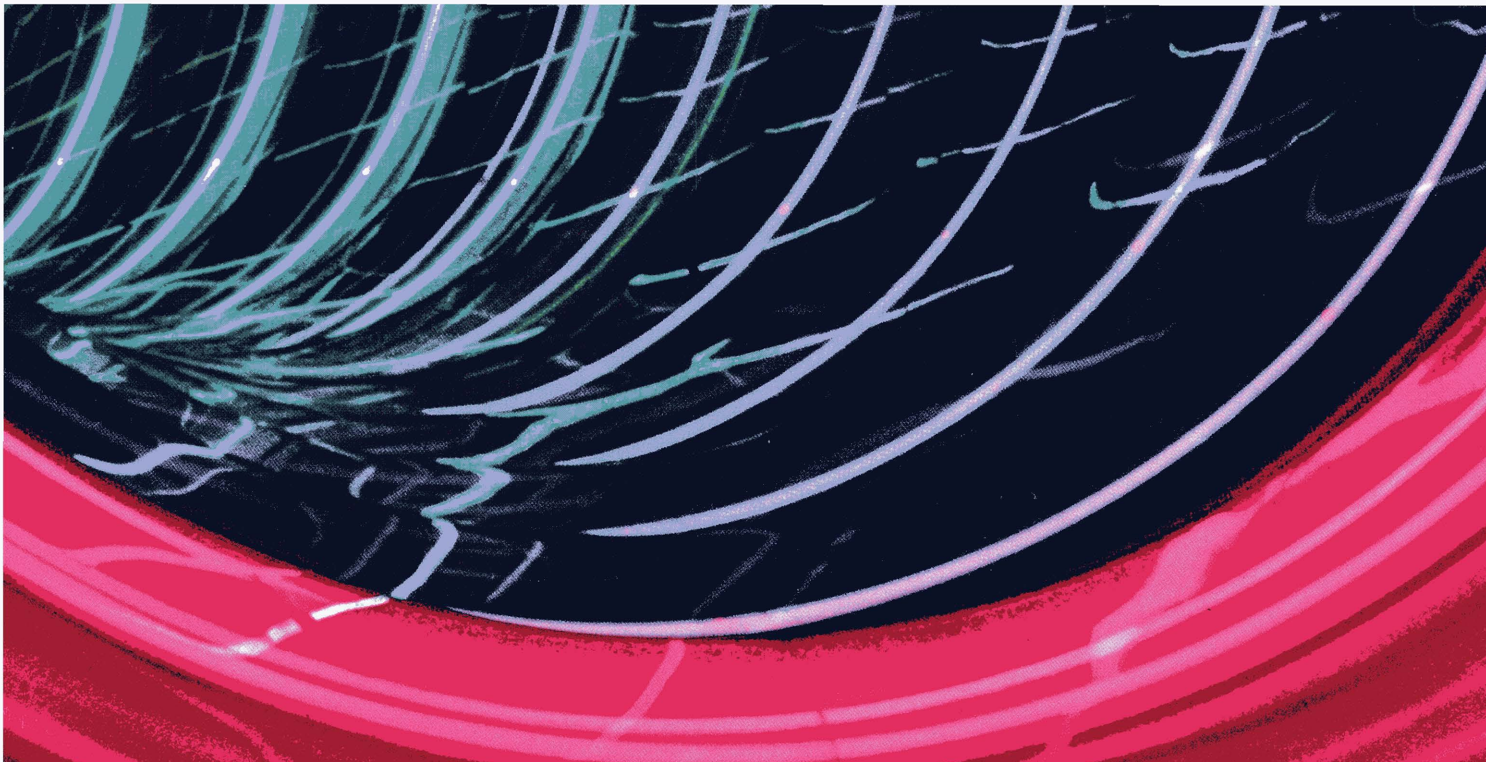

European Information Technology Observatory 97

European Information Technology Observatory – EITO

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Preface

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

The EITO 97 presents the most comprehensive data currently available about the ICT market in Europe. It also provides special ICT studies as on technological trends, standardization, the information society, the Internet and specific markets such as electronic commerce.

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

The EITO 97 has been produced with the support of the EITO sponsors, the trade fairs KONTOR OG DATA in Oslo, and SYSTEMS in Munich, and the EITO company sponsors Deutsche Telekom and Telecom Italia.

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

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

The EITO 97 has been produced in close cooperation between the EITO Task Force experts and leading market research companies in order to discuss and guarantee the quality of the statistics and data.

The copyright for the major parts of the market analysis, data and statistics is held jointly by EITO/GzF and International Data Corporation. The copyright for the two special papers lies with EITO/GzF and Analysys and Romtec.

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

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

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

The EITO Members

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In 1996, the slow-down of European economic growth was reflected in the performance of the Information and Communication Technologies market. However, the 7 per cent growth rate experienced by the European ICT market, despite being lower than that of 1995, is nevertheless higher than most sectors of the economy. This is an impressive result for a broad and diversified industry, whose market in Europe in 1996 exceeded 300 billion ECU.

Stefano Micossi, Director General Industry, EC

The ICT market includes sectors which are approaching maturity. The slow-down in these sectors has been more than matched by the particular dynamism of other sectors. This is for instance the case for segments such as network equipment and software related to the Internet, as well as telecommunication services and mobile telephony. The number of Internet hosts in Europe has nearly doubled over the past year, indicating a similar increase in the number of users and creating a strong base for further development of applications.

In recent years, growth rates for the European ICT market have remained consistently lower than those of the growing Asian economies and the United States. Since 1990, Europe's share of the world-wide IT market has declined from 35% to 28%. In the same period, the American IT market has grown from a similar starting point to represent about 41% of the world-wide market in 1996.

Europe appears to be lagging behind for at least two reasons. The first is that enterprises still take a conservative view of investments in ICT, which only rarely are regarded as a real opportunity for new forms of business. Too many companies simply regard ICT as an element of cost, to be cut as soon as business confidence slows down.

The second reason reflects the relatively low penetration of ICT in the sphere of individual life and the home environment. Statistics show that in Europe IT expenditure represents just 2% of GDP, compared with 3.7% in the USA. The per capita IT expenditure is of 365 ECU in Europe, compared to 763 ECU in the USA. Computers and telecommunications are far from becoming an integral part of the European life style, like the telephone or TV.

Besides the short term difficulties of the economy, such structural delays represent critical challenges for the European ICT industry, both in the context of the movement towards the Information Society, and the development of industrial competitiveness policies.

Social and Economic Impact of Information and Communications Technologies

Investment in ICT has a significant impact on the competitiveness of the whole economic system. ICTs are horizontal technologies and their use produces effects outside the original investment area. The use of ICTs leads to changes in the organization processes of companies. They not only improve the efficiency of internal business functions, but also offer new mechanisms for relations with customers and with other businesses, as indicated by recent developments in electronic commerce. Tighter links between design, sourcing, manufacturing and sales are possible. The traditional distinction between internal and external tasks and functions becomes flexible. By combining internal core functions with external outsourced services, companies can optimize costs and improve competitiveness.

More generally, ICTs have a profound impact in opening-up many service activities. ICTs are making some services more tradable and more akin to manufacturing, leading to further convergence of industrial and service activities. Examples can be found in financial, business, media and cultural services. Increased tradability of services, broader use of outsourcing and new delivery mechanisms are substantial factors for change, not only in the structure of economic and social activities but also in the occupational and skills structure of employment. Beyond their short-term effect on restructuring and necessary adjustments, ICTs are powerful potential sources of new jobs. The most important effects of the development of the Information Society are foreseen in the opportunities generated for employment in the service and content sectors, in particular through new business activities in the area of electronic commerce and multimedia.

The potential of ICT for increasing productivity in a broad range of industrial and service sectors presents European companies with new possibilities for achieving competitiveness at a global level. European policy towards the Information Society ensures that such potential is properly exploited and that the economic and social benefits are maximized for all.

New Policy Priorities for the European Information Society

A number of building blocks have been put in place. These include: the establishment of the framework and timetable for the liberalization of telecommunication infrastructures; the support provided by the ICT programmes of the 4th R&D Framework Programme to the research, development and take-up of technologies and applications; the actions launched at international level to put the Information Society in a global context; and the effort devoted to analysing the social effects of the Information Society and to clarify the challenge that this represents for European citizens and workers.

The adoption in November 1996 of a comprehensive action plan for the Information Society has served to fine-tune the Commission's priorities. The new action plan is based on four priority areas:

- *improving the business environment,* in order to ensure that the appropriate market conditions are established for the development of new applications and services;
- *investing in the future,* to take into account the need to invest in education - from the earliest age - and in R&D efforts aimed at keeping abreast of the fast pace of technology development;
- *putting people at the centre,* to reflect in action the results of the debate on the implications of the Information Society for social, regional and employment policies;
- *setting global rules,* to develop the international initiatives made necessary by the global nature of the Information Society.

A number of EU policy areas have a direct or indirect impact on the ICT industry. Some of these are particularly critical and have shown important progress during 1996.

Improving the Business Environment

The liberalization of telecommunication infrastructures is the most important step to improve the business environment for the development of ICTs. It is now essential that all those measures which are necessary to ensure that the market is fully open be in place by 1st January 1998. It is necessary that the combined effect of competition and technological progress brings down telecommunication tariffs and results in opening the way to the emergence of new services. It is not just a coincidence that, as this EITO report shows, the highest growth rates of the ICT market have been experienced in those countries where the liberalization of telecommunications was started earlier.

A particularly important area where development, uptake and demand must be encouraged, is that of electronic commerce. Electronic commerce constitutes a key driver for the development of new business models and offers enormous potential for new applications. Progress now hinges on the move from the automation of internal business processes to the automation of the transactions between business organizations and consumers, as well as between companies and administrations or other companies. Electronic commerce encompasses the whole commercial transaction cycle. It includes advertising and promotion, relations between traders, provision of market intelligence, pre- and post-sales support, electronic procurement and support for shared business processes. It has a strong international dimension offering a route to doing business in the global marketplace.

A New Approach to Standardization

The liberalization of the telecommunications market will only become a reality if it is possible to guarantee the interconnection of networks and the interoperability of services and applications. The European Commission has undertaken a thorough review of ICT standardization processes: increasingly shorter product life cycles make traditional procedures inadequate. The shortcomings of the current standardization system, in particular the difficulties in obtaining the technically appropriate specifications of interoperability at the right time, have led to the issue of the recognition of *de facto* standards developed by fora or consortia. It is therefore necessary that publicly available specifications or *de facto* standards are considered and, when necessary, properly integrated in the standardization framework. Standardization can provide a firm base for industrial competitiveness by allowing rapid establishment of new markets and by giving users the confidence to invest.

Putting the Information Society in the Global Context

The ICT industry has always been the most clear example of a global industry. It is characterized by global technology trends, world-wide markets and the rapid diffusion of applications across all countries and regions. The establishment of global networks, such as the Internet, and developments in electronic commerce have highlighted the need for a global approach to the Information Society on at least two levels.

The first is *global cooperation* in setting the rules. In particular we have to ensure the development and acceptance of internationally agreed regulations covering intellectual property rights, privacy and individual rights, information security, interoperability and standards.

The second is facilitating *global market access* by opening markets and removing barriers to trade. The positive conclusion of the Information Technology Agreement at the WTO Conference in Singapore in December 1996 is an important step in this direction. The abolition of trade duties for all IT products gives immediate effect to the process started by the last round of GATT negotiations. It helps reduce the cost of producing ICT equipment in Europe, while providing European manufacturers with better opportunities for exports in foreign markets.

Investing in Technology

The technologies of the information society are developing fast, and substantial investment in R&D is required at an early stage in order to maintain market competitiveness. Take-up actions need to be integrated with R&D to stimulate the early adoption of ICT, as this underpins the competitiveness of users in their respective markets. In addition, the participation of users in R&D activities is essential for ensuring that these efforts meet real needs and are in line with market requirements. These priorities are regarded as central in the preparation of the 5th Framework Programme for R&D. Experience has shown that the best results are achieved when R&D is focused on satisfying users needs. Creating a user-friendly Information Society will be a primary goal of the 5th Framework Programme and the research themes, the instruments and the modalities of execution of the Programme will be shaped to meet this goal. Research will focus on the development of technologies, tools, infrastructures, services and applications that are interoperable at world level and can lay the foundations for the creation of new jobs in tomorrow's Information Society.

Promoting Industrial Competitiveness by Benchmarking

Improving the competitiveness of the European ICT industry is a primary objective for the competitiveness of the European economy as a whole. To achieve this will require systematic reviews of industrial performance, the identification of weaknesses compared with competitors and the adoption of corrective measures.

This is primarily the responsibility of industry itself: at company level, *benchmarking* implies identifying *best practice,* i. e. examples of successful comparable players, comparing performances and related factors against this reference and identifying which production, distribution or management processes need to be corrected. The European Commission considers benchmarking to be an effective and powerful tool for improving competitiveness and intends to promote and facilitate its use by all companies, and SMEs in particular.

The Commission also intends to promote benchmarking at sector and industry level. An important example is represented by the electronic parts and sub-assemblies industry, whose production practices have been compared with those of similar Japanese companies. This has been done within a pilot benchmarking project jointly organized by the European and Japanese consumer electronics industries, with the support of the Commission and MITI. This exercise has produced many useful suggestions, as well as helping suppliers and users to understand each other's requirements better.

Because of its economic importance and global nature, the ICT industry is of course first in line for the application of benchmarking. The Commission has welcomed the Netherlands initiative in benchmarking the ICT industry and intends to use the results of this exercise as the basis for improving those factors which are the causes of performance gaps between the European industry and the best practice.

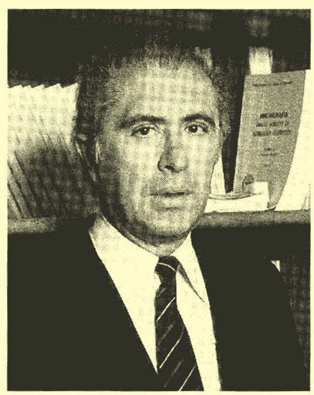
The European Commission cannot substitute for the talent, energy and capital provided by private entrepreneurs. What the Commission can do is to promote, with the Member States, a sound and consistent framework for improving the background conditions which form the basis of world-wide competitiveness. This means examining the legislative, economic and social requirements for rapid progress of the Information Society, as well as those factors which influence the industry's ability to be competitive in global markets. The Commission's aim is to act as a catalyst, bringing together the industrial players and helping to identify weaknesses, remove barriers and set common objectives for action.

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

The Global Information Society

We have definitively entered the Global Information Society (GIS).

The GIS is becoming a common term of reference and a common target for both government and business at world level. It is also a common ground for joint action to speed up the construction of a new industrial cycle based on three major factors: information, intelligent knowledge and networks.



Bruno Lamborghini, President of EUROBIT

The technological convergence of computers and telecommunications is today the major driver of change: change in the economy and in society, not just in technology.

The construction of the Global Information Society is an industrial and a socio-political issue. It is a challenging task for government and business. It is something more than the construction of a Global Information Infrastructure (GII) and it also represents real progress compared with the concept of an Information Society at national or regional level (the National Information Infrastructure in the US the European Information Society). We live in a global world and the Information Society has to be global to be effective.

Intelligent information and communications will be at the centre of the new scenario. It will replace more and more traditional hard goods. In the words of Negroponte bits will replace atoms, and the remaining atoms will be increasingly full of bits.

In the world of intelligent bits, the digitalisation process is breaking down the boundaries between different kinds of information and different industrial sectors. Digitalisation is the common esperanto which will permit communication between all people, all networks, all objects.

Information technology and telecommunications are radically changing their traditional applications: data for IT and voice for telecommunications. Now all kinds of information are processed and communicated. There is no difference between data, voice, sounds, images and physical signals. These are the raw materials of the Global Information Society.

The Information Society has to be built locally through applications and through a bottom-up approach, not a top-down approach, but it cannot really maximise market benefits if it does not follow global rules and if a global political environment is not achieved.

Driving Role of the Business Sector

The business sector has the major merit to have shown clearly and convinced governments of the need to follow a global approach and not national fragmented roads.

I want to mention the role played in early 1995 by the Tripartite Agreement between EUROBIT, ITI (Information Technology Industry Council) of the US and JEIDA (Japan Electronic Industry Development Association) of Japan in preparation of the G7 Conference on the Global Information Infrastructure end of February 1995 in Brussels. As a matter of fact a large part of our recommendations were included in the Chair's Conclusions of the Conference.

The second set of recommendations presented in December 1995 by the Quadripartite Agreement, including ITAC of Canada, has been widely appreciated by the European Commission and by the US Administration and has been incorporated in the official papers.

Particularly through the vigorous efforts of trade associations and business circles, the business sector has established a strong lead and has high credibility in the definition of the new environment for the Global Information Society. It is perceived by governments as a fundamental partner in the phase of change towards the new scenario.

Industry should be proud of this achievement, but at the same time it should be well aware of its big responsibilities and commitment.

There is a long road in front of us if we really want to promote the construction of a Global Information Society, that means new business, new firms, new jobs, new markets and better quality of life for everybody on the planet.

And time is of the essence.

Some Basic Guidelines

There are some guidelines that governments and the business sector together should follow:

- taking coherent and convergent action on various issues following a common global framework (telecom liberalisation policy, standardization, various trade issues, regulatory environment for privacy, data protection, intellectual property rights, security, etc.);
- accepting common global rules;
- being transparent in action and in exchanging as far as possible information, experience and best practice;
- promoting general awareness on benefits of GIS;
- avoiding any attempt at dominance by a single country/company in imposing non global, non multilateral approaches;
- extending participation to other countries and regions outside the Quad countries environment;
- speeding up World Trade Organisation (WTO) resolutions and agreements on GIS issues.

Europe is Moving in the Right Direction

After a late start, Europe is moving in the right direction following the presentation of the Bangemann Report which represents the real cornerstone of the Information Society in Europe.

I want to mention some points related to the first phase in the construction of the Information Society in Europe during 1994-96:

a. Telecommunication policy

As recommended in the Bangemann Report, the European Union has accelerated the liberalisation process in telecommunications, fixing the deadline of 1st January 1998 for full liberalisation of networks and services including voice telephony.

A number of directives has been approved, also applying Art. 90 of the Treaty which permits to reduce the approval process time.

Implementation by Member States is underway and the liberalisation process is taking place in France, Germany, Italy and Spain, which are now following more advanced European countries like Great Britain and Sweden.

Liberalisation is proceeding in parallel with the privatisation process of public monopolies.

What is now under examination is the opportunity to have a consolidated regulatory framework unifying the various Directives and a stronger coordination and enforcement power by the Commission in law implementation at country level, as clearly indicated in the new Rolling Action Plan.

A European Regulatory body is also under consideration in order to better harmonise the regulatory environment at European level and take into consideration transnational issues.

Speed and conditions of the liberalisation process are fundamental issues for achieving a harmonised and competitive European telecom market, ensuring competitive prices and high quality services. In this area EUROBIT is strongly committed to accelerate the removal of monopolies and is supporting the action taken by the Commission.

Without decisive action taken by the European Commission and notably by the Competition Directorate, European countries still would have maintained protected national monopolies and closed markets. GSM mobile telephony, Europe's trump card, would probably have failed to develop.

While the UK and Scandinavia have been at the forefront of telecom liberalisation since many years, Germany, France, Spain and partly Italy now realise that they cannot participate in the multimedia challenge without creating real market competition in the communications market.

European countries are starting to understand that the GIS development does not only refer to some specific industrial sectors, but it will determine a radical change of the entire economic and social system.

Time has become a fundamental variable. Taking a decision with a six months delay can have a dramatic impact on companies and governments.

Telecom liberalisation in mobile networks has already produced extraordinary benefits in terms of market growth (close to 45 million subscribers at yearend 1996), new jobs (more than 120,000 people) and business development.

From the progressive widening of market competition in data networks, multimedia, online and Internet services and, from January 1998, also in voice services, we expect tariff reductions and a multitude of new services and applications.

b. Internal market policy

Competition in telecommunication is a fundamental condition for the construction of IS, but it is not sufficient. Telecom liberalisation is not enough to ensure wide development of applications based on new technologies.

European countries have to remove many impediments and obstacles to the development of new applications. Take, for example, teleworking which will not grow unless changes are introduced in labour contracts, or take Electronic Commerce, which will not develop until obsolete procedures, bureaucratic constraints and legal procedures are updated and adapted to the new environment.

To build the Information Society, it is necessary to deregulate or re-regulate the environment in order to develop demand for new services.

In Europe there is a number of obstacles to the development of new services for IS. Free circulation of services is not yet a reality in the European Union and action has been taken to speed up service market integration which is extremely relevant for IS services.

A new regulatory environment for services requires a global approach and the business sector is taking action in this direction.

EUROBIT's action in the area of privacy, intellectual property rights or security is following this approach.

Since the adoption of the European Data Protection Directive by the Council in July 1995, EUROBIT has been active in the phase of its implementation at national level in order to take care that no new obstacles to trans-border dataflow will be created.

c. Intellectual property rights (IPR)

Actions in the field of IPR include:

- implementation of the directive on the legal protection of databases into national laws of member states and
- contributing to the EU Commission's consultations on the Green Paper on Copyright in the Information Society as well as on Industrial Property Rights in the Information Society.

To achieve a coherent international IPR framework action also covers the implementation of the GATT/WTO TRIPs agreement and the negotiations within the World Intellectual Property Organisation on treaties concerning copyright protection and protection of databases.

d. Cryptography

Electronic Commerce and Electronic Government are main drivers of the GIS. They require the right environment of privacy and trust.

Digital signatures will play a major role in order to push electronic commerce. Signature systems must work beyond national borders. They must be internationally accepted. Businesses, individuals and governments may have a need to protect their data or communications against espionage. Crypto-technology is the basis for both digital signatures (integrity, non-repudiation) and encrypting information (confidentiality).

The technical means to fulfil many new requirements are based on the use of sophisticated cryptographic methods. Electronic business transactions and electronic business documents must be given equal recognition to paper based transactions and business documents.

Presently there are constraints on the public use of high quality cryptographic methods as well as the worldwide availability of such products.

At OECD a set of Cryptography Policy Guidelines is in preparation, with the objective of providing guidelines to the OECD member states and hopefully also others on how to implement national cryptographic policies in the GIS environment.

e. Standardization policy

For fast implementation of the GIS the critical standards, e. g. for interfaces and infrastructure, have to be provided in the voluntary domain.

It is crucial that standards keep pace with the rapidly changing technology i. e. timeliness and market focus are essential.

Procedures like PAS (Public Available Specifications), groups like HLSG (High Level Standardisation Group) and events like the GIS conference mentioned below are established to achieve this goal.

Independently of the rate of progress in individual European countries, the process of globalisation exemplified by the diffusion of the Internet is advancing the construction of an Information Society throughout Europe.

Internet is multiplying networks, applications and services driven by the strength of diffusion of interoperability standards. The number of Internet hosts in Europe is now more than 3 million and grows at 50% a year.

The standardization process based on market *de facto* standards (and no longer on traditional *de jure* standards) has become a powerful driver.

Speed of diffusion and success of *de facto* bottom up standards is not comparable with the diffusion of *de jure* top down standards: for example the diffusion of TCP/IP e-mail service compared to the ISO/OSI X 400 diffusion.

Interoperability is a fundamental achievement and can be realized only through the creative use of market standards and their diffusion at world level.

The European Commission has taken the decision to propose a big international Conference on Standards for the GIS which will take place in October 1997.

The Conference should permit the identification of standard-related impediments to the timely deployment of GIS applications throughout the world via effective use of consensus based standardization.

The Conference will include major industrialists, leading technology developers, standard developers, users, standardization bodies, governmental agencies, and will work by workshops on application areas (electronic commerce, services to the public, home/individual use) and has to become a powerful driver for accelerating new standard development and new applications for GIS.

f. Information Technology Agreement

The Information Technology Agreement (ITA) has represented a major challenge in 1996 and the major success at the WTO Conference in Singapore.

The objective of the ITA is the total elimination of residual customs tariffs on ICT products by all concerned countries with the goal of achieving truly open markets before the year 2000. ITA is a step forward to the GIS. In this direction the absolute target is to have the widest possible product and country coverage.

In my role as chairman of the TABD (Transatlantic Business Dialogue) ITA Issue Group and through the decisive action of EUROBIT we have strongly promoted agreement on ITA between all concerned organizations and industrial bodies. This constructive cooperation has permitted favourable conclusions on the Semiconductors Agreement issue, positive negotiations at the Quad Conference and a successful result at the TABD Conference in Chicago on November 1996 which has created the basis for the WTO Conference. On a transatlantic basis it was agreed to search for the maximum enlargement in terms of product list and country coverage and to reduce tariffs in one step by the second half of 1997.

After Singapore, a lot of work has still to be done in terms of implementation, enlargement, but also in terms of product classification.

Converging technologies are creating problems in IT product classification with relevant trade issues.

The evolution of digital and interactive TV on one side and the incorporation of loudspeakers or cameras and microphones into PC monitors on the other side raise the question of the appropriate definition of the demarcation line between TV- and PC-monitors. Another example of the growing complexity of classification due to converging technologies are so called "multifunctional" products which provide printer/copier/fax/scanner capabilities where these capabilities until now were provided by separate products.

Against this background the European Commission started to reclassify IT products such as LAN equipment and CD-ROM drives from computers to telecommunications and consumer electronics, effectively or potentially raising import duties from no more than 4% to 7.5 or 14%.

With the CD-ROM drive reclassification as the starting point, the national European IT associations and EUROBIT and ECTEL together with its partners in the US and Japan launched a joint campaign. The objective thereby was to achieve a revision of the classification, and to ensure that no negative economic consequences would arise from this decision for the European IT Industry. Duty suspensions came into place which ensured that no 14% import duty had to be paid for CD-ROM drives either in the second half of 1995 nor in 1996.

In May 1996 the WCO (World Customs Organization) finally decided that the specific CD-ROM drives under examination have to be classified as computer products.

Further classification issues may arise from new products in the field of optical disk storage technology like CD-R's as CD-ROM drives with recording capability and DVD-drives. The Industry's view is that these products have to follow the same classification rational as CD-ROM drives.

Due to these classification issues the ITA has to ensure by appropriate means that future developments in its product portfolio will be covered and are not undermined by classification decisions. The review of the Harmonised System just starting represents an additional opportunity to appropriately adapt new technology and product developments in the Information Technology area.

g. Mutual Recognition Agreement

The Mutual Recognition Agreement (MRA) on product testing and certification is under negotiation between the EU and the US on an urgent time schedule.

The MRA will cover telecommunications and information technology products in the following areas:

- telecommunications terminal approval;
- EMC requirements;
- product safety.

The MRA should be flexible enough to allow for much needed simplifications of approval procedures in both geographical areas. Of utmost importance in this respect is the general adoption of the principle of Supplier's Declaration of Conformity (SDoC) as offering sufficient evidence of compliance to technical requirements. Mandatory use of third party testing and certification bodies can be costly and time-consuming and should not be required.

Conclusions

We are living in an exciting time and we face an exciting challenge, most probably something never experienced before by human beings. This challenge will bring about a new society, where it seems possible to achieve a real improvement in life conditions all over the world.

We have the possibility for the first time in human history to accelerate and rebalance development all over the planet. We have already now clear examples of rapid change in development conditions for many countries, until yesterday left out of the process of economic development and in conditions of extreme misery.

It is possible to create better quality of life through the diffusion of new technologies, adding intelligence and personalisation to all new products and services. Our common target is to create new business and new jobs through the diffusion of ICT to all sectors of economic and social activities.

Business targets have to move in parallel with the political targets of governments and institutions. Together we have to promote the most favourable conditions for change and development, and to create a real awareness of benefits among institutions and citizens.

We expect real progress from concrete initiatives taken by the EU Institutions together with Member States through the Rolling Action Plan launched at the Dublin Summit in December 1996.

Our common target is to think global, while acting locally.

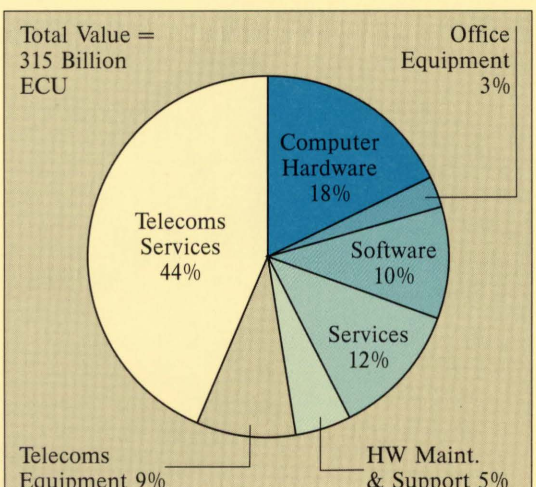
The Information and Communications Technology Market in Europe

ıble 1
*'estern European ıformation and ommunications ·chnology (ICT) 'arket, 1996 illion ECU***

	1996 Value	% of IT/TLC	ICT
Total IT	**148**	**100.0**	**47.1**
Computer and Datacom Hardware	58	39.0	18.4
Office Equipment	8	5.3	2.5
Software	31	21.0	9.9
Services	37	24.7	11.6
Hardware Maintenance and Support	15	10.1	4.7
Total Telecommunications	**167**	**100.0**	**52.9**
Telecommunication Equipment	29	17.2	9.1
Telecommunication Services	138	82.8	43.8
Total ICT	**315**		**100.0**

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

'gure 1
'estern European ıformation and ommunications ·chnology (ICT) 'arket by Product. 1996



The data and forecasts presented in this paper have been jointly prepared by IDC and the EITO Task Force on the basis of information available at the end of November 1996.

1. Overview

1.1. IT and ICT Market Size

The Western European ICT market reached 315 billion ECUs in 1996. It represents some 4.4% of the overall GDP. Information technology categories (including office equipment, electronic data processing equipment, software, professional services, processing services, network services, hardware maintenance and support) contributed 148 billion ECU. Telecommunication equipment and services accounted for the remaining 167 billion ECU of the market.

