with a new set top box is given below. The table also shows an estimate of the investment in set top boxes required for 'new' customers - those additional customers that would be brought into service if networks were expanded to address 90% of urban communities. It is likely that over the next five years a large proportion of existing set-top boxes will be replaced so that they can handle the new interactive multimedia services being proposed.

Set-top boxes	Present investment	Additional required to expand network to 90% of rural homes
	(M ECU)	(M ECU)
Belgium	450	30
Denmark	180	70
France	490	1,550
Germany	2,350	1,300
Greece	0	250
Ireland	40	40
Italy	0	1,830
Luxembourg	0	20
Netherlands	670	50
Portugal	0	150
Spain	90	1,410
UK	340	2,100
Austria	120	110
Finland	100	70
Norway	80	90
Sweden	220	150
Total (M ECU)	5,130	9,220

Figure 32 *Set-top box investment requirements*

Related network investment

An estimate prepared by the UK Cable Communications Association (CCA), of the required investment in cable TV infrastructure in the UK is shown below. It can be seen that significant investment, aside from civil engineering and physical infrastructure, needs to be made including investments in land and buildings, switching and set-top convertors. These non-network costs are expected to be large. The cost of administration, finance, marketing and operations could readily add up to 25% of the physical infrastructure cost.

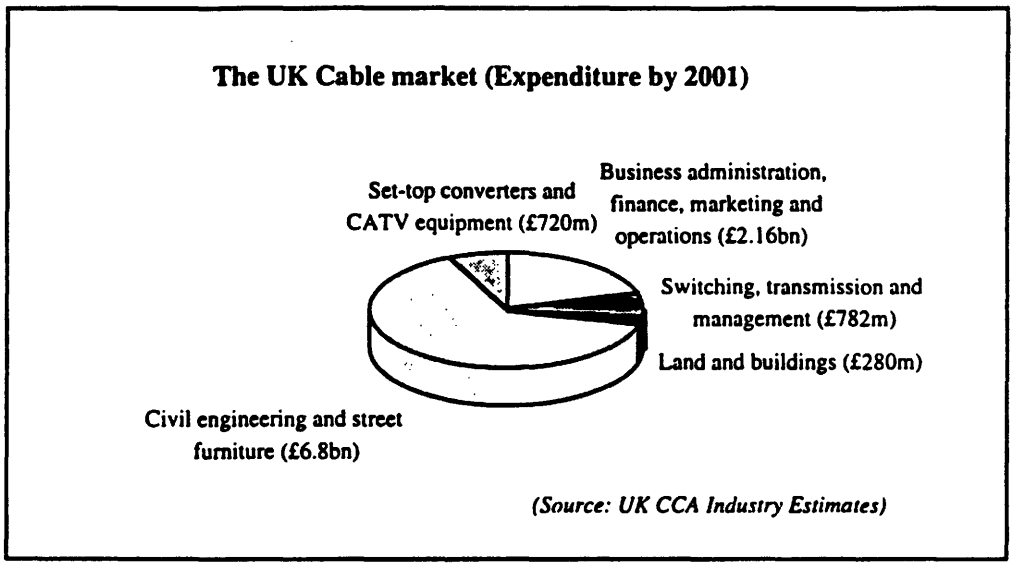


Figure 33 *UK cable TV projected expenditure*

Multimedia servers

Multimedia servers (also known as video servers) are repositories for multimedia information which can be called up on demand and would be needed if the cable TV industry were to provide access to films on a demand basis rather than according to a pre-determined schedule. The investment in these servers has not been treated in this study as a telecommunications network infrastructure cost. This 'service provision' cost will be borne by service providers which may or may not operate the infrastructure over which the services are carried. The take-up of services requiring these multimedia servers is very unclear, a fact confirmed by our interviews with industry leaders. The sums involved are difficult to estimate as they are linked to the take-up of these services by the general public. Indicative costs however, under a number of different deployment scenarios are shown below.

Video server investment requirements			
Year	1995	1998	2000
Cost per subscriber (ECU)	375	250	125
European connected cable homes		- 35 Million -	
Penetration	5%	40%	80%
Investment (M ECU)	650	3000	1750

The figures shown above indicate the investment required in video server equipment across Europe to achieve given penetration levels in each of the three years, to reach a maximum of 35 million cable TV subscribers. The investment figure in the last row of the above table is that needed to increase the penetration from the previous level - it is not cumulative. The number of subscribers could be greater or smaller, and the costs are still uncertain, however these figures estimate the scale of the investment involved.

8.3.4 Cable TV investment summary

Combining the upgrade and expansion costs, the total investment required in European cable TV infrastructure in order to carry a broadband video signals in one direction and a degree of limited interactivity in both directions, is of the order of ECU 130 billion. This is broken down as shown on the following diagram. The ECU 85 bn 'civil works, cables, installation and equipment' relates to the cable TV upgrade cost of figure 30 while the ECU 17 bn 'network upgrade costs' related to the total shown on figure 16 less the cost of set-top boxes detailed in figure 32.

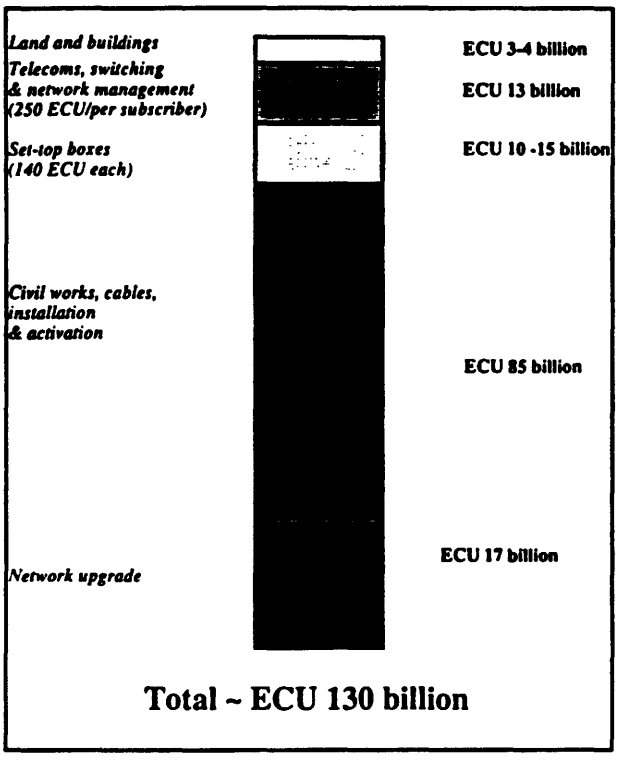
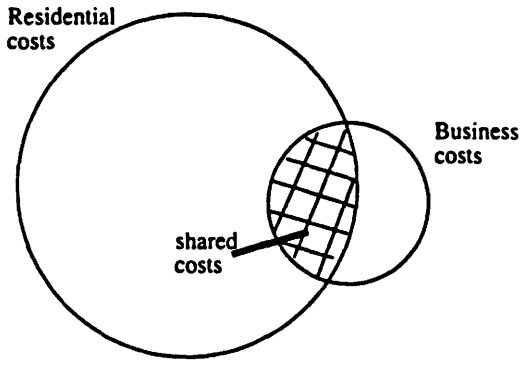


Figure 35 *Required cable TV investment in Europe*

8.4 PSTN infrastructure

The coverage of PSTN infrastructure in Europe is much wider than that of cable TV because telephony is considered an essential service by many and universal service obligation requirements exist on TOs. The requirement of PSTN networks is therefore primarily to upgrade rather than expand. Despite some localised waiting lists, virtually anyone who wants a telephone in the EU already has access to one. It is instructive however to consider the cost of providing a greenfield telecommunications infrastructure to serve European residential and business customers. This gives a measure of the costs associated with setting up competing telecommunications infrastructures and allows conclusions to be drawn regarding a range of options/regulatory scenarios which may allow the total investment requirement to be reduced, thereby encouraging the entrance of new competitors to the market.

A sensible plan for the provision of services to both the residential and business communities will share costs. Costs of providing fibre to the business and fibre to the home will therefore overlap as shown below. Nevertheless, for simplicity business and residential costs are separately addressed.



8.4.1 Fibre to the business

To estimate the infrastructure requirement for fibre-to-the-business (FTTB) it was desirable to obtain information regarding the number of businesses, spilt by size (ie large and small/medium sized enterprises, SMEs) and their distribution within a country's geographic area.

Without substantial research, consistent data regarding the geographical distribution of the sizes of businesses is not available. Nevertheless, distribution of businesses is weighted even more heavily towards urban areas and especially city centres than that of population. In the absence of better data the working assumptions used in our model are that 50% of all business are located in city centres, 40% in urban areas and 10% in rural areas. Furthermore, all of these businesses were assumed to be distributed within half of each respective geographical area. Large businesses will have several sites; we made broad assumptions based on representative numbers of employees per site.

Country	*Businesses*	
	Large	**SMEs**
Belgium	640	201,708
Denmark	307	207,161
France	2,717	1,586,011
Germany	5,608	3,078,497
Greece	239	266,306
Ireland	165	88,894
Italy	1,660	1,834,445
Luxembourg	29	14,295
Netherlands	474	510,839
Portugal	460	212,829
Spain	959	868,686
UK	4,079	1,430,919
Austria	295	332,099
Finland	472	276,963
Norway	427	254,643
Sweden	540	477,999

Figure 37 *Businesses throughout Europe*

Our network infrastructure model was run for this input data and the estimates of the cost of FTTB contained in the table below were calculated. These estimates represent an approximation of the construction costs (ducts, cables and installation) of building a telecoms infrastructure to address all businesses within a country from scratch (ie no existing network build or duct sharing). This investment includes costs for both the trunking and access parts of a telecommunications network in each country. However no switching or service processing costs have been assumed.

Fibre to the business	*Country total* (M ECU)
Belgium	1,200
Denmark	1,200
France	12,500
Germany	12,300
Greece	1,400
Ireland	700
Italy	8,500
Luxembourg	100
Netherlands	1,500
Portugal	900
Spain	6,600
UK	6,800
Austria	1,800
Finland	2,900
Norway	3,000
Sweden	5,300
Total	66,700

Figure 38 *FTTB investment costs*

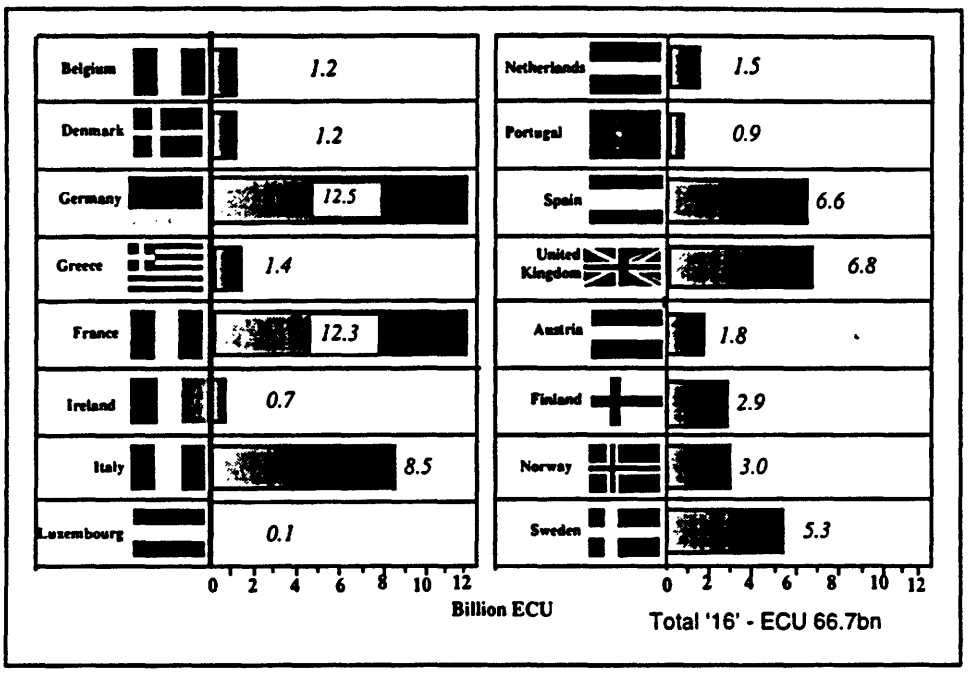


Figure 39 *European FTTB costs*

Figure 38 and 39 give the cost of providing a service to all business. For comparison, we also calculated separately the cost of accessing large businesses and city centre locations alone. The total costs across the 'sixteen' were ECU 13 bn for all large businesses and ECU 11 bn for city centre businesses (large, medium and small). These figures show the considerable reduction in investment required by being selective in terms of the markets to be addressed. These figures each represent approximately 5% of the cost of addressing the total market, yet this investment will enable considerably more that 5% of call volumes to be targeted.