Despite confirming a faster dynamic than the overall economy, the Western European ICT market growth has slowed down again in 1996, with a rate of 7.2%. The IT portion of the market alone grew by 6.5%, while the telecommunication portion grew by 7.9%.

The slower dynamics in the European ICT markets damaged the market share contribution of Europe to worldwide markets. Overall Europe accounted for 29.7% of worldwide ICT consumption in 1996. Europe accounted for a share of 28.3% of the worldwide IT market, and European telecommunications accounted for 31.1% of worldwide total.

The US ICT market continued to show sustained growth, confirming an outstanding fifth consecutive year of positive performance. ICT market growth in the US recorded a 9.8% rate in 1996. IT provided the strongest support, among the most developed regions, for the worldwide market, which expanded 11.0% for the year. The Japanese ICT market continued the positive growth trend started in 1995, with a performance of 7.9% in 1996.

The ICT markets of the Four Tigers (South Korea, Taiwan, Hong Kong, and Singapore) continued to grow faster than the worldwide average with a combined 1996 market growth of 18.6% in IT and 7.2% in Telecommunications.

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

Western European GDP growth has slowed down in 1996, but is expected to accelerate in 1997. US economic growth is likely to slow down slightly in 1997. After a remarkable increase in 1996, Japanese economic growth is expected to slow down in 1997.

The European economic landscape continues to be dominated by the agenda of the European Monetary Union (EMU) and related major intertwined challenges:

- restrictive fiscal policy to meet qualifying criteria;
- co-ordinated monetary policy;
- harmonisation of legislation (including taxation) in order to implement the single currency.

Monetary Union is scheduled to begin in January 1999, with the "core" group of participants to be decided in 1998.

Table 2
Worldwide IT Market by Region: Percentage Breakdown Calculated on Market Values. 1995-1997 Billion ECU

	1996 Value	1995 %	1996 %	1997 %
Europe*	154	29.4	28.3	27.5
US	225	41.0	41.4	41.8
Japan	92	16.9	16.8	16.6
4 Tigers**	16	2.7	2.9	3.0
RoW***	57	10.0	10.5	11.1
Total	**544**	**100.0**	**100.0**	**100.0**

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

Table 3
Worldwide ICT Market by Region: Percentage Breakdown Calculated on Market Values. 1995-1997. Billion ECU

	1996 Value	1995 %	1996 %	1997 %
Europe*	328	30.3	29.7	29.3
US	381	34.5	34.6	34.7
Japan	164	15.1	14.9	14.6
4 Tigers**	44	3.9	4.0	4.0
RoW***	185	16.2	16.8	17.4
Total	**1,102**	**100.0**	**100.0**	**100.0**

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

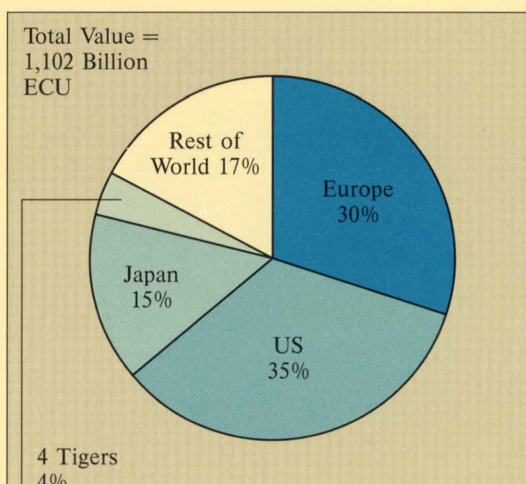
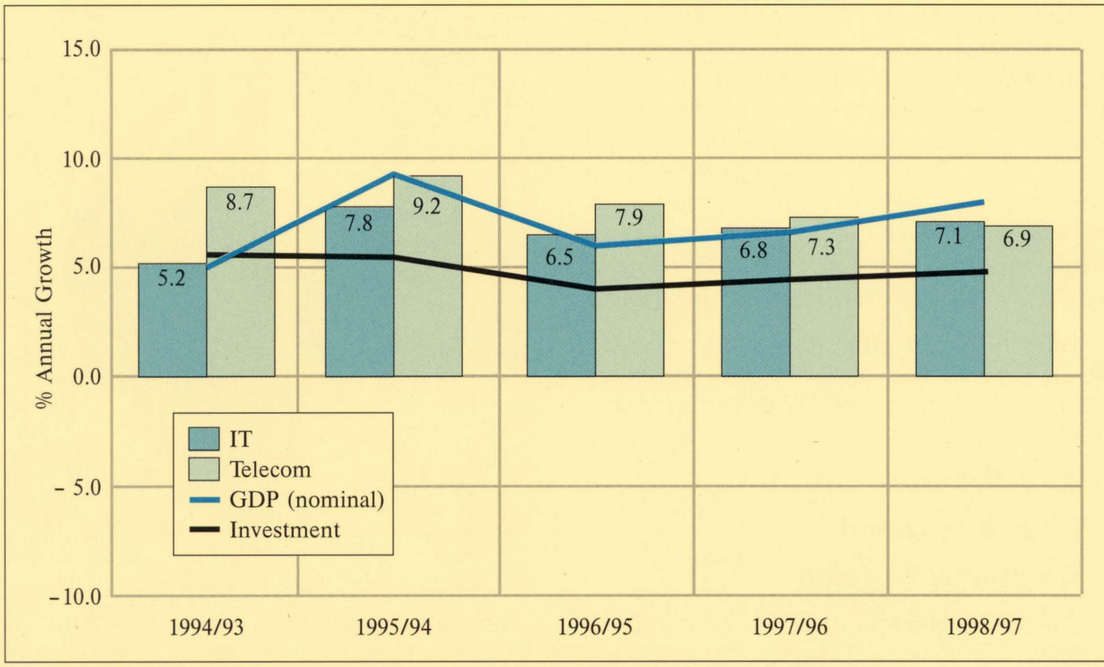


Figure 2
Worldwide ICT Market by Region. 1996

igure 3
'estern European GDP, ıvestment, IT and TLC larket Actual Growth nd Forecast. 1993-1998



able 4
Vestern European IT larket by Country: ercentage Breakdown alculated on Market alues and Growth. 996-1998. Billion ECU

	1996 Value	1996 %	1996/95 %	1997/96 %	1998/97 %
EU	138	93.2	6.4	6.8	7.1
Germany	40	26.8	5.7	6.9	7.5
France	26	17.3	6.0	6.5	7.0
UK	23	15.6	7.9	7.5	7.3
Italy	13	8.4	4.0	5.6	6.3
Spain	6	3.8	8.2	8.1	8.6
Other EU	31	21.2	7.4	6.6	6.8
Non-EU*	10	6.8	7.3	7.1	7.2
W. Europe	**148**	**100.0**	**6.5**	**6.8**	**7.1**

Note: * Switzerland and Norway

Overall the current economic prospects are that:

- high deficits will trigger new fiscal tightening in the short term;
- favourable inflation and deficit prospects will drive a more favourable credit situation with a lowering of interest rates.

The current impact on confidence levels, however, is of:

- soft orders expectations for businesses;
- high moderation, as the labour market is slack and reforms restrain wages for consumers.

The overall consideration of the economic perspective effect on IT spending dynamics would suggest that positive effects on IT purchases of lowering interest rates will prevail over negative impact of restrictive fiscal policy. This is especially likely for investment in high-tech initiatives aimed at improving productivity and generating economic growth.

The two largest European economies, Germany and France are expected to record improving performance in 1997, although still struggling with unemployment. The Italian economy also appears sluggish at present with extraordinary efforts being made to meet Maastricht criteria for the EMU. The UK economy is showing signs of stability in the last two years and is expected to improve in 1997. Spain is starting to record recovery in employment levels.

After declining GDP growth in 1996, the Nordic economies are set for increasing economic growth in 1997, with the exception of Norway.

1.2.1. IT Trends

i. Trends by country

Germany: solid growth

After a modest growth of 1.1% in 1996, the German economy is expected to gain momentum in 1997, with an expected GDP growth of 2.2%. This more upbeat picture is reflected in recent data on production output as well as in several business confidence surveys.

The German IT market has halted its pace of recovery in 1996, but growth has continued to prove solid with a 5.7% increase. The IT market is expected to increase by 6.9% in 1997. The urgent need to improve productivity levels to compete in the global economies, has accelerated the adoption of new technologies, especially in manufacturing.

In the hardware sector, the shift to lower cost multi-user systems has continued. The business sector kept the PC market buoyant as consumer purchases were disappointing - a direct reflection of crumbling consumer confidence amidst an uneasy economic situation.

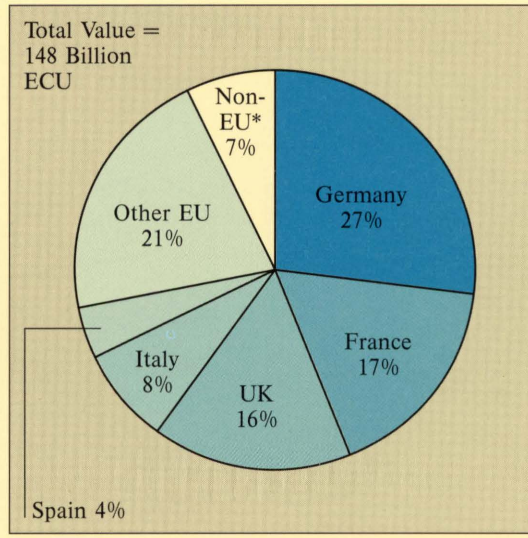


Figure 4
Western European IT Market by Country, 1996.

* Non-EU: Norway and Switzerland

The software market is expected to reap the rewards of continued strong growth in the business PC market. Accelerating Windows 95 adoption, booming sales in the area of problem-oriented software solutions, and increased demand for client/server integrated business systems are the major growth drivers in this segment. As a result the German packaged software market accounts for more than a quarter of the European market. Growth in services is expected to improve in 1997. Outsourcing, project management and application re-engineering services (required to overcome the year 2000 date boundaries) are high on demand.

France: towards recovery

Fiscal austerity and poor domestic demand kept consumer and business confidence low in 1996. Austerity measures have been partly offset by tax cuts introduced at the end of 1996 to raise consumer expectations with regard to their standard of living and personal financial situation. Overall economic growth was 1.3% in 1996, and is expected to rise to 2.5% in 1997.

Economic conditions did not assist IT market development. Growth in 1996 was 6.0%, or 0.5 points lower than experienced across Europe. In 1997 the IT market is still set to under-achieve against Europe as a whole, with a 6.5% growth.

The outlook for IT spending growth seems to have improved since the end of 1996, thanks to more public and private initiatives to promote productivity gains in the business sector. A revitalised competition in some traditionally public segments, such as transport, communications and utilities, also contributed to raise confidence on increasing growth dynamics in IT spending.

In the hardware sector the French market is nonetheless one of the most active in its uptake of faster-speed Pentium-based machines. While consumer PC purchasing has been declining, in the professional marketplace revenue is increasing faster (as the market has not witnessed the same high price reductions on high end servers experienced elsewhere in Europe), although growth in unit sales may prove more difficult.

The software market continues to be driven by strong growth in the application tools and solutions sector as customers move towards a packaged solution approach. On the other hand, systems and utilities software is showing limited improvements.

The burgeoning packaged software market is currently eroding the share of IT implementation services. Large computer services companies have started to refocus their organization structure and business model. They have concentrated on improving strategic consulting skills as well as on effective fulfilment of IT services projects for large multinational organizations. As a result revenue growth in this sector is starting to pick up again, while IT services suppliers regain customers' trust and outsourcing contracts improve strongly.

UK: record expansion

GDP growth has kept to a sustained 2.4% in 1996, and is expected to improve further to 3.3% in 1997. A favourable economic environment has witnessed accelerating investments and consumer demand. As demand keeps strengthening, though, risks of higher inflation are increasing.

The UK IT market is still among the heroes of growth in Europe with a 7.9% increase in 1996. Its performance is expected to slow down this year to 7.5%, after five consecutive years of leading annual growth levels.

A very advanced and dynamic PC retail market has been stimulating growth in the PC consumer and business channels. New entrants, new joint ventures among distribution channel players and new purchase type offers (such as "rent to buy" schemes) are heightening competition and the quality of the offer.

The software market is continuing to boom, driven by demand for more advanced function-based applications that enhance large IT users business processes productivity. The scare concerning packages conversion for the year 2000 is high in this country, too. The UK Government has set up a special Task Force to press for coordinated efforts.

IT outsourcing remains the biggest contributor to growth, although public sector projects have recently suffered from lack of cost efficiency. Lack of harmonisation in project development and implementation phases, and lack of experienced staff have also increased concern about outsourcing initiatives. The number of new contract announcements remains sustained, though, and ranges from food retail to insurance.

Italy: modest growth

The tightening of fiscal policy in 1997 has left little scope for domestic demand stimulus and has restrained GDP growth acceleration. GDP growth was 0.8% in 1996, and is expected to reach 1.2% in 1997.

The lack of a strong economic recovery and the prospect of continued tight fiscal policy are not helping to stimulate the local IT market. In 1996 growth was 4.0%, and in 1997 it is expected to improve slightly to 5.6%, a much lower rate than the potential size of the market would allow.

Although declining in nominal terms, Italian interest rates remain high in real terms. This situation will continue to impact on small to medium-sized companies IT investment attitudes. IT budgets are likely to be squeezed and longer term plans for capital IT investment remain modest. The PC market has felt this squeeze acutely in the second half of 1996. As a consequence, Italy's delay in terms of diffusion of PCs has increased.

On the positive side, expectation of increasing government commitment to IT projects and initiatives for privatisation provide better prospects to drive new investment in general, with more demand for IT and more IT outsourcing initiatives.

In the software market, tools continue to show strong growth, broadly in line with software growth in general.

The boom in network services is among the major contributors to growth. Facilities management is also expected to grow strongly as companies embrace the outsourcing concept, although the actual number of contracts remains relatively small.

Spain: back to growth

GDP growth continued to expand in 1996, to reach a 2.1% level. The positive trend is expected to improve to a 2.7% growth in 1997. Investment and consumer demand will remain sustained despite fiscal tightening. Steady increases in employment and low interest rates are producing more confidence in businesses and consumers.

With a 8.2% increase in 1996 and an expected 8.1% in 1997, the IT market in Spain is finally back to strong growth. The potential of a large economy is not yet fully exploited, though.

The shift to more modern and higher-value technologies gets stronger. The personal computer consumer market remains relatively small, despite the increasing popularity of the Internet among home users. Considerable growth is expected in the home software, hardware and peripheral market.

Client/server software applications are driving accelerating growth in the software market. Increasingly positive trends are also recorded in the professional services market.

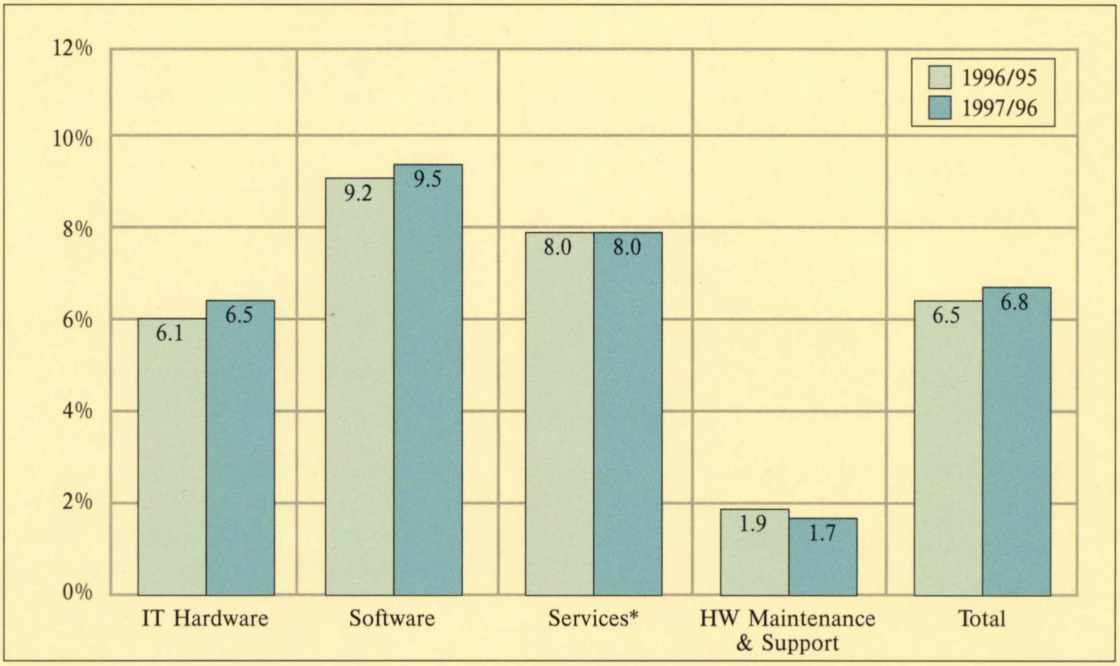
A further indicator of a buoyant IT market is the rapid growth in new entrants throughout 1996.

Other countries

The market for IT in the Nordic countries has outperformed the European market as a whole in the past few years. Recently it has started to grow more slowly compared with general European trends, especially due to increasing saturation in the personal computer market.

The IT market in Austria will benefit from extremely high growth rates in packaged software and in network services. Switzerland's IT market growth is improving after a better economic outlook and confidence levels.

Figure 5
Western European IT Market Value Growth by Product Segments. 1996-1997



* Services include: Professional services, processing services and network services

In line with the rather downbeat economy, IT growth in Belgium will be modest and below the EU average. The Netherlands' IT market is experiencing strong growth with the software market as a major driver. Manufacturing, retail and consumer confidence are all well ahead of European averages which sustains this optimistic outlook.

The IT market in Ireland is set to grow below the European average. The Greek IT market shows the fastest double digit growth in Europe, although magnified by higher inflation. Much of the expansion has been driven by the public sector, but the private sector is expected to take the lead shortly. The Portuguese IT market is expected to keep ahead of the European average growth rates. Facilities management looks set for phenomenal sustained growth and reflects the recent change in corporate culture.

ii. Trends by product segment

Broadening acceptance of client/server computing and the development of the consumer market continue to drive IT market growth.

IT hardware: the PC dominance

IT hardware revenues increased by 6.1% in 1996, and a 6.5% growth performance is anticipated for 1997. The continued sustained growth in the personal computer market has led it to contribute some 38.5% of the overall IT hardware market in 1996.

The increasing adoption of PC-based solutions has changed the profile of the overall IT spending mix, with increasing value being devoted to the costs of managing and enhancing these solutions, more than to the costs of the base hardware technology itself.

% sites	Germany %	France %	UK %	Italy %	Benelux %	Western Europe %
Manufacturing	47.1	33.7	44.5	37.3	43.4	41.2
Transport/Communication/Utilities	62.4	40.4	58.9	52.0	47.2	52.5
Retail/Wholesale	61.5	20.3	41.3	63.9	22.0	41.2
Finance	85.3	81.6	65.0	58.4	55.3	71.8
Government	84.0	44.3	75.0	40.5	51.0	67.6
Education	48.6	20.2	61.2	22.2	31.2	30.8
All Industries	62.2	34.7	45.9	43.2	37.7	48.0

Table 5
Implementation of Client/Server Computing by Vertical Markets 1996
% of Sites Which are Moving/Have Moved or are Planning to Move Towards a Client/Server Strategy

The main positive factors include:

- increasing demand for high-end multimedia features in standard PC configurations;
- increasing uptake of Pentium products also in the notebook segment;
- lowering prices and increased availability of IT applications for the home;
- continued enhancements in network capabilities;
- the increasing availability of business applications for client server platforms.

In the *multi-user hardware systems* market, the large scale systems market experienced another year of shrinking revenues in 1996, due to the movement of mainframe chip designs from bipolar to CMOS, jumping the price/performance curve. A slowdown in revenue decline is likely to be met in the future as the market will stabilise to its new core size. Growth will occur in the medium and small scale systems markets, where the adoption of Unix-based and Windows NT-based systems continues to grow rapidly. Growth in terms of units is faster than value. An increase in low-end Intel-based server shipments is leading to significant growth in indirect selling in this market.

In the *Personal Computer* market the slowdown in the "first time" home buyer market has been compensated by a healthy growth in business upgrades in 1996. The wave of upgrades is expected to continue in 1997.

PC market accelerators include:

- prices reducing to mass market levels also for Pentium based machines;
- continued downsizing and client/server trends;
- increasing adoption of workgroup applications;
- demand for improvements in streamlined logistics and structures;
- expansion of networks and on-line services;
- upgrade demand driven by shrinking system life cycles;
- wider consumer acceptance of home computing in the less IT penetrated markets;
- continuing growth and hype surrounding the Internet.

In the *portable* market, the entrance of Pentium notebooks into a mass market price range has expanded the potential demand targets beyond the traditional demand for corporate mobility.

The *workstation* market continued to expand in 1996. The high growth rates were mainly driven by high NT/Pentium growth as well as healthy growth in technical environments, on which major workstation vendors have re-focused.

Also, in the *printer* market, price wars have stimulated the consumer market, together with increasing availability of brands by high street stores. Different trends are shown in the major segments: the dot matrix and monochrome ink jet markets have experienced decline, while the colour ink jet market has increased with the launch of many new products. Accelerators in the market include the uptake of Windows 95, the enhancement of graphics and increased choice of colours. Factors that may restrict growth include the need for improvement in definition, and high costs compared to low-end laser printers. In the laser market, pressures are coming from low-end ink jet and from colour laser printers.

The shift towards distributed computing and networked architectures keeps nurturing growth in the *LAN hardware* segment. The bulk of growth in this segment comes from Internet-working equipment and smart hubs. Network interface cards experience a less high growth as new PCs will ship with a new adapter. Growth in data communications equipment, although remaining below LAN dynamics, is positively influenced by increasing demand for higher speed modems, driven by the booming Internet services.

In the new age of digital document handling, standard *office equipment,* such as copiers, printers, and scanners are blending into new, multi-purpose systems. The shift is helped by the pace of new technology announcements. With aggressive marketing and support initiatives, office equipment suppliers are striving with each other to provide the document centre solution of choice for computer networks. The growth of multi-functional printers (that act not only as printer, but also as fax machine, scanner and copier) is shaking up the mature copier market. This growth is not enough, though, to compensate revenue decline in mature technologies. The overall result is a flat growth leading the market to its natural consolidation level.

The most interesting growth areas include:

- small, cheap "personal" photocopiers addressing users demand for fewer features and higher productivity;
- vertical specialised solutions, such as a turnkey systems for banks to print images of cancelled checks on bank customers' statements;
- high speed (40-pages-a-minute) full-colour document production systems;
- digital front-end technology and software connecting computers to copy machines, that can work as a high-speed colour printers;
- digital copiers that can print computer files and fax documents while linked to networks.

Technology push is coupled with other initiatives to build demand, such as free toner cartridge offerings, user-friendly features, customised programming, large paper capacity, built-in auditron (to audit the number or volume of copies used).

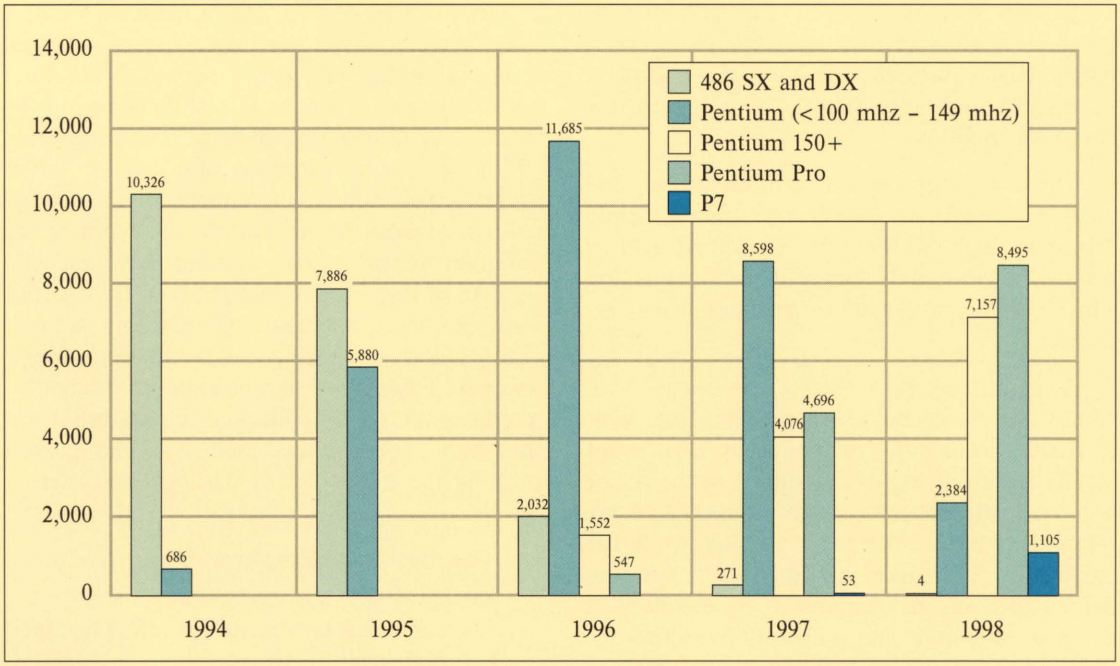


Figure 6
Western European Personal Computer Market, 486 Systems versus Pentium, Pentium Pro and P7. 1994-1998.
Unit Shipments (Thousands)

Scanner technology is also improving to drive increasing sales against price erosion. New features to enhance productivity and quality include: increased rate of up to 3-4 page-per-minute scanning, "scan as you copy", higher resolution, digital images enhancement.

Software products: booming growth

Software products confirmed to be the strongest drivers of IT market growth. Software sales rose 9.2% in 1996 and are set to increase by 9.5% this year.

Demand for client/server software continues to be the strongest driver. All major suppliers attempt an increase in their application software coverage to other areas of functionality, seeking to control the customer platform.

The increasing convergence of tools, applications and systems software to form one solution system - such as groupware products - is increasingly perceived as a very cost-effective alternative to investment in customised software development. Large vendors are seeking co-operation with niche players to exploit the market.

In the operating systems and tools segment, growth is driven by increasing demand for relational database software on all of the major operating platforms - Unix, NetWare, OS/2 and Windows NT. Despite a high potential, obstacles to growth are still strong in the groupware market. Major suppliers have not yet found the most effective initiatives to gain users' trust in the potential benefits and reliability of these new products.

The good news comes from datawarehouse tools. IT users realise that competitive advantage can be gained by transforming write-only databases into repositories of corporate information. Data warehousing is introduced to improve supply-chain performance across a number of businesses by identifying and tracking a wide range of new performance metrics. More ambitious requirements are also emerging of accessing and leveraging knowledge - using a combination of "virtual" data warehouse architecture and World Wide Web technology.

Availability of specialist data warehousing solutions and packages is increasing from both traditional software suppliers and suppliers of services including consulting and systems integration. Benefits experienced from other large user organizations whilst building warehouses for core transaction data are also an incentive. Problems still exist, though, in designing and managing very large warehouses.

Another potential growth area in the short term is emerging with tools to help in re-programming information systems to handle the transition to a unified monetary system by January 1999 and the year 2000 date change.

The *application software* market is getting stronger. Cost considerations drive more users to purchase off-the-shelf applications, reserving in-house development for unique strategic components. Software application frameworks are increasingly viewed as the integration point for complex distributed applications. As a result application suppliers are gaining more attention from users relative to database vendors for supplying integrated solutions.

Sales of client/server enterprise application suites have scored the highest growth in the segment. Integrated suites span such applications as accounting, human resources management, distribution/materials management, and manufacturing applications. Accounting is the largest application segment of all, but manufacturing is expected to become stronger in the short term.

Imaging/workflow, e-mail/collaborative computing and Internet-deployable client/server applications - providing electronic access to information at a lower cost of ownership - also fuel greater growth across application markets. Strong growth is attributed to:

- pressure on organizations to improve corporatewide end-user access to information;
- maturity of first-generation client/server products;
- higher availability of new products;
- incentive to move to new applications pending the year 2000 debacle;
- promotion to client/server migration by many client/server suppliers;
- pervasive end-user demand for information.

IT services

Professional services

The professional services market confirmed its strong growth pace by increasing 7.6% in 1996, and is forecast to increase by 7.7% in 1997.

In the *pre-implementation services* segment, overall growth of consulting services continues to lag behind the US, with the exception of booming demand in the UK. This is due to changes in corporate culture and the different markets. The content of consulting projects continues to be focused on business process reengineering. This is coupled with a shift towards architectural perspectives as migration towards Unix NT accelerates.

Demand for consulting services will be fuelled by IT users' increasing need to access external "business-oriented" expertise. Increasing and broadening competition in the economy in general is encouraging large European organizations to search for better efficiency in processes and more consistent IT and business strategies at both global and local levels. The opportunity cost of high fees and the acceptance of IT as utterly critical to business performance more often prevail against the option of developing expertise internally. The decreasing available choice of external expertise that is consolidating into fewer practitioners seldom acts as inhibitor.

In the *implementation and operation services* segment, high growth is recorded in facilities management and systems and networks implementation and operation. The business impact of booming outsourcing activities starts to provide an increasing revenue growth contribution.

Outsourcing decisions are driven by positive and negative forces. Users' decisions to give up responsibility for the management of core areas of their information systems result from the combined influence of the following considerations. Among the positive ones:

- savings from rationalising equipment, systems and staff, especially in highly decentralised environments;
- better access to new technological skills and new emerging technologies by suppliers;
- more flexible access to increasingly needed computer power;
- shared risk, through financial penalties to the supplier, if quality of service falls below acceptable standards;
- more flexibility in changing the supplier, should it be needed if the worst made to worst.

On the critical side, objections to outsourcing decisions include:

- suppliers inability to deliver certain skills/ services;
- security, especially when highly strategic or confidential data are involved;
- increasing power of facilities management companies over computing practices in a specific sector (especially in government) and for particularly important functions;
- military/intelligence reasons in government;
- concentration of IT control by a small number of giant providers;
- cost savings over the long term not proven.

Two major growth drivers of implementation and operation services in Europe are:

- the unification of European currencies by 1999;
- the year 2000 date change requirements.

Businesses that depend heavily on computer systems are called upon for a strategic and tactical response to handle core programming changes in their computer systems. Demand will be stronger very shortly in the following areas:

- evaluation of how existing systems are equipped to handle multiple currencies and to carry, process and archive dates;
- evaluation of risk and impact of how payroll, inventories and invoicing systems would operate in critical business tasks with/without the date change;
- evaluation of main options, with comparative exposure, workload involved, and opportunity ratings.

Growth in custom software continues to suffer from increasing price pressure. Market share erosion is coming from more competitive, versatile and powerful off-the-shelf solutions able to perform effectively complicated business tasks.

Education and training keeps performing well. Demand is kept sustained as a result of the recent introduction of new generation client/ server applications. Potential is high due to the increasing number of information systems "power" users, with the adoption of client/ server architectures.

Network services: towards a booming performance

Network services grew 14.3% in 1996, and are forecast to keep the same growth rate in 1997. This segment includes managed network services such as EDI and electronic mail services.

Demand for information exchange on the organization network is increasing. It goes beyond the traditional core areas of accounting to encompass all levels of businesses' value chain. The availability of external skills to provide flexible network solutions and optimise companies' communication exchanges has led more large- and medium-sized businesses to consider using an external service provider to supplement these skill sets. Competitive environment, and the importance of the network to customer satisfaction and support are also key factors driving usage of outside vendors for network services.

Among fast growing value-added network services, Electronic Data Interchange (EDI) is facing a crucial challenge. One of the next frontiers for EDI is the integration with Enterprise Resource Planning (ERP) software applications, for example in the automotive industry. IT users experience growing pressure to implement EDI further down the automotive supply chain, to all phases of their business relationship between auto suppliers and their tier-one suppliers. EDI in the supply chain can help reduce cycle times, speed up payments, improve product quality and reduce costs.

Support services opportunities

With the increase of investment in desktops and network environments there has been a correlative demand for service management of these products. Desktop services and software support services are among the fastest growing segments of the support services industry.

The hardware support segment continues to tighten, and deflates the overall trend. Nonetheless it still contributes more than two thirds of the overall support services business. Demand is tightened by the following factors:

- the trend towards smaller, easier to use systems;
- increased reliability of systems;
- lengthening of warranty time beyond the average usage cycle times.

Viewed from the perspective of hardware support activities, the decline is occurring in the largest segment of on-site maintenance. The traditional maintenance contract budgets for large systems have turned into additional internal expenditure of many sites that have to deal with integrating and using large networked PC bases. The commoditization of on-site maintenance has overshadowed any small high growth opportunities associated with value-added support services, telephone support, online support and preventive maintenance.

1.2.2. TLC Trends

The Western European telecommunications services and equipment market recorded a 7.9% growth in 1996, and it is set for continued growth over the next five years. The overall market will grow from 167 billion ECU in 1996, to a value of 179 billion ECU in 1997, by an annual growth rate of 7.3%.

Telecommunications products and services generated a higher business value than information technology, and growth dynamics were faster too. The overall market growth rate hides a number of diverging trends in the overall market, both by country and by segment.

Two primary trends are affecting growth:

- the impact of deregulation intensifying competition and driving down prices;
- the changing ways in which businesses and consumers use network services.

Increasing mobility and portability in the business and consumer sectors is driving demand for mobile telephony. Consumer use of online services, such as the Internet, will see a widening demand for connectivity from the home in the next one to two years. Whilst interactive multi-media services are some way off in Europe, there will be a growing awareness of their potential. Early technology adopters trial the new services. In the business sector, companies will increasingly seek hybrid solutions for corporate networking, rather than opting for single technology solutions.

i. Trends by country

Germany: increasing competition

The German telecommunications market grew by 5.4% in 1996 and is expected to record a growth of 5.2% in 1997.

Telecommunications investment continued to decrease in 1996. The pressure suffered in the public equipment segment was compensated by a positive performance in the mobile equipment and private data communications equipment markets. Over half the total number of ISDN lines installed in Western Europe were located in Germany in 1996. Growth in the number of ISDN connections will be marginally less than the European average. Mobile phone equipment is also expected to show positive growth trends. Due to the reunification with East Germany, the penetration of residential lines in households is low, as is the number of mobile phones per head of population.

	1996 Value	1996 %	1996/95 %	1997/96 %	1998/97 %
EU	157	94.3	7.9	7.3	6.9
Germany	42	25.2	5.4	5.2	5.6
France	27	16.0	9.1	8.7	7.3
UK	23	14.0	8.6	7.1	6.6
Italy	21	12.4	9.5	8.2	6.7
Spain	11	6.8	8.7	8.3	8.3
Other EU	33	19.9	8.7	8.1	8.0
Non-EU*	9	5.7	7.9	7.6	6.8
W. Europe	**167**	**100.0**	**7.9**	**7.3**	**6.9**

Note: * Switzerland and Norway

Table 6
Western European Telecommunications Market by Region Percentage Breakdown and Growth Calculated on Market Values. 1996-1998. Billion ECU

The outlook is more positive as new competitors in the telecommunications scene plan major infrastructure investments in the short term. BT and the German utility VIAG have confirmed their plans to integrate their telecommunications activities and to invest 600 million ECU in telecommunications over the next 10 years.

Basic voice services achieved a modest growth in 1996. Mobile revenue increased by healthy double-digit rates. Connections and traffic volume growth more than compensated for cuts in charges by mobile phone operators and resellers, unveiled ahead of the year-end 1996 shopping season.

Subscriptions for online services and ISDN were up sharply in 1996, and look set to continue their upward trend. The short term growth potential in this area is very high, as Germany has the world's biggest ISDN network.

According to the new Telecommunications Act in the run up to deregulation from January 1, 1998, operators of alternative infrastructure (such as cable TV, and telecommunications networks operated by energy groups) are allowed to offer their network capacity to third parties. This will make Germany one of the most competitive markets for infrastructure wholesaling. Many utilities companies already have available widespread long-distance fixed-line and wireless infrastructure.

The major goal of the Telecommunication Act is universal service provision that includes voice and ISDN at a given level of price and quality; it also establishes, on January 1, 1998, a separate PTT regulatory authority that will be able to request information, inspect and audit business records, and impose selective sanctions.

Competition has been flourishing in mobile communications. The fourth licence is expected to be granted in March 1997. The telecommunications competitive environment has also been crowded by several joint ventures, backed by a number of the world's major players operating in telecommunications, cables, chemical, energy, and steel industries.

The privatisation of Deutsche Telekom has started with the listing of around 11 billion ECU of its capital on international stock exchanges last November 1996, to be followed by a further share offer in 1998. This operation will reduce the German government's stake in the company to 50.1%. The remaining shares will be sold after the year 2000. The company was transformed in a corporation in January 1994.

Deutsche Telekom has pushed the deadline of completion of its nation-wide digital network from 2006 to January 1, 1998. Other priority projects of the company include the development of ATM and optical fibre systems.

France: positive dynamics

The French telecommunications market is showing more interesting dynamics than the national information technology market. The market grew by 9.1% in 1996 and is set to grow by 8.7% in 1997.

The telecommunications equipment market growth is still modest, with the exception of mobile equipment, but the outlook is more positive.

In the telecommunications services sector percentage growth in the number of mobile subscribers is higher than the European average. This is driven by the low penetration of mobile communications and the introduction of competition in the segment. Revenue from ISDN services is also growing at higher rates than overall in Europe, despite the relatively large ISDN installed base. Demand for enhanced voice services and data services is also a major contributor to growth.

Alternative infrastructures have been liberalised since July 1996 for all telecommunications services. At present only a few companies can now compete with France Télécom in providing infrastructure. In July 1996 the French government drafted the legislation for independent telecommunications companies to offer alternative telecommunication carrier services for domestic calls, as well as international calls. The Government is also considering opening the market to a third operator, to rival France Télécom and the recent formed Cegetel Group.

France Télécom privatisation is moving forward. The Senate approved the privatisation law in June 1996 and in July the National Assembly approved the law that will put up to 49 per cent of France Télécom shares on the open market, of which about 20% by April 1997. The company was transformed in a corporation in January 1994.

In the mobile market there are three licence holders: France Télécom, Société Française du Radiotéléphone (SFR), and Bouygues, the last started its cellular telephone service in May, 1996.

In order to make Numeris, its ISDN network, more accessible, France Télécom has taken two major actions:

- an agreement with Microsoft that allows PC users to subscribe to Numeris via Windows 95 and Windows NT;
- a cut in its monthly subscription charges to FFr 150 (with the alignment of national and international call charges to standard telephone call tariffs). Subscription gives access to two 64 kbit lines.

The Numeris network has 1.5 m lines (an annual increase of 30% since 1993) and is mainly used by professionals and companies. Domestic use is expected to be pushed up by the growth of the Internet and a rise in the number of PC users at home.

United Kingdom: the most advanced deregulated environment

The UK telecommunications market grew by 8.6% in 1996 and is forecast to expand 7.1% in 1997.

The market for public telecommunications equipment has shifted from digitalising the network to upgrading the transmission and access network for the deployment of higher speed data services such as frame relay and ATM.

Price erosion, especially in international traffic has slowed revenue growth in telecommunications services. Higher growth than the European average is seen in mobile services, freephone, ISDN and higher speed data services.

Since the privatisation of BT, more than a decade ago, the UK telecommunications market has become one of the most open in the world, comparable to Finland and Sweden in Europe. Since the government's duopoly review in 1991, the telecommunications' regulator has issued almost 200 operator licenses.

The structure of the UK telecommunications market continues to change shape. Concert is the name for the proposed merger between BT and MCI. Cable telephony operators continue to consolidate, most recently with the formation of Cable and Wireless Communications from Mercury, Nynex, Videotron and Bell Cable Media.

BT faces increasing competition from new operators, resulting in a net loss of 10,000 residential customers per month. BT is responding to the loss of market share with special discounts and promotions as well as new network services like ring back when free and three party conference calls.

The high growth rate in the mobile sector has started to slow due to increasing price competition between mobile operators and the continued churn of customers. The average revenue per customer is declining as new customers are predominantly light users.

In the mobile sector there are six networks run by four different operators. Analogue and GSM services are offered by Cellnet (60% owned by BT) and Vodafone. Cellnet launched its GSM service in July 1994, while Vodafone was first to launch in December 1991. Hutchinson Orange (PCN) and Mercury One-2-One launched their GSM services, in April 1994 and September 1993 respectively.

Italy: slow deregulation

Growth of the Italian telecommunications market overperformed the European average. The telecommunications market grew 9.5% in 1996, and is expected to increase by 8.2% in 1997.

Slow growth in telecommunications services revenue and connections (compared to Europe) is due to the delayed entry of effective competition and to the high tariffs. Growth in fixed network voice services is set to remain relatively low, while the mobile services market is booming. The missed growth opportunity is also occurring in data network services. In relative terms the highest growth is in ISDN and related data services revenues, as well as in value added services based on intelligent networks. This growth is not enough to fill the gap with the dynamics in the other major countries.

Subscriptions to mobile services accelerated in the second half of 1996 as Omnitel's GSM network has introduced its Libero subscription-free tariff and Telecom Italia Mobile has launched its "Timmy" pre-paid-card-based service.

Telecom Italia's monopoly of network infrastructure should have ended in July 1996, when alternative infrastructures were formally liberalised. Alternative infrastructures are owned by the Italian Railway, the Highway Administration, ENEL and ENI/SNAM. The implementation of the European Directive on the usage of these infrastructures has been delayed, though. Until the creation of the Communications authority, regulation is a responsibility of the Ministry of Post and Telecommunications and its Secretary General. The national Antitrust Authority and the EU Commission are pushing to speed up the process of telecommunications liberalisation.

Data services are open to competition. Telecom Italia Mobile has the monopoly in the analogue mobile market, while it shares the GSM service with a second carrier, Omnitel. The government is working on the award of a third mobile licence. On the fixed side, Olivetti (which has plans to join forces with France Télécom and Global One) and Mediaset/Albacom (Albacom is a joint venture among British Telecom and Banca Nazionale del Lavoro) are lining up to receive voice telephony licences.

Unfortunately the Italian deregulation process is slow. The approval of the new Telecommunications Act and the creation of the regulatory authority have been delayed to 1997. This has created major problems to potential new entrants, who need clear rules to plan their investment and prepare for liberalised voice services in 1998. The privatisation of STET, the public holding company for telecommunications services, controlling Telecom Italia and Telecom Italia Mobile, has also been postponed to 1997, due to increasing political controversy. A preliminary step is the merger of STET and Telecom Italia.

In 1996 Telecom Italia reduced its long distance call rates, considered among the most expensive in the world, and it expects increase in traffic will offset the price cuts. However, rebalancing local versus international/long distance call tariffs remains one of the key issues for Telecom Italia.

Public effort is also concentrated in improving the quality of infrastructure. In 1996 STET announced multiple year investment in the following areas:

- 1.9 billion ECU in Stream's interactive multimedia services development;
- 5.06 billion ECU in Telecom Italia's Project Socrates, cabling homes with fibre-optic broadband telephone wires networks to transmit multimedia material at high speeds.

Initial plans to wire up to 1.8 million residential homes in the first year, and complete universal wiring by 2005 have been slowed down. Prospects for video-on-demand and other interactive multimedia services have been downgraded;

- development of DECT-based services to improve telecommunications mobility. The decision to offer DECT-based services on a commercial basis from early 1997 has created strong reactions from potential competitors, which have asked the Italian Government to be allowed to provide similar services.

Spain: catching up to European development levels

The market expanded 8.7% in 1996 and is forecast to increase by 8.3% in 1997. Compared to the other major European markets it is experiencing a bullish performance.

Spain has a considerable amount of catching up to do, which is reflected in higher than average growth also in the most mature segments like voice services and voice public telecommunication equipment. The Spanish telecommunications network is undergoing rapid modernisation. This is driving exceptional positive growth in equipment markets.

Growth in services is coming from overall market increase in volumes, as the market is still relatively underdeveloped, compared to most major European countries. Volume growth is strong enough to offset the negative effect of decreasing services and equipment prices.

Among the fastest growing areas are ISDN and mobile voice. In 1996 mobile phone penetration was at 4.6 per 100 head of population against a European average of 8. Also, in the same year, only 39.8 packet switched telephone network lines per 100 of population were installed, against a European average of 49.9. Data services such as X.25 and ISDN, and enhanced voice services, are also among the major contributors to telecommunications services market growth.

In 1994 the government elaborated a new strategic telecommunications plan to bring forward full liberalisation of the sector to January 1998, and forego the special deferment originally granted for Spain to 2003. Spain has met the deadline for the liberalisation of alternative infrastructure, although the lack of an independent regulator and the absence of clear rules continue to hamper the market. Under this plan and under pressure from alternative providers, the national operator Telefonica has also begun a radical restructuring of tariffs, which still remain among the highest in Europe.

Telefonica still enjoys a monopoly in most sectors of the Spanish market and in the infrastructure as well. The first step towards liberalisation was taken in the mobile market in 1995, when the government granted a second licence. The new operator is Airtel, a consortium including BT of the UK, Airtouch of the US with backing from Banco Santander amongst others. Under the term of the licence, Airtel must offer nation-wide GSM facilities within five years. In October 1995 the operator launched its GSM service in Spain's six largest cities, covering 35% of the population.

The government started to sell a part of its stake (12%) in Telefonica in October 1995, through a Public Sales Bid. The final remaining 21.2% government stake in the telecommunications group is expected to be sold in the first half of 1997.

Other countries

In some of the *Nordic countries* growth performance in the telecommunications market is recovering due to the pick up of ISDN and frame relay services, as well as traditional voice services. Internet, mobile telephony and international telephony all contribute to a double digit growth in voice traffic, promoted by double digit cuts in mobile services prices and single digit cuts in fixed voice services. Penetration level of voice line subscriptions and of mobile phones is among the highest in Europe, and the increasing adoption of digital wireless services is the strongest growth generator in this segment. Interestingly, Nordic countries record a very high proportion of subscribers on the GSM network among residential or private customers, rather than the business subscribers who tend to dominate cellphone networks elsewhere in Europe. Because of increasing saturation national carriers are moving towards GSM 1800 and dual-mode phones, and allow increased capacity. Frame relay service revenues are among the most expanded in Europe and have overtaken X.25 service revenue in 1996. Value-added network services also contribute to growth. Among the forerunners in opening up to infrastructure and services competition, Nordic telecommunications markets are already crowded with several licence holders. The complete deregulation of telecommunication fees is the next step, at least in Finland, towards free competition in the market.

Switzerland is trying to follow the principles of the European liberalisation directive, introducing competition gradually, although at a slow pace. Only data services are open to competition. Enhanced services, ISDN and frame relay are driving growth, which is the least dynamic in Europe.

In the *Netherlands,* telecommunications market growth is slower than the European average partly due to late introduction of effective competition. A fast uptake of leading growth areas such as ISDN is recorded. Liberalisation of fixed infrastructure was enacted by end 1996. A strong presence of alternative infrastructure suppliers among cable TV operations, energy company networks and other company networks will stimulate market growth.

Belgian telecommunication services are growing faster than average due to increasing ISDN and mobile voice services, albeit from a low base of customers. International traffic is an important contributor to growth, but competition is becoming stronger in the short term. Apart from data services, which were liberalised in 1992, Belgacom still enjoys the monopoly of voice services and infrastructure. Two laws have been drafted to promote liberalisation.

Mobile and fixed voice services revenue in *Austria* are stronger contributors to growth as penetration of both services has not yet reached saturation levels. The monopoly in the provision of network infrastructure still has to be lifted, although the government is committed to full service and infrastructure liberalisation by January 1998.

Growth within all segments in the *Irish* market is higher than the European average. The country tries to catch up with Europe in infrastructure modernisation and service penetration levels. Ireland intends to use the special EU dispensation to postpone services liberalisation to January 1, 2000, and infrastructure liberalisation by July 1999. The government has however introduced competition in mobile communications and data and business services. Privatisation of Telecom Eirann started with the sale of 20% of the company (and additional 15% option in three years) to the consortium formed by Swedish Telia and Dutch KPN.

Similarly *Portugal* and *Greece* continued the efforts to modernise their telecommunications infrastructure and started to provide better opportunities for market expansion. The availability and use of ISDN, frame relay and digital leased lines is very low. The privatisation process is in place in both countries. Full liberalisation of the market is expected by 2003.

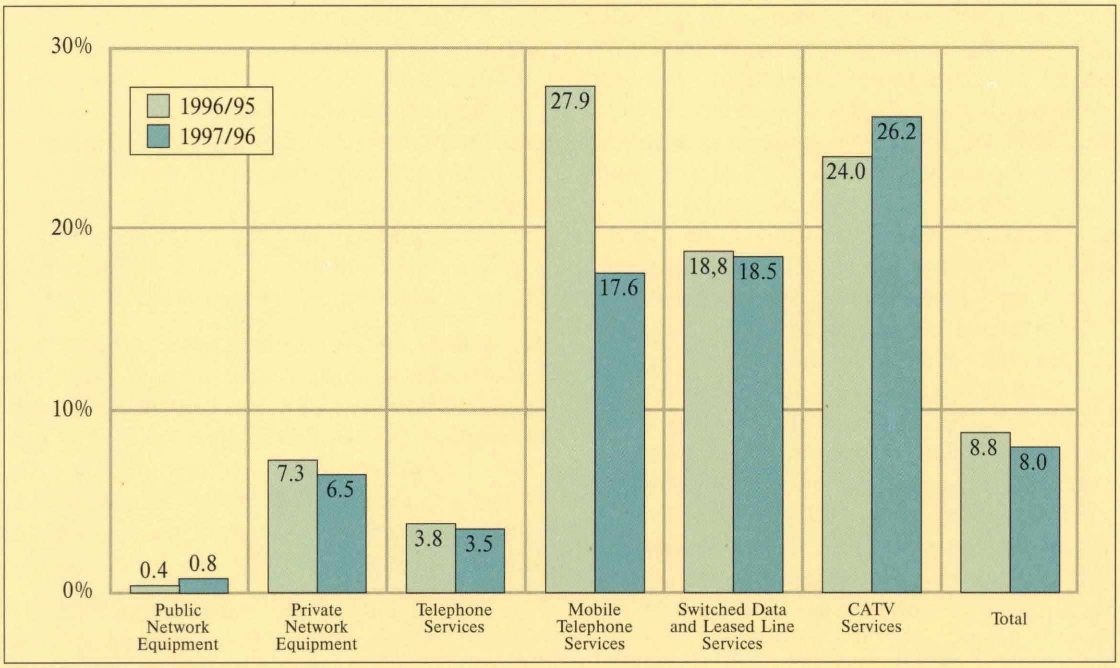


Figure 7
Western European Telecommunications Market Value Growth by Product Segments. 1996-1997

ii. Trends by product segment

Mobile equipment and wide area network services remain the fastest growing segments of Europe's telecommunications market. Spending on ISDN services and mobile services were both experiencing fast growth rates.

Areas that are of strategic importance to the telecommunications industry at present include:

- digital mobile telephony;
- cordless telephony;
- microwave technology;
- transmission for fibre optical cables;
- high capacity routers;
- broadband communication networks for high speed data;
- telecommunications management systems for the different types of network.

Telecom equipment: new technologies dynamism

Public network equipment

The public network equipment market continued to be under pressure in 1996, after investment cuts carried out by the major public telecommunications operators. Overall the public telecommunications equipment market recorded a flat growth of 0.4%, to a total value of 13 billion ECU in 1996. The market is expected to keep the same flat performance in 1997, with a growth of 0.8%, but new growth trends are emerging.

The focus is on meeting the world's ever-increasing communications demands, from traditional voice telephony to multi-media and the Internet. Access networks, intelligent networks, telecommunications management systems and customer services represent a faster growing part of the market than traditional switching and transport systems. Cable television (CaTV) telephony networks and services are increasingly emerging as the natural second network in many national markets and drive demand for access technology. Penetration rates for CaTV continue to increase throughout Europe with near universal coverage in many regions.

In the *public equipment* market, video, multimedia applications and services, on-line services and the Internet are driving demand for infrastructure upgrades. Pressure on bandwidth requirements continues to increase strongly. As a result, the public equipment market is benefiting from PTOs investing in infrastructure.

Demand is growing for:

- local exchange switches that can be upgraded to support long distance traffic;
- digital switches that are any-media support machine for voice, wireless, data;
- intelligent networking technology alleviating congestion from online service and Internet usage;
- remote access applications and surveillance applications using ISDN;
- systems for carrier networks able to handle provisioning, maintenance and billing processes;
- new generation public ATM switches equipped to handle switched virtual circuits, enabling more enhanced services from public networks.

Liberalisation of Europe's telecommunications markets, due in 1998, is spurring demand for core switches, especially for voice trunking, as well as ATM core switch deployment. New entrants, like utility companies, want to get into voice, and they want to build and use an ATM infrastructure to connect their business customers. Existing players are required to face competition on productivity gains and are accelerating the modernisation of the infrastructure, if they have not done it already.

Improvements in the infrastructure are increasing the size of the equipment market. Fibre optics and SDH will be increasingly implemented in large network backbones, telecommunications, cable television, and the Internet in the near to mid-term future.

The *mobile telecommunications infrastructure* market confirmed its double digit growth in 1996, and is set towards almost equal performance in 1997. Enhancements and extensions of existing GSM networks are driving strong growth in the demand for base stations and offset the declining analogue cellular infrastructure business.

Increased mobility requirements both within and outside the office environment are creating the need for better communications with remote workers, boosting demand for remote access and VSATs.

Private network equipment

The private network equipment market is expected to post a 6.5% growth in 1997, down from a 7.3% growth in 1996. Price erosion, discounts and maturity are eroding growth. Increasing business is coming from demand for higher featured PABXs and telephones, but is not enough to offset price erosion.

In the *PABX and Key Systems* market, increasing demand for wireless ISDN PABXs is driven by an increasing need for mobility and improvements in wireless ISDN technology. Improvements in digital cordless telephony are expected to drive demand for cordless PABXs, high quality residential cordless phones. Cordless PABX growth is also pushed by purchase incentives by major suppliers, such as altering the pricing structure with free installation of the base stations and a fixed price charge per additional phone.

The market is expected to benefit from the implementation of end-to-end ATM networks that will lead to upgrades in PABXs, hubs, LAN switches and routers. However growth is expected in the longer term, as barriers to usage of ATM technology are still high. They include:

- high price, as it involves radically changing the user network infrastructure;
- lack of standardization and interoperability of equipment;
- availability of cheaper alternatives such as switched Ethernet to support bandwidth applications;
- network management challenges.

In the *telephone sets* market, technology advances push growth. "Smart" touch-tone phones are offered with advanced transactional and computing capacity. Technology is evolving to the point where a high-end smart phone and a low-end PC will be virtually indistinguishable. The positive effects on demand from technology are inhibited by steeply falling prices.

Mirroring the fast uptake of subscriptions, *mobile telephones* sales are showing impressive expansion. Falling average selling prices are challenging suppliers' ability to make profits in this area. The average replacement period for digital phones is only 2.5 years.

The *fax machine* market is recording double digit growth driven by multifunction fax machines – that also provide copying or telephony capabilities –, and low-end plain paper fax machines that become a viable alternative to thermal fax counterparts. The steady adoption of low-end plain paper faxes is also continuing and offers interesting prospects of growth in the consumer markets.

Telecommunication services: gaining data services share

The market for telecommunications services was worth 138 billion ECU in 1996, contributing more than 80% to the telecommunications market. The market grew 8.8% in 1996, and is due to increase 8.0% in 1997.

Growth in *voice service* revenues is driven by increasing usage of enhanced services, after aggressive marketing and new features offered by all voice service providers. Usage is increasing due to higher use of such features as caller identification, as well as the penetration of second residential main lines often due to Internet usage. The overall increase in telephone services will be moderate, though, in the short term – at a growth of 3.5% in 1997 – largely due to falling prices. Increased availability of intelligent network services, such as freephone, premium rate, personal numbering and calling card services will raise call volumes and revenues per line in the residential and business sectors. Service providers will experience severe pricing pressure, and building of services will start to impact call revenues as penetration approaches saturation. The greatest growth in this market will come from *mobile voice services* which is also boosting PSTN call revenues, despite increasing price pressure.

The market for *ISDN* lines in Europe is growing rapidly in both the Basic Rate Access ISDN (BA-ISDN) and Primary Rate Access ISDN (PA-ISDN) sectors. This market has several key characteristics that affect growth in the use of ISDN in individual countries. These characteristics include service tariffs, availability and promotion, and users' applications for ISDN. Applications for BA-ISDN have largely been confined to leased line backup and specific applications such as videoconferencing. However, other applications such as provision of bandwidth on demand for corporate wide area networks and remote LAN connectivity are growing in popularity as businesses increasingly install and increase utilisation of LANs. A further boost to the BA-ISDN market will come with the growth in Internet-related access applications. PA-ISDN applications have largely been confined to voice-related applications.

Switched Data Network (PSDN) services are now increasingly being supplemented by higher-speed services based on frame relay, SMDS and ATM. Frame relay services have not had the take-up rates enjoyed by services providers in the USA, as they have not been particularly well promoted by the PTOs concerned on the effects of such a service on other well-established services. Growth rates are expected to increase as the need to handle LAN-to-LAN communications efficiently becomes more important to users. New service providers will soon enter "opened" national markets with competitive frame relay services.

Recent reduction in the market for *leased lines* services has put downward pressure on overall market growth. Growth rates for the installed base of digital leased lines are forecast to decline. The installed base of digital leased lines is growing, but the installed base of analogue leased lines is declining.

1.3. Europe as a Consumption Area: Business and Home

1.3.1. IT Penetration

IT market projected growth remains powerful compared with many other industries. In a worldwide perspective, though, European IT market growth is lower than average.