8.4.2 Fibre to the home

Next, the greenfield optical fibre infrastructure required to connect all residential homes in each European country was calculated. Urbanisation, land use and household data was obtained from a number of sources. Population distribution within each of these countries was estimated using a weighted average European telephone line length distribution. This factor, also used for calculating the investment in European cable TV infrastructure, was based on the assumption that 90% of the population in any geographic area, live within 50% of that geographic area. The costs resulting from this analysis are shown below:

FTTH (100%)	Total (M ECU)
Belgium	5,800
Denmark	6,400
France	61,100
Germany	57,000
Greece	5,800
Ireland	2,800
Italy	41,600
Luxembourg	400
Netherlands	8,000
Portugal	4,200
Spain	32,100
UK	26,500
Austria	9,800
Finland	16,800
Norway	16,000
Sweden	31,000
Total	325,300

Figure 40 *Fibre to 100% of homes*

FTTH (90%)	Total (M ECU)
Belgium	4,100
Denmark	4,700
France	44,800
Germany	40,800
Greece	4,300
Ireland	2,100
Italy	30,300
Luxembourg	300
Netherlands	5,700
Portugal	3,100
Spain	23,600
UK	19,000
Austria	7,200
Finland	12,500
Norway	11,900
Sweden	23,000
Total	237,400

Figure 41 *Fibre to 90% of homes*

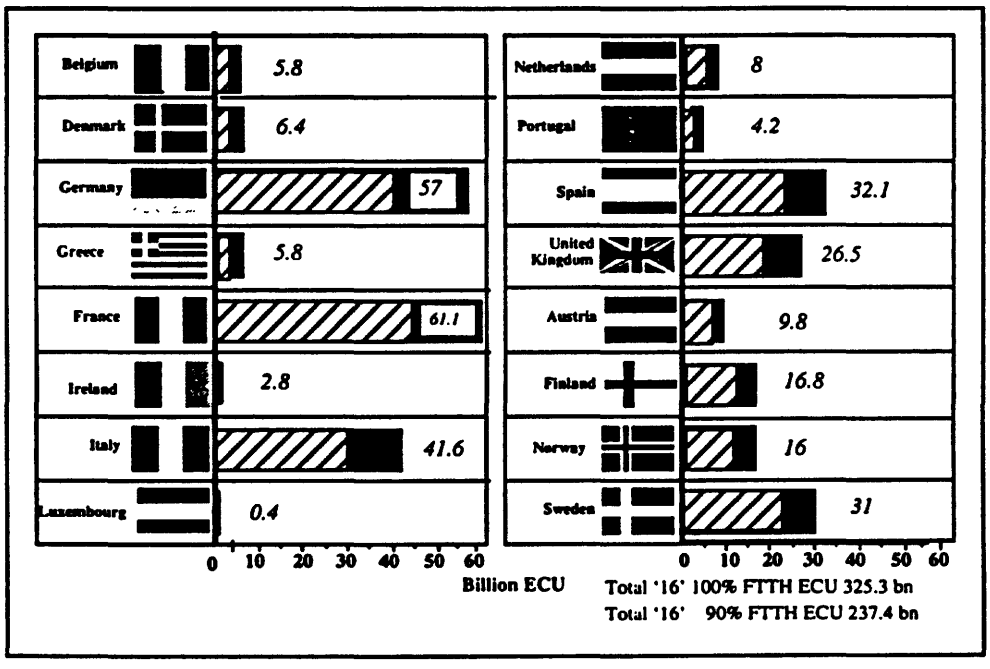


Figure 42 *FTTH (100%) & FTTH (90%) investment requirements*

As has been already discussed, a network initially built to serve high traffic generating business customers could also be subsequently extended to serve residential customers. However the figures given in the above table are still useful in comparing the relative size of the investments needed to meet the needs of these different user groups.

To estimate the incremental cost of adding residential subscribers to a network designed for business users we subtracted the FTTB figures quoted in section 8.4.1 from the headline figures quoted in section 8.2 for addressing all homes and all businesses. The incremental cost of adding 90% of residential users to an existing business network is thereby estimated to be ECU 178 bn.

8.4.3 Other related costs for enhancing PSTN

ADSL

Figures on European PSTN penetration are given in Chapter 6. The PSTN network is primarily a narrowband network consisting of high capacity trunks interconnecting local and national switching exchanges. The local access network consists almost entirely of twisted copper pairs spreading out from local exchanges up to a distance of 6 kms. These copper pairs have limited capacity for providing broadband services to end users.

ADSL technology however can be used to enhance the capacity of these copper wires so that a number of compressed video services can be sent to the home simultaneously. The cost of this ADSL technology is presently prohibitively expensive. If we accept the costs quoted by telephone operators planning to trial this technology of 500 ECU per line for volume deployment, the total investment required to provide all European telephony lines with ADSL capability would be around ECU 70 billion. Manufacturers are however quoting much higher prices for ADSL.

It is unlikely that more than a small fraction of Europe's network will use ADSL technology. It is perceived as an interim solution which does not provide the future proof investments of other infrastructure technologies (eg fibre-to-the-home).

Country	Total ADSL lines req'd (Million)	Total Cost (M ECU)
Belgium	4	1,800
Denmark	3	1,400
France	26	13,100
Germany	28	14,600
Greece	3	1,600
Ireland	1	400
Italy	22	11,100
Luxembourg	0	100
Netherlands	6	3,300
Portugal	3	1,300
Spain	11	5,700
UK	26	13,100
		0
Austria	4	1,900
Finland	2	1,200
Norway	2	1,100
Sweden	4	1,800
Total	143	73,500

Figure 43 *Investment required in ADSL to address all of Europe*

Processing

We have not explicitly calculated a cost for multimedia processing or switching. The usual split between switching, trunk and access is well known for basic voice telephony services. The likely relative split for broadband switching is much less certain.

In a broadband network with optical fibre to the home, there is a view that excess transmission capacity can be traded off against switching. Passive optical networks and wavelength division multiplexing architectures are being proposed which require little or no active switching functionality to route a signal to its destination. The removal of the bandwidth and distance limitations of copper in the local loop, allows fewer, bigger switches to be located throughout the network, rather than numerous local switches, located close to the subscriber as is presently the case.

ATM (asynchronous transfer mode) technology is the preferred switching technology for multimedia and allows services of different bit-rates to be switched and transmitted over the same network. The speed of introduction of this technology and the price at which it will be offered is unclear. If however voice telephony remains the predominant revenue generating service it is unlikely that operators will pay much of a premium to introduce new switching platforms to switch predominantly narrowband services.

The introduction of ATM switches is likely to be as an overlay and the scale of investment is unlikely to exceed that being currently invested in conventional PSTN switches. A number of industry sources have indicated an expectation that the total investment in multimedia network infrastructure by existing telecoms operators is no greater than the investment which have already been made to upgrade existing PSTN switches from analogue to digital.

8.5 Infrastructure re-use

As was mentioned at the end of section 8.2 some of the physical infrastructure needed to meet any of the scenarios discussed above may already exist in a usable format and elements of the total build cost may thus be avoided. To illustrate the scale of this reduction, we consider in the table below how the cost of new provision of fibre to all homes and businesses in the 'sixteen' (estimated in section 8.2 to be ECU 333.2 bn) would change if we assumed that 60% of the infrastructure build costs could be avoided. The results of this analysis are shown below.

FTTH & B	*Total* (M ECU)
Belgium	3,000
Denmark	3,300
France	31,800
Germany	29,600
Greece	3,600
Ireland	1,600
Italy	21,800
Luxembourg	100
Netherlands	4,200
Portugal	2,600
Spain	17,500
UK	13,900
Austria	5,100
Finland	8,900
Norway	8,400
Sweden	16,400
Total	171,800

Figure 44 *FTTH (100%) and businesses (100%) with 60% duct sharing*

The effect of re-using or sharing resources is dramatic. Investment costs of ECU 333 bn are reduced by 48% to ECU 172 bn. Since Europe is entering a competitive era in the supply of telecommunications services and infrastructure, and two conclusions can be drawn. First, companies with usable infrastructure (and this group need not be not restricted to existing TOs but may also include, for example, cable companies or other utilities) will have the potential for considerably reduced network build costs. This in turn means that one or more of the following may occur:

- incumbent TOs maintain competitive advantage into the multimedia era;
- market entry into local distribution will be restricted to those geographic areas where companies have re-usable infrastructure;
- competition in local competition is focussed in specific market segments (for example large businesses where high revenues justify investments.

The other major conclusion to be drawn is that the advantages of competition will be more readily achieved if a practical method can be found for sharing new or existing ducts. This is recognised to require significant effort but the scale of saving cannot be ignored. Some of the problems are lessened if a very long term view is taken.

8.6 Network competition

Competing infrastructure will duplicate some, but by no means all, infrastructure components. Commercial decisions will determine how much duplication is deemed by the market to be necessary.

To explore this effect, the model was used to calculate a generic curve which shows how much extra infrastructure (directly proportional to investment) is required if different numbers of competitors build networks within any one area, in order to address equal penetrations of customers, rather than having a single infrastructure provider supplying all customers. The ratio of the sum of the size of the competing networks divided by the size of a single network provider is shown on the Y-axis. The number of equal-sized competitors, each achieving equal penetration in the same geographical area is shown on the X-axis.

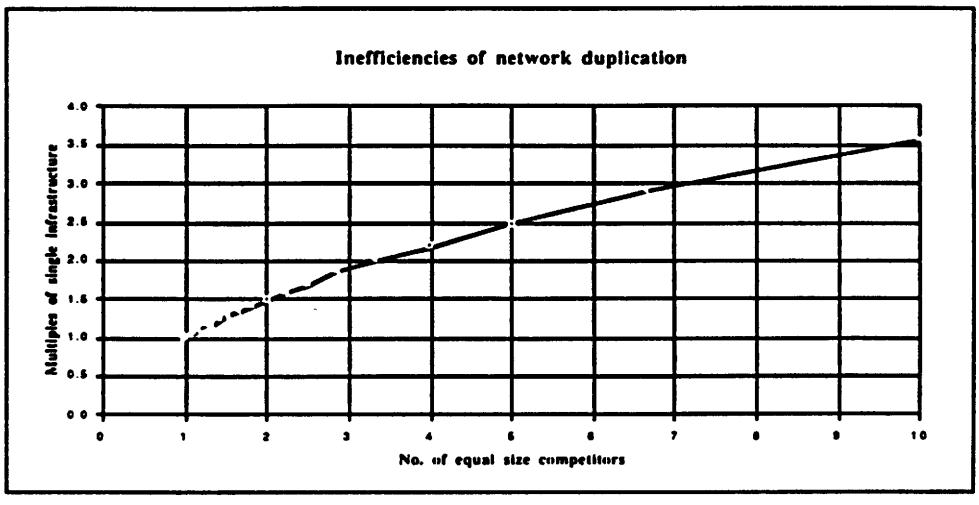


Figure 45 *Inefficiencies of network duplication*

It can be seen that for two network operators, each optimising the design of their networks to address equal penetrations of customers in the same area, require 50% more infrastructure than would be required if only one infrastructure provider addressed all the customers. For five competing operators in the same area, the penalty would be 150%.