From a consumption perspective the delay experienced in Europe is the result of its high heterogeneity across countries, in IT user attitudes and in sophistication of IT implementation. On average European users are not embracing information technology with the enthusiasm of users in other regions in the world, they tend to wait for proven and optimised solutions to be in place. Considered separately, though, there is a pioneering mentality in the UK and Nordic countries as in the US. To the contrary IT attitudes in Continental Europe

Table 7
IT Penetration by Country. 1995. ECU

	IT/GDP %	IT per Capita ECU	Number of PCs per 100 White Collar Workers
Western Europe	2.04	365	88
EU	2.01	351	88
Germany	2.07	460	99
France	2.05	417	76
UK	2.55	370	93
Italy	1.34	214	72
Spain	1.18	131	80
Austria	1.80	396	88
Belgium/Luxembourg	2.25	453	84
Denmark	2.76	698	107
Finland	2.31	426	89
Greece	0.62	50	61
Ireland	1.63	217	85
Netherlands	2.71	521	118
Norway	2.50	648	142
Portugal	1.10	88	58
Sweden	2.90	630	106
Switzerland	2.86	942	132
US	3.67	763	104
Japan	2.40	672	24

Source: EITO, IDC, OECD

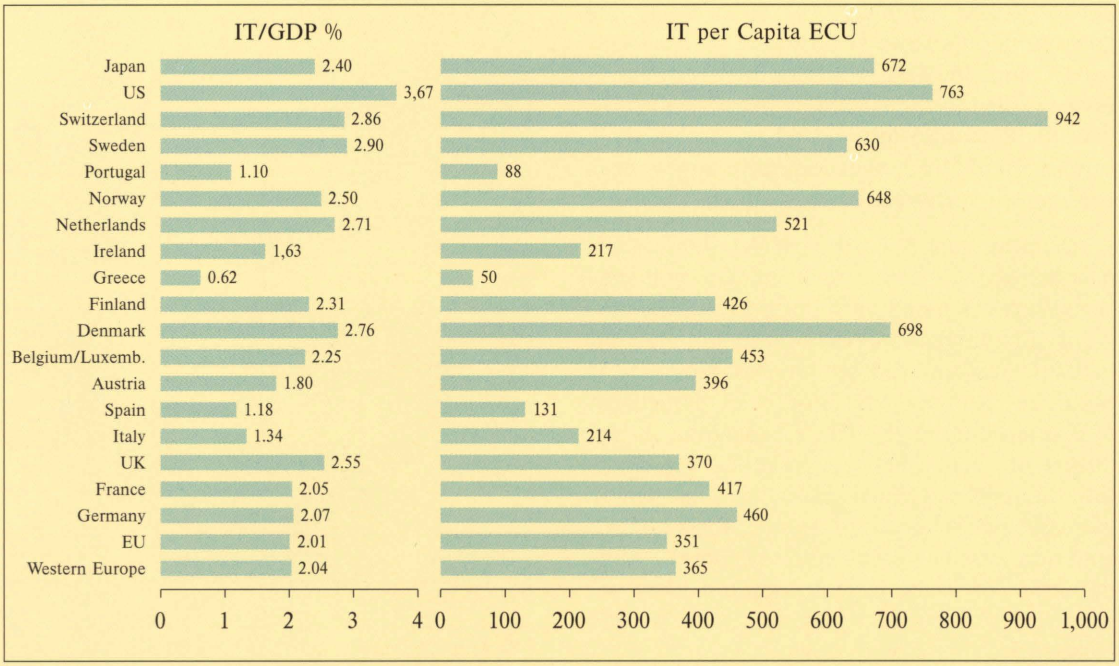


Figure 8
IT/GDP and IT per Capita in Western Europe, the US and Japan. 1995

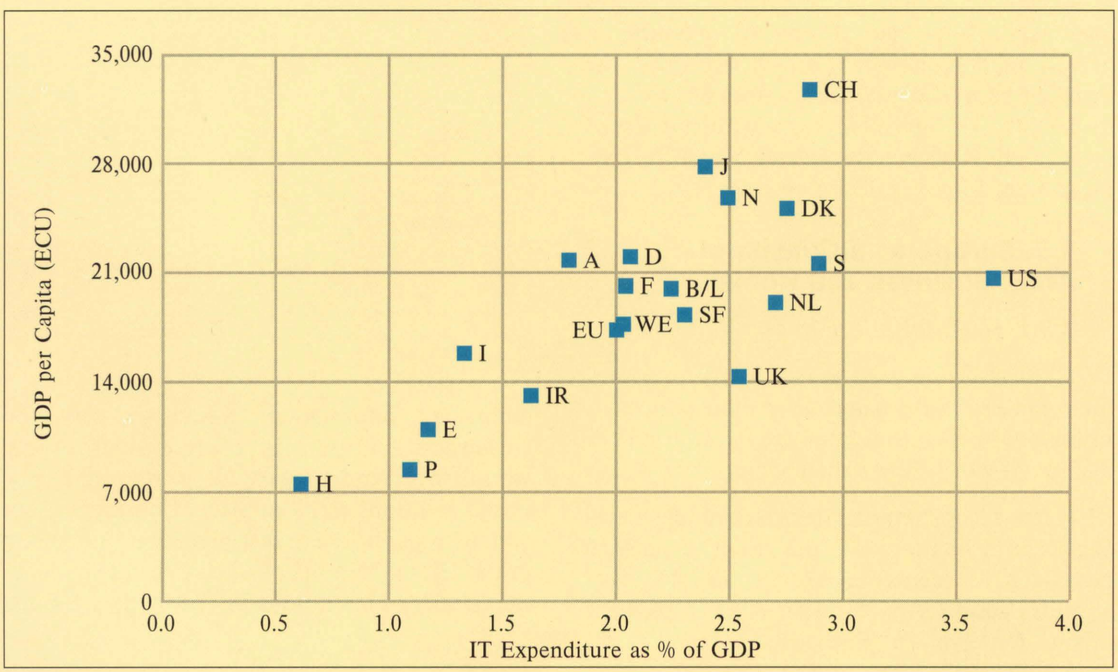


Figure 9
IT/GDP versus per Capita GDP in Western Europe. 1995.

are more cautious. It is not just a question of waiting for prices to fall. Because of economic malaise continental Europe is characterised more by lower investment confidence and conservative perception of the role of IT in improving efficiency and effectiveness in organizations.

Intensity of IT penetration

As a result, IT spending as a percentage of total GDP, in Scandinavia, the UK, Germany and France averages a penetration rate of around 2.05% or more. On the other hand Italy, Greece, Portugal, Spain and Ireland are very well below average, with a level of 1.63% or even less. The gap in IT spending continues to remain too wide to be accounted for by structural factors alone.

Rankings of IT expenditure on a per capita basis also continue to highlight the relative wealth of Switzerland and most of the Nordic countries. The low-lying position of Southern European countries emphasises the general backwardness of their economies with less-developed services sectors.

IT consumers' potential

The average profile of IT home-user households is characterised by 31,500 ECU or more income, high penetration of consumer electronics goods, higher level of education and knowledge of English. From a consumers' perspective, the same different and polarised IT usage profiles emerge between Northern Europe and Continental Europe. Much of these differences is due to the higher ability of Northern economies to promote familiarity with new technologies in the households by different means: education, access in public institutions, continuous provision of best state-of-the-art ICT infrastructure.

1.3.2. Telecommunications Penetration

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

Intensity of telecommunications penetration

Differences in the number of residential telephone lines continue to point to a similar polarisation in the usage of telecommunications technologies. At the end of 1995 of the 17 West European countries, three (Spain, Portugal, Ireland) have fewer than 38 exchange lines per 100 people. Portugal has the fewest, with 34 lines per 100 people. Sweden tops the European league with 69 lines per 100 inhabitants, followed by Switzerland and Denmark with 62.

Between the two poles, France, Netherlands and the other Scandinavian countries have a teledensity of between 55 and 62 lines per 100 inhabitants, closely followed by Germany and the UK with 53 lines. Most other countries are less than or close to the European average of 46 lines per 100 inhabitants.

Similarly penetration of mobile connections (1995 yearend) confirms the widening gap between most developed and less developed regions, as a consequence of consumer attitudes and available income levels as well as differences in level of liberalisation, and price wars among competitors.

Table 8
Telecommunications Penetration by Country, 1995

	Inhabitants (000)	Households (000)	Main lines per 100 inhabitants	Mobile Subscribers (%)	CaTV Subscribers per HH	% of digital main lines	ISDN lines per 100 main lines
Europe	447,525	163,146	46	5.16	24.0	74.9	1.5
Germany	81,750	37,159	53	4.61	45.2	65.4	3.9
France	57,970	22,296	55	2.37	8.7	93.9	1.6
UK	57,870	23,148	53	9.35	6.1	88.7	0.8
Italy	58,030	20,010	43	6.76	0.0	75.6	0.5
Spain	39,270	11,900	38	2.40	2.5	65.4	0.9
Austria	7,980	3,069	47	4.81	35.8	58.8	0.9
Belgium/Lux.	9,895	3,958	47	2.37	91.8	66.8	1.1
Denmark	5,175	2,352	62	15.27	56.1	61.0	0.8
Finland	5,070	2,113	56	19.90	39.8	91.7	0.4
Greece	10,440	3,600	50	2.75	0.2	37.1	0.0
Ireland	3,590	1,056	37	3.37	45.5	80.0	0.2
Netherlands	15,403	6,418	53	3.51	90.4	74.3	0.8
Norway	4,330	1,804	56	22.82	34.9	82.0	0.4
Portugal	10,600	3,419	34	2.93	2.0	70.0	0.4
Sweden	8,720	4,152	69	22.80	45.2	90.1	0.7
Switzerland	6,980	3,035	62	6.38	77.4	66.5	3.1

Source: ITU, OECD, ECTEL

The Nordic countries have the highest penetration of mobile connections. Among the major countries the UK has the highest rate of penetration, followed by Italy. While Germany almost equals European average mobile penetration, France still lags far behind with a level that is less than a half the European average.

Public network digitalisation has progressed, and differences across countries are reducing.

Table 8 shows the relevant indicators for the European countries.

Competition in telecommunications

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

Strong promotion of new enhanced services and increasing traffic volumes from traditional and new target markets are the major recipe in confronting falling prices in the face of competition. Telecom operators and new entrants are increasingly involved in acquisitions, joint ventures and partnerships to enter new markets or foster investments in new areas.

Nowhere more so than in telecommunications, global presence and reach are key aims of the strategies of the leading players.

The reasons for this are not hard to see:

- The world telecommunications market is large and growth is particularly rapid in emerging economies. Cellular and satellite technologies mean that some developing countries may be able to skip installing a comprehensive hard-wired network entirely.
- Demand is expanding apace in the advanced economies too, as data-transmissions, interactive communications, entertainment and other value-added services require greater and denser network provision.
- Technology is releasing massive economies of scale. Transmission of electronic pulses across a global network is almost costless, yet setting up networks requires heavy investment, so access and control are important. Costs and prices are falling rapidly and continuously, making financial returns dependent on volume rather than on profit margins.
- Deregulation has led to relating tariffs more closely to the cost of supply, reducing the scope for cross-subsidisation (traditionally profits from the long-distance sector were used to subsidise the local network). Rebalancing tariffs to reflect costs is cutting profits in their core markets, encouraging telecommunications operators to look to other geographical areas.
- Competition from new entrants to the industry is increasing for the major operators in their home markets. This is in part due to regulators giving protection to new firms to encourage competition, and in part as the consequence of new technology.
- Higher bandwidth fibre optic cables can provide a broader range of services, than copper wires. Cable companies are using fibre optics for data, entertainment and voice services to customers in cabled local areas. Telephone services through the cable are offered at very low cost in order to attract customers to purchase a range of other services.
- Competition is also coming from cellular services which meet the demand for mobility, and which in some markets are replacing rather than complementing fixed-wired equipment.

1.4. Europe as a Production Area

1.4.1. Current Status in Employment and Production

Employment in the IT industry declined at a level of some 940,000 people, or 1.1% of the European employees in 1995. According to conservative estimates, some 220,000 people were employed in the data processing and office machinery segment (255,000 in 1994), and some 720,000 in the software, services and distribution channel segments. Overall the top 80 players, in terms of European revenue, contributed to some 375,000 jobs in 1995, compared to 390,000 jobs in 1994, and 415,000 in 1993.

Micro-electronics in particular employs 119,000 people in Europe (30,000 in Germany, 24,000 in the UK, 19,000 in France, and 15,000 in Italy). New microchip factories will be open in 1997 in France and the UK.

On the other hand major IT supplies went through further streamlining. The closure of some hardware manufacturing plants generated additional job losses in 1995 (approximately 20,000) and in 1996 (approximately 10,000). Some 20,000 jobs were lost in 1993 in Europe, and 35,000 more losses were estimated for 1994.

Positive news came from the software and IT services sector. Booming demand for software applications and tools in the areas of databases, Internet, multimedia and edutainment have driven expansion of R&D, manufacturing and logistics initiatives. Shortage of skills in the area of IT consulting, operation and implementation have spurred demand for new consultants. Growing share of staff in information systems departments has been outplaced by large companies and public organizations, and hired by professional services companies within the scope of large outsourcing projects.

The countries, where software and services industries are stronger (Ireland, UK, France, the Netherlands) are benefiting more from this growing employment trend. In the other countries even these segments are experiencing job cuts. In the UK some 20,000 jobs were created in 1995 by the top 2,000 software and services companies, and some other 10,000 jobs were created in Ireland. Ireland confirmed its status as the second largest software exporter in the world and reached a total output worth about ECU 3.6 billion in 1995. Ireland and Scotland confirmed the highest European employment growth in IT hardware also in 1996. At least 4,000 new jobs were announced in 1996, with new facilities opened for the manufacturing of semiconductors, memories, components and videos for IT and multimedia products. Increasing new jobs were created among software companies in the Netherlands and Germany and among professional services companies in France. On the contrary some 1,800 jobs were lost in the software sector in Italy during 1995, while in the hardware sector jobs downfall was 3,000.

The opening of call-centres for on-line support services, telesales, telemarketing also contributed to job creation in 1996. Three major IT suppliers have opened their European call-centres in Ireland, attracted by the availability of a young and relatively less expensive English-speaking workforce, low operating costs, low corporate taxes, State incentives, and cheap toll-free telephone services. Telecomm Eirann invested 1.7 billion ECU in infrastructure with fibre optic connections on all major European routes, providing also an intercontinental routing system (designed for companies with international call centres) enabling a toll-free capability between Europe and the US.

A better outlook is expected for 1997. Professional services and application software suppliers have started major hiring campaigns between 1996 and 1997.

Europe's telecommunications industry employed some 1,100,000 staff in 1995 (1,180,000 people in 1994), or 1.4% of European employees. Enterprises operating mainly as makers of communications equipment number 4,390, of which 90 employ more than 200 employees.

Companies providing telecommunication services employed some 790,000 staff in 1995 (880,000 staff in 1994). They include national PTOs, managed data network service providers, and mobile services companies. The number of businesses is small due to Europe's regulated market structures.

Employment at traditional equipment manufacturers has declined steadily since 1985 and is not expected to improve in the future. Also major telecommunications services suppliers were forced to cut jobs to adapt to the rapidly changing technical environment and the increased pressure to be competitive. Pressures include the introduction of labour-saving technologies, such as digital telecommunications systems, which require fewer operators and significantly fewer people for installation, maintenance and repairs. The quest of better efficiency to face privatisation and more liberalised environments generated increasing job cuts in 1996.

Job losses are partially offset by increasing employment among new entrants and high growth technology suppliers in the telecommunications industry (utilities, cable services companies, mobile technology and services, call-centres, Internet on-line content providers, Internet access providers).

Job creation is particularly high among mobile telecommunications equipment and service providers. OECD estimates that in cellular services 1 new job is created every 250 subscribers. According to the Cable Communications Association (CCA), in the UK market only, growth in cable television and cable-telephony subscribers, coupled with the launch of new networks, will create more than 24,000 jobs over a four-year period, starting from 1994. Of these, 14,000 will be in the areas of sales, marketing and customer relations and 10,000 in the related areas of programming and engineering. Many former employees of traditional telecommunications operators are finding new jobs in emerging telecommunications-related companies.

1.4.2. R&D Effort

Private R&D has been inhibited by serious financial challenges at major European ICT companies, leaving the European industry lagging behind other major regions in the effort to develop competing technologies. The share of privately funded R&D for ICT technologies as a percentage of total R&D is declining throughout the major European countries.

The most notable case is Germany where companies operating in fields such as biotechnology, health, and information technology account for 40 percent of the national business but they only account for 10 percent of research. According to the government's report on R&D in Germany, during 1995, 60.3 percent of research was privately funded, down from 63.7 percent in 1989. The German government is currently funding around 39.4 percent of research.

The push for R&D initiatives by private and public bodies has been increasingly driven by the European Union R&D programmes ESPRIT, ACTS and Telematics within the Fourth Framework Programme.

European research initiatives announced in 1996

- Standardization Projects. Six information society projects aimed to improve/develop potential new standards. They include: EUKIOSK (bringing together local authorities and industry in five cities in a scheme to provide multimedia information services); EUROMED (developing medical imaging techniques); and KALIMEDIA (providing information services for Small and Medium Sized Enterprises).
- MEDEA (Micro-Electronics Development for European Applications) programme, (2.5 billion $ fund) launched during the 14th ministerial meeting of the European research initiative EUREKA. MEDEA is to run between 1997 and 2000. The project - to be financed by industry, the European Union and governments - will promote advanced semiconductor technologies in areas including multimedia and communications as well as car and traffic applications.
- Integrated MultiMedia Project (IMMP) (partially funded) within the Fourth R&D Framework Programme. It involves ten organisations from Finland, Sweden, the United Kingdom and Germany. The objective is to develop common standard technologies for multimedia services for both business and residential environments over ATM networks. The trials starting in 1997 will particularly focus on video conferencing, tele-education, teleworking.
- Ethos project a three-year 6.5 £ million project (started in 1996) is undertaken by utilities companies. It involves more than 1,000 homes in the UK, France, Italy and Denmark, to test consumer acceptance of interactive services such as energy management, remote meter reading, itemised billing and appliance automation. A common link is the use of the European Home Systems (EHS) domestic communications system, developed under EU's Esprit programme.
- 120 projects within ACTS: ACTS is the stage between basic research and commercial product, and will build on the results of the individual Race projects. About 120 projects started in 1996. The big emphasis is on multimedia for fibre optic or wireless networks, and the development of hardware to go with this. All the projects are expected to be viable commercial systems or products by 2000.
- ATM trial within ACTSI. 15 telecommunications providers are linking all the National Hosts (NHs) in each country to run a consumer and services-intensive ATM trial, for use by the ACTS projects. A private ATM trial between telecommunications operators ended in 1996. The NHs are consolidated advanced platforms, comprising generic application layer and access to a specific user community. The trial aims to establish standards in broadband communication.
- SEMPER (Secure Electronic Marketplace for Europe) project to develop solutions for secure commerce over the Internet and public information networks. Industry partners and academic institutions joined the initiative. Research areas include: open security architecture for the electronic marketplace, secure payment and information delivery. Subsequent phases will focus on advanced document processing; notary services; multimedia-specific security services, protection of intellectual property rights.

- OASIS 2 (Online Automated Shopping and Information System). The consortium's two-year trial for the development of hardware and multimedia for payment system applications ended in 1996, partially-funded with a 4 million $ EC grant. The trials revealed that customers are increasingly willing to use the kiosks to obtain further information and to purchase goods or services online.
- Satellite telecommunications research promoted by the European Space Agency (ESA) and the European Union to encourage research in satellite mobile communications, satellite navigation and broadband communications for upcoming multimedia services.
- TEN-Telecom approved in the last quarter of 1996 with the granting of 18.1 million ECU Community financial aid to 11 commercial validation projects, involving 63 partners in 14 EU States. They include a network of city information highways, a telemedicine application, a distance education and training scheme, access networks to cultural heritage, generic services, telework and electronic commerce for small and medium sized enterprises (SMEs).

R&D co-operation initiatives undertaken by private companies in 1996 include:

- Mobile Data Agreement among communications technology companies, joining forces in an industry-wide European venture to enhance the prospects for digital wireless data communications. The initiative will develop GSM based cordless computer applications for business to allow fast and rapid connections to company networks and the Internet;
- joint development efforts in the areas of broadband telecommunications and interactive multimedia;
- joint development efforts with universities to enhance learning systems;
- development of semiconductor research initiatives, also partially funded by national governments.

1.4.3. Concentration, Mergers, Acquisitions and Cooperation in the ICT Industry

Concentration

Competition in the IT market in the past two years has been increasingly characterised by changing business strategies. Ability to change and optimise the implementation of new business models has defined clear distinctions between leaders and laggards.

The strong of the IT market have got stronger, and the vendors that were showing signs of weakness were victims of major shake out, acquisition, or financial breakdown. Meanwhile, the pace of merger and acquisition activity has continued, especially among the major professional services and application software suppliers. These players have been trying to leverage solid revenue growth, cash availability and financial stability to foster:

- market share growth in niche or national markets;
- skills acquisition for selected vertical markets;
- a mix of specific business applications for selected vertical markets.

The success of the fittest led to the increase of the combined market share of the top five European vendors to 33%, after four consecutive years of decline. This market share passed from 36% in 1992 to 34% in 1993 and 31% in 1994. In 1982, these vendors held slightly more than 50% of the market.

The number of companies whose combined market share accounts for some 40% of the European market demand for IT increased from seven to eight. The overall European figure hides different national dynamics, according to 1995 indicators (figures are for data-processing sector only, excluding office products):

Number of Leading Companies with Combined Market Share of 40%

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

These variations stem from differences in the rate and structure of growth, in the technology and services areas prevailing in the different countries, and in the performance and business models adopted by dominant players and national champions in the national markets.

Mergers, acquisitions and cooperation

Acquisition and alliances continued to emerge in 1996, confirming the high pace trends achieved since 1993. Three major factors have driven the pace:

- IT suppliers quest for new business from the convergence of IT and telecommunications and the telecommunications liberalisation;
- lowering barriers for new entrants competing on the blurring borders with the multimedia and information content industries;
- the need to develop pan-European and global presence in liberalised telecommunications services markets for traditional and new telecommunications operators.

Partnerships and agreements to exploit opportunities from the interactive digital infrastructure involve IT technology platforms and services providers, consumer electronics companies, network service providers (telephone, cable, broadcast, satellite, and online services), content providers (publishers, newspapers, movie studios, interactive programming developers), consumer software providers.

As a result of the highly interrelated major drivers of industry change, alliances and partnerships focused around:

- competition and opportunities in the user interface and access areas;
- the emergence of consumer multimedia technology;
- the expansion of Internet and on-line services;
- the liberalisation of telecommunications infrastructure and services in national markets;
- the globalisation of telecommunications services (see also section 3.4.).

1.5. Trade in the European Union

Europe continues to run a trade deficit in IT and telecommunications products. After the improvements in 1993 and consolidation in 1994, the EU's ICT trade balance with the rest of the world has worsened again. The negative balance has passed from -14 billion ECU in 1994 to -17 billion ECU in 1995, reaching the negative levels of 1992. Exports rose by almost 18% or 10 billion ECU in 1995 in comparison to the previous year, spurred by the improving performance of European mobile telecommunications equipment providers.

Table 9
European Trade by Country.
Office Machines and EDP Equipment, 1995
Million ECU

		EU	Non-EU	US	Japan	4 Tigers	RoW	Total
EU	Import	40,488	586	12,003	7,435	9,146	5,357	75,015
	Export	43,022	2,426	5,118	1,379	1,051	5,255	58,251
	Trade Balance	2,533	1,840	- 6,885	- 6,055	- 8,095	- 102	- 16,764
Germany	Import	7,601	220	2,374	2,537	2,263	1,440	16,437
	Export	6,424	777	834	133	165	1,163	9,495
	Trade Balance	- 1,178	556	- 1,540	- 2,404	- 2,098	- 277	- 6,941
France	Import	6,120	66	1,657	862	1,081	487	10,273
	Export	5,299	266	436	44	76	878	6,999
	Trade Balance	- 821	200	- 1,221	- 818	- 1,005	391	- 3,274
UK	Import	7,240	69	3,019	1,576	1,649	1,164	14,718
	Export	9,365	428	1,941	599	271	1,283	13,887
	Trade Balance	2,125	359	- 1,079	- 977	- 1,378	119	- 832
Italy	Import	3,648	37	431	250	448	346	5,160
	Export	2,814	90	500	179	112	347	4,042
	Trade Balance	- 834	53	69	- 71	- 336	0	- 1,118
Spain	Import	1,848	14	323	86	164	234	2,669
	Export	542	14	159	4	95	16	831
	Trade Balance	- 1,306	0	- 164	- 82	- 68	- 218	- 1,838

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

		EU	Non-EU	US	Japan	4 Tigers	RoW	Total
EU	Import	4,583	364	2,002	743	717	1,262	9,671
	Export	5,235	461	584	136	268	5,693	12,376
	Trade Balance	652	97	- 1,419	- 606	- 449	4,430	2,705
Germany	Import	706	153	486	232	218	322	2,116
	Export	906	157	189	16	41	1,698	3,007
	Trade Balance	200	5	- 297	- 217	- 176	1,376	890
France	Import	414	8	140	69	89	126	847
	Export	726	41	31	9	27	841	1,675
	Trade Balance	312	33	- 109	- 61	- 63	716	828
UK	Import	518	56	788	184	106	457	2,110
	Export	1,061	41	207	9	71	433	1,823
	Trade Balance	543	- 15	- 581	- 176	- 34	- 24	- 287
Italy	Import	450	6	81	20	57	67	682
	Export	377	12	9	0	10	338	747
	Trade Balance	- 73	6	- 73	- 20	- 47	271	65
Spain	Import	431	12	167	15	24	36	685
	Export	157	2	10	0	4	517	691
	Trade Balance	- 274	- 10	- 157	- 15	- 19	481	5

Table 10
European Trade by Country. Telecommunications, 1995. Million ECU

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

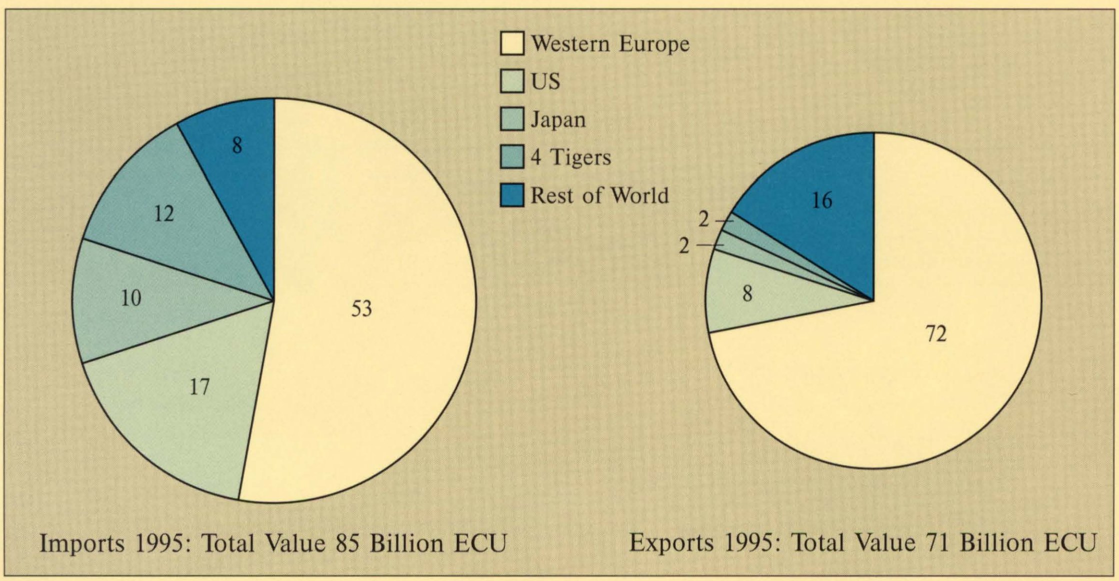


Figure 10
European Total ICT Equipment Import/ Exports by Region in %. 1995. Billion ECU

1.6. Eastern Europe: Sustained Development

1.6.1. General Trends

The region of East/East Central Europe continues to represent one of the largest IT industry opportunities in the world, with overall IT spending reaching an 5.5 billion ECU in 1996. Ongoing programmes to modernise a broad range of infrastructure and basic services, combined with the demands of an evolving private sector, will continue to drive strong IT hardware and software/services market growth throughout the region in the short term.

Once largely oriented to hardware sales, the East/East Central European IT market is increasingly focused on other elements of market development comprising packaged and custom software, services and networking, as the economies of the region move to stability. Demand for basic hardware remains strong, however.

While spending on information technology has grown remarkably over the last five years, both the relationship of IT expenditures to GDP and per capita IT spending reveal that expenditures are still considerably lower than that of the average country market of Western Europe. *Table 12* illustrates that only the Czech Republic exhibits spending levels which match those of many Western European countries. The vast majority of East/East Central European states spend less than 1 percent annually on information technology. Similarly, per capita spending across the region is quite low, from the Czech Republic's high of approximately 112 ECU in 1995 to the Ukraine's paltry 2 ECU (see *Table 13*). There is still considerable pent-up demand for information technology throughout the economies of East/East Central Europe.

1.6.2. IT Trends by Product

i. IT hardware

The country markets of Eastern Europe remain heavily oriented on personal computers and PC-related technologies (PC add-ons, peripherals), which accounted for the largest percentage of IT hardware spending in the 1995-96 period. Similarly, other segments such as the low-end office equipment market and the LAN server market have experienced considerable growth over the last several years. Reflecting the regional market's low-end focus, the computer systems (mainframes, servers, workstations) segment has stagnated in several countries in terms of unit sales and value due to reductions in funding for public IT projects (Hungary), problems in the banking sectors (Russia, Bulgaria, Czech Republic), limited demand for high performance mainframes, and a decline in average system values for servers.

ii. Software and services

Services are among the fastest growing sectors of the IT market now that the region has entered a more advanced level of computerisation. Particularly strong growth is being seen in the market for packaged software, such as PC software and application tools for database development and management, and in the demand for basic services such as IT consulting, contract programming and software design, IT education and training, systems and network implementation.

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

While a number of Western software and services providers have initiated operations in the region, local firms have emerged to become important systems integrators, value-added resellers, support providers, software developers and training centres. They provide vital support to outside hardware vendors active in this marketplace.

1.6.3. IT Trends by Country

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

Czech Republic

The Czech Republic continues to field the most dynamic information technology market among the countries of East/East Central Europe, with the exception of Russia. The combined value of sales of all computer hardware, peripherals, networking, software and services for this country market reached an estimated 1.09 billion ECU in 1996. While much of this figure was derived from hardware sales, software and services have become increasingly more important to the IT market's overall development, accounting for more than 38 percent of all local IT expenditures in the 1995-96 period.

The Czech IT market is unique in the East Central Europe region for several reasons:

- The hardware market alone has quadrupled in size in the 1989-95 period. Total expenditures on IT hardware have grown from 99 million ECU in 1989 to more than 664 million ECU in 1996. Particularly strong growth was seen in the 1992-95 period.
- The country has the highest ratio of IT hardware spending to GDP in the region (1995: 112 ECU). While overall spending is still considerably lower than in Western Europe, it exceeds expenditures in all other East/ East Central European countries.

Country	1996	1998	CAGR 1996-98 %
Czech Republic	577	665	7.3
Hungary	288	341	8.9
Poland	630	793	12.2
Russia	1,709	2,291	15.8
Slovakia	143	176	10.8
Western Europe	52,560	60,577	7.4
Germany	16,256	18,621	7.0
France	7,753	9,071	8.2
Italy	4,007	4,465	5.6
United Kingdom	8,190	9,684	8.7
Spain	2,216	2,668	9.7

Table 11
East vs. West: Compound Annual Computer Hardware Spending in Eastern Europe by Country. 1996-1998. Million ECU

Country	%
Czech Republic	2.80
Hungary	1.60
Poland	0.90
Russia	0.40
Slovakia	1.76
Western Europe	2.04
Germany	2.07
France	2.05
Italy	1.34
United Kingdom	2.55
Spain	1.18

Table 12
East versus West: Ratio of Spending on Information Technology to GDP. 1995

- IT spending levels as a percentage of GDP in the Czech Republic are comparable to some Western European countries.
- The Czech Republic has one of the strongest growing personal computer market in the region, with annual sales close to 240,000 units. It is significantly larger than markets with similar sized populations like Hungary and Bulgaria. It also represents more than two thirds of the Polish market, despite only a quarter of the population.
- The country's professional services market is almost as big as the combined markets of Hungary, Poland and Slovakia in terms of value. The demand for professional services surged in the 1994-96 period.
- The country has the most active high-performance mainframe and server market in the region. Annual sales generally exceed the combined total for the other markets of East Central Europe.

The Czech Republic has also moved quickly to become one of the most advanced IT markets in the region, based on an examination of IT ratios, which are now beginning to reflect spending patterns in Western European markets. Unlike Poland, Romania, Russia and several smaller states in the region, in which more than 50 percent of annual IT expenditures are devoted to personal computer hardware, the ratio for the Czech Republic has now fallen below 35 percent, as IT spending is being shifted to implementation services, networking hardware/software, application solutions development and support.

The dynamism of the Czech market has also carried over into the growing success of a wide range of international IT vendors and local IT companies in this country. While a number of vendors such as IBM, Digital Equipment, Hewlett-Packard, Siemens Nixdorf, Microsoft and Compaq are reporting record turnover for this country market, much of the increased investment in information technology has been to the benefit of the estimated 3,000 local IT companies. Recent research conducted on IT distribution channels in the Czech Republic revealed that more than 50 percent of the country's twenty largest IT distributors experienced revenue growth in the 1994-1995 period exceeding 20 percent. A further 25 percent indicated a rise of 10 percent to 19 percent in sales revenue. Most expect this trend to continue in the 1996-1997 period.

In view of the structure of the Czech Republic's IT market and its strong focus on personal computer technology, most local firms continue to concentrate distribution, sales and support operations on the market's low end, particularly on hardware. Nonetheless, the growing sophistication of local users combined with falling margins on hardware and the rising demand for more complex, enterprise-wide, multi-user solutions has facilitated the emergence of a large group of local firms. Their operations consist of providing value-added services, from basic network implementation to IT consulting and site management. A particularly large number of local IT companies are involved in the development of localised packaged software and custom software solutions. The market's leading systems integrators, PC software vendors and value-added resellers all consist of local software houses.

Overall, the information technology market in the Czech Republic is expected to increase in value by a compound annual growth rate of nearly 10 percent through the year 1998. The value of the market will exceed 1.3 billion ECU through the end of the forecast period. While most spending will remain focused on hardware, software and services will comprise an increasingly larger share of annual IT expenditures in the country through the year 2000. Particularly strong areas of growth aside from personal computers include networking hardware/software, LAN servers, networking services (implementation/management), software application development, professional services and customer support services.

The most solvent segments in the Czech marketplace continue to be banking and financial services, government administration, insurance, industry and manufacturing, telecommunications, health services, transportation and small private firms. Banks are purchasing systems, servers and PCs with the intention of developing such sophisticated capabilities as fibre optic and wide-area networking. A number of local companies in industry and energy have also sought to upgrade IT facilities with both used and new equipment over the last two years. Medium and small-sized countries represent the most important user segments for personal computer sales.

Hungary

Hungary is now rebounding after several years of economic and political stagnation. Despite dissatisfaction with the government's austerity programme, the current coalition has produced a much needed sense of political and economic stability. The speed of implementation of the government's stabilisation programme is reassuring foreign investors and the international lending community alike. Hungary remains the leading regional recipient of foreign direct investment, with approximately 11 billion ECU coming into the country during the last five years.

Table 13
East versus West:
Per Capita IT Spending by Country. 1995
Million ECU

Country	1995
Czech Republic	112
Hungary	59
Poland	26
Russia	15
Slovakia	51
Western Europe	365
Germany	460
France	417
Italy	214
United Kingdom	370
Spain	131

Table 14
Eastern Europe:
Computer Hardware Value Category Comparison. 1994-1998
Million ECU

Category	1994	1995	1996	1997	1998
Multiuser Systems	360	355	378	426	471
Workstations	48	59	63	71	80
Personal Computers	1,552	2,003	2,410	2,770	3,075
Printers	391	442	497	567	641
Total	2,351	2,859	3,347	3,834	4,266

Spending on information technology in the Hungarian market recovered somewhat in 1996, reaching 610 million ECU, after undergoing a sharp decline the previous year, due to the impact of measures incorporated in the Bokros austerity package. Designed to stabilise the Hungarian economy, elements of the government's reform programme such as the crawling peg devaluation and import duties led to sharp price increases on IT equipment to the detriment of the market. Confronted with an unstable currency, rising inflation and prices, higher taxation, and limited access to hard currency and capital reserves, local users were forced to focus on price as the chief buying criterion. Moreover, expenditures on IT were curtailed sharply in a number of sectors, particularly in government administration and banking/financial services.

As one of the more developed markets of East/East Central Europe, spending on information technology in Hungary is increasingly focused on software and services, despite ongoing strong demand for new hardware. In 1996, expenditures on hardware declined to 58 percent share of the total market, while spending on software, professional services and support services rose to 42 percent. Much of the growth in hardware has been confined to personal computers, PC add-ons and peripherals, as demand for systems and servers has stagnated with a decline in orders from key vertical markets such as government administration and banking/financial services. This development has impacted most strongly on the demand for high-end systems, such as high performance mainframes and SMP servers. Limited capital and the price sensitivity of local end-users have resulted in an increased popularity of LAN server technology as the most common server solution.

Software and services has become an important factor in the country's information technology market over the last three years. These two categories currently illustrate the highest level of growth in the market, with combined revenue reaching an estimated 253 million ECU in 1996. Professional services and systems integration, in particular, have seen a flurry of activity, with most major international vendors taking up operations in this market. Moreover, Hungary's retains a notable local software industry focused on exports.

The Hungarian government is positioning itself to become more active in overseeing IT developments in the public sector. The Hungarian Co-ordination Office of Governmental Information Systems set requirements for making public any government IT procurement exceeding 0.3 million ECU. Moreover, it has made open systems and Unix an integral part of its overall computerisation strategy, requiring that all computer equipment installed in public administration meet open systems standards.

Hungary's information technology market is expected to grow at an average annual rate of just under 9 percent in terms of value through 1998. Most vendor activity will be confined to Unix and PC hardware, data communications hardware and office equipment. Market growth through 1998 will stem largely from three vertical markets: the evolving private sector, banking/financial services and government administration. Moreover, the SOHO segment will become increasingly more important for low-end equipment sales.

Poland

After years of economic decline, Poland appears to have made the successful transition to a parliamentary democracy and market economy. The current coalition government remains committed to the broad economic reform objectives set out under the "Balcerowicz Programme" from the early 1990s. Poland now boasts a stock exchange index which rose 54 percent in 1996, steadily falling inflation, climbing bank reserves, economic growth bordering on 5 percent annually and one of the highest gross domestic products in Europe. The current coalition government has also moved forward with the long delayed mass privatisation programme. Moreover, its monetary and fiscal policies and regulations have had substantial impact on the evolution of the country's information technology market.

Overall spending on information technology reached an estimated 1.01 billion ECU in Poland in 1996, which marked a 17 percent increase over the previous year's figure of 862 million ECU. Despite the size of its population and GDP, this country market is largely oriented to personal computers. PCs accounted for an average of 45 percent of total IT market value in the 1995-96 period. The remainder of the market is largely concentrated on PC-related technologies such as peripherals, PC add-ons, office equipment and LAN hardware. Nonetheless, shipments in the country's systems and server market have also shown high growth, because of increased demand in finance, government and manufacturing.

Western vendors control the greater part of the official software and services market in Poland which is valued at 270 million ECU in 1996. Reflecting PC hardware predominance, most software vendor activity is focused on sales and support of packaged software, customised applications development, networking and hardware/software support services.

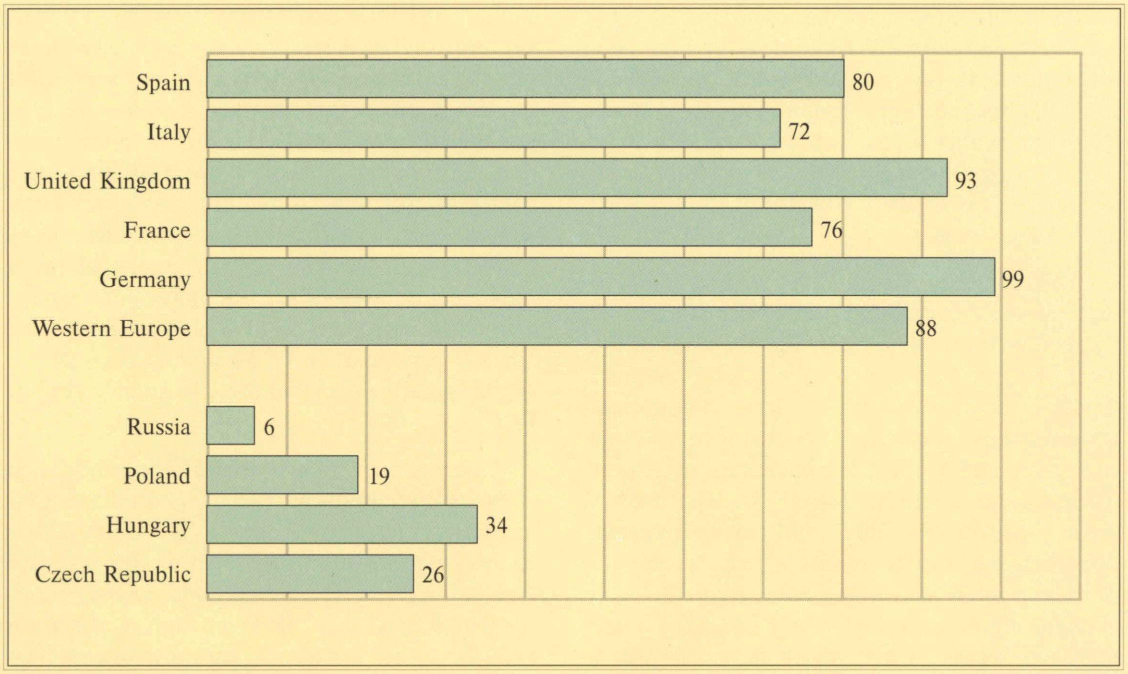
Polish companies continue to play an important role in the software market in terms of distribution, education/training and customised application development. A number have also become important players in the country's evolving professional services market. Many smaller value-added resellers have ensured themselves a niche with the creation of software for a specific vertical market, platform or application. Others are focused on providing applications and support for the country's evolving Unix systems marketplace. Local Unix expertise can be found in a few large software houses and a number of smaller software organisations, the majority of which provide application development support for PCs and workstations, in particular for sectors such as banking. The ongoing consolidation in the Polish PC market has also led a number of local companies to become involved in the emerging market for IT training and educational services.

In the 1993-1996 period, the Polish government has become a major purchaser of information technology, including hardware, software, telecommunications and professional services. It has also taken an active role in both the computerisation of the public sector, with the establishment of several organizations to oversee IT procurement.

In 1994, for example, spending by central government administration on information technology (hardware, software, professional services) reached 112 million ECU, or 16.2% of total IT expenditure in the country for the year. Projects included hardware and software installations in 80 administrative organisations (including ministries, government agencies). The Ministries of Communications, Finance and Industry accounted for the largest share of spending.

Uniquely for the Eastern European region, Poland has seen the emergence of several official organizations which are now closely involved in the computerisation of the public sector. Most important is the Office for Information Technology at the Bureau for the Council of Ministers, the government's steering committee for IT development created in 1991. The office is seeking to formulate IT directions and strategies for public administration, in compliance with the standardization requirements of the European Union, and to supervise the development and application of IT in central and local government. In May 1994, the Polish Prime Minister created an additional body for IT called the Government Plenipotentiary Office for Informatics. The office serves to oversee the activities of the BIURM, as well as general investment and strategy development for the public sector.

Figure 11
East versus West: Number of PC Installed per 100 White Collar Workers



Poland's information technology hardware market will continue to develop rapidly in the years ahead, with a projected growth rate of nearly 12 percent through 1998 in terms of value. Although high growth rates exist for high-end mainframe equipment, most shipment activity will take place at the low end of the market, particularly for small-scale systems (proprietary systems, Unix-based machines, network servers, and client server technology), personal computers, data communications hardware and other office equipment items.

Russia

Despite ongoing economic and political instability, the Russian Republic accounts for the highest proportion of information technology spending among the states of East/East Central Europe. Similar to other countries of the region, the Russian market is heavily oriented to personal computers and related technologies. These categories accounted for 60 percent of the estimated 2.53 billion ECU spent on information technology in this country market in 1996.

While personal computer technology predominates in Russia, this country market has also seen a sharp increase in the demand for computer systems, comprising mainframes, Unix servers and technical workstations. Overall spending reached 175 million ECU in 1996, which represented an 11.5 percent increase over the previous year. Sales of various types of LAN servers have also risen sharply in the 1995-1996 period, exceeding 44,000 units last year.

The software and services market in Russia is largely a local one with 438 million ECU in revenues in 1996. While a number of Western software vendors have entered this market, their operations are limited in scope due to the extensive black market for pirated software and the large pool of local programmers. In terms of future developments, the large number of local software specialists will facilitate strong demand for application development tools, particularly for relational database management systems (RDBMS). Other sectors which can be expected to see strong growth through 1998 include Unix, networking services, professional and data processing services.

The Russian IT market is projected to increase by a compound annual growth rate of 15 percent through 1998. In the short term, the most important sectors of IT market growth are represented by financial services, government administration (statistics, tax/customs, revenue collection and central bank operations), basic infrastructure (energy and transportation), social security systems, and manufacturing. Private firms also represent a major recipient of PCs, printers and office equipment. Russia's evolving banking industry is clearly the most lucrative sector in the short term, despite a range of problems and a major crisis in the latter part of 1995. With significant hard currency profits, banks are the only organizations which are procuring more expensive, sophisticated hardware and software solutions.

Other East/East Central European Countries

Overall spending on IT in other countries throughout the East/East Central Europe region, such as Bulgaria, the Central Asian states, Croatia, Romania, Slovakia, Slovenia and Ukraine comprised a combined total of only 1.18 billion ECU in 1996. Spending in most of the smaller states of the region is well below 160 million ECU annually, with the exception of the more dynamic IT market in Slovakia.

The state of economic development and government stability represent the most important factors impacting on the IT markets of the region's smaller states. In countries such as Slovenia and Slovakia which have relatively stable economies and political systems, IT market growth has been notable, with significant investment stemming from sectors essential for the development of a market economy such as banking/financial services, public administration and manufacturing (export-oriented). In contrast, Bulgaria and Romania have fairly small, undeveloped information technology markets, with annual spending in the range of only 100 million ECU, due largely to severe economic problems and political instability. Despite a population of 52 million, annual per capita spending on IT in the Ukraine falls below ECU 3.

One region which has more recently drawn considerable attention from IT and telecommunications equipment vendors is Central Asia. Rich in natural resources such as minerals, oil and natural gas, the newly independent countries of Kazakhstan, Turkmenistan, Uzbekistan and the other republics are now seeing significant outside investment in economic sectors such as gas and oil exploration, mining, resource processing industries and banking.

2. The IT Market Driving Forces

2.1. Introduction

The new ICT industry provides a crucial contribution to business globalisation and consumerisation. The key technology trends contributing this shift are:

- the merging of telecommunications and computing;
- the consumerisation of information technology;
- the new role of ICT as business competitive advantage factor;
- the delivery of increasing bandwidth (almost infinite capacity);
- the expansion of wireless applications;
- Internet/Intranet.

European opinion surveys show that ICT technology and infrastructure are among the top three critical factors for successful global expansion, after political stability and a skilled workforce, and well above cost of capital, cost of raw materials and transportation.

2.2. The Consumer Upside for IT

The connection of consumers into the electronic marketplace with the creation of a community of "networked consumers" will be a quantum jump in the scope of computing and growth in the ICT industry.

Suppliers that see the Internet's greatest opportunity in the context of a consumer-influenced marketplace are repositioning to compete in the Networked/Internet environment. New initiatives to compete relate to product/services mix, price points, consumer market segmented targeting, redefinition of the selling proposition and of head-to-head competitor profiles.

As the shift to the networked consumer era progresses, direct consumers are contributing an increasing portion of IT spending. 10% of worldwide IT spending and some 6% of European IT spending comes directly from consumers. The upside potential for consumer IT spending is huge in the medium long term, when the IT industry is able to provide a more attractive proposition for consumer IT applications.

Meanwhile the focus of the industry will be on overcoming all of the strong barriers to growth of this market, which involves:

- developing features that attract the interest of networked consumers;
- achieving minimum set of services/products affordability;
- ensuring transparency and awareness of contractual terms that apply to electronically mediated transactions;
- protecting against unprecedented scope for intrusion, such as collection and usage of personal data without the consent of the individual;
- prices monitoring;
- ensuring acceptable quality of service and protection from harmful content;
- easing access to information on meaningful price and quality comparisons, and fair information on possible additional costs.

2.3. The Role of the Internet

The Internet is the main driving force of the market. Aspects related to latest demand and supply developments in Internet applications are dealt with in detail in Part 2 of the EITO. The following section aims to provide a general outlook on the role of the Internet in the overall ICT market scenario.

i. Internet and home users

A common driver for Internet access in the home is the association with such values as caring for children, participating in children's education, increasing adult job security, and extending work productivity to the home environment. Major inhibitors among many consumers are associated with the abundance of choice, rapidly changing technologies, a frustrating shopping experience, generalized discomfort interacting with technology, high system prices, limited discretionary income, lack of a perceived need for personal computers or Internet access devices in the home. Lack of perceived need is more often the major reason for not buying a personal computer among non-owners, than price.

The higher value application of ICT technologies in the home remains teleworking. Teleworking comprises a range of different types of employment which involve some form of relocation of work at domestic (individual teleworking) or non-domestic (collective teleworking) premises facilitated by the use of information and communications technologies.

Teleworkers represent approximately up to 1-1.5% of the workforce (including part-timers and self-employed) across the various countries in Europe, with peaks in the UK and Nordic areas.

The typical cost of setting up a teleworker has fallen from 3,200 ECU to 2,200 ECU in 12 months due to more competitive telecommunications, lower computer and office equipment/service costs as well as increased technological advance. This makes teleworking a more attractive and economic proposition for businesses compared to five years ago when the average price of equipping a home office was about 8,000 ECU.

Cost of setting up a teleworker in the UK

ECUs	5 years ago	1 year ago	This year
PC	6,700	2,400	1,500
Modem	770	260	130
Printer	450	260	250
Fax		260	250
Phone	45	35	35

Source: British Telecom

General benefits from setting up teleworking initiatives in large organizations include remarkable savings in office and transport costs alone (some 2.6 million ECUs a year for a medium-sized central London firm employing 100 people). In the UK nearly one in three employees (32 percent) expects to be able to work from home within the next fifteen years and six in ten (59 percent) say they would prefer to do so.

ii. Internet and businesses

Communication and management of information are the key to competing in global markets. Demand by large businesses who invest in ICT as a profit enabler is driven by new concepts in managing the business processes value chain. These new approaches include:

- the *virtual company value chain* or the ability to replicate real business processes by effective management of the information; for example home banking applications enable customers to analyse the services they are interested in via a network connection service, before approaching a bank employee;
- *supply chain management,* with demand and distribution planning software applications designed to simplify inventory management across complex distribution networks, increasing inventory turns, reducing cycle times and improving customer service levels. Integrated demand forecasting elements and modelling techniques are improving decision-making;
- *Internet banking* to tighten the electronic ties and for the provision of banking services on home personal computers or network access devices;
- *mass customisation* combining the large consumer manufacturing production volumes with the personal service and customisation of goods normally only available through small specialised – and therefore expensive – suppliers. Groupware products over the Internet link the company with all the manufacturing and delivery contractors. Benefits include higher margins for a given volume of business and greater customer loyalty.

The challenges that large businesses still need to overcome to implement ICT and Internet applications competitively are mainly related to:

- information overload;
- co-ordinated reorganization of business processes;
- lack of appropriate EDI interface standards;
- potential threats to the traditional distribution chain from the Internet as a delivery channel;
- the need for more bandwidth.

Interest, at the moment, is increasing in developing Intranet to apply all of the benefits of the Internet to internal networks. Technically speaking Intranet can be defined as any site based on Internet technology that is placed on private servers within an organization. It does not allow anyone outside the company to access the server. Intranets allow such benefits as:

- continuous up-to-date dissemination of corporate data;
- technology cost savings;
- simplified job for internal software developers authoring pages in HTML;
- standardization of the user interface across platforms with Web browsers accessing applications on the server;
- collaborative work environments in which several people work together on a single document.

Major Intranet applications include:

- *workgroup computing:* allowing companies to implement multi-disciplinary roles, rather than fixed functions. For example financial analysts can be more easily seconded into marketing or sales groups, to help with product pricing and planning, all sharing applications relevant to the task in hand, regardless of their location;
- *automated order taking* reducing the cost of making sales. Security problems may arise. The crucial point, is to set up firewall and other security features so that outsiders can access the information they need without compromising system security;
- *automated supply chain* making the Internet an opportunity even with smaller suppliers in the distribution industry, where volume and cost preclude the use of EDI, provided that the emergence of standards and improvements in the infrastructure are strong enough. Security and standardization of transmission needs to be improved to generate a critical mass of interest.

2.4. New Technologies for the Networked Marketplace

Full migration towards electronic information access, commerce and transactions requires a number of key technologies - in telecommunications, security, payments, access, search and navigation. Current technologies are filtered through the new set of requirements for the next networked computing wave and are evolving along multiple fronts to help the market become increasingly electronic.

Access devices: the hottest debate in the industry is related to the concept of Internet-specific devices - often called Internet appliances, with little local storage, minimum software, and price under $ 500. These devices are seen as an alternative to the personal computer as preferred consumer access device to the networked world. Pilots have been launched in 1996, and more products are to come in 1997. The two alternative visions about the use of the Internet as a computing infrastructure and the outlook for low cost access devices can be framed as shown in the following table:

Vision	Internet Appliance	PC
Architecture	Resources on the network	Resources downloaded from the network to the personal computer
Bandwidth	ISDN (but slow)	14.4 kbps (but slow)
Desktop	Internet access device with operating system, graphical user interface, hard disk	Pentium personal computer with 32 MB, 2.0 GB disk, Windows NT
Cost Structure	ECU 300 device + application access + telephone	ECU 3,000 + network access

Different types of devices will support Internet access in the future. They include general purpose PCs, special PCs designed for the Internet (generally with no or limited disk space), terminals designed by today's terminal suppliers to access the Internet, video games and other interactive entertainment devices, TV set-top boxes, hand held computers and smart cellular phones. An estimated 24% of unit devices connected to the Internet are non PC devices at present.

Application development: Internet application programming languages and associated development tools and chips are another major issue for the development of the networked consumer marketplace. Among the most famous, Java is a version of C++ with commands modified to optimise development in the Internet environment. Programmes would be distributed to clients on an as needed basis, in the form of downloaded applets. The potential advantage of a truly open, truly interoperable client is inhibited by issues related to difficulties of learning new programming languages, lack of dissemination, lack of testing certification and catalogues of accessible "applets" programmes.

Content creation: the amount of content on the Web is already prodigious and the potential is even higher as the ability to generate Web pages gets automated. There is no end to the number of tools already available to develop Web pages, including standalone Web publishing software and translators for common word processing and graphics programmes, to tools for linking large databases to Web sites.

Navigation and search: search tools can be grouped according to the variety of ways they allow to get to information on the Internet. Some work as directories, some as search engines (or both), some initiate searches using multiple search engines at once (search brokers). Tools called "crawlers and spiders" often do the actual searching and directory building, polling Web sites continuously for content and address changes or additions. "Monitors" are continuously available to allow updated knowledge of the changes in favourite or target sites. "Agents" are used to obtain information profiles through the Web. This area remains among the more challenging ones for the industry to ease the pick up of the networked consumer market.

Telecommunications: Telecommunications issues are treated in the next section of this chapter. From the networked end-user perspective affordable and reliable access telecommunications bandwidth remains the biggest incentive to migrate to new forms of computing over the Internet.

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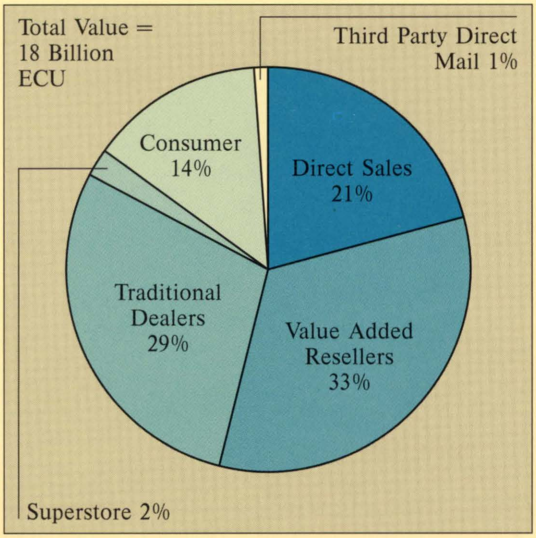
arket. Value Shipments by Channel. 1995



Transactions: As the number of buyers over the Internet is expected to grow, so will the average size of a transaction. The Web as a giant electronic catalogue is an appealing concept and developing a Web page is much cheaper than building stores or sending glossy catalogues. The major challenges for the new "networked marketeers" would be to overcome consumer cautiousness against frauds and deliver the right kind of traffic to their electronic storefronts.

Access protection: firewall software is usually placed between internal LANs and WANs and external networks such as the Internet to control access. The firewall identifies names, applications, Internet Protocol (IP) addresses, and other characteristics of the incoming call. It then checks this information against the access rules the administrator has programmed into the system. The firewall industry is growing and volatile, providing as many access control solutions as it has vendors.

2.5. The New Business Model Requirements for the IT Industry

IT suppliers need to improve their competitive advantage by concentrating on the following major areas:

- defining the value proposition they want to be best at to attract customers, through the right mix of product innovation, efficiency, and customer support;
- focusing on manufacturing in core areas and start joint ventures, contracting out, or licence agreements for non core production;
- enhancing cost effectiveness of sales and distribution using indirect sales channels;
- speeding up adaptability to market environment changes through more decentralised organizations;
- innovating branding and marketing strategies for the consumer market.

Competing in the IT business market

The evolution of organization and business models in the IT industry has been influenced by suppliers attempts to find the best balanced focus among three challenges: faster product innovation, increasing process efficiency and better customer support. Focus has been shifting remarkably from one area to the others depending on the core business areas.

The major trends by type of emerging business models are the following:

- IT hardware/software technology suppliers are focused on faster product innovation and more efficient manufacturing and logistics;
- driven by their legacy, some companies are trying to combine a product-business centred around innovation with a service-based business model, more focused on customer support, process efficiency, and demand-based marketing;

Software Market Description	1995 Worldwide Market Size (Billion ECU)
Consumer Applications Used in the home for recreation, education, and/or personal productivity enhancement	1.53
Cross-Industry Applications Address problems such as office automation and accounting	15.91
Vertical-Industry Applications Address problems that are unique to a particular industry, such as manufacturing or health care	16.38
Information Access Tools End-user oriented tools for ad hoc data access, analysis, and reporting	4.73
Programmer Development Tools Support the professional developer in the design, development, and implementation of a variety of software systems and solutions	16.38
Systems Management Software Used to manage the full range of computing resources	5.41
Operating Systems The machine-level instructions that operate the CPUs and networks	9.48
Utilities/Middleware Enabling application and user interoperation and communication, system utilities, and distributed object management	5.57
Software Market	75.39

Table 15
IT Software Market Taxonomy

- some companies are trying to move from a product-based business model towards a purely service-based business model, and therefore trying to shift priorities from product innovation towards a more focused customer support and process efficiency-centred approach;
- services companies focused on process efficiency and on delivering highly specialised skills on a global basis, are leveraging on tightly controlled organization rules and processes set centrally and implemented locally;
- consulting companies are trying to expand their offer of business consulting towards IT operations and management consulting, leveraging more strongly on customer support. These companies are more decentralised, more flexible and able to provide more effective response to local business requirements.

The organization structure of IT vendors is increasingly polarizing towards two major business models:

- centralized models, with strategy, and support performed at central level; and sales operated at local level. This is typical of companies acting in the high-volume technology business, that increasingly requires tight control of processes to achieve maximum efficiency, in a highly undifferentiated, price-driven business;
- decentralized models, with strategy, and support technical support performed both at

central level and local level, or exclusively at local level, to allow better responsiveness to the different local requirements in each country. There are different levels of "decentralization", with the highest ones being implemented at companies more focused on building competitive edge through customer support.

Competing in the home market

To capture consumer demand, home IT suppliers need to couple edging on family values with global brand management. Brand management strategies are faced with both structural and cultural challenges. Structural challenges are related to distribution channels fragmentation, government mandates and fiscal/VAT policy, heterogeneous distribution of disposable income and seasonal cycle variations. Cultural challenges are related to adapting global campaign messages to local cultural differences, through local language, attitudes and social conventions. Other challenges are represented by scarcity of indigenous multimedia software, and different underlying cultural drivers for PC acquisition. There is still an overemphasis on generic attributes and technical specifications, and messages still need to focus more on communicating how PCs are tied to such higher values as health, welfare, security, community, and family care.

To generate more interest among potential networked consumers and foster lasting relationships IT suppliers need to become more active participants in the delivery of continuous product value extensions. The value is embodied in the potential of software, accessories and services to deliver solutions, enhancements and satisfaction over time. Mass customisation to diverse constituencies and ability to deliver a stream of continuous value long after the initial sale will achieve the loyalty, brand equity and profit margins that enable competition in the home consumer IT marketplace.