This curve assumes that operators will compete equally across all geographic areas. In practice some operators will prove dominant in certain areas, thereby reducing their per customer spend accordingly. In this sense, this curve gives an upper level to the network inefficiencies of competition. Supplier churn and diversification of supply means that there will be an extra element of duplication to consider. However, the curve takes no account of any existing infrastructure that may be re-utilised as part of the network build

as was discussed in section 8.5. This effect would reduce the duplication cost substantially. The exact level will depend on practical consideration but if we assume that 60% of ducts are shared the cost penalty of duplication falls to 14% (from 50%) for two competitors and to 54% from 150% for five competitors.

This analysis suggests that:

- without duct sharing, local competition is less likely to occur and may be restricted to those areas where higher revenues compensate for additional costs;
- duct sharing is a very attractive way of reducing entry costs to new competitors and removes a substantial element of the inefficiencies of infrastructure duplication; if any element of a communications network is a natural monopoly, it is the ducts themselves;
- the cost of several (more than two) competitors (especially where duct sharing arrangements exist) is not simply a multiple of the number of suppliers.

9 Investment availability

The overall conclusions from our interviewing is a general acceptance that the necessary funds can be found to build competing broadband networks under the right conditions. There are however a number of uncertainties relating to what the 'right conditions' include.

9.1 Telecommunications investment history

The table below (sourced from the ITU) shows the investments made by TOs in telecommunications.

Telecommunications Investment in Europe

	ECU m 1991	ECU m average 1988-91
Belgium	1012	954
Denmark	543	614
France	5928	6104
Germany	18172	14916
Greece	673	446
Ireland	290	310
Italy	10699	9841
Luxembourg	79	70
Netherlands	2002	1885
Portugal	1053	706
Spain	7128	7002
UK	5604	5927
Austria	2021	1684
Finland	843	890
Norway	578	602
Sweden	1643	1446
Total 'sixteen'	58269	53398

Source: ITU

Figure 46 *Historic investment in European telecommunications*

The table shows a total annual investment of nearly ECU 60 bn in 1991. If this scale of investment were to continue and was directed at the enhancement of transmission infrastructures that could support broadband services the levels of investment required to develop the infrastructure do not appear unachievable over the decade or so that is envisaged necessary to build a European broadband network.

Recognising that the total level of investment required is not so high as to be totally unreasonable, we consider some of the conditions that would encourage or hinder it occurring.

9.2 Investment in cable TV

The successful flotations of the UK cable operator TeleWest (and, for that matter, BSkyB to some extent) at the end of 1994 shows the favourable sentiment that the market currently holds for at least the early entrants into new entertainment services. It is by no means clear that this will continue in the long run without a stable regulatory framework and evidence of sufficient revenue potential to cover cost.

The UK cable industry provides a useful indication of the conditions under which private investment can be attracted into underwriting the very large capital costs that building a large public network involves. By the end of 1994, the industry had invested approximately £2.7 bn of the estimated £10bn required. This has occurred despite the date at which many of the operations are forecast to make an operating profit still being some way off. This long pay back is partially due to the capital costs in building the networks but it is also due to 'limited' revenues resulting from the high rates at which customers give up or 'churn' the cable TV service and a penetration level that has been firmly stuck at about 21% for over 18 months.

The attraction for investors is that cable networks operators in the UK can offer both entertainment and telephony services over a single network. Though there is extensive competition in both television and telecommunications, it is currently only the cable TV operators that can offer both services. The other national telecommunication organisations have been prohibited from providing entertainment services over their telecommunication networks until at least 2001 (although this date may be reviewed in 1998).

There is strong indication (both in terms of comments made to us and more publicly) that the investment community regards cable TV revenues alone as insufficient to support the heavy capital investment required to invest in cable TV networks suitable for multimedia services. The general belief is that they would have as a minimum to be supplemented by telephony and, furthermore, that some protection against erosion of the existing cable TV revenues may also be required. The main concern when it was originally proposed that cable TV operators should begin to offer telephony was that there could be a competitive response from BT which would cause significant damage to revenue prospects of new cable companies.

The ability to combine two or more revenue streams and protection against loss of entertainment revenues was considered crucial to attracting investment in the UK. They reason that the same situation will be required if investment is also to occur in other markets where cable TV is either yet to be developed or needs enhancing. Investors in this group frequently believe that the most appropriate form of market entry assistance is through asymmetric regulation that permits alternate infrastructure providers to offer both entertainment and telephony while prohibiting the national TO from providing entertainment services. It is generally recognised that this entry assistance should only be temporary and that its nature should not be such that it would harm the economic health of any existing operator.

In the UK, BT has argued strongly that prohibiting it from providing entertainment services limits the amount of capital available to invest in new multimedia services,

delays the creation on new services and may have a significant impact on the long term commercial success of the firm. Nevertheless, BT's preclusion from general entertainment services will be maintained to at least 2001.

9.3 Funding new entrants

In telephony the costs of building a rival network to the indigenous TO's are considerable, and it is generally assumed that the investment will only be justified where one or more of the following applies:

- the focus is on long distance trunk services where investment is more concentrated;
- limited networks that address low cost and high revenue subscribers;
- the new entrant has re-usable assets (eg utility companies);
- the new entrant can otherwise reduce network build costs by sharing ducts or, if the price falls sufficiently, using wireless access.

As in the case of upgrading existing cable TV networks the expectation is that telephony revenues alone are insufficient to justify the high cost a risk of building a new local loop serving residential subscribers. If this is to occur the finance community will be seeking additional assurances of lower cost or higher revenues.

On the other hand, there is a strong expectation that as soon as regulatory restrictions are lifted, the provision of alternative PSTN services (especially trunk and international services) on self provided infrastructure will be offered to large business users.

9.4 The global investment climate

Fewer restrictions on cross-border investment has made capital increasingly mobile and the rapid pace of telecommunications liberalisation across the world has meant that investors take an increasingly global view. The attractiveness of the EU for telecommunications investment is, however, uncertain as other markets open up. It does not have the rapid economic growth of, for example, some East Asian countries or the rapid growth of, say Latin America or East Europe in basic telecommunications services which have a more certain demand. The regulatory climate in Europe, is generally perceived by new investors as neither dynamic nor liberal.

At a global scale availability of capital for telecommunications investment is seen to be under pressure. A large number of state-owned telecommunications operators are scheduled for privatisation over the next five years and are likely to consume much of the investment capital in the financial markets available for the telecommunications sector. Therefore, new entrants or expansion by the smaller alternative infrastructure providers may have to depend more on financing through venture capital and/or more highly geared debt funding. Taken together, these factors may significantly affect the costs of finance.

Often investment decisions are based on the performance of previous investments and existing operators. At this stage of the development of this new market, the investment community is likely to face a problem. It can examine the results of telecommunications operators and get some benchmarks for financial performance and have a degree of confidence in future projections. It can do the same for the cable TV companies. With multimedia companies, investors do not have the same benchmarks to call on and they also have the added risks of two separate technologies being brought together in an, as yet, untried manner.

However, although neither venture capital nor debt is available without limit the creation of quoted sectors for telecommunications and cable companies increases the exit possibilities for venture capital and offer a wider mix of equity funding which should help improve availability.

A recent KPMG study that involved a comprehensive review of investment in cable TV in the UK indicated a number of concerns and suggested the potential need for considerable debt funding. A copy of this report is attached to this report as Appendix C. The main findings from the report are as follows:

- most financiers and operators expect the current UK cable franchises to be fully built by 2000;
- most financiers are still cautious about cable with North American banks expected to provide some two thirds of the lending to the sector;
- bank finance is still heavily dependent on support from North American telco and cable parents;
- financiers stress the need for high quality management but are relying on the operators' parent companies to provide it;
- financiers mainly think of cable as a telecoms network. They may under estimate the role of entertainment in attracting subscribers and generating revenue. The importance of the TV programme offering is not properly appreciated;
- although interactive services are much discussed, financiers do not know how to evaluate them properly;
- revenues from TV advertising and value added telephony are also not being evaluated;
- the main threat to cable's future is thought to be the possible deregulation of BT;
- overall, financiers believe that cable will be the best delivery method into the home.

We gained no evidence during this study to suggest that the broad findings, which are to some extent specific to the UK, need substantial review. Indeed, confirmation of a number of the findings was provided by the TeleWest flotation prospectus which was based on telephony and TV entertainment revenues only. Multimedia opportunities

were only mentioned as an ancillary aspect. The success of the flotation has, nevertheless, injected new optimism that further flotations may be able to provide at least some of the future funding required. The success also provides potential trade investors with evidence of an exit strategy adding credibility to those seeking strategic investment partners.

A particular question concerns the availability of US funding. The injection of capital by Regional Bell Operating Companies (RBOCs) and North American cable companies has fuelled the rapid expansion of the UK cable industry. Part of the attraction of UK cable for these companies was the rate of return regulation of telephony in their domestic PSTN operations coupled with the regulatory constraints prohibiting them offering entertainment services in their home markets. As a result, the RBOCs not only had large sources of cash but also had the incentive to build cable TV experience in the UK before liberalisation occurred in their home markets. However, the domestic situation has changed and many of the US network operators have announced very large investment programmes to upgrade their US networks. This may limit the availability of capital from a previously important investment source.

9.5 Interventionist funding

Another source of funding is from government or the European Union itself. Many companies are certainly hoping that funding of this type can be made available. For many of the alternate infrastructure providers, capital is very limited and investment is unlikely to be undertaken unless there is a guaranteed investment stream. Creating multimedia services where the demand is uncertain and commercial opportunity is, as yet, unclear is seen as a speculative investment.

A number of interviewees indicated that funding of pilot networks by the EU may be a useful way of reducing the uncertainty and encouraging wider investment in more innovative services. This would only advance the objectives of the Bangemann report if funds are used as a seed for attracting additional private investment. The pilots would need to have an applications focus and may, for example, address public administration systems. TENs in particular was seen as an appropriate mechanism.

9.6 Summary

In summary, while the industry seems positive about the opportunities for attracting investment, the growth of telecommunications investment opportunities across the world improves choice for investors and increases the emphasis on the strategic value of an investment. Protection of established TOs is seen to be a barrier investment in new ventures from outside of the region and multimedia generally is seen to be high risk. Companies will not therefore find it easy to finance all new network developments and it is likely that the investment community will become increasingly selective in the projects they fund.

10 Achieving European policy objectives

A number of measures can be used to encourage infrastructure development. In this chapter we first summarise the findings of our study before considering how European policy objectives can best be met. We make a number of recommendations throughout the chapter.

10.1 Key findings

There are two types of multimedia services: information (or content) services where information is provided to users in a variety of formats including text, video, image or audio; and communications services that allow the electronic conveyance of multimedia information. Communications services may be provided in their own right, for example, a multimedia e-mail service, or may be used by information service providers as a means of delivering products to their customers. Multimedia services of both types provide significant opportunities for users and suppliers alike and are fundamental to the realisation of the European information society.

Multimedia services have become feasible as a result of developments in both information technology and telecommunications. Much, however, still has to be done before services are widely available. The focus of this study is one of the key elements of this development plan - the provision of an infrastructure that will support multimedia communications services. This will require significant investment.

A new industry must be created to deliver the new multimedia services. This industry will result from the convergence and interaction of three historically distinct industries - telecommunications, media and consumer electronics (including in particular the personal computing industry). Major players in each industry view the development of multimedia services as a fundamental element of their strategy and are actively considering their response to the anticipated convergence. Alliances are being formed, trials are being planned and infrastructure requirements are being assessed. Nevertheless, there is still considerable uncertainty and as yet it is not possible to see how the new industry will be structured. The uncertainty is exacerbated by as yet undefined markets and services. As a result detailed deployment plans do not currently exist and, as a consequence, investment requirements remain unclear. Our cost estimates are therefore provided for a range of implementation options.

Multimedia services will be delivered on broadband networks largely constructed from optical fibres. These fibres may eventually extend right into each business and home on the network. In line with the Bangemann report and the Green Paper on infrastructure liberalisation, competing networks will be developed and funded from private investments. These competing networks may be deployed in a variety of ways with differing commercial impacts. The early stages of development are likely to include:

- cable TV networks may be enhanced to allow telephony and other interactive services. This would allow cable TV operators to broaden their service offerings especially to residential users;

- asymmetric digital subscriber line (ADSL) may be used to increase the bandwidth of existing local loop used for telephony. This would allow

telecommunications operators (TOs) to provide entertainment services;

- high value customers (for example large businesses), who because of geographic concentration can be more cheaply addressed, will be targeted with new fibre based networks using synchronous digital hierarchy (SDH) transmission. This provides a low cost entry route for new competitors.

All approaches have an increased penetration of optical fibre in common.

As demonstrated in chapter 8, the investment required to develop the necessary infrastructures will be considerable. To build a new fibre based, broadband network entirely from scratch and covering all homes and businesses in the 'sixteen' is estimated to cost ECU 333 bn. However, this cost can be substantially reduced. For example, restricting coverage to urban homes reduces the cost estimate to ECU 201 bn, while concentration on large businesses reduces the cost to ECU 13 bn. Another major saving can be achieved if civil construction costs are avoided. Our figure of ECU 333 bn assumes all cables are laid in underground ducts. If 60% of the new network were laid in pre-existing duct the cost would reduce to ECU 172 bn - a 48% saving. Upgrading existing cable TV networks is estimated to cost ECU 17 bn, while expanding cable TV penetration (using latest technology) to 90% of urban homes, or 71% of all homes, would require ECU 84 bn.

A mixture of debt and equity will be needed to fund this investment and we believe that investment will be forthcoming if certain conditions are met. These conditions will arise as a result of the inherent risk of the long term nature of infrastructure investment and uncertainties about service revenues. Whether these conditions are met will depend in part on regulation. In this chapter we discussed these conditions in broad terms and give a number of specific recommendations.

10.2 Policy objectives

We suggest that the objective of the Commission should be to define policy options for the development of multimedia services that balance the interests of users, providers and investors. Measures should also ensure that short term objectives are met while recognising the need to lay a sound foundation for long term development. These interests were discussed in chapter 4.

In section 6.5 we indicated that the deployment of broadband infrastructure will follow a natural progression reflecting the commercial reality that some customers will be more profitable to address than others. The Information Society will become a reality in the shortest timeframe if investment occurs over a broad front. A number of measures can influence this process. Examples include:

- competition and lines of business: measures controlling the extent of competition in the provision of infrastructure and controls on the lines of business pursued by these competitors. Issues of note include support to new entrants and the extent to which vertical and horizontal integration is appropriate;

- regulatory framework: definition of the overall framework within which regulation will occur and the specific manner (for example what licensing terms will be applied) to realise this framework;

- other policy measures: including resource sharing, standards, R&D funding and taxation.

We consider each of these areas in turn.

10.3 Competition and lines of business

10.3.1 General concerns

The competitive environment will influence investment decisions. For the telecommunications industry, where there is often an established monopoly provider, two areas in particular need to be considered. These are market entry assistance and measures to prevent anti-competitive behaviour; the objectives of the two can conflict. In a developing market such as multimedia, encouragement to early entrants can stimulate more rapid and more widespread deployment of services. Support may include more lenient regulatory conditions or restrictions on an existing monopoly aimed at helping new entrants develop a sustainable position. However, it is important to ensure that this encouragement is neither abused nor excessive in both the short and the longer term.

Below we consider the factors that might influence where the balance between entry support and measures to protect against anti-competitive behaviour lie. We begin this discussion by looking in general at competitive environments.

When assessing this environment, questions include: how many competitors are appropriate; what, if any, restrictions should be placed on them or their activities; what, if any, support should be given to new entrants; and over what period restrictions or support should be offered. It is important that:

- competition is fair;

- entry support is reasonable and does not unnecessarily restrict established operators;

- vertical and horizontal integration is not abused.

We consider basic competition models first. The two extremes are monopoly provision or totally de-regulated competition. Maintenance of a monopolistic environment in the provision of infrastructure may create an environment conducive to investment but it would not necessarily provide benefits to users of the infrastructure in terms, for example, of service innovation, level of service, operating efficiency or price. For these and other reasons the Green Paper has recommended against the continuation of monopoly supply. The UK has demonstrated how effective competition can be, particularly in reducing price and improving quality.

At the other extreme total de-regulation may enable dominant operators to abuse that position and their economies of scale by, for example, excluding new entrants through

predatory pricing or allowing the company to gain advantage in other related fields through cross-subsidy. Nevertheless, free market economists argue that only a truly competitive market will result in the 'creative destruction' that ensures that consumers benefit from the least cost solution.

There is, however, a middle ground between the two extremes of unfettered competition and monopoly supply. This ground is occupied by the idea of regulated competition. The challenge is achieving an acceptable balance between regulatory safeguards and free market mechanisms. Without intervention, competition in embryonic markets such as multimedia may well fail. This concern is considered by many in the industry to be the only justification for intervention of any kind.

Free market economists argue that 'protected' new entrants tend not to create innovative, lower cost solutions. They are concerned that these organisations tend to hide behind the regulation and expend effort lobbying the regulator rather than achieving true competitive advantage. They also believe that this has the compounding effect of diverting the innovative resources of the dominant operator. A final concern they express, is that protected new entrants never develop the strength to compete in an open market and regulation becomes self-perpetuating.

The issues of vertical integration (across services) and horizontal integration (across markets) must also be addressed. Integration is not by itself of concern. What is of concern is where, for example, a vertically integrated supplier has a dominant position in one part of the value chain that is exploited in other areas or where a horizontally integrated supplier cross-subsidises activities in one market from revenues in another. The Treaty of Rome already has instruments to preclude abuse of this type, although mention of specific concerns are relevant to this study. Short term vertical integration may benefit market developments, but has the danger of creating, in the long term, dominant players that abuse their position.

Attention to the avoidance of abuse should increase as the risks of abuse rise. If investment is to be encouraged, the conditions under which more onerous terms will be introduced must, however, be known and accepted by the market. Otherwise risks may be judged to be excessive.

Asymmetric Regulation

One key aspect relating to competition and lines of business is the extent to which conditions should be imposed equally on all players regardless of whether they are the dominant operator or are a new entrant. The imposition of different terms on different competitors is frequently referred to as asymmetric regulation.

This is particularly important when regulating lines of business (for example, whether telephony companies should be allowed to provide entertainment services even though cable TV companies are able to provide voice services) but can also apply to the full range of licence terms. In the UK, it is often argued by many that the investment in cable TV infrastructure would not have occurred without the incentive of a protected monopoly in the provision of cable TV supplemented by the added advantages of telephony revenues.

There is a danger, however, that an overly extended period of asymmetry could result in one dominant operator being replaced by another. As the revenues for multimedia services grow, we may see that traditional voice telephony providers see substantial pressure on traditional markets while being precluded from entering new ones. Investments in broadband infrastructure may, in such a situation, be controlled by the providers of cable TV.

Free market economists criticise asymmetric regulation as having all the faults of regulations - compounded by unequal application.

The challenge is to recommend 'necessary and sufficient' asymmetry between the two extremes outlined above. There are two issues of particular importance; namely the timing of the period of asymmetry and the extent of services covered. Regarding timing, investors require confidence that they will benefit from a period of sufficient length to achieve a reasonable payback period. A short period will do little to encourage investment. On the other hand, too long a period could result in complacency and the problems mentioned above becoming embedded in the industry.

In terms of the services covered, one approach would be to ensure no restrictions are placed on the provision of any new services, and to limit asymmetrical restrictions to well definable and existing services such as voice telephony or broadcast TV. In this way all parties should be encouraged to develop new applications while retaining a level of protection in the business of delivering established (and profitable) services. This should help gain investor confidence.

In summary, some of the dangers of asymmetric regulation may be removed if it is clear from the outset that there are definite limits to the level and duration of asymmetric controls. A regulatory balance may be achieved by setting a term and scope which will be reviewed either at certain times or at certain trigger points (relating, for example, to revenues). So long at the criteria for modification are understood and accepted, investors should still have the confidence to invest.

Differences between the state of infrastructure development and regulatory position of different national markets are likely to require different balance points to be defined.

These issues indicate the importance of a balanced approach to market entry support and prompts two recommendations concerning lines of business. The first is on specific market entry support, the second is on collaboration. These issues also impact the regulatory framework (especially when looking at timing issues) but we will return to this issues in section 10.4.

10.3.2 Recommendation 1.1 - Assistance to new market entrants

Motivation for policy

Existing operators may be so strong, and new infrastructure so expensive, that new investment will only be made if some advantage (over the incumbent) is provided to new entrants. This is particular true in the provision of local loop infrastructure to SMEs and residential users. For trunk services less investment is required, and for large businesses the potential revenues are greater.

Pros and cons

Organisations investing in UK cable television infrastructure have reiterated to us that they did so only because they:

- were protected against BT providing entertainment services;
- could supplement cable TV revenues with telephony revenues.

Prior to this stage of regulation, cable TV investment was slow in the UK and only large corporate accounts had competitive supply of local loop infrastructure.

However, such assistance to new entrants itself creates market distortions and may restrict development. Some argue that TOs are the organisations best able to invest in new infrastructure and that barring them from particular revenues streams will prevent new service development. They also express concern that denying established TOs new revenue streams will unacceptably weaken them - a particular concern where privatisation is planned or under consideration.

Generalisation from the UK example is difficult. Not only do other countries have different television and entertainment services, but also the cable television industry has developed significantly since the investment decisions of the 1980s. At first the decision was not to invest in UK cable television infrastructure for entertainment services alone. The position changed only when the advantages to cable TV operators over BT were confirmed by restricting BT from providing entertainment service while allowing cable TV companies to offer telephony.

Nevertheless, some likely conclusions from the UK experience can be drawn:

- provision of alternative wired local loop infrastructure to homes and small and medium sized enterprises (SMEs) will not be made for telephony services alone if the competitor has to build its own ducts;
- unless advantages over the TO are offered, significant risks exist that competitive supply of broadband infrastructure to homes and SMEs will not be made. Particular concerns include:
  - in a country like Greece or Portugal where the extent of cable infrastructure is now modest at best, the TO will have several years (because of derogations of EU policy) in which only it can install modern interactive broadband infrastructure to carry telephony as well as other services;
  - in a country like Germany, Ireland or the Netherlands which already has extensive cable television infrastructure installed by the TO there is little encouragement for new investment.

We recommend that the Commission should develop policies to address these risks. The challenge is to identify mechanisms that will give new entrants the necessary confidence to invest without precluding the development of new services by the TO.

KPMG sees two major alternative types of policy as being suitable:

- market entry assistance to new investors;
- resource sharing (see section 10.5).

Without either, strong risks exist that the Bangemann Committee's desired reliance on private sector investment and market forces will be undermined. The development of a multimedia service industry is then likely to rely on a single national infrastructure being operated under tight regulatory constraints to ensure operating efficiency. The development of Europe wide services would in turn require a strong European dimension to regulation.

Neither approach should be lightly dismissed, despite their obvious technical and political difficulties.

In this study we have developed models that allow the costs of alternative infrastructure provision models to be considered. But the economic feasibility of different competitive scenarios cannot be addressed without a simultaneous consideration of revenues. Informed debate and policy making can only occur if this action is progressed.

If market entry assistance to new investors is to be policy, then we recommend that a clear duration of any preferential treatment should be specified either in terms of a number of years or market circumstances (this is explored further in recommendation 2.1).

For speculative investments, such as those required to support multimedia services, some potential investors believe that the cost of early investment should be recognised through intervention funding or mechanisms that allow early investors to recoup their development costs from those who enter the market later. They argue that early entrants face the following specific concerns:

- the greatest risk in terms of market uncertainty;
- the need to wait a long time before realising revenues;
- the need to spend more as manufacturing economies of scale for equipment (particularly CPE) will not be available.

Those who oppose this position argue that competitive advantage outweighs the disadvantages and that reimbursement would discourage innovation. We support this view and do not believe that specific financial support should be provided to early entrants. However, support in terms of a 'supportive' regulatory regime appears to be more appropriate.

We therefore recommend the following.

> Recommendation 1.1 - market entry assistance
>
> The Commission should evaluate the need for, and extent of, market entry assistance, and in particular asymmetric regulation, taking into account a full cost benefit assessment (costs are addressed in this study - the benefits still need to be quantified).