3. The Telecommunication Market Driving Forces

3.1. New Technologies and Actual Needs

Demand for new bandwidth and easier access to network backbones is rapidly increasing, as business telecommunications have become vital for business activities.

Demand for telecommunications traffic is growing exponentially in large companies due to the following drivers:

- data transmission networks support the adoption of flat organizational structures, with an increased number of star-shaped interlinks;
- work is now organized in parallel (not sequentially) and is interactive. Teams work together on projects or products networking with simultaneous exchanges of information among different divisions;
- high-bandwidth applications, such as video conferencing, are seen as a way of boosting productivity and reducing corporate costs at all levels of the business value chain;
- the potential of creating new markets through the network is significant, even if uncertain, and large organizations cannot ignore the potential of the universal nature of the Internet;
- data exchanges will increasingly include images, together with voice and data. It is estimated that images transmission technology and services will account for 12 % of the telecommunications budgets of large companies worldwide by year 2000.

Many corporate networks are at breaking point and local area networks are expanding to cope with data-intensive applications. To work efficiently they require a complex and expensive network infrastructure. Network technologies capable of transferring voice, video and data simultaneously, such as ATM, ISDN, frame relay, and the Internet backbone are the ideal candidates to meet these demands, enabling such new applications as virtual networks, enhanced data services, and smart cards.

Intelligent network services deliver a remarkably enhanced level of service from the network infrastructure. Intelligent call routing enables a call to follow the user when away from the office. EDI and electronic messaging are evolving towards a more viable and universal solution through the Internet.

An increasing array of products has become available for phone-card based customised transaction services, such as prepaid phone cards, stored value cards, electronic gift cards, prepaid cellular, and Internet payment systems. Daily metered billing services eliminate the need for up-front deposits and minimise carrier exposure to bad debt. Turnkey connectivity, electronic bank interfaces, computerised tracking, and reporting required to support the service are also provided.

Virtual network technology is applied to local and wide area networks to develop new services. For example this technology is used in education to offer a multipurpose, secure school card programme letting students access their school records, student information and school services through the Internet. The cards could also be used to pay for telephone calls and other vendors, and students may be able to transfer cash to their smart cards directly from bank accounts by using advanced card readers located on campus. These products handle user identification, authentication, integrity, authorisation and encryption using firewall, smart cards and encryption technology.

3.2. Liberalisation and Re-regulation: Where Are We?

The competition focus of telecommunications legislation has progressively shifted from policy development to ensuring its application and discouraging anti-competitive practices in the national markets. Initiatives by the European Commission include infringement procedures for action against delays by national governments and new rules for handling unfair-competition complaints from telecommunications operators.

Infrastructure

The complexity of European telecommunications deregulation and the relatively tight implementation timetable has challenged the European countries' governments in 1996. The Directive on Alternative Infrastructure, approved in March 1996, required that by 1 July 1996 EU States should have lifted all restrictions on owners of alternative infrastructure who want to provide liberalised services or sell capacity to competitive service providers. This raises the prospect of lower tariffs from new operators who will no longer be tied to expensive monopoly infrastructure.

Out of 15 countries, six - Denmark, France, Finland, Spain, UK and Sweden - had implemented the directive by then, and three - Spain, Germany and the Netherlands - with a delay of a few weeks. Other national regulators have acknowledged delays with the commitment to support alternative operators who want to make an immediate start and cannot wait for legislation. The situation at the end of 1996 was the following:

Austria: The Austrian government turned Post and Telecom Austria into a separate entity in May 1996, and is drafting a new telecommunications bill to bring the country in line with the 1998 timetables of the EU. Alternative infrastructure providers, allowed to offer transmission services in the interim, include the power utilities grouped into Verbundsgesellschaft AG, and the state-owned railways, Oesterreichische Bundesbahn.

Belgium: Belgium hopes to fall into line by the end of 1996 and is granting temporary licences to alternate networks until then. One law to end Belgacom's monopoly on infrastructure and another to provide for the award of licences to alternative operators wait for government's implementation. Telenet Vlaanderen (joint venture of US West International and local investors in Flanders) is building an advanced broadband network to 2 million homes.

Denmark: TeleDanmark effectively lost its fixed-line monopoly on 1 July with the new legislation. Interconnection, frequency allocation and rights of way issues have been left for secondary legislation, to be dealt with by the end of 1996. Telia is the main rival to TeleDanmark, and plans to buy into Danish cable TV companies, build its own infrastructure and lease capacity from the railway and power companies.

Finland: Local and long-distance/international monopolies are gradually being allowed to each other's markets. Alternative infrastructure providers include: Telivo Oy (subsidiary of the power company Imatran Voirna Oy (IVO) and 35% owned by Swedish Telia) operating a nation-wide fibre optic trunked network, the Finnish railways leasing capacity, and several of the country's approximately 50 cable TV companies planning to upgrade their networks to carry telephone traffic.

France: Under the new law any company which already has an operating licence needs only ask for a modification in order to be able to sell capacity to any other licenced operator. This includes highway owners SANEF (Société des Autoroutes du Nord et de l'Est de la France) and Cofiroute, the national railway SNCF, the IBM outsourcing company Axone, Sprint, BT/Cegetel, the Generale des Eaux/Unisource joint venture Siris, Air France and SITA.

Germany: Germany has become Europe's most competitive and richest market for infrastructure wholesaling. The local connection to every home and business in the country will be available when the German telecommunications ministry licences fixed radio access technologies in the local loop. Early infrastructure competition was a condition for European Commission's approval of the Global One alliance between Deutsche Telekom, France Telecom and Sprint. The grant of two licences for alternative infrastructure by 1 November was a condition for the approval of Deutsche Telekom's disputed corporate discount scheme. Alternative infrastructure competitors include: the German railways telecommunications unit DBKom GmbH (also owned at 49.8% by Unisource), Communications Network International GmbH (majority stake Mannesmann Eurokom) and energy groups, including RWE AG of Essen, Viag AG of Bonn, Veba AG of Dusseldorf and Wingas AG of Mannheim. A few cities, such as Berlin, Cologne, Dusseldorf and Hamburg, are launching city carrier services.

Greece: The Greek telecommunications market continues to be dominated by the Hellenic Telecommunications Organization (OTE). Because Greece has been granted a five year extension on introducing telecommunications competition, any new operator would have to wait until 2003 before it could compete head to head with the dominant national carrier.

Ireland: The government has proposed that Telecom Eireann should have reserved rights on public voice telephony at least until 1 January 2000, although infrastructure ownership would be reserved only until July 1999. Value added service licences have already been issued to Esat Telecom and Stentor plc. Electricity Supply Board (ESB) and CIE, the national bus and railways operator, both have infrastructure which could be commissioned for telecommunications operators' use.

Italy: The proposal of the telecommunications law planned to implement the European directive on alternative infrastructures by 1 January 1997 is late. The approval of the law has been delayed. In the meantime Italy's antitrust watchdog is not opposing alternative usage of network infrastructure. Alternative providers include Olivetti-Infostrada and the venture between Albacom (joint venture of BT and Banca Nazionale del Lavoro) and Mediaset.

Luxembourg: The government has applied for a derogation to delay EU directives liberalising voice telephony and alternative infrastructure competition until 2000, to allow the state carrier P&T to complete structural adjustments. There are no plans to develop alternative networks to compete with P&T. P&T and Hermes Europe Railtel BV are discussing a partnership agreement to lay fibre cables along Luxembourg's national rail lines.

Netherlands: Liberalisation of fixed infrastructure has been enacted through an interim revision of the Dutch telecommunications law soon after the deadline of July. Alternative infrastructure providers include Enertel BV (a consortium of electricity utilities and cable operators) offering leased lines to corporate network builders, Electricity utility NV Edon of Zwolle, and Telecom 2 (joint venture of BT and railway company Nederlandse Spoorwege) offering telephone services. Telecom 2 is using the national railway telecommunications infrastructure for TCP/IP transport for some major Internet service providers.

Portugal: In Portugal, the 1 July lifting of restrictions has generated little interest in expanding existing network infrastructure.

Spain: The lack of an independent regulator and absence of clear rules for interconnection continue to hamper the market. A licence was awarded to state-owned broadcaster Retevision, which is trying to complement its microwave network through partnerships with national electric companies' who have fibre optic cables. This was a condition for the European Commission's approval of the joint venture of Telefonica with Unisource. Postal utility Correos have a licence to provide infrastructure. Some local governments are building a regional network, initially to provide voice and data services for their municipal operations. Foreign cable TV firms and local utilities are expected to join.

Sweden: One of the most liberal markets in Europe, Sweden has never had a monopoly on infrastructure. National railways Bahnverket has an agreement with second operator Tele 2 to provide transmission capacity over its fibre optic network. Electricity utilities, organised under the umbrella organization Svenska Kraftnat, are offering transmission capacity over their long-distance networks. Stockholm is among the first cities in Europe to fold its telecommunications infrastructure and private network into a publicly held company, Stock AB.

United Kingdom: By lifting the duopoly of international facilities, the British government has progressed in its leading efforts to liberalise infrastructure. An estimated 150 companies are operating licensed telecommunications networks already in the United Kingdom and many of these are based on alternative infrastructure.

Implementation of the Directive on Alternative Infrastructure Liberalisation as of July 1st 1996

MEMBER STATE	DATE OF NOTIFICATION
Belgium	Not implemented
Germany	3 July 1996
Denmark	Implemented
Greece	Requested additional implementation period until 1 July 2001
Spain	Proceeding
Austria	To be confirmed
France	Implemented
Italy	To be confirmed
Ireland	Requested additional implementation period until 1 July 1999
Luxembourg	Requested additional implementation period until 1 January 1998
Netherlands	To be adopted on 15 July 1996
Portugal	Has requested additional implementation period until 1999
Sweden	Implemented
United Kingdom	Implemented
Suomi/Finland	Implemented

Source: European Commission

Mobile telecommunications

Liberalisation of mobile communications remains well in advance of fixed telephony services. New operators have been licensed in Belgium and the Netherlands, while newly licensed operators have just launched services in Italy and Spain. In the leading markets of France, Germany and the UK, competition has been established for several years.

In Germany competition contributed to lower prices, infrastructure improvements, and pick up of new subscriptions. Together with the UK this is the only European country to have licensed four cellular operators. The UK has become the first European market to top 5 million users in 1995. Most of the growth has benefited the first two entrants, attracting consumers with cheaper fixed charges but more expensive call costs. France has one of the lowest mobile subscription penetrations in Europe, since competition of Société Française du Radiotéléphone (SFR) with France Telecom has been partly hampered by the cost of leasing lines from France Telecom. Prices are expected to drop with the entrance of the third operator. In Italy, strong price competition among Telecom Italia Mobile (TIM) and Omnitel has generated one of the fastest-growing subscriber bases in Europe, despite a slow process to grant further licenses. Scandinavian countries - where low prices for phones and services have led to high penetration - are the most advanced model for European cellular markets. Several factors, together with competition, are behind the Scandinavian phenomenon:

- competition was introduced in the early 1990s;
- national PTOs were already offering affordable good service before competition;
- national PTOs worked closely with domestic telecommunications manufacturers using their home market as a basis for developing the cellular equipment;
- cultural factors;
- fast introduction of common standards for mobile telecommunications.

Directives on interconnection, licensing and standards

The European Commission's directive on interconnection is expected to be adopted in early 1997. This directive will provide a common framework for interconnection between existing and new operators in the context of 1998 liberalisation. It aims to assure trans-European operability, competitiveness through interconnection and that the "universal service" concept cannot be abused to prevent new entrants from coming into the market.

The Commission is working on another directive, on licensing, which aims to streamline authorisation procedures as much as possible. Rather than continue licensing for individual services, the Commission wants member states to issue a general authorisation as a telecommunications operator. Individual licences should be required only where radio frequencies must be allotted, such as for voice or mobile services. Licences can be limited only if radio frequencies are too scarce. The assumption driving this directive is that, seeing wireless replace fixed telephony, the industry will increasingly call for pan-European management, if not global frequency management.

Other directives are being prepared, to revise the open network provision (ONP) directive. These directives set out:

- the criteria for interconnect and licensing agreements to be met by members;
- the scope of the universal service, which must be available to all users in the EU, at affordable conditions.

The directive for licensing would lay down the following in particular:

- provision of telecommunications services and/or networks either without authorisation or on the basis of a general provision authorisation, to be supplemented where necessary by rights and obligations requiring individual licences;
- limitation of individual licences to infrastructure providers only to the extent required to ensure the efficient use of radio frequencies, or for the time necessary for the entry into service of a sufficient quantity of numbers;
- conditions for authorisations should be objectively justified in relation to the service concerned, non-discriminatory, proportionate and transparent;
- licensing "one-stop-shopping" procedure.

Several issues are calling for initiatives by the European Commission to take policy action in the area of the Internet. In particular the following areas are concerned:

- security for electronic transactions, including digital signature;
- legal protection of encrypted services;
- measures to fight illegal and harmful content;
- harmonisation of copyrights and related rights.

3.3. New Business Models for the Telecommunications Industry

Telecommunication equipment providers

The days when telecommunications equipment providers simply made the systems and customer premises equipment that make up a telephone network have long gone. Some of this can be done more cheaply by sub-contractors. The focus now is rather on meeting the world's ever-increasing communications demands, from traditional voice telephony to multi-media and the Internet. To gain advantage over competitors, telecommunications manufacturers need to provide customer marketing support, network planning and engineering knowledge, as well as alternative financing concepts for network operators.

Major challenges they face in the terminal equipment business are:

- repositioning the technology offer to best benefit from the convergence of fixed and mobile networks. New fixed and wireless access technologies are compensating the decline of PABX equipment revenue contribution from almost one third to a much lesser share;
- re-balancing the channel mix, shifting towards indirect sales from selling through telecommunications operators;
- enhancing market segmentation and product differentiation for traditional and new fixed and mobile terminal equipment, as penetration in every age group increases;
- reorganizing production through subcontracting and outsourcing, focusing manufacturing capabilities on final assembly and testing.

Telecommunication services providers

For telecommunication service providers, substantial presence - if not dominance - in national markets remains the pre-requisite for global success, despite the strong drive towards globalisation. Localisation and globalisation are complements and they want to achieve both, although securing the local market puts a claim on scarce resources and slows down the global shift.

Globalisation is needed because:

- large users become global, and need to buy services globally;
- traditional voice services market are saturated in developed countries.

Localisation is needed because:

- millions of local retail customers identify with familiar "local" providers;
- cable service is a local service, and competition from cable technology is growing;
- content, that is inherently local, is increasingly important to fill spare capacity and attract new users to enhanced telecommunications services;
- investment pay-back depends on having a secure customer base, so local presence is needed.

A truly global telecommunications service market is likely to be a long time coming. The typical pattern that is emerging in the industry is one of international cross-entry by means of partnerships and alliances, with the leading companies keeping a significant position in their home markets but subject to regulation to encourage competition.

Cross-border acquisitions are difficult to make because of differences in the legal and financial business frameworks as well as because of business governments' commitment to "national champions". Regulatory conditions also generate barriers to mergers. Similarly networks of partnerships needed to enter developing countries are time-consuming to set up and to manage and give a fragmented and unstable structure on which to build a global strategy. Entry in new countries is usually concentrated on the business services market, taking minority financial stakes in second-level players and allying with banks, utilities or other organisations that can provide capital and access to potential customers.

One major initiative that goes together with globalisation accomplishments is changing priorities in name branding. Names changes not only want to give the new ventures international recognition with little indication of their national roots, but want now to reflect the globalisation abilities of the operators (Global One, Concert to take the two most notable examples).

New entrants in national markets, usually multi-headed alliances, are showing two alternative approaches to compete with national dominant players:

- the classic route of building up basic infrastructure is usually undertaken by the second-tier telecom competitors, not always with great success. This approach is sometimes coupled with organization structures consisting of a "network" company and a "services" company;
- the other approach, by contrast, aims to create a single network capable of carrying both telephony and CaTV services. Basic infrastructure is not built but rented as much as possible, while investment is concentrated on innovative applications and customer service.

3.4. Wireless Telecommunications

Wireless telecommunications could become the key feature of the new information age, if service prices. The next life cycle of mobile phones, as transmitters and receivers of images, is very close. New application areas will require integration between mobile technology and computer capabilities, to perform time-sensitive information exchange in such tasks as engine tests, order taking, credit card verification, travel bookings.

Cellular data telecommunications

High-speed routing technologies, smartphones and the Internet promise to kick-start the cellular data services market.

A boom in cellular data traffic will require affordable, intelligent devices and software upgrades to mobile networks that can provide end-to-end digital connections. The major market for cellular data will be business users, who regularly send electronic mail messages and faxes, and who access corporate databases. The first-generation cellular smartphones have been launched in 1996. Apart from telephony, these half-phone, half-computer devices offer a range of functions, including E-mail, fax, short messaging and Internet access. Prices are expected to drop (from the current 1,000 ECU) as the devices are pushed into the mass market.

An interesting alternative to traditional GSM technology is emerging in the local loop with DECT technology. The three main applications of DECT are cordless PABX systems, high quality residential cordless phones, and radio in the local loop. This technology is getting cheaper and provides a better alternative solution for indoor wireless service than an in-building GSM or DCS1800 network. DECT cordless PABX systems were launched in 1990, but had a relatively slow start, because of weak technology push and high cost to the customer of testing the technology. Since then the pricing structure of DECT PABXs has been changed with the offer of free installation of the base stations and fixed price charges per additional phone.

European cellular equipment vendors are also addressing another key inhibitor: slow transmission. Speeds of up to 9.6 kilobits per second, which is enough to send faxes and E-mails, is too slow to transmit graphics or surf the Internet. The European Telecommunications Standards Institute (ETSI) is expected to approve a new standard for high-speed circuit-switched data very shortly. The standard requiring software modification in the mobile switching centre will allow terminals to use several airtime slots to transmit data at speeds of up to 64 kbps, instead of one dedicated slot, as is currently the case. In addition, ETSI is working on a high-speed packet-switched service for GSM cellular data.

European mobile operators are rolling out new cellular data services allowing customers to send and receive faxes and E-mail, access local and wide area networks and surf the Internet. To enable attractive and marketable wireless Internet access four main conditions are still needed:

- lower cost per kilobyte of data;
- high data throughput;
- wider cellular access coverage;
- lower network latency.

Strong competition between European and US suppliers is taking place over who will take the lead in the next generation of high speed wireless local area networks technology. This technology will support data rates up to 23.5 Mbit/s which is the level of bandwidth required if wireless systems are to make any impact on the LAN market currently moving from 10 to 100 Mbit/s.

Satellite telecommunications

The prospect of a compact, hand-held satellite phone by the year 2000 nurtures positive expectations of satellite telecommunications. It will be some time, though, before wide, cost-effective wireless voice and data access that provides the equivalent of landline connectivity is a reality. Development of the enabling technology is the relatively simpler part, as the major trends in mobile and satellite telecommunications technology are clear. Demand potential is also high, with the increasing availability of content on Internet and Intranets that mobile users may benefit from. Getting the technology into customers' interest is more difficult, as rarely location, cost, and access time requirements are completely fulfilled by the existing offer. In particular many of the current characteristics of the Internet, that make it attractive for businesses, cause problems for many current methods of wireless access. More video and interactive content to make Web pages attractive also means longer time to access or download, at a much higher price than using fixed line connections. As a result Internet wireless access is not close to mainstream deployment, yet. Business applications are a short term opportunity as more price-attractive solutions become available.

The European Union has started to investigate the initiatives to develop a single system for licensing satellite personal communications operators. The United States have already licensed three personal communications systems that are poised to set up global operations by the end of the decade. Two of those operators are jointly funded by US and European telecommunication players.

Mobile satellite services are more expensive than their cellular counterparts, and satellite operators will have to work hard to convince the average customer to pay a premium on the price of both handsets and airtime. Cellular handsets can sell very cheaply in the more mature markets. The worldwide cellular market is fragmented between several different standards, and networks rarely provide complete geographical coverage in any one country.

The potential global reach of mobile satellite services is seen as a selling point that can command a significant premium. For example, a European business person using a satellite handset would still be able to use it when visiting the USA, a facility that would not be possible using a GSM digital cellular handset.

Mobile satellite services will ultimately be positioned as complementary to terrestrial cellular networks and will occupy niche markets such as off-shore communications, or communications in remote areas such as deserts or mountainous regions where it is too difficult or costly to deploy cellular networks. Mobile satellite services could also find a market, albeit a limited one, in developing countries with challenging terrain where wireline connections are not readily or widely available outside the main population centres.

4. Main Market Orientations

4.1. The "New Players" Perspective

As the ICT industry moves towards globally integrated networks, and integrated business users and home IT consumers, a new generation of players is crowding the competition scene. The most hectic areas where new players are emerging are value-added telecommunications services, entertainment software, and Internet products and services.

Telecommunications and content providers: The new wave of megamergers and joint ventures that are being formed in Europe are characterised by vertical integration among content producers, IT suppliers and telecommunications carriers, as well as by a horizontal convergence among the telecommunications, cable and computer networks.

This new wave is giving birth to a number of new "global consortia" ventures aimed to help telecommunications' providers facing challenges related to:

- protecting their market share;
- accessing the international services market;
- meeting the demands of international corporate customers;
- providing one-stop-shopping and one-stop-billing services to global customers;
- gaining access to infrastructures;
- pooling resources to provide best technologies and support;
- providing global enhanced Internet backbone networks.

Telecommunications and multimedia: Complementary alliances are also developing between telecommunications services providers and different players in the multimedia markets. These alliances present enormous challenges both to regulators and to managers of the operations involved, because of the lack of copyright protection and because of the need to achieve cohesion among different cultures.

Entertainment software: In the effort to enhance the "entertainment value" of software applications, new start-ups and joint ventures among software developers and multimedia content providers are aimed at enhancing playability and content depth.

PC utilities programmes suppliers are emerging, as market potential is fostered by consumer migration to Windows 95, the increased adoption of Internet platforms, and the disappearance of free technical support from software vendors. Tools for software configuration resolution, or automatic update of PC software applications over the Internet are generating considerable revenue growth.

Consumer new media browser platforms for non-PC devices: New ventures and spin-offs from Internet access platform providers are evolving browser technology into a platform to run on three major target devices: TV-centric (video-game consoles, set-tops, home entertainment), telecommunications (cellular phones, personal digital assistants), and information terminals (kiosks, network computers, home appliances). At least three different user interfaces are expected to emerge: one from multimedia computing, one from home entertainment and one from mobile information access.

Internet technology and service providers: Internet browsers, server software, and service providers are facing the battle to catch early *de facto* standard recognition as the market is still at an early phase of development. They have to struggle against the freeware that allows companies to set up Web sites with little product investment, and against users low premium value perception for additional ease-of-use functions.

Internet firewall software providers: Just born in 1995, this market has already segmented into three main technologies: packet filtering gateways, circuit filtering, and application filtering. To capture users preferences suppliers appeal to different marketing leverages: ease of use, different levels of security, crystal-box software solution approach, cost effective hardware and software combination.

4.2. Who Is Funding the Shift?

Public policies in Europe are concentrating on building up innovation strength by promoting R&D and encouraging large-scope technology dissemination initiatives.

The core of European public actions to promote the shift towards the information society is increasingly focused on exploiting the full potential of European demand, which is the largest demand base in the world.

It is a common understanding, among the industrial, business and consumer communities in Europe, that full economic gains cannot be secured from the Information Society without involving people in managing the process of change. As a result the promotion of the Information Society in Europe is developed upon a people-centred approach, aiming at removing major cultural and organizational barriers.

The priorities to facilitate this transition towards a higher technology-intensive society are identified as follows:

- giving people education and know-how to ease the use of new information technology devices and applications;
- ensuring universal service and access to basic on-line services such as public information, education and health at reasonable prices;
- involving people early in the development of new useful applications;
- using the new technologies to guarantee open access to public information services and bring people into decision-making.

Viewing the Information Society as a primarily market-driven activity, the Commission expects that primarily private investment should be the driving force behind the development of information infrastructures. The role of the Community and of the Member States would be to support this development by giving "political impetus", by co-operating with the private sector in experimental applications and by creating a clear and stable regulatory framework.

The expansion of new services as part of the information society has led to regulatory initiatives in most Member States. Broad guidelines for interconnection, licensing and financing universal service have been adopted.

European Commission Short Term Action Plan for the Information Society

The Commission future priorities to promote the Information Society are the following:

- *Improving the business environment* through the effective implementation of a favourable regulatory framework, particularly in the fields of licensing, frequency allocation, electronic authentication, security and copyright;
- *Investing to enhance Europe's knowledge-base.* Information society-related research will have an important place in the 5th Framework Programme;
- *Putting people at the centre:* reviewing the role of different policies to better protect citizens' interests and to improve the opportunities for new jobs in the service and content sectors;
- *Meeting the global challenge* by reinforcing international co-operation and basic global rules in such areas as market access, interoperability, intellectual property rights, standards.

The new orientations regarding standardization policy take into account the particular characteristics of ICT (including the very short product cycles) and the essential role of standards in providing interoperability and allowing to be taken of full advantage from liberalisation of telecommunications.

It is proposed that *de facto* standards and publicly available specifications play a major role in the standardization process. Without questioning the function of existing standardization bodies, more attention needs to be dedicated to market forces and industry requirements. The global dimension of the information society also requires that public authorities seek world-wide consensus in establishing standards.

To avoid refragmentation of the internal market in this key sector, more co-ordination of national rules and regulations is required. In two communications on "The Implications of Information Society on European Union Policies" and on "Standardization in the Information Society" the Commission has expressed the views about future actions to promote the most effective competitive environment to implement the Information Society. Details of this plan are outlined in the box above.

5. Changing the Vision for the ICT Market

5.1. Entering the Era of Networked Consumers

New scale and scope of ICT use will drive growth and create challenges. In the past thirty years, the IT industry has experienced two major periods of growth - each driven by the application of new groups of ICT users and applications.

In the first era, the mission was to use IT to automate the back-office functions in the business. This limited business scope required a relatively small number of users to actually touch the technology; and from a revenue standpoint, the industry was a shadow of what it is today.

The introduction of the PC and LAN in the second era, beginning in the early 1980s, enabled businesses to enlarge the scope of IT use to include automating the front-office and, eventually the field. This expansion of the scope of computing resulted in an order-of-magnitude increase in the scale of the user base, and an order-of-magnitude increase in ICT industry revenues. Most importantly, the much larger scope and scale presented by the second era required suppliers to fundamentally rethink strategies for development, distribution, marketing pricing and support. In the process of this transition, some first-era leaders couldn't adapt and a wave of new leaders came into existence.

With the "networked consumer" era, the industry is once again about to open up another new, and dramatically larger, community of users-consumers. Internet's greatest impact ten years from now will have been in extending the reach of business directly into the home. The creation of a community of "networked consumers" will be a quantum jump in the scope of computing and, consequently, growth in the ICT industry. Not only personal computers and end-user access devices will be sold as "consumer" goods, but the whole shape of the industry structure will record major changes.

To prepare for this, ICT players that see the Internet's greatest opportunity in the context of a consumer-influenced marketplace will and must make major decisions. These decisions are about how to compete in the networked/Internet environment: what product and services to, and not to offer, what price points to drive toward, who their customers and competitors really are, and, in the process, to define the company's identity.

The following are some challenges the Networked Consumer Era will offer to the current rules for success in the new ICT marketplace:

- The inclusion of a vast new user base, with different sensibilities and expectations than the business employee, brings major changes to the ICT business model. Corporate customers' priorities are changing, from systems that automate employees to systems that automate customers. Successful suppliers will recognise these changes and explore what this means to their current product offerings.
- For ICT suppliers who are in the business of providing end-users hardware, software or services, direct participation in the consumer marketplace is an important opportunity. Not only does the consumer market represent the next big end-user market: it will also set the standards for features, functions, price points and design for business end-users.
- For ICT suppliers selling infrastructure and telecommunications to the corporate market it is important to address the complexity that the increased scale of consumer-centred systems will bring.
- For suppliers of large-scale applications, support of "entertaining" interfaces will be critical for systems aimed at attracting consumers.
- Brand equity will become more important – albeit less secure – in a virtual world.
- In the second era of IT growth, the industry shifted from a rental to a purchase model, and from a direct to an indirect distribution model. In the Networked Consumer Era, distribution of an increasing number of IT products will shift back to direct, through the electronic marketplace.
- Partnering has been the hallmark of the second era of ICT growth. In the third era, partnering will continue but many partnerships will be between IT suppliers and their corporate customers – aimed at reaching consumers.

- The consumer market will require that cost structures be re-examined - and trimmed - in order to drive consumer-friendly price points.
- Given the increasing influence (direct and indirect) of consumers on the ICT industry, suppliers must be prepared for greater volatility in the marketplace, and establish processes to mitigate it.

5.2. Positioning Europe in the New Scenario

Positive factors related to the ICT market, as well as to the particular shape of the economy and population structure can help Europe recover position against other major regions in terms of ICT production and consumption.

Positive factors related to the industry ICT uptake will affect European, as much as other regions' developments, towards the networked consumer era. These factors include:

- the development of Internet commerce;
- the availability of cheaper technology and access to telecommunications;
- the dissemination of Web technology usage across all activities of the individual.

Ultimately growth in the usage of ICT in an almost networked consumer society will depend on the intertwined effects of:

- increasing population (consumers and businesses) accessing the Internet, at increasing frequency;
- increasing content made available on the Internet;
- decreasing price of access of the Internet (attracting more volume and compensating revenue decline).

In principle, Europe is well positioned in all the above three perspectives:

- *population:* Europe has a higher density of population, than other regions in the world. More than that, Europe has a higher concentration of population between 15 and 45 years old, which is the highest potential target for Internet usage;
- *content:* different cultures and languages generate a higher need for content than in other regions. Demand potential for media is much higher than the current actual use, despite the risk of overcoming dominance of a fewer languages and homogenisation of habits through the Internet itself, similar to the effect of TV;
- *price:* competition in Europe is due to increase over the next few years, which will generate sharper price declines for ICT technologies and services. European prices are currently set for most segments at average higher values than in the US. Higher rates of increase in IT spending by home consumers and telecommunications traffic are expected.