10.3.3 Recommendation 1.2 - Collaborative ventures

Motivation for recommendation

Exclusive collaborative ventures may lead to vertical and horizontal integration, creating powerful new monopolies in the emerging multimedia industry and risking abuse of a dominant position. On the other hand such ventures may both simulate the development of innovative multimedia services and make infrastructure investment more likely.

Pros and cons

Collaboration between infrastructure and multimedia 'content' providers may facilitate the development of compatible services and stimulate innovation. For the content provider, collaboration gives more control over distribution channels that are fundamental to business success. For infrastructure providers new revenue streams become available and some of the risks of an uncertain market are reduced. Vertical integration reduces the risks of incompatibility between, or delays in, the simultaneous availability of new infrastructure investments and interactive services. An appropriate joint venture may find it easier to finance the required investment.

However, if such collaboration were exclusive (in other words if content were only available through one network) companies, each powerful in their own right, may be combined into an even more dominant force. Risks of abuse of dominant positions must be avoided, especially as the multimedia industry has the potential to create major new businesses and of significantly informing social and political debate.

Vertical integration through acquisition increases these risks. Media companies could exclude competition by having undue control of network distribution channels using broadband infrastructure. Network operators owning 'content' could give preferential treatment to it on their networks, or use it to command a price premium for their network services. Vertical integration of this type would nevertheless ensure that service revenues were available to fund infrastructure development.

The balance between these concerns will change with time. Collaboration may be required to 'kick-start' the industry, yet in the longer term when the industry has developed it is essential to guard against abuse.

European Competition law is probably adequate to ensure that abuse does not occur. Legal procedures, however, are time-consuming and create uncertainty which risks undermining, or delaying, the positive benefits of properly structured collaborative ventures.

Recommendation 1.2 - collaborative ventures

A permissive approach to collaborative ventures (including acquisitions) may be appropriate when considering the early development of multimedia markets. Decisions should take into account the extent to which a venture may stimulate the development of new multimedia services and the benefits this would bring to Europe. However, conditions should be applied that ensure early advantage does not translate into future anti-competitive behaviour.

10.3.4 Other issues of note

Finally we note in this context, that foreign acquisitions may of be of concern to some Member States if they are made by companies with a domestic base where foreign ownership of media or network companies is not permitted. This can result in a distortion to competition through economies of scale and scope being available to foreign based operators that are denied to European ones. European service providers have the right to expect the same access to foreign markets as that given to foreign companies entering EU markets.

However, as demonstrated in the UK and elsewhere, multimedia infrastructure opportunities will encourage investment by foreign companies. Foreign investment will result in jobs and benefits accruing to Europe.

Uncertainty in this policy area may restrict otherwise desirable investment from outside the EU in the development of European network and content services. We note this concern and observe that collaborative relationships between the EU and other major trading groups should be considered within the context to the General Agreements on Trade and Services. This issue must be considered in its broad context which extends beyond the scope of this study.

10.4 Regulatory framework

10.4.1 General concerns

A key issue, already noted, is that appropriate regulatory controls may change with time and circumstance. Initially, the concern is to 'kick-start' the market and some compromise on market dominance may be required to achieve this. However, in the longer term when the market has started to become self-sustaining the regulatory focus must switch to abuse of a dominant position. Timing is crucial and recommendations must clearly distinguish between market entry support as opposed to ongoing regulation in a market where competition is already established.

Different implementation approaches are appropriate at different stages of market development. For example, a greater level of regulatory control may be appropriate to encourage market entry. However in the longer term it is likely that existing competition law will be adequate to avoid abuse of dominant position using court action as the appropriate enforcement mechanism.

However, it is of fundamental concern that the mechanisms are transparent. Investments in multimedia are already considered risky and if investors do not want to see the prospect the regulatory ground rules being changed before investments have been recouped. It is essential therefore that the conditions that will prompt a regulatory change are well understood and accepted.

Specific measures performed by the regulator can affect competition, including procedures for awarding licences and charges levied against licence applicants and holders. The allocation of limited resources such as frequency and number ranges and the right to acquire wayleaves and dig up public highways will also affect opportunities for competitors.

Regulatory actions of this type and licensing terms for telecommunications operators remain the primary concern of Member States. There are, nevertheless, important issues relating to cross-border operations and harmonisation across the Union that are of direct concern to the Commission.

With this general discussion in mind we make the following recommendations.

10.4.2 Recommendation 2.1 - General regulatory framework

Motivation for recommendation

Regulation has a major impact on a company's ability to attract external investment and to achieve an acceptable return. Investment in infrastructure for multimedia applications is considered to be risky and regulation may increase or reduce this risk.

Pros & cons

In the early stages of the development of a new competitive market, regulation may be required to compensate for weaknesses in competitive structures. In particular, protection may be required by new entrants so as to enable them to enter the market. This may require specific and detailed regulation.

In the longer term it is preferable to reduce regulation progressively and increasing rely on the application of competition law. The process of change should be transparent.

Potential investors need certainty on the regulatory environment before they will commit financial resources. The period of certainty needs to match the pay-back period for the investment. However it is difficult to achieve a regulatory framework that is appropriate under changing and uncertain market conditions. The regulatory measures need not be unalterable, but any permitted changes have to be transparent. For example, it may well be defined that regulatory conditions would be relaxed when a certain market share is reached or where a particular revenue or profitability target is achieved. Provided that an investor accepts and knows these criteria assessment of risk and plans can be made accordingly. This transparency will be important in convincing investors of a less risky future.

We therefore recommend the following.

Recommendation 2.1 - Regulatory framework

- The long term goal should be to rely on competitive forces and competition law; regulation should only be used while competition in infrastructure is too immature to be fully effective and if historic structures prevent the development of competition.
- The licence for infrastructure provision should be based on a regulatory framework that is clear and certain to facilitate investment.
- Licence award procedures should not bias competition against new entrants. This should clearly identify changes that may occur and trigger points for these changes based on industry consensus.

10.4.3 Recommendation 2.2 - Universal service obligations

Motivation for recommendation

Universal service is a desirable yet expensive requirement.

Pros & cons

Universal service obligations must be addressed and interconnection arrangements need to consider how such obligations can be equitably funded. Europe needs to ask itself whether it is appropriate to extend universal service obligations to multimedia services based on a consideration of the cost of universality. Chapter 8 shows that excluding the 10% of homes that are most expensive to service would, according to our model, reduce the investment cost from ECU 333 bn to ECU 245 bn (a 26% reduction). It would be an error to impose universal service obligations prematurely, since doing so could discourage the early investment and innovation needed to define service possibilities. As yet the commercial potential of multimedia is too poorly understood for a universal service obligation to be imposed. Nevertheless, it is worth noting that universal service is more easily afforded if physical structures (eg ducts or trenches) or transmission media (eg fibres) are shared.

The implications of establishing a universal service obligation (USO) on broadband services, and funding that USO via a "tax" on operators without a USO are complex. They depend timing and the nature of the process.

KPMG recommends that a "USO-tax" only be applied once demand for a service is shown to be universal, not specialist, and once the true additional costs of a USO on that specific service are known. It is also important to understand clearly what a USO means in the context of multimedia service

Recommendation 2.2 - Universal service
Universal service obligations should not be imposed on multimedia infrastructure until the commercial potential is better understood.

10.4.4 Other issues of note

Many of the issues concerning licence terms and conditions are no different to standard telecommunications services and are not specific to infrastructure for multimedia. Terms of this nature are not covered here but would need to be defined before widespread implementation of multimedia services commences.

Issues include, for example, the extent to which commonality of licence terms and conditions should be common across the EU. Such commonality could stimulate the development of an EU-wide multimedia service industry, and encourage investment. This needs to be balanced against the need for flexibility to encourage innovation, especially in the early stages of new service development.

As ever with competitive telecommunications, interconnect is also a critical issue. Free and open access to infrastructure must be available to all service providers in such a way that interworking occurs across organisational and geographic barriers. Furthermore, it is important that network services support different types of information services. Administrations also need to ensure, for example, that network integrity is protected.

However, negotiating interconnect arrangements is a time consuming overhead for all concerned and mechanisms should be explored that reduce this overhead.

It is not appropriate to define a comprehensive list of license terms in this study but it may include, for example, that licenses should be based on a harmonised set of general terms and conditions, and that all operators should have an obligation to interconnect at tariffs that reflect fair costs of an efficient operator. We recommend that the Commission should review, over the next two years, whether harmonisation of licence terms and conditions would encourage the development of EU-wide multimedia infrastructure and services and what these terms should be.

10.5 Other policy measures

10.5.1 General concerns

Investment in infrastructure may also be encouraged through more general measures, including, for example:

- resource sharing;
- support for developing standards and measures to promote adoption;
- tax incentives for investment;
- funding for research and development through existing programmes;

Our study shows how much investment is consumed as a result of civil construction costs and 'inactive' resources such as poles or ducts. Sharing such resources has little

impact on service innovation and would not endanger the development of fair competition in services but it would substantially reduce overall investment. Effective mechanisms for sharing resources are not easy to define but, because of the likely impact, they cannot be lightly dismissed.

A free market economist would argue that the market alone should be left to decide what research and development is required and what standards should be adopted. Yet, interventionists would cite GSM as a notable success for the alternative approach. Further supporting the interventionist view, the USA has made considerable funds available to support development activities in National Information Infrastructure (NII) through the High Performance Computing and Communications Initiative (NPCCI). The US Agenda for Action also calls on the National Institute for Standards and Technology (NIST) to "review and clarify the standards process needed to speed NII applications".

The Union also needs to be alert to the dangers of proprietary specifications being adopted as de facto standards. This can result in an effective monopoly for those companies that registered the technology.

Tax incentives can have a powerful effect and indeed form a part of the Clinton administration's approach to encouraging the development of the NII. Fiscal policy is an issue for individual Member States yet the Commission may wish to provide advice aimed at achieving harmonisation. The need to off-set infrastructure investment against service revenues is of particular importance. For example, we have stressed the desirability of encouraging information service providers to participate in the development of infrastructure. If they do this by investing in an infrastructure company, what, if any, tax concessions are appropriate?

Direct intervention funding of infrastructure development is not appropriate but pilots and demonstrators can be a useful stimulant to market development.

Given this general discussion we make the following recommendations.

10.5.2 Recommendation 3.1 - Duct sharing

Motivation for recommendation

This KPMG study shows that the physical ducts required to carry the transmission medium represent the largest percentage of the capital cost of a multimedia infrastructure. Chapter 8 shows that if a new network (including new ducts) were built the cost would be ECU 333 bn. If it were possible to avoid building 60% of these new ducts the cost would fall to ECU 172 bn - a fall of 48%.

Pros & cons

If any area of multimedia telecommunications has the characteristics of a natural monopoly it is the provision and operation of the physical infrastructure into (or onto) which transmission media are installed. Although competition in telecommunication and transmission infrastructure services has been shown in many countries to have strong benefits to consumers, in terms of faster innovation and lower prices, it is far

from clear that competitive provision of inactive, physical structures (for example poles and ducts) is necessary or desirable for competitive multimedia communication services.

Duplication of ducts has high capital cost; while their operation and maintenance is relatively inexpensive, so that sharing raises few risks that inappropriate allocation of shared costs will be a barrier to competition.

If ducts were shared, then the cost of network build could be substantially reduced - a saving of 48% would result from sharing 60% of ducts. Moreover the possibility of competition in multimedia transmission services to households and SMEs would be significantly increased, and universal service would be significantly aided.

The creation of ducts also has the greatest environmental impact. The installation of new ducts by UK cable television operators has been resented in many residential areas. Unnecessary environmental impact should be avoided. It is likely that BT will, in order to provide a broadband infrastructure need to install second conduits in some recently cabled suburban areas, where BT still provides telephony via twisted pairs hung from poles. Repeating the recent disruption to traffic and quality of life is likely to be strongly resented by the communities.

Inevitably, incumbent operators are likely to present many obstacles to duct (or pole) sharing. Sharing would make it much easier for new competitors to enter the market.

Arguments about difficulty are likely to include:

- the ducts are full and removing traditional transmission media is not justified in cost terms and risks damage or disruption to customer service;
- duct sharing poses risks to the safety and well-being of the transmission media;
- sharing imposes costs on the first operator which may be difficult to measure and recover.

Some of these arguments have validity, but can easily be exaggerated. Nevertheless serious consideration should be given to overcoming these difficulties so as to allow resources to be shared in view of the very significant benefits in terms of cost saving, feasibility of competition in transmission, universal service, and avoidance of environmental damage. The savings are very large, and a small proportion spent addressing the difficulties may facilitate technical solutions. This debate is fundamental and must be progressed.

Various means of addressing duct sharing exist. The following list is intended to show options and is not intended to suggest recommendations:

- central planning procedures to ensure coordination of duct installation (two or more ducts in one trench);
- obligations on builders of new ducts to ensure spare capacity of second duct;
- divestiture of physical infrastructure business into a new authority;

- regulatory obligation for competitors to cooperate;
- an obligation to quote prices for duct usage.

If duct sharing is not feasible, costs in local loop may also be reduced by sharing a single multi-fibre transmission medium with each operator having one or more fibre pair. Separate electronics would be operated. It may even be possible to share a single fibre, since the transmission capacity in the local loop is likely to be sufficient for several operators. This option is more controversial and would be harder to implement. Many of the issues are similar to duct sharing. Operational risks are, however, different: there may, for example, be a reduced potential for deliberate sabotage but one party must still take responsibility for maintaining the medium (the fibre) and this poses issues of cost allocation and sharing.

This approach would need much more careful consideration than duct sharing but the cost benefits are still substantial and it might make competition both in services and the operation of infrastructure more feasible. The possibility should not, therefore, be ignored.

> Recommendation 3.1- Duct sharing
>
> The desirability and feasibility of duct, or trench, sharing should be assessed based on a comprehensive cost/benefit analysis eg building on this study's cost model.
>
> If for some countries or regions duct or trench sharing is appropriate regulatory controls must be identified to ensure that ducts are provided efficiently, in a timely manner and at low cost

10.5.3 Recommendation 3.2 - standards

Motivation for recommendation

Standards are necessary to achieve common access to services. The IT industry and the telecommunication industry traditionally have adopted different approaches to standardisation. *De facto* standards (based on proprietary specifications) are more widely used to advantage in the IT industry but can led to abuse. A balanced approach is necessary.

Pros and cons

Standards are needed if competing services are to share infrastructure. Two different approach to the development of standards exist. *De jure* standards are developed through considerable industry consultation and their adoption may be enforced through regulation. *De facto* standards are those that become accepted by the industry even if in the beginning the specification on which they were based was proprietary.

De jure standards are time consuming to develop. However, *de facto* standards can result in de facto monopolies if care is not taken. Because of this, the value of IPRs can be substantial and the ownership of a *de facto* standards may be seen as the reward for

innovation. Striking the correct balance between allowing innovation to progress rapidly and the danger of dominance by the owner of a 'standard' is hard to achieve. The debate is continuing.

> Recommendation 3.2 - standards
>
> The debate on appropriate mechanisms for the development of standards for emerging multimedia services and infrastructure should start now and should include an assessment of how different regimes may impact investment potential

10.5.4 Recommendation 3.3 - Pilots and demonstrator projects

Motivation for recommendation

Working applications are the key to investor confidence and the take-off of the multimedia industry. Demonstrable applications developed in an environment where risk is reduced would help in this process.

Pros & cons

Direct funding of application development by the Commission is inappropriate. The Commission's research programmes should, within the context of TENS, be considered as a means of realising support to applications developers.

> Recommendation 3.3 - Pilots and demonstrator projects
>
> The Commission should plan a programme of well defined pilots and demonstrator projects together with the criteria for a project to qualify. The need and appropriateness should be assessed of seed money for application development especially that with a public sector focus.

10.5.5 Recommendation 3.4 - Tax

Motivation for recommendation

Investment in multimedia infrastructure is expensive and the pay-back period is long. Encouraging investment across a broad community through taxation may make funding significantly more attractive.

Pros & cons

Taxation is the concern of Member States yet the Commission may wish to encourage them to consider how innovation can be encouraged by allowing tax concession to all potential investors.

One of the causes of delay to development of UK cable TV infrastructure was the withdrawal of tax allowances.

Other competing economic blocks, notably the USA, are considering granting tax breaks to encourage multimedia investment. This could lead to a competitive disadvantage for Europe.

Recommendation 3.4 - Taxation regimes to encourage investment The Commission should assess whether taxation policy in Member States is a useful mechanisms for encouraging investment

Appendix A

List of interviews

National operators

BT
OTE (C-Jet)
Telefonica
Telecom Eireann

Equipment manufactures

Alcatel
Alcatel (UK)
Olivetti
Northern Telecom
IBM *

Other/new telecoms operators

DEI (Greek power company)
Scottish Power
SBC Cable Comm
NTL
TeleWest
Retevision
Iberdrola (Spanish electricity)
Irish Electricity Supply Board

Content providers

Knight Ridder
CAS (independent CD-Rom publisher)

Banks

Guinness Mahon
S G Warburg *

Miscellaneous

MC Crash Programme (Greece)
Ministry of the Presidency (Greece)
IGR (Spain)
CCA (UK)

(* - shortened interview)

Appendix B

Model assumptions and key input parameters

Demography	Area (km^2)				Population (000's)			
Country	*City Cent*	*Urban*	*Rural*	*Total*	*City*	*Urban*	*Rural*	*Total*
Belgium	1,054	9,486	20,460	*31,000*	960	8,640	400	10,000
Denmark	903	8,127	33,970	*43,000*	442	3,978	780	5,200
France	8,832	79,488	463,680	*552,000*	4,190	37,712	15,498	57,400
Germany	6,783	61,047	289,170	*357,000*	6,932	62,384	11,284	80,600
Greece	2,208	19,875	223,282	*245,365*	659	5,933	3,708	10,300
Ireland	700	6,300	63,000	*70,000*	203	1,827	1,470	3,500
Italy	5,719	51,471	243,810	*301,000*	4,046	36,414	17,340	57,800
Luxembourg	88	792	1,707	*2,587*	33	300	37	370
Netherlands	1,184	10,656	25,160	*37,000*	1,353	12,175	1,672	15,200
Portugal	1,472	13,248	77,280	*92,000*	343	3,087	6,370	9,800
Spain	8,080	72,720	424,200	*505,000*	3,089	27,800	8,211	39,100
UK	3,430	30,870	210,700	*245,000*	5,144	46,298	6,358	57,800
Austria	1,596	14,364	68,040	*84,000*	466	4,195	3,239	7,900
Finland	5,408	48,672	283,920	*338,000*	300	2,700	2,000	5,000
Norway	5,184	46,656	272,160	*324,000*	327	2,941	1,032	4,300
Sweden	12,150	109,350	328,500	*450,000*	731	6,577	1,392	8,700
Total	64,791	583,121	3,029,040	*3,676,952*	29,218	262,961	80,791	*372,970*

Figure 47 Demographic data used in model

	Large businesses				SMEs (000's)			
Country	Total	City	Urban	Rural	Total	City	Urban	Rural
Belgium	*640*	320	260	60	*202*	101	81	20
Denmark	*300*	150	120	30	*207*	104	83	21
France	*2,720*	1,360	1,090	270	*1,586*	793	634	159
Germany	*5,600*	2,800	2,240	560	*3,078*	1,539	1,231	308
Greece	*240*	120	100	20	*266*	133	107	27
Ireland	*170*	80	70	20	*89*	44	36	9
Italy	*1,660*	830	660	170	*1,834*	917	734	183
Luxembourg	*20*	10	10	0	*14*	7	6	1
Netherlands	*480*	240	190	50	*511*	255	204	51
Portugal	*460*	230	180	50	*213*	106	85	21
Spain	*960*	480	380	100	*869*	434	348	87
UK	*4,080*	2,040	1,630	410	*1,431*	716	572	143
						0	0	0
Austria	*300*	150	120	30	*332*	166	133	33
Finland	*480*	240	190	50	*277*	139	111	28
Norway	*420*	210	170	40	*255*	127	102	26
Sweden	*540*	270	220	50	*478*	239	191	48

Figure 48 Large businesses and SME distribution in Europe

CATV	Total households	Homes passed	Homes connected /subscribers	Penetration per pop.
Belgium	3,950,000	3,700,000	3,550,000	90%
Denmark	2,338,868	1,700,000	1,173,000	50%
France	22,000,000	5,283,367	1,286,745	6%
Germany	33,400,000	21,519,000	17,495,000	52%
Greece	3,121,000	0	0	0%
Ireland	1,032,811	500,000	372,000	36%
Italy	20,643,000	0	0	0%
Luxembourg	132,000	-	-	-
Netherlands	6,370,000	5,920,000	5,530,000	87%
Portugal	3,267,000	0	0	0%
Spain	15,000,000	920,000	130,000	1%
UK	21,600,000	3,000,000	600,000	3%
Austria	3,070,000	1,600,000	910,000	30%
Finland	2,240,000	1,300,000	780,000	35%
Norway	1,751,000	800,000	588,000	34%
Sweden	3,500,000	2,100,000	1,800,000	51%
Total 'sixteen'	143,415,679	48,342,367	34,214,745	24%

Figure 49 European cable TV data (source: ECCA)

Country	Total lines	Residential lines	Business lines	Total lines/pop.
Belgium	4,603,000	3,590,340	1,012,660	46%
Denmark	3,391,000	2,712,800	678,200	65%
France	32,000,000	25,600,000	6,400,000	56%
Germany	35,590,000	28,472,000	7,118,000	44%
Greece	4,437,000	3,105,900	1,331,100	43%
Ireland	1,218,000	816,060	401,940	35%
Italy	26,685,000	21,614,850	5,070,150	46%
Luxembourg	251,000	175,700	75,300	68%
Netherlands	8,000,000	6,480,000	1,520,000	53%
Portugal	3,351,000	2,580,270	770,730	34%
Spain	15,181,000	11,082,130	4,098,870	39%
UK	33,118,000	25,500,860	7,617,140	57%
Austria	4,570,000	3,656,000	914,000	58%
Finland	3,316,000	2,420,680	895,320	66%
Norway	2,694,000	2,074,380	619,620	63%
Sweden	7,000,000	5,460,000	1,540,000	80%
Total	185,405,000	145,341,970	40,063,030	50%

Figure 50 European PSTN data (source: ITU)

KPMG

Appendix C

Valuing the future: a convergence of views? A survey of the cable industry in the UK

The attached reproduces a report prepared by KPMG in December 1993.

1 Introduction

1.1. Purpose

KPMG commissioned this survey by Charon Capital to identify the attitudes and expectations of the financial community in the UK towards the cable industry. It focused on the extent to which their views differ from those of the cable operators and whether any divergence of views explains the relative difficulty experienced by the industry in raising finance from the UK.

1.2. Methodology and scope of the survey

Face to face interviews based on a questionnaire were held with senior executives of banks and equity investors responsible for the industry, and with senior managers of cable operators (either the chief operating or financial officer responsible for UK operations). The fieldwork was carried out between September and November 1993.

The survey included 22 financial and investing institutions which were either already financing the sector, or actively pursuing involvement. The sample included leading North American banks with cable finance experience in their domestic markets, UK clearing banks, UK merchant banks, and the larger Continental banks with branches in the UK.

Ten Multiple System Operators (MSOs) were interviewed, controlling 9.9 million franchised homes and representing 66% of the current UK market.

The issues facing the industry and its backers are complex. For some questions respondents were able to give a quantitative ranking of the issues. Qualitative responses were given to others. Both are summarised in this report.

1.3. Benefit of the survey

During the period of the survey, a number of major financing deals were being negotiated. The outcome of these negotiations will continue to shape the responses which a survey such as this can elicit.

Only a handful of financial investors have made equity investments in the industry. This small sample size limits the generalisations that can be drawn but their individual responses on their reasons for investing are still valuable.

1.4. Summary and conclusions

Our survey's principal findings were:

- Most financiers and operators expect the current UK cable franchises to be fully built by 2000 (ie, 14 million homes to be passed).

- Most financiers are still cautious about cable with North American banks expected to provide some two thirds of lending to the sector.