In the new emerging context of knowledge-based economic growth, the positioning of Europe as a major regional driver of economic growth is likely to improve versus other regions in the world. The condition is that the potential, represented by its higher density of population and related higher demand for information exchange, needs to be fully exploited, especially in the services sector. This sector contributes to the European GDP at a higher level compared to other regions worldwide. Thanks to both ICT and increased competition, services are already beginning to play a bigger role in driving growth in the most advanced economies.

Inhibitors and public policies

Cautious optimism is shown in Europe, though, about the prospects for the information society. Many warn that the benefits could be unevenly distributed if people who have little contact with ICT are unprepared for the new generation of technology.

As a result a "culture change" is emerging in public policy initiatives, that will increasingly concentrate on promoting "knowledge-based" economic growth and will be constructed to avoid the development of a two-tier European information society.

Governments actions to encourage the creation and diffusion of knowledge in Europe are required in three areas:

- R&D;
- favourable economic environment;
- education.

R&D: Government subsidies or spending on R&D continue to be required to exploit the spillover benefits to other firms from increased knowledge. Studies suggest that the annual rate of return from R&D to society as a whole may be close to 50%, twice the private return to an individual firm. Unable to capture all the benefits from their R&D, firms may therefore invest too little. The value of governments getting directly involved in stimulating innovation needs can be improved. R& D support can both be focused on basic scientific research and in technology projects driven by the industry. Collaboration and exchange in jointly funded private/public R&D initiatives need also to be encouraged, together with the exchange of researchers and practices.

Favourable economic environment: Initiatives are expected to include:

- deregulating markets to encourage competition;
- promoting private entrepreneurs initiatives to explore new market/application opportunities;
- adopting a regulatory framework and standards to promote effective integration of national markets across Europe;
- promoting small businesses competitiveness and investments (as two-thirds of all European employment is provided by companies with fewer than 250 employees) also through the creation of national second-tier stock markets;
- retraining schemes to equip people for job mobility;
- developing a new "charter" of skills to help young people adapt to the information revolution.

Education: The role of education in this shift towards the new era is crucial both as supplier of new specific skills and as the first true promoter of familiarisation of the individual with the new technologies. Education is one of the few sectors which has so far remained largely outside the technological revolution. There is huge potential for using IT to improve education, give students in poor schools electronic access to the best teachers, and make books more widely available through electronic libraries.

5.3. Promoting the Networked Consumer Era

The evolution of the ICT market (see *Figure 13*) will be shaped by the public and business communities' initiatives to accelerate the emergence of the Networked Consumer. The major factors influencing this shift relate to widespread availability of ease-to-use end-user devices to access the networks, access to home users via World Wide Web (WWW) sites, more bandwidth, and strategic deployment of ICT as a business competitive factor.

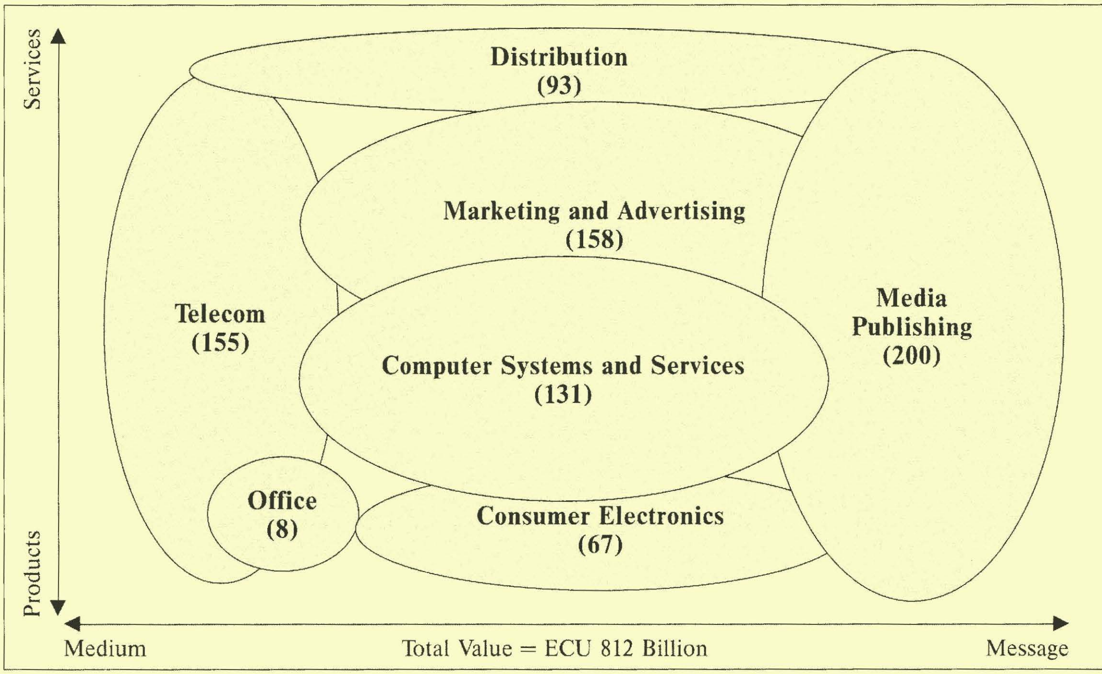


Figure 13
The Western European Information Business Arena. 1995. Billion ECU.

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

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

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

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

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

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

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

End-user devices: The first requirement of this next era, is to get devices into the hands of consumers that will allow them to electronically connect. Internet appliances may be in the future, but today the device of choice is the PC. The beginning of the shift to a consumer-focused market is already well underway in the PC market: in 1996 the home was the biggest segment in the US market, while in Europe it was a close number two, before government and education. The consumer will become an even bigger force in the next decade, driving acceleration in the business of home personal computers and of other end-user network access devices. Internet access devices include Internet terminals (with limited storage and software), TV-set top boxes, interactive entertainment devices, hand held computers and smart cellular phones.

WWW: The second requirement for the Networked Consumer Era is the emergence of a network that can provide businesses with widespread access to those devices in the home. In 1996 the World Wide Web has become that network. 1996 was an explosive year of growth on the Web, after an already booming 1995, and 1997 promises similar growth.

Bandwidth: The bandwidth crisis has got worse in 1996 and the local loop has become the biggest performance bottleneck for most consumers surfing the Web. Private industry and public policy initiatives have fostered their initiatives to drive towards the next era of growth. ISDN, cable modems or future broadband wireless infrastructure will be the ultimate solution, while competition will drive down margins in both local telephone and cable businesses. Adding new services like high-speed digital information to the home will be critical to carriers to maintain growth in revenue levels and support margins. The recent global consortia initiatives to jointly develop local-loop plants is an early sign that competition will accelerate the upgrade of local-loop to high-performance media.

Strategic deployment of ICT: During the coming decade, business' growing strategic priority for ICT will be the building of systems that interface directly with customers. This complements, but will eventually overshadow, the recent wave of spending on systems enabling corporate employees' support of customers (such as customer service systems, sales automation systems). The incentives to interface directly with customers are many. In insurance a key objective is to dramatically reduce the exorbitant costs of direct distribution. In banks the incentive is the ability to rapidly and inexpensively expand market reach. Retail is pushed by the opportunity to lower the costs of bringing goods physically close to the shoppers. For virtually all industries, the allure of an electronic connection to the consumer is the ability to detect marketplace changes with perfect fidelity and react with real-time speed, as well as the possibility to affordably develop highly-customised product offerings for the mass-market.

The effects of this transition on the ICT marketplace will be stronger in 1997 compared with 1996, as the past year developments suffered from functional and regulatory inhibitors. Looking at just the most important manifestation of the industry shift, the emergence of the WWW, 1996 enormous growth was coupled with both intoxication and hangover, as inflated expectations about the speed of development of the electronic marketplace were encountered by the harsh realities of: underdeveloped services, user boredom and continuing traffic jams on the information highway.

Rapid changes in the market and in the regulatory situation, as well as improvements in technology, will make the playing field still unstable. But the market will shape up to meet customer demands, and new networks will be developed at a rapid rate for global corporate communications. Strategic alliances will determine who the key players are. The net movement will be decidedly forward, in the short term, and the key success will be in resisting the temptation to see an interim setback as a sign that the future is not coming and that change is not required.

The Technological Evolution of ICT and Standards

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

1. Evolution in ICT: A Global View

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

These technologies cooperate and interoperate by means of architectures and their evolution plays a meaningful role in ICT, both influencing and being influenced by the developments taking place in the technologies themselves.

The technological megatrends indicated in our previous reports have been confirmed, and the Internet phenomenon is now the main driver for the innovation of IT (Information Technology), TLC (Telecommunications) and also of the enterprise architectures. Up to now the PC has been the "centre" of the "new" systems, both as "stand alone" or as client or terminal emulator for hosts, but this approach has an increasing cost of ownership that the diffusion of the web server and of the web browser as *de facto* GUI, Graphic User Interface, standards can reduce in a balanced equilibrium among the user-centric, network centric, and client-server-centric paradigms.

As pointed out and described in the previous EITO reports, the rate of ICT change is accelerating and ICT application areas are growing continuously. The key technologies which will continue to characterize this trend include:

- wireless systems;
- fibre optics;
- high-speed transmission and switching techniques and protocols;
- VLSI-ULSI chips;
- special purpose processors;
- storage technologies;
- speech processing;
- image processing;
- software;
- display technologies;
- battery technologies.

A few phenomena are driving both ICT development and ICT deployment in both business and domestic markets:

- Internet and Intranet logics and architectures with the emergence of "thin client", of active and dynamic web pages, of new web servers with the need to use high-speed communication techniques;
- mobile "commuting".

The Internet is no longer just the first step, the conceptual embryo of the Information Highway. The hyperlink concept, the evolution of the browser, the mix of practically all TLC technologies into the NET are changing the enterprise architectures and their components, introducing the "thin client" and the network application, effecting software development, and replacing traditional broadcasting with interactive TV on demand, pay-per-view. The Internet phenomenon is also driving (and is driven too, of course, by) the TLC evolution. The "content" which ICT processes and transmits has changed: now it is multimedia with logic and comprehensive integration of data with text, images, sounds and much more. The capacity to share information easily world-wide implies a global re-think and re-vamp of the present systems and architectures. At the same time it provides and supports an actual vision of the "virtual community", that is, the present kernel of the future Information Society.

Mobile systems add to this and allow the pervasive ubiquity of communication and computing. New hand-held systems and new communication services, associated with Internet and Intranet systems and services, are going to support the "old" ICT dream of easy, cheap and pervasive access to every type of information we need anywhere, any place and at any time.

1.1. Standards and Standardization Bodies

The merging of computers, telecommunications, consumer electronics and multimedia outlined above requires the constant introduction of new standards, but in this context the concept and the meaning of standard is also changing. Up to now, by *de jure* standards we refer to standard recommendations released by international standardization bodies such as ITU-T (ex CCITT) and ISO; *de facto* standards refer to recommendations and/or technical specifications accepted by the market, i. e., by the user, at an international level, even if released by a single company or by a group of companies. The Windows PC environment or the Netscape browser are typical examples of world-wide *de facto* standards.

The main problems encountered with *de jure* standards include long delays for definitive formal approval and the often overly academic and theoretical approaches followed, which in some cases are not actually supported by manufacturers and implementors. The OSI (Open System Interconnection) protocols' pile is a meaningful example of a good concept which was not followed by real implementation. On the other hand, the TCP/IP protocol's pipe has been implemented in various ways. Last but not least, in some cases *de jure* standards have been the excuse to stop or to delay innovation produced by the development of new concepts and products. In the present very dynamic evolution of ICT, *de jure* or *de facto* standards no longer matter, they must be "temporary" and "evolutionary". The standard is an index of the lifecycle of a technology, and as it must be considered and used in this way. Consequently, the distinction between *de jure* and *de facto* standards is less significant for users and in any case, standards cannot be (and must not be) seen as static influences or constraints on introducing innovations.

For these reasons the "standardization bodies" are changing: in respect to the "traditional" ISO (the International Standards Organization), IEC (the International Electrotechnical Commission) and ITU-T (International Telecommunications Union, ex CCITT, the International Telegraph and Telephone Consultative Committee), an increasing role is played by consortia, associations and fora based on specific topics, such as OSF, Open Software Foundation for DCE, IEEE for LAN or ATMForum for ATM.

The organizational structure and the standardization procedures are changing for all bodies, in particular for the most traditional ones, that are trying to improve their agility with both quicker procedures to define and formalize standards and with a quicker acceptance of the dominant *de facto* standard in a logic of "intercept strategy". The organizational structure is normally based on a general assembly that determines the general policy and makes decisions on the management and on the strategy of the body, on a "full time" operating secretariat that manages routine decisions relating to the operation of the whole organization, and on a set of technical committees and working groups that provide the actual standardization activities in the specified competence field.

The International Standards Organization, (ISO), the International Electrotechnical Commission, (IEC) and the International Telecommunication Union (ITU), with its Consultative Committees CCITT and CCIR are the worldwide *de jure* standardization bodies operating in the interdisciplinary ICT sector. They have their counterparts in the European standards organizations: the Comité Européen de Normalisation (CEN), the Comité Européen de Normalisation Electrotechnique (CENELEC) and the European Telecommunications Standards Institute (ETSI). The Internet phenomenon has also elevated the IETF, Internet Engineering Task Force, into an actual *de jure* standardization body. In every way, both at the world and European level, these bodies have organized and co-ordinated their activities in order to able to cooperate.

In Europe, with the strong support of the European Union, the main goal in standardization activity is to create a uniform body which meets the needs detailed above and is applicable throughout the European market. This task is the responsibility of the Joint European Standards Institution, CEN/CENELEC and ETSI. European Standards (EN and ETS) are generally based on the standards of ISO, IEC, and ITU-T. However, specifically European standards are also created in cases where corresponding international standards are not yet available from ISO and IEC.

1.1.1. ISO

ISO, International Standards Organization, is the largest *de jure* standardization body on technical topics. At the present time, ISO consists of 214 Technical Committees (TC) which cover everything from "Screw threads" to "Elevating work platforms", including mechanics, electricity, chemical industry, aeronautics, petroleum products, lubricants, etc. Standardization in the field of information technology is followed by the TC "JTC 1" where 26 countries participate directly, in addition to 33 observer countries. JTC 1 was created in 1987 as a joint activity between ISO and IEC. The ICT topics covered by specific Sub Committees (SC) are listed in *Table 1.*

ISO standards are reviewed at least once every five years by the relevant technical committee, to determine whether they should be confirmed, revised or withdrawn.

For more information and the list of the released standards, visit: http://www.iso.ch.

1.1.2. ITU

The ITU, International Telecommunications Union, was originally set up by national governments (now 184) to co-ordinate and promote the development of telecommunications throughout the world. It is an agency of the United Nations designed to debate and develop standards. Its principal goals are to stimulate the advancement of technology and to ensure the compatibility of national networks so that international communications are possible.

In 1992 the ITU was reorganised: two segments of the ITU, the CCITT (International Telegraph and Telephone Consultative Committee) and the CCIR (International Radio Consultative Committee), were disbanded.

Table 1
ISO JTC
Sub Committees

JTC 1 / SGFS	Special group on functional standardization
JTC 1 / SC 1	Vocabulary
JTC 1 / SC 2	Coded character sets
JTC 1 / SC 6	Telecommunications and information exchange between systems
JTC 1 / SC 7	Software engineering
JTC 1 / SC 11	Flexible magnetic media for digital data interchange
JTC 1 / SC 14	Data element principles
JTC 1 / SC 15	Volume and file structure
JTC 1 / SC 17	Identification cards and related devices
JTC 1 / SC 18	Document processing and related communication
JTC 1 / SC 21	Open systems interconnection, data management and open distributed processing
JTC 1 / SC 22	Programming languages, their environments and system software interfaces
JTC 1 / SC 23	Optical disk cartridges for information interchange
JTC 1 / SC 24	Computer graphics and image processing
JTC 1 / SC 25	Interconnection of information technology equipment
JTC 1 / SC 26	Microprocessor systems
JTC 1 / SC 27	IT Security techniques
JTC 1 / SC 28	Office equipment
JTC 1 / SC 29	Coding of audio, picture, multimedia and hypermedia information
JTC 1 / SC 30	Open electronic data interchange
JTC 1 / SC 31	Automatic data capture

They were replaced by three new divisions: the Telecommunication Standardization Sector (ITU-T), the Radiocommunication Sector (ITU-R), and the Telecommunication Development Sector (ITU-D).

Private sector organizations can also be members and now number 380. The ITU has not addressed the place of global service operators, such as AT&T, MCI, etc. No decision has been made on whether they can become members, or even on which governments would take part in deciding the matter. For now, government members hold the power in the ITU. They control the constitution, set the budget and establish the goals at plenipotentiary conferences held every four years. They also elect the ITU council, consisting of 40 governments, which meets every year to control developments, adjust budgets, etc. Private sector members, on the other hand, must be approved for membership by their respective governments, and they have no say in how the organization is run.

Once work starts on drafting a standard, 18 to 20 months can pass before it is adopted as an ITU Recommendation. Under current practice, ITU study groups finalise a specification and then vote on it. If the standard receives unanimous acceptance, a paper ballot of all 184 government members is organized. That alone can take six months.

Until 1990, (former) CCITT Recommendations were grouped for publication in fascicles of the CCITT Books and parts of the CCITT Blue Book (1988) remain in force today. Since 1990, CCITT/ITU-T Recommendations have been published as individual booklets.

For ITU-T, the present standardization areas are listed in *Table 2*, and the list of Recommendations is given in *Table 3*.

For more information and the list of the released standards, visit: http://www.itu.ch.

1.1.3. ETSI

ETSI, the European Telecommunications Standards Institute, was set up in 1988 to set standards in Europe in telecommunications and, in co-operation with the European Broadcasting Union (EBU) and CEN/CENELEC respectively, in the related fields of broadcasting and office information technology. The telecommunications market has changed considerably since ETSI was established (as the successor of the CEPT, European Conference of Post and Telecommunications Administration) and ETSI has changed with it. ETSI is becoming increasingly adept at responding to the market environment and anticipating new developments. ETSI brings together in standardization activities network operators, service providers, manufacturers, administrations, users and the research community.

ETSI's standardization activities are carried out by Technical Bodies which are responsible for the drafting of standards and by the Editing and Committee Support (ECS) department which has the responsibility for the collection of public enquiry comments, approval and publication of the standards. The ETSI Technical Committees, and therefore the main technical standardization activities, are listed in *Table 4*.

For more information and the list of released standards, visit: http://www.etsi.fr.

1.1.4. CEN/CENELEC

CEN/CENELEC, based in Brussels, is an association comprising the national standards bodies and the electrotechnical committees of the following European countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Sweden, Switzerland, Spain, and the United Kingdom.

Table 2
The ITU-T Standardization Areas

Area Code	Standardization Area description
00	Generic
01	Cables/network component
02	PSTN
03	Leased lines
04	ISDN
05	Signalling networks
06	IN
07	B-ISDN/ATM
08	Data networks
09	TMN/CNM
10	UPT
11	PDH
12	SDH
13	FTTH/FTTC/FITL
14	Wireless
15	FPLMTS/Mobile
16	Satellite
17	Software applications
18	Other
19	Telephone service
20	Facsimile
21	Bureau services
22	Telex
23	INTEX
24	PSTN based services
25	Data services
26	Videotex
27	Directories
28	Cards
29	MHS
30	AVMMS
31	Sound & TV transmission
32	OSI

The main goal of CEN is to plan, draft and adopt European standards as a technical basis for a common homogeneous European market. The CEN field of activity covers the whole technical sector except electrotechnical (CENELEC) and telecommunications (ETSI).

For more information and the list of the released standards, visit: http://www.etsi.fr.

Table 3
List of Recommendations ITU-T

* Series A Recommendations –	Organization of the work of the ITU-T
* Series B Recommendations –	Means of expression
* Series C Recommendations –	General telecommunication statistics
* Series D Recommendations –	General tariff principles
* Series E Recommendations –	Telephone network and ISDN
* Series F Recommendations –	Non-telephone telecommunication services
* Series G Recommendations –	Transmission systems and media
* Series H Recommendations –	Transmission of non-telephone signals
* Series I Recommendations –	Integrated services digital network
* Series J Recommendations –	Transmission of sound-programme and television signals
* Series K Recommendations –	Protection against interference
* Series L Recommendations –	Construction, installation and protection of cables and other elements of outside plant
* Series M Recommendations –	Maintenance: international transmission systems, telephone circuits, telegraphy, facsimile and leased circuits
* Series N Recommendations –	Maintenance: international sound-programme and television transmission circuits
* Series O Recommendations –	Specifications of measuring equipment
* Series P Recommendations –	Telephone transmission quality
* Series Q Recommendations –	Switching and signalling
* Series R Recommendations –	Telegraph transmission
* Series S Recommendations –	Telegraph services terminal equipment
* Series T Recommendations –	Terminal equipments and protocols for telematic services
* Series U Recommendations –	Telegraph switching
* Series V Recommendations –	Data communication over the telephone network
* Series X Recommendations –	Data networks and open system communication
* Series Z Recommendations –	Programming languages

1.1.5. IETF

The Internet Engineering Task Force (IETF) is the protocol engineering and development group for Internet. There are two types of Internet documents: Internet-Drafts and Requests for Comments (RFCs):

- Internet-Drafts have absolutely no formal status and can be changed or deleted at any time.
- RFCs are the official document series and are archived permanently (i. e., they are never deleted and, once an RFC is published, it will never change); however, it is important to note that not all RFCs are standards. Generally, an RFC is a description of a protocol, procedure or service, a status report, or a summary of research. Most of the standard protocols on the Internet started as RFCs. With a few exceptions, they are considered public domain documents and are available on-line from various repositories. RFCs are numbered sequentially and the number is never revised; new versions of the documents are issued instead. More information on RFCs and the Internet protocol standards process can be found in RFC 1310.

For more information and the list of the released standards, visit: http://stdsbbs.ieee.org.

1.1.6. The ICT Standardization Board

The ICT Standardization Board was formed in 1995 by the European Standardization Organizations, CEN, CENELEC and ETSI, and a number of publicly-available specification providers to consider standardization requirements in the field of Information and Communication Technologies (ICT) and to translate these into coherent, project-based standardization programs. Such standards are a crucial prerequisite for the creation of the information society – without them, proper interoperability of systems and services will not be possible.

The Board received a progress report from the industry's High-Level Strategy Group (HLSG). This was formed last July to prepare the industry's strategic requirements for ICT standardization. The HLSG began its work with three initiatives: electronic commerce, interoperability of broadband networks and city information highways.

The Board's Secretariat is provided jointly by the European Standardization Organizations CEN, CENELEC, and ETSI, the other members at present are the ATM Forum, the Digital Audio-VIsual Council (DAVIC), the European Board for EDI Standards (EBES), the European Digital Video Broadcasting Project (EP-DVB), the European Association of Consumer Electronics Manufacturers (EACEM), the European Broadcasting Union (EBU), ECMA (which standardises information and communication systems), ERTICO (the European Road Transport Telematics Implementation Co-ordination Organization), the European Workshop on Open Systems (EWOS), the Network Management Forum, and X/Open. The services of the European Commission, the EFTA Secretariat, and the European Committee for IT Testing and Certification (ECITC) are observers.

For more information and the list of the released standards, visit: http://www.ict.etsi.fr.

1.1.7. IEEE

The IEEE , Institute of Electrical and Electronics Engineers, Standards Board is responsible for standards in the fields of electrical engineering, electronics, radio, and the allied branches of engineering or related arts and sciences and is in particular required to encourage, co-ordinate, and supervise IEEE participation and co-operation with other organizations (including governmental bodies) on matters concerning standards.

In the ICT field, IEEE is the engine for the standardization on LANs with the 802 set of recommendations that are also included in the ISO standards as IS 8802 series.

Table 4
Technical Committees

TC Business Telecommunications
TC Methods for Testing and Specification
TC Transmission and Multiplexing
TC Signalling, Protocols and Switching
TC Terminal Equipment
TC Network Aspects
TC Radio Equipment and Systems
TC Satellite Earth Stations and Systems
TC Special Mobile Group
TC Equipment Engineering
TC Human Factors
JTC EBU/ETSI

Table 5
IEEE Working Groups Active in the ICT Area

* AI-ESTATE (P1232, P1347)
* Abbreviated Test Language for All Systems (ATLAS)
* Computer Dictionary P610 Working Group
* Electric Power System Compatibility with Electronic Process Equipment (P1346)
* Electromagnetic Compatibility Standards
* Heterogeneous InterConnect (HIC) – IEEE Std 1355-1995
* LMSC, LAN/MAN Standards Committee (P802)
* MIB (Medical Information Bus) Standards Committee
* National Information Infrastructure
* Neural Networks Council
* PASC (Portable Applications Standards Committee)
* Reliability Society – Standards Development
* RSA, Diffie-Hellman, and Related Public-Key Cryptography (P1363)
* Standard for Information Technology for Education – Personal Learning System (PLS) – Learner Model (P1484)
* Virtual Intelligence

Table 6
Some Other Bodies Active or Involved in the ICT Standardization Activities

- ATM Forum
- Digital Audio Visual Council (DAVIC)
- Digital Video Broadcasting (DVB) Project
- European Association of Consumer Electronics Manufacturers (EACEM)
- European Board for EDI Standardization (EBES)
- European Broadcasting Union (EBU)
- European Committee for Banking Standards (ECBS)
- European Computer Manufacturers Association (ECMA)
- European Workshop on Open Systems (EWOS)
- European Committee for IT Testing and Certification (ECITC)
- European Association for the Co-ordination of Consumer Representation in Standardization (ANEC)
- European Telecommunications and Professional Electronics Industry (ECTEL)
- European Association of Manufacturers of Business Machines and Information Technology Industry (Eurobit)
- European Telecommunications Informatics Services (ETIS)
- Fast Ethernet Alliance
- Frame Relay Forum
- High Level Strategy Group (HLSG) of European Union
- Network Management Forum (NMF)
- OLAP Council
- Open Group (ex X/Open)
- Video Electronic Standards Association (VESA)
- W3 Consortium
- 1394 Trade Association

The Working Groups now active in the ICT area are listed in *Table 5*.

For more information and the list of the released standards, visit: http://stdsbbs.ieee.org.

1.1.8. Other Bodies

Several other bodies provide significant contributions to standard-setting activities: these bodies act as fora for specific technologies, such as ATM Forum for specific categories of ICT players, for users such as ANEC, for manufacturers such as ECMA, or for specific industry sectors, such as ECBS for banks.

The following *Table 6* is not an exhaustive list of the bodies most active in Europe.

2. Microelectronic Components

Semiconductor components, from microprocessor to memories and other logic chips, are the foundation of all electronics and ICT. Silicon technology is dominating these products. A rough taxonomy of the main types of silicon components is shown in *Figure 1.*

Trends forecast in the last report have been confirmed. The state of the art for the main microprocessor families (i. e., Intel Pentium, PowerPC, DEC Alpha, Sun UltraSparc II, MIPS/SGI R10000, HP PA-8000, AMD/NexGen6x86, Cyrix M1, etc.), memories and the DSPs (digital signal processors) is the same as described in [EITO96].

Increasing in speed, CMOS (Complementary Metal Oxide Semiconductor) technology is finally the main technology for all microprocessors, from the PC to the mainframes, replacing bipolar technology, which was until yesterday faster but larger and with higher power consumption.

Besides some new frontiers which will be briefly mentioned in the next paragraph, the main item is a strong orientation to ASIC: integrate fast RISC with several other components, in particular RAM and ROM, graphics and sound processors, I/O and networking elements (e.g. modem), multimedia format decompressor (such as JPEG), oriented to specific sets of applications at very cheap prices.

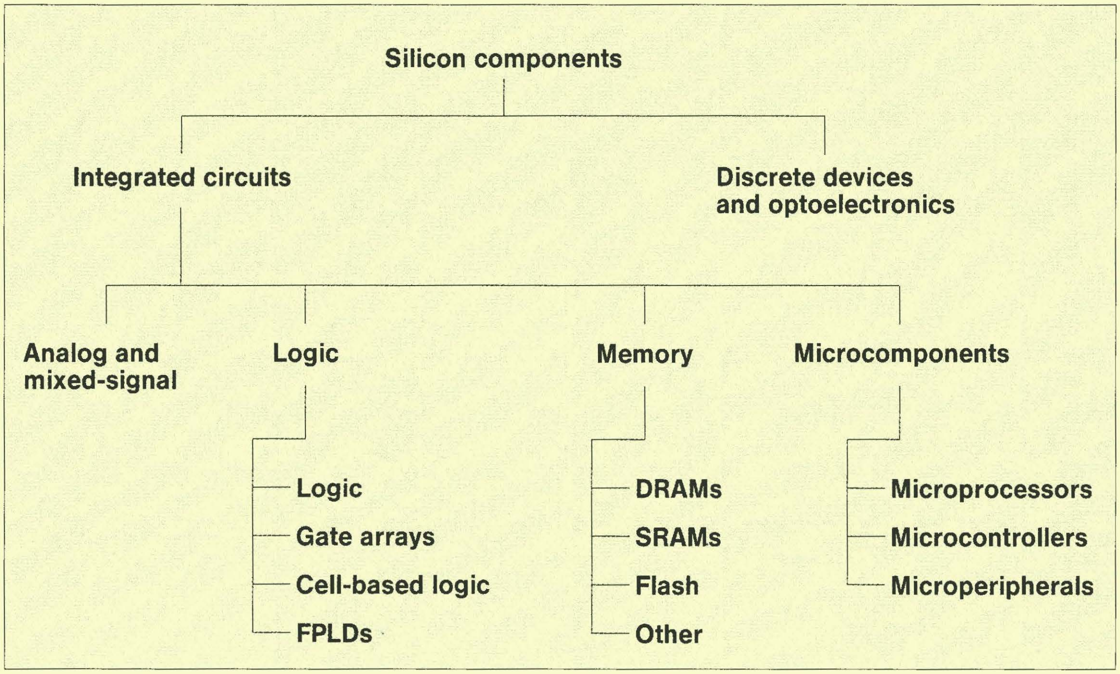


Figure 1
The Silicon Components Tree

This orientation involves the following key product segments:

- PDA/"thin client"-oriented microprocessors;
- multimedia-oriented microprocessors;
- ATM switch: a single chip switch element that incorporates ATM capabilities in order to manage these protocols and high speed digital transmission. Some manufacturers are offering chips that can be connected in serial or in parallel in order to achieve higher performance.