- Bank finance is still heavily dependent on support from North American telco and cable parents.

- Financiers stress the need for high quality management but are relying on the operators' parent companies to provide it.

- Financiers mainly think of cable as a telecoms network. They may under estimate the role of entertainment in attracting subscribers and generating revenue. The importance of the TV programme offering is not properly appreciated.

- Although interactive services are much discussed, financiers do not know how to evaluate them properly.

- Revenues from TV advertising and value added telephony are also not being evaluated.

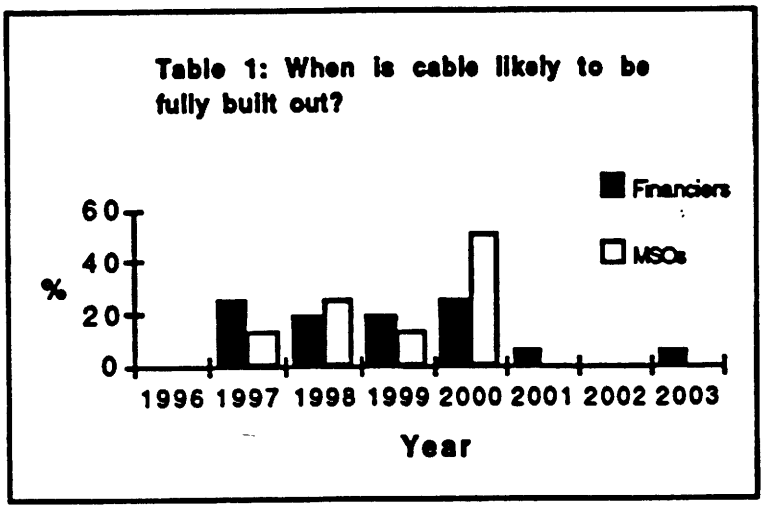
- The main threat to cable's future is thought to be the possible deregulation of BT.

- Overall, financiers believe that cable will be the best delivery method into the home.

2 Assessing the financing of the sector

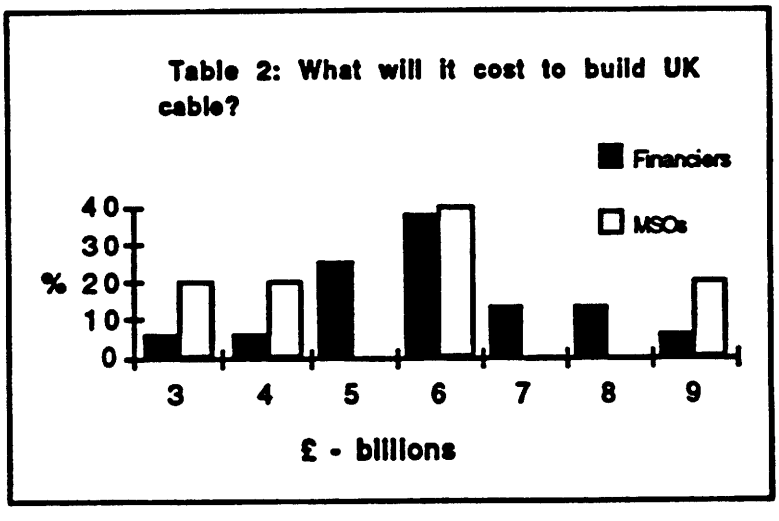
2.1. When will the current UK franchises be fully built?

All of the operators expect the building of current UK franchises to be completed by 2000. Half of them believe completion could be earlier. Financiers views vary a little more widely with 6% not expecting completion until 2003.



2.2. How much money is need to complete the cable build in the UK?

Estimates of the total build cost range between £5 billion and £9 billion. Most financiers (63%) estimate that it will cost between £5 billion and £6 billion to pass 14 million homes. This variation is due largely to differing assumptions about the technology to be installed which directly affects the build cost. Banks base their estimates on business plans which they have reviewed and on the trade press.



2.3. What proportion of funding will be provided by UK financial institutions and when?

Both MSOs and financiers agreed that most of the debt funding will come from North American banks, based in London. Even by 1995, British and European banks are expected to be providing only around 30% of the debt. Several banks mentioned their uncertainty in making these predictions due to the possible role which the US high yield market might play in funding UK cable.

Equity

The survey found a consensus amongst both groups that 1994 will be the last year in which new external equity finance will be required. A significant number of systems are expected to begin generating positive operating cash flow within the next year. This should enable the remaining build to be financed largely by borrowing. Financiers interviewed in the survey expect this process to be accelerated if networks own the telephony switches. This will make more debt finance available on terms acceptable to the operators.

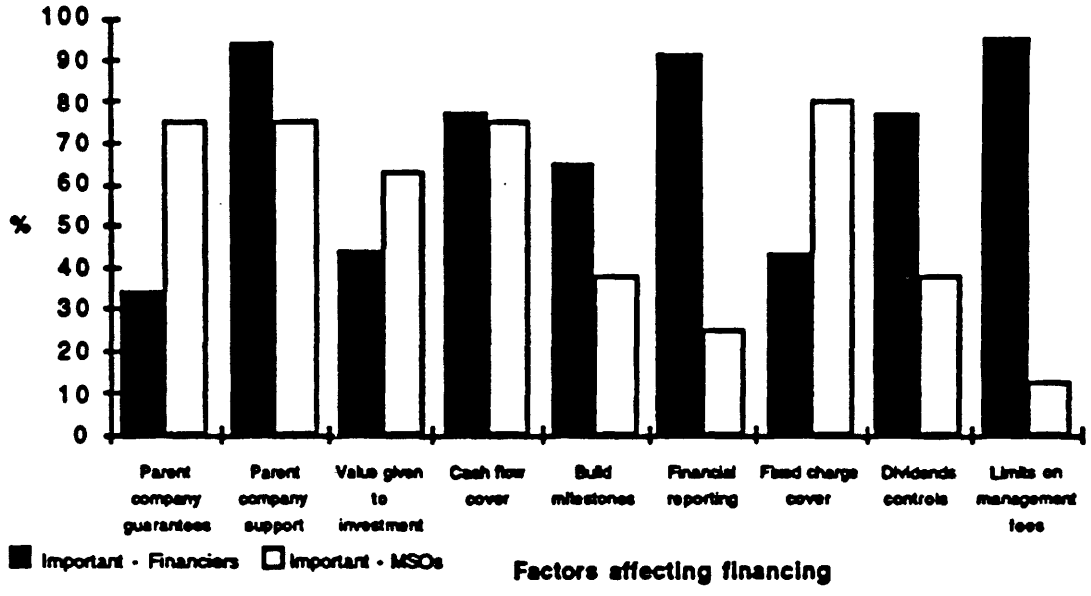
2.4. How much or will your institution commit to cable?

Only six lenders (27% of the sample) expressed an explicit long term strategy for the sector. Our survey identified pre-approved lending limits of £250 million for 1993. Most banks review each transaction on a case by case basis.

2.5. Importance of financing conditions?

Financiers rank parent company support ahead of any other condition they impose on loans to finance a cable operation. 94% scored this as important. Whilst financiers impose operating covenants and take security over the cable system the parent's financial strength is the most important factor in their credit assessment. 75% of operators indicated that giving formal guarantees is an important issue for them. Their parent companies are generally reluctant to do so and this is usually accepted by the banks.

Table 3: Factors affecting financing



Other conditions which banks rate more highly than do MSO's are:

- limits on management fees (95% of banks rate this as very important or important, only 13% of MSO's);
- dividend controls (Banks 77%, MSO's 38%);
- build milestones (Banks 65%, MSO's 38%).

Conversely, we found that while operators are anxious to gain recognition for the money already invested in a system (63% rate it as important) bankers see it only as an assurance against operators walking away (only 44% rated this important).

Both financiers (80%) and operators (77%) regard the level of operating cash flow cover used to limit borrowings to be of great importance. However, the survey found significant differences between the financiers and the operators over defining operating cash flow. Most operators want to exclude the overheads capitalised into build costs from operating cash flow in order to support higher borrowing limits but lending banks are not willing to go as far as the operators would like.

Both financiers and MSOs agreed that it is unrealistic to expect the sector to pay dividends when there is still a large cash deficit. Equity investors in the survey expect to achieve their return by way of capital growth, rather than income yield.

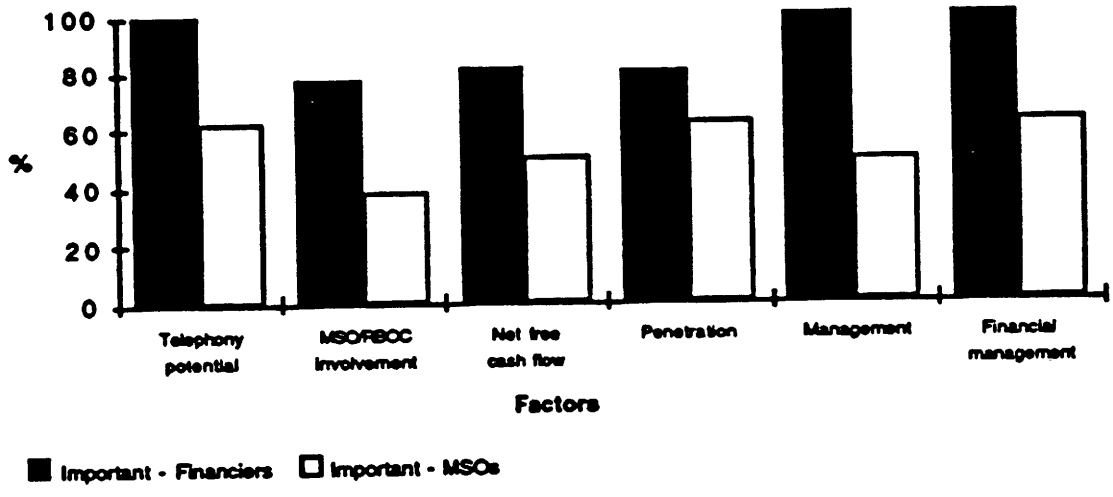
3 Evaluation

3.1. Importance of criteria for evaluating a cable operation?

Financiers and operators agree on the importance of build cost and the amount of equity already invested in evaluating a cable operation. However, the financiers place more emphasis than operators on:

- telephony potential (100% rate it as important);
- expected penetration rate;
- quality of management;
- level of net free cashflow;
- involvement of MSO/RBOC parent.

Table 4: Evaluating a UK cable operation



3.2. What creates value in a system?

Financiers place more emphasis on telephony as a creator of value than do the operators. 71% of the banks said it was very important, but only 33% of the operators. Cable's role as a delivery system for entertainment, especially television programmes, appears to interest financiers less than its telephony service.

Economies of scale available from contiguity between franchises is more important to the operators than the banks realise. Only 53% of the banks rated it as being very important compared to 66% of the operators.

3.3. Valuing the network

Most financiers calculate the expected rate of return by discounting future cashflows over a 10 year life together with a terminal value based on a multiple of the last year's cashflow.

Some smaller operators, who expect to seek a flotation, value their business over a six year horizon as do those of the financial investors also expecting a similar exit. A small number (10%) of larger companies look as far ahead as 20 years.

Multiples applied to final year cashflows to calculate terminal value vary between eight to fifteen times cash flow. Higher multiples were used by those attributing value to the newer interactive and premium services to be delivered by the systems. 20% of the operators, with a US cable background, do not think that this calculation is appropriate for an investment made to achieve capital gains. They prefer to follow US yardsticks ie, multiples of capital invested and cash value 'per pop' (per subscriber).

3.4. Management

The survey found that the financial community believes the quality of management at both the local and national level to be very important to their investment decisions . However, it also acknowledges that the short history of UK cable makes it very difficult to judge the track record of any team or individual.

Potential lenders considered that marketing (68%) and sales (36%) were the most important skills they required in a management team. Operators and equity investors focussed on the personal qualities required, citing flexibility (27%) and team work (36%) as key qualities.

A number of investors and smaller operators in our survey are concerned by the perceived lack of entrepreneurial culture in the RBOCs and of customer orientation.

The main change expected during the next few years is that local management (ie, UK nationals) will play a more important role. New skill sets are expected to be added as new products are developed and more training is expected to be provided. Some financiers are concerned that the best people will be attracted to the USA, with the UK used only as a training ground by US parent companies.

3.5. Key performance indicators for judging quality and growth

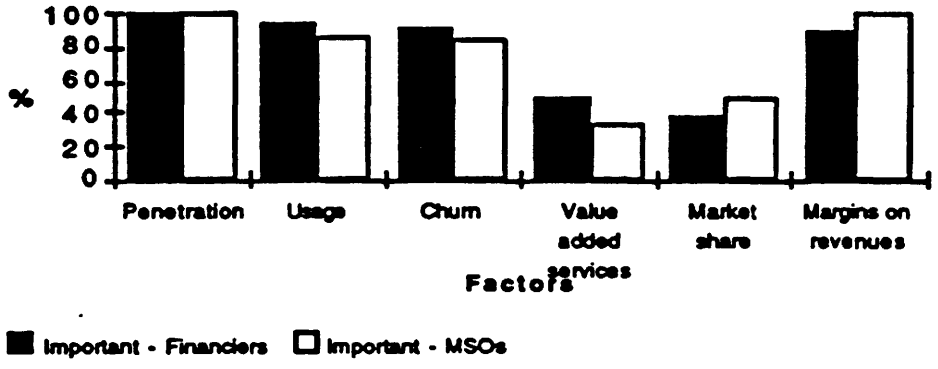
Penetration is regarded as important by both groups but the operators stress the need to evaluate this jointly with the churn rate to measure performance. This reflects the fact that if existing subscribers drop away this raises the penetration rate needed to increase subscriber numbers. Residential and business telephony ratios are also highly rated by all financiers.

For financial performance monitoring, financiers consider operating margins as more important (88% rate it as important) than return on equity (only 18%) which 58% of operators also score as important. Other detailed operating ratios eg, bad debts, dropped customer calls etc, were also mentioned in the survey

3.6. Evaluation criteria for telephony

Operators and financiers agree on the importance of penetration, churn and margin on revenue for evaluating residential and business telephony.

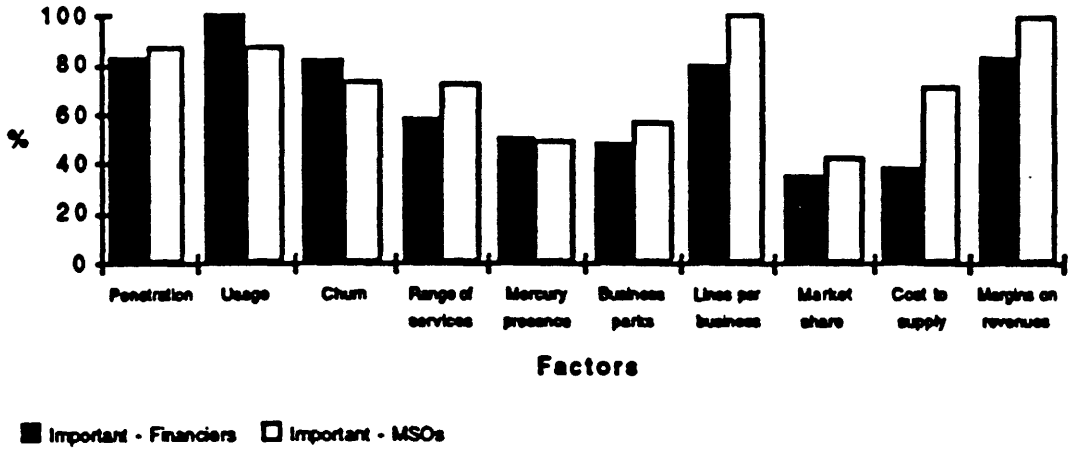
Table 5: Evaluating residential telephony



For residential services, operators are less concerned with potential usage (76%) than financiers (94%). Value added services are rated as important by only 34% of operators and 50% of financiers.

In business telephony, all operators stress the need to maximise the number of lines per business user as do 76% of the banks.

Table 6: Evaluating business telephony

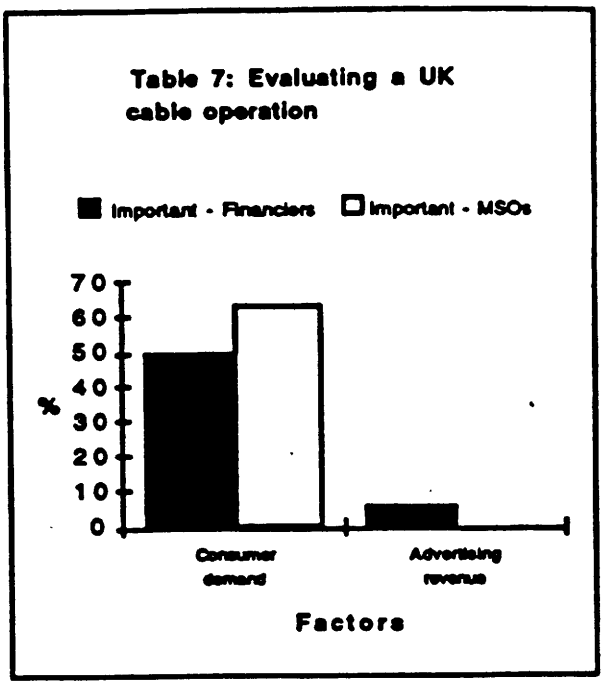


Mercury's presence in the market is not perceived as a major threat by either group although 50% of each rate it as important. Financiers made little mention in the survey of the impact of regional interconnects on the telephony business.

Financiers expressed concern in the survey over the quality of the service provided to business. Several also commented on the shortage of experienced business telephony sales people.

3.7. Importance of interactive/premium services (the electronic pipeline)

Only 23% of the financiers were prepared to place any value on the interactive services expected to be delivered by cable in the future (eg, home shopping or pay per view) although a number of them recognised its importance. They expect loan finance to be repaid without relying on these services or on advertising.



Operators also have mixed expectations for interactive services. 55% said that premium services would be very important, whereas 22% expected them to be of little importance. Some operators expect only 5% of their profits to arise from these services, while one operator expects them to form "the majority of revenues by the year 2000."

3.8. Advertising revenue

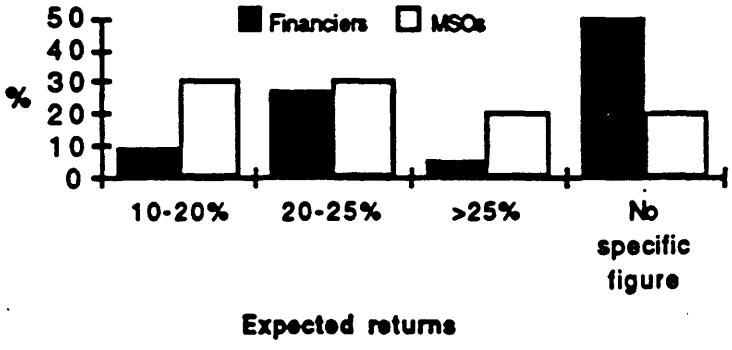
The survey suggests that advertising revenue is perceived to be of only minor significance, even in the longer term. While contiguity between franchises is expected to attract local and regional advertisers, few respondents mentioned the possibility of attracting national advertising. Long term estimates of revenue given in the survey show advertising revenue is rarely expected to exceed 5% of total revenue. Consequently, no reliance is placed on local advertising potential as a creator of value either by financiers or operators.

4 Realising value

4.1. Equity return expectations

Most operators considered that their business will deliver equity returns of between 20% and 25%. Some admitted that expected returns have fallen to between 15% and 20% based on performance to date. This contrasts with the rate of return of around 25% expected by the equity financiers in the survey.

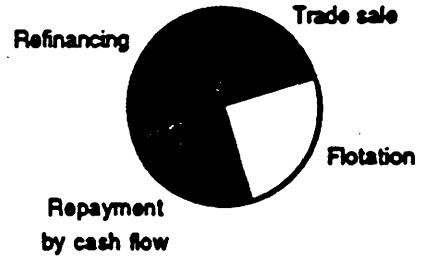
Table 8: Equity return expectations



4.2. Exit strategy and timing for equity

The survey found a divergence of views about the timing of any development of a public market in cable system shares. UK merchant banks appear to have the shortest time frame, expecting it to develop within 18 months to two years.

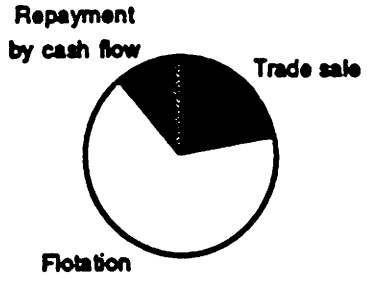
Table 9 : Financiers preferred exit methods



We found that operators are divided between those who are seeking to exit within five to seven years and those that see UK cable as a long term investment and centre of operation. 25%, mainly the US telephone companies, do not anticipate realising their investment. 37% of operators consider flotation a preferred exit.

Larger operators said they expected to use public markets to create liquidity for their stock, especially where they have financial investors as partners. Two operators expressed concerns that the market will undervalue their business. A few operators interviewed acknowledged that the cash needs of North American based parents will influence the timing and size of any flotation.

Table 10 : MSOs preferred exit methods



4.3. Repayment of debt

All of the banks in the survey said that debt is provided on the basis that it will be repaid in full out of operating cashflow but 50% of them expect to be repaid through a refinancing operation. These are expected to begin in 1996/7 onwards.

5 Industry developments and concerns

5.1. Event risk

In general, financiers did not cite any one potential event which might prevent their involvement in the industry. Their most frequently mentioned concern (86%) was of changes in regulation favouring BT, perhaps under a different government. 20% mentioned an unforeseen leap in competitive technology eg, micro satellite dishes that could receive all the stations that cable offered.

Some investors expressed concern at a possible accumulation of events changing their attitude to the industry such as three consecutive quarters of declining penetration combined with a large increase in programming costs.

Any change in the enthusiasm shown by the industry's larger sponsors (ie, US MSOs & RBOCs) would also cause concern. Given the scale of the commitment they have already made this is considered to be a remote threat.

5.2. Industry regulation

The most important regulatory issue identified by 62% of the operators and 70% of the financial community is that BT may be deregulated. Another major concern, mentioned by banks and operators, is Sky's creeping monopoly over programme channels.

Continued flexibility by OFTEL over build milestones was raised by several of the operators but rarely by the financiers.

In the medium term, control over programming rights and delivery technology, including pay per view, may come under regulatory review according to several of operators and banks. Some also worry that cable TV and telephony may become price regulated.

In general the favourable UK regime was highlighted as very attractive with operators and North American investors anxious to see regulation kept to a minimum.

5.3. Competition

45% of operators see Direct-to-Home (DTH) satellite as a threat and are concerned both by the cost of programming and the competition from DTH for subscribers. One third of the operators considered that a rapid build which presents a viable alternative to DTH quickly, was their best defence. However, most financiers do not consider DTH as a serious competitor (80% see it as a low level threat).

Neither do financiers see mobile telecommunication services as providing competition (74% rated PCN as a low threat). Operators believe that they will be able to compete on price for local calls as they have a lower cost structure.

In general, the survey found only a limited awareness among the banks of the alternative telecommunication offerings that will emerge later in this decade eg, number portability was only mentioned by one bank. Nor was much mention made of compression of 'over the air' TV and entertainment services.

6 Other issues

This section summarises other issues raised by respondents to the survey.

6.1. Consumer perception

Some cable operators suggested that a joint marketing exercise of cable, perhaps including Sky, would help to increase awareness of cable and to increase overall penetration.

Some respondents were concerned about consumer confusion in the face of too much choice.

6.2. Operating costs

Some smaller operators in our survey believe strongly that the cost base of the industry is far too high, due largely to the 'big company' approach of the US telephone companies.

They consider that the industry needs to be more entrepreneurial and less dominated by engineering.

Financiers' concerns uncovered by the survey include:

- the importance of local political approval of new systems;
- changing tastes in TV viewing;
- the lack of cable reaction to Sky;
- apparent old-fashioned process still used for construction (ie, digging holes by hand!).