2.1. The New Frontiers

The manufacturing process is approaching the outer limits of silicon technology, which due to the limit of the optical lithography stands at around 0.12 micron. This is the basic tool for manufacturing ICs (Integrated Circuits), in particular VLSI and ULSI (Very Large, Ultra Large System Integration).

The present limit of the top processor is about to 0.25 micron: there is a forecast to put 15 million transistors on a chip 156 millimeters square. A Pentium processor has about 3.3 million transistors on a chip of the same size and the 8 inch production wafer has about 150 or 300 raw devices per wafer, varying from 0.5 to 0.35 microns.

Building chips smaller than 0.12 micron requires using light sources with shorter wavelengths like x-rays. Inspite of some production problems involved with this new technique, forecasts expect processors with 50-100 million transistors operating at about 1 GHz in the next 10 years.

In [EITO94] the limits of silicon integration were analysed in depth, and the new frontiers of quantum components and photonics were explained in advance.

Quantum phenomena now offer an alternative way to do computing. Quantum computing is based on quantum mechanics where every atom acts either as a particle or as a wave and occupies only discrete energy states called quanta. When particles behave as waves, a quantum wave represents only a probability to find the electron in a specific place at a specific time. The electron can be everywhere. But when the electron interacts with another particle or photon that reveals its position, it can be used as a state and this state can be used to make calculations.

It is important to note that quantum logic does not work like electron logic because the state space is far larger than the state space in classic electron computing. Because of this, quantum bits are called qubits instead the electron "bits". Introducing quantum parallelism allows complex tasks to be performed quickly based on the behaviour of the quantum properties of the particles.

Today quantum computing has great potential but many problems remain to be resolved.

Another frontier is research on new alternatives for mass storage.

Holography is an optical recording technology which can achieve very high storage density as well as fast access time. The expected density is about 10 GB per cm^2 versus actual densities of 100 Kb per cm^2. Expected data throughput is greater than 1 Gbps, thanks to parallel access and to the absence of moving parts. Holographic data-storage systems are expected to be on the market in the next few years.

Researchers are also investigating the possibility of storing digital bits in memory subsystems using *protein memories* based in particular on a protein called "bacteriorhodopsin". This molecule has two different states that makes it similar to a flip-flop. These states are stable for an estimated period of about five years.

Molecules change their state in microseconds, but read/write operations actually take about 10 ms due to the complexity of the associated device.

The low cost of protein production, persistence of data, and absence of moving parts make this technology an appealing alternative to solid state disk with an actual predicted capacity of about 1.3 GB.

2.2. PDA/"Thin Client"-oriented Microprocessors

The strong technological and market push to Internet/Intranet and to mobile systems requires the availability of "thin", cheap, low-power but high-performance microprocessors. Typical applications will include industrial data-acquisition devices, PDAs, cellular phones, set-top boxes, and "thin clients" (also named network computers).

2.2.1. Javachip

Sun Microsystems, the company which launched Java, is counting on dedicated Java chips to deliver the performance needed for Java-based business and embedded applications.

The initial Java processor family includes PicoJava, a low-cost core (< $ 25) optimised for Java and targeted for industry-wide licensing beginning in mid '96. The estimated PicoJava die is .35 microns with a core of 8.0 mm^2 and optional FPU of 5.5 mm^2. These sizes do not include the instruction or data caches which are both variable from 0 to 16 KB.

The PicoJava architecture will be the foundation for the first-generation Java chips, known as microJava, a low-cost (approximately $ 25 – $ 50) family with application-specific I/O, memory, communications and control functions. This product will be available in the first quarter of 1997.

A more expensive (approximately $ 100) chip called ultraJava, will be for "network computers", entertainment, 3D graphics/imaging applications. These chips will include multimedia capabilities such as JPEG decompression and the graphics-processing optimisations now found in RISC processors. This product will be available in product sampling from the fourth quarter of 1997.

These chips might run Java programs about 12 times faster than a Java interpreter. Just-in-time (JIT) compilers should run Java code even faster than interpreters, but PicoJava chips could be five times faster than a Pentium with a JIT compiler.

MicroJava chips could fit well on small platforms, thanks to their memory efficiency. A Java chip will execute Java byte code in native mode (on Java see section 6) without converting it to another CPU instruction set. Also, the byte code is generally smaller than that for a RISC processor. For example, Java byte code averages 1.8 bytes per instruction (without the tables for dynamically linking the code during method calls), while RISC code generally requires 4 bytes per instruction.

2.2.2. StrongARM

After the Javachips, another PDA/NC oriented microprocessor is the StrongARM, a family of high-performance, low-power microprocessors from Digital Semiconductor. The first member of this family is the SA-110 which is founded on a hybrid technology that combines the raw power of the Alpha with the super-efficient power consumption of the ARMs. The StrongARM product line will consist of three products. The first two StrongARM processors will be a 1.65-volt chip with an internal clock nominal frequency of 100 MHz and 160 MHz. A 2-V, 215-MHz StrongARM will follow shortly. For the first time, a CPU that outperforms a high-end Pentium will be available for use in battery-powered PDAs.

The newest StrongARM manufacturing plant uses a next-generation process called CMOS-6. This is a 0.35-micron, four-layer-metal CMOS process that yields high-speed, low-voltage transistors, thanks to extremely thin oxide insulation layers only 65 angstroms deep. Ultimately, this process will yield transistors that run at 0.9 V.

A chip manufactured on the 2-V CMOS-6 process will consume only 37 percent as much power as a chip fabricated by a comparable 3.3-V process. At 1.5 V, the power consumption is 21 percent less. The small feature size also reduces capacitance, saving even more power. The first StrongARMs will probably have 32 KB of primary cache. However, the StrongARM core has only 115,000 transistors, compared to 3.3 million on a Pentium.

StrongARM's system interface can handle either 32 or 64 bits. System designers can synchronise the interface to the CPU core (at fractional speeds ranging from one-half to one-ninth the core frequency) or to an external clock as fast as 66 MHz.

2.2.3. NEC VR4300

NEC developed a 64-bit RISC microprocessor "VR4300" that is a high-performance integrated RISC microprocessor with a clock speed of 100 MHz. It can perform 125 MIPS (dry stone bench mark) over MIPS Technologies, Inc. 64-bit architecture. This microprocessor is software-compatible with VR4000 family and can accept a variety of OS's and applications. Its on-chip cache has 16 KB for instructions and 8 KB for data, a 32-bit interface and simple system design leads to system cost reduction, on-chip MMU and virtual address support and it can perform double precision/single precision floating point operations. Chip size is made smaller and performance is improved by an innovative process and three-layer wiring technology which doubles performance/cost when compared with the conventional devices.

2.2.4. IDT R4650

IDT (Integrated Device Technology) developed the R4650, a high-performance low-cost embedded 64-bit RISC microprocessor with a 80 MHz, 100 MHz, 133 MHz operation frequency and performance comparable to a 100 MHz Pentium.

With its high level of integration it can perform a 66.7 million Integer Multiply-Accumulate Operations/sec at 133 MHz and 44 Mflops (floating point operations) at 133 MHz. The R4650 adds features that enable system cost reduction (e.g., optional 32-bit system interface) as well as higher performance for certain types of systems (e.g., cache locking, improved real-time support, integer DSP capability).

2.3. Multimedia-oriented Microprocessors and MMX Technology

As multimedia applications continue to proliferate in the marketplace, PC systems suppliers are being challenged to deliver multimedia-enabled PC solutions covering all mainstream price/performance points. To improve multimedia and 3-D processing (see also section 3) Intel has introduced a technology (named MMX) capable of packing multiple pixels into one register and of manipulating them with a single instruction. In such a way, MMX brings a new level of parallelism to x86 processors.

MMX is the most significant revision of the x86 architecture since the 32-bit 386 chip in 1985. Programmers get eight new registers and 57 new instructions that are optimised for multimedia tasks. Users will get better performance with video, graphics, animation, and sound. Yet the new MMX-enabled CPUs will be compatible with existing x86 software and should cost about the same as regular x86 processors without MMX technology.

Instead of adding new physical registers to the x86 architecture (which would slow down the adoption of MMX), the existing floating-point (FP) stack is used as logical MMX registers. MMX instructions use only the 64-bit mantissa portion of the 80-bit FP registers, ignoring the 16-bit exponent portion. This yields eight 64-bit logical registers without significantly altering the x86 architecture.

Even though MMX instructions use FP registers, they are all integer-type instructions. Their 64-bit operands may contain eight packed bytes, four packed 16-bit words, two packed 32-bit doublewords, or a single 64-bit quadword.

Preliminary simulations and tests on development systems have apparently shown performance boosts of between 50% and 400%, depending on the application.

Programmers should be able to get away with modifying only small portions of their code, by including their own enhanced subroutines or calling MMX technology-enabled drivers and library routines through existing application programming interfaces. MMX is operating system-independent.

While significant in the scope of the instructions and their impact on applications performance, this enhancement does not alter the implementation of existing instructions. MMX technology does not create a new mode or a new state, so no change to operating system software is necessary for applications to run. MMX technology-enabled processors, like all Intel processors, will undergo the most thorough validation and testing. Intel will also conduct extensive testing of current and MMX technology-enabled applications.

The instructions are very simple and general-purpose, so they will scale well with improvements in each new generation of processors. Once developers integrate the new instructions into their applications, systems based on succeeding generations of processors will also realize these performance benefits.

MMX introduces a set of general-purpose integer instructions that use the single instruction/multiple data (SIMD) paradigm. One instruction processes the multiple data in the packed registers. This parallelism increases performance.

Another feature of the new instruction set, parallel-compare operations, could improve performance by eliminating branches. Combined with packed data features, parallel-compare operations are useful when, for example, it is necessary to combine or overlay two images.

As it is, the 64-bit operands are long enough for typical multimedia jobs. Suppose a program is manipulating graphics in 8-bit colour, which is often the case in games. An MMX instruction can pack eight pixels into a single operand and process them all at once. An ordinary x86 CPU can shuffle only one pixel at a time. Audio and communications programs often use 16-bit data types, so a single MMX instruction can process four of those values in a single chunk.

Other x86 vendors are adopting MMX besides Intel. Thanks to a recent cross-licensing agreement, future x86 processors from Advanced Micro Devices and AMD's subsidiary, NexGen, should be compatible with Intel's P55C. Cyrix, another x86 vendor, maintains that its future CPUs will be fully compatible with MMX, either by licensing or reverse-engineering the Intel technology.

2.3.1. Intel MMX

Intel says it will ship the first MMX Pentium (code-named the P55C) in the fourth quarter. Next year, Intel plans to integrate MMX into all its new x86 chips, including the sixth-generation Pentium Pro. By 1998, MMX will probably be as integral to the x86 architecture as the extended 32-bit instructions that Intel added to the 386 more than a decade ago.

2.3.2. Cyrix M2

Called the M2, the chip is pin-compatible with Cyrix's current 6x86, but **reworks** the 6x86 architecture for faster performance, particularly with multimedia applications. The M2 is expected to ship in the first quarter of 1997.

Like the 6x86, the M2 chip will offer the Pentium Pro's most attractive features (including register renaming, out-of-order completion, and speculative execution), but will also include a 64K primary cache. Currently, the Pentium Pro has a primary cache of only 16K, although it offers an on-board secondary cache as well. Unlike the 6x86, the M2 will boast optimisation for 32-bit code and for MMX.

Of course, the Pentium Pro already offers 32-bit optimisation and will offer MMX in its Klamath incarnation by the time the M2 is in production. What sets the two chips apart is the M2's compatibility with the 64-bit socket standard in the Pentium and the 6x86.

2.3.3. AMD/NexGen K6

The AMD-K6 processor is the first member in the AMD family of processors to incorporate a robust set of multimedia instructions that are fully software compatible with the Intel MMX instruction set.

The AMD-K6 processor delivers leading-edge performance to mainstream PC systems running industry-standard x86 software. The

AMD-K6 processor is capable of issuing, executing, and retiring multiple x86 instructions per cycle, resulting in superior scaleable performance.

3. EDP Systems

Internet/Intranet and multimedia paradigms are the driving forces: the concept of thin client and web server is producing innovative products of a new type, mainly based on RISC architecture, with the capacity to handle multimedia and access telecommunications services where the TCP/IP protocol pile is the ultimate universal standard. Multimedia functions and related increasingly higher transmission speeds require an increasing capacity to handle and store great amounts of data: innovative answers include high performance hard disks, DVD, and *ad hoc* solutions for 3-D.

3.1. Computer Technology and Hardware Products

As analysed in depth in section 5, the preferred model up to now (see [EITO96]) has been a hybrid three/four-layer client-server architecture. Web-client-server architecture is changing this and strongly influencing the development of a new set of "thin clients" which are simple PCs optimised for a sophisticated utilisation of browsers, applets (see section 6) and the integration of local "end-user-computing" (if any), and a new set of high-performance "web-oriented" servers, which can range from "new mainframes" to "new PC servers".

3.1.1. Large-scale Systems

The web-centric paradigm is revitalising the mainframe approach, even if the mainframe is becoming a "big server" and plays the role of a web server, able to act as a logical "front end" for the traditional "legacy" systems and environments. The IBM S/390 G3, Parallel Enterprise Server Generation 3, is a typical example of this evolution.

As pointed out also in previous reports and in section 2 here, the leading mainframe suppliers are using CMOS technology and reaching a very high level of scalability. Therefore the distinctions between large-scale, medium-scale and small-scale systems depend more and more on the configuration and less and less on the technology.

Cost orientation, parallel architectures and openness are other driving forces in the evolution of such systems.

3.1.2. Medium-/Small-size Systems

The innovative trends in the area of medium-scale systems are the same as for large-scale systems: parallel processing based on RISCs, a strong orientation to web server, and openness. Even if the main components are traditional and relatively stable, Unix and Unix-like operating systems play an increasingly dominant role.

The technical difference in relation to large-scale systems is disappearing, and also in relation to the lower segment of Workstations and LAN Servers, both in terms of power and capacity, and also in terms of function: the distinction is more and more based on functions and configurations rather than one of technologies and hardware architectures.

3.1.3. PCs

The on-going changes from PC-centric to web centric systems are very extensive, both for the corporate PC and for the home PC. The thin client is also an evolution of the "traditional", "fat" PC, the biggest segment in the IT market, but the PC hardware architecture continues to evolve both to guarantee backward compatibility as much as possible and to be able to keep up with the evolution of disks, CPUs, communication and multimedia devices.

Serial buses

Two emerging technologies have the potential to kill off parallel cables, serial cables, and SCSI cables, virtually everything on the back of the PC except the VGA connector and power connectors: the Universal Serial Bus (USB) and the IEEE P1394 (nicknamed FireWire). Both USB and P1394 promise to connect multiple I/O devices to your PC at high speed using thin cables and small connectors. The two emerging standards are complementary and therefore not competitive.

USB

USB is a peripheral bus standard developed by PC and telecommunication industry leaders to bring plug-and-play (PnP) to computer peripherals just out of the box, eliminating the need to install cards into dedicated computer slots and reconfigure the system.

USB makes PnP (Plug and Play) a hardware reality for the serial cables. USB configures itself dynamically and allows hot swapping. USB detects when devices are added and removed. The bus automatically determines what host resource, including driver software and bus bandwidth, each peripheral needs and makes those resources available without user intervention.

USB allows multiple devices - up to 127 - to run simultaneously on a computer, with peripherals such as monitors and keyboards acting as additional plug-in sites, or hubs.

With USB many kinds of peripherals can be connected to every PC, including telephony sets, modems, keyboards, mice, CD-ROM drives, joysticks, tape and floppy drives, scanners and printers.

USB's 12 megabit/s data rate will also accommodate a whole new generation of peripherals, including MPEG-2 video-based products, data gloves and digitizers. Also, since computer-telephony integration is expected to be a big growth area for PCs, USB will provide a low-cost interface for ISDN (Integrated Services Digital Network) and digital PBXs.

The next versions of Windows operating systems will come equipped with a driver that will allow your PC to recognise USB peripherals. Ultimately, you will not need to purchase or install additional software for each new peripheral. However, new peripheral products (including those never before seen) may create a gap between the peripheral availability and software upgrades. A diskette with a new USB peripheral with the updated driver information will come with each new peripheral.

USB can be also used between two hosts, like a laptop and a desktop.

IEEE-1394 FireWire

The IEEE-1394 High Performance Serial Bus is a versatile, high-speed, and low-cost method to connect a variety of personal computer peripherals and consumer electronics devices. The IEEE-1394 bus began life in 1986 as Apple Computer's alternative to the tangle of cables required to connect printers, modems, external fixed-disk drives, scanners, and other peripherals to PCs.

The proposed standard (P1394) deriving from Apple's original FireWire design was accepted as an industry standard at the 12 December 1995 meeting of the Institute of Electrical and Electronics Engineers (IEEE) Standards Board. The official name is IEEE 1394-1995 Standard for a High Performance Serial Bus. The 1394 Trade Association was formed in 1994 to accelerate adoption of the bus by personal computer and consumer electronic manufacturers.

FireWire is a candidate for the "Home Network" standard initiated by VESA (Video Electronic Standards Association) and other industry associations.

The primary advantages of FireWire over other current and proposed serial buses are:

- versatility: FireWire provides a direct digital link between up to 63 devices without the need for additional hardware, such as hubs.
- high speed: The present implementation of IEEE-1394 delivers 100 or 200 Mbps of data (payload) and control signals (overhead). Future versions that support 400 Mbps are in the development stage, and a 1.2 Gbps version of IEEE-1394 has been proposed.
- low cost: The cost of the integrated circuits and connectors required to implement FireWire is often less than the cost of the connectors and circuitry it replaces. FireWire uses a flexible, six-conductor cable and connectors to connect devices. (A four-conductor version of the standard cable is used to connect consumer audio/video components.) Use of FireWire for consumer electronics gear, such as camcorders and VCRs, will provide the high-volume market needed to achieve low-cost implementation of FireWire on PCI adapter cards and PC motherboards.
- easy installation and use: FireWire extends Plug and Play features far beyond the confines of the personal computer. When you add a new device, FireWire automatically recognises that device; similarly, when a device is disconnected, FireWire is automatically reconfigured.

3.2. Three Dimensional Graphics

The term 3-D refers to the three dimensional graphic environment that now is no longer required only for traditional applications, such as CAD-CAM design, architectural walk-throughs, virtual reality, animation, and state-of-the-art games, but also for desktop applications, such as graphics editors, spreadsheets, and word processors.

The three dimensional graphic environment has spread because mass-market 3-D products, such as software libraries and graphics chips, are cheap.

3-D tasks can be distributed in various ways between the CPU and the graphics chip. Graphics boards work with integer values. Therefore, at the very least, the CPU must translate an application's floating-point values into integers. Most often, the graphics chip works as a rendering engine, while tessellation (breaking up a 2-D image into polygons) and geometry (adding lighting and perspective) are left to the PC. For the third processing step, rendering (adding surface characteristics), low-cost 3-D boards often economise by combining frame, texture, and z-buffers (stored depth values) and allocating memory dynamically.

The majority of high-end 3-D accelerators employ separate buffers for frame, texture, and depth information, with each buffer having a capacity of at least 2 MB. However, the cost of buffer memory alone keeps these products out of the mainstream market.

Although 3-D accelerators divide up processing tasks in similar ways, 3-D chip architectures can vary considerably. Some chips are programmable and use a very-long-instruction-word (VLIW) architecture. The performance of programmable 3-D chips depends to a large extent on the low-level software that drives them. Both Rendition and Chromatic currently supply such firmware. OEMs that write their own low-level software can enhance these processors with new features, data formats, or algorithms. Hard-wired solutions sacrifice this flexibility but often achieve higher performance. As APIs and other standards evolve, customers must depend on these vendors to update their designs quickly or, in some cases, to develop new software drivers to support the emerging standards.

Many of the graphics companies now offering low-cost 3-D chips and boards have been selling to the 2-D graphics market for years. The new 3-D chips are pin-compatible with previous generation chips, so the 3-D chips can slip into a proven card design.

A dedicated 3-D solution does not replace a PC's graphics card; instead, it complements it and works in parallel with the graphics accelerator that is on a separate PCI board. After the 3-D chip calculates the pixels, they are passed across the PCI bus to the graphics card.

Actually the 3-D acceleration in many low-cost boards works only at a resolution of 640 by 480 pixels with 64,000 colours. Some newer cards accept additional memory to support 3-D acceleration at 800 by 600.

3.3. Hard Disk Drives

Hard drive technologies now include quantum mechanics, aerodynamics, and dizzying spin speeds. As a result, capacities are increasing at a rate of 60 percent each year – a tenfold increase in capacity every five years. Analysts expect this rate to continue into the next century.

The way to increase the speed and the capacity is first of all to move the heads closer to the surface of the disk. The heads can write and read smaller magnetic domains, and the smaller the domain, the more data each platter can hold. Of course, the closer the heads, the better is the chance that the heads can hit the platter and completely shave off magnetic domains, but platters can be coated with protective materials. The danger here is that the head will plunge into the surface of the platter. What designers want to ensure is that these close encounters do not cause any damage, and they do this in several ways.

Proximity-recording, tri-pad (the head consists of three parts), and virtual-contact heads all do what was formerly unthinkable: make occasional contact with the platter surface. It takes considerable aerodynamic savvy to design a smoothly gliding component. Covering the head with non-stick lubricating materials helps preserve the platter's surface, while tough coatings protect the head itself.

To improve the speed of a hard disk drive without reducing its access time, one way is to speed up the rotation of the disk. Earlier all desktop spindle speeds were 3,600 rpm (revs per minute). Current PC drives rotate at 5,400 rpm. Current hard drives for servers rotate at an even zippier 7,200 rpm. The newest prospects for spindle speeds is 10,000 rpm. Some research groups are looking even further ahead, to 14,000-rpm drives.

Inductive heads are now being replaced by newer magneto-resistive (MR) technology. In a typical MR drive, different physical heads perform the reading and the writing tasks, so better signal-to-noise ratios can be offered than with inductive heads. MR heads can handle much smaller magnetic domains, increasing the number of tracks per inch and the number of bits per inch (bpi). Current tpi can top 6,000, and bpi can exceed 100,000. Areal density using MR heads, reaches up to 1,000 megabits per square inch so far.

One drawback to MR technology is price: MR heads cost more than inductive heads, and the cost cannot necessarily be justified by benefits. Some manufacturers use a dual-stripe MR design that connects two MR elements and works on the difference in response of the two elements.

Other researchers are already looking beyond to advanced technologies like Giant MR (GMR). GMR will permit even higher areal densities than MR technology does.

A further refinement offered by GMR is spin valve technology. Some estimates suggest that this technology will increase areal density by ten- to twentyfold (which would mean 10,000 to 20,000 megabits per square inch).

Many techniques for increasing driver speed and capacity require a new method for turning magnetism into bits. For years the only method used was peak detection. The method called partial response maximum likelihood (PRML) is largely replacing peak detection in the read channel, especially to interpret MR head data. But PRML costs more than peak detection and consumes more power. Analog PRML designs, however, decrease power consumption and chip size without major impact on performance. PRML permits higher areal densities, and faster data rates, even with older head technologies and spindle speeds. Data rates with PRML currently reach above 150 Mbps, which is decidedly better than the below-80 Mbps common just two years ago.

Another problem with current hard-drives is their low MTBF. The newest hard-drive MTBF nearly reaches the million-hour mark, or 114 years. The industry standard self-monitoring analysis and reporting technology (SMART) lets some hard drives perform checkups on themselves.

3.4. Digital Video Disc (DVD)

DVD, Digital Video Disc, is essentially a bigger, faster CD that can hold video as well as audio and computer data. DVD aims to create a single digital format for home entertainment, computers, and business information, eventually replacing audio CD, videotape, laserdisc, CD-ROM, and perhaps even video game cartridges.

DVD has widespread support from all major electronics companies, all major computer hardware companies, and most major movie and music studios. Originally two next-generation standards were proposed for DVD. The MMCD, Multimedia Compact Disc, format was backed by Sony, Philips, and others. The competing SD, Super Density, format was backed by Toshiba, Time Warner, and others. A group of computer companies led by IBM insisted that the DVD proponents agree on single standard. The combined DVD standard was announced in September of 1995.

No single company "owns" DVD: the DVD Licenser Consortium owns the proprietary rights of the standard and any company making DVD products must license the technology.

The primary advantages of DVD are quality and extra features. DVD will not degrade with age or after many playings as will videotape.

DVD defines two classes, DVD-Video and DVD-ROM. DVD-Video holds video programs and is played in a DVD player hooked up to a TV. DVD-ROM holds computer data and is read by a DVD-ROM drive hooked up to a computer. DVD-ROM also includes future variations that are recordable once (DVD-R) or many times (DVD-RAM).

There is also a DVD-Audio format. The technical specifications for DVD-Audio will not be finished for the first release of DVD. The DVD Consortium has decided to seek additional input from the music industry before defining the DVD-Audio format.

DVD video is compressed from studio-quality CCIR-601 format to MPEG-2 format. This uses "lossy" compression, and the resulting video, especially when it is complex or changing quickly, may sometimes contain “artifacts” such as blockiness or fuzziness. It depends entirely on the quality of compression and how low the data rate is. At average rates of 3.5 Mbps, artifacts may be occasionally noticeable. Higher data rates result in higher quality, with almost no perceptible difference from the original master at rates above 6 Mbps.

One of DVD’s audio formats is LPCM (linear pulse code modulation) at sampling rates higher than audio CD. Audio can also be stored as discrete multi-channel surround sound using Dolby Digital or MPEG-2 audio compression.

Two forms of simple copy protection are specified by the DVD standard:

1) Videotape (analog) copying is prevented with a special dedicated circuit in every player. Composite video output will have pulses in the vertical blanking signal to confuse the automatic-recording-level circuitry of VCRs. Unfortunately, this can degrade the picture, especially with old or non-standard equipment.
2) Digital copying is controlled by information on each disc specifying how many times (if any) the data can be copied. This is a “serial” copy management scheme designed to prevent copies of copies.

There may yet be a third form of copy protection based on some form of encryption to prevent reading media files directly from the disc.

HTDV is not supported by DVD, but the designers have it in mind. Since HDTV uses MPEG-2 it will be easy to upgrade the DVD format. The limited data rate of DVD may make it difficult to support high-quality HDTV, but this can be solved by either increasing the spin rate (as with multi-speed CD-ROM drives) or using higher-capacity blue lasers.

There are many variations on the DVD theme. There are two physical sizes: 12 cm (4.7 inches) and 8 cm (3.1 inches), both 1.2 mm thick. A disc can be single-sided or double-sided. Each side can have one or two layers of data. The amount of video a disc can hold depends on how much audio accompanies it and how heavily the video and audio are compressed. A standard DVD can actually hold up to 6 hours of video and audio if it is heavily compressed (which reduces the quality).

3.5. "Thin Client"

The web-centric paradigm is quickly reshaping the concepts of client-server and of the PC itself: a new type of personal computer, connected via Internet/Intranet, is coming into existence which is small, inexpensive, easy to use, and without the complexity and the cost associated with today’s very “fat” personal computers. Everytime software and/or applications (or the client part of an application) are needed, they are downloaded from servers over a network, and the cost can vary from $ 500 to $ 1,000, depending on the drivers and the facilities plugged in. Data encryption technology is in place to ensure privacy and security. Even if simple and cheap, the kernel of this new line of products can provide very high performance, and is normally based on RISC CPU. The standard interface to the end-user is the browser, and the system has a built-in Java interpreter (see sections 5 and 6). The most innovative trend is that the thin operating system will become the browser itself, at least from the point of view of the end-user.

All the main ICT industries are proposing products and some have joined forces in groups in order to collaborate to establish a common set of guidelines. The first products on the market include NC, the Network Computer (key players Oracle and Sun), the IBM Network Station, the NetPC from Microsoft/Intel, the HPC for mobile systems, the WYSE Wintern. Other major players working on thin client products include Apple, Acorn Computer, and Silicon Graphics.

3.5.1. NC, Network Computer

The NC consists of a Central Processing Unit, at least four megabytes of memory, a network interface, I/O interfaces, and a way to establish network service.

For the initial prototypes, the CPU used was the ARM 7500 processor, a multimedia, 32-bit RISC chip with performance equivalent to a 66 MHz Intel 486. The ARM 7500 is a highly integrated silicon package that incorporates many functions that have been handled separately from the CPU chip: video and I/O subsystems, keyboard input, audio capability, memory bus, network graphics, etc.

The NC supports standard network interfaces: 28.8 kbit/sec modems, Ethernet (both twisted-pair 10-BaseT and coax 10-Base2), 25 megabit/sec ATM (for corporate installations), high-speed E1 and T1 telephone lines, and ISDN.

The NC supports keyboards, mice, joysticks, microphones, headphones, speakers and infrared remote interfaces. The infrared connectivity is especially useful to home users, eliminating the need for cables stretching across the living room from the NC to the TV. The NC has connections for VGA and Super VGA and it also employs "anti-twitter" support in software to compensate for the difference between computer and TV display technology. The NC is able to use a smart card interface to identify and authorize the user on the NC.

Its own operating system, NCOS, occupies no more than 300K and is designed to run simple PC and Java applications, to browse HTML, to support e-mail and to play video clips and listen to music.

3.5.2. NetPC and HPC

NetPC, is a new PC family, promoted by Microsoft and Intel with the support of other leading software and hardware vendors, based on Intel x86 and Windows architectures. The overall benefit will be reduced support costs, a hardware platform which will remain stable for several years, a lower initial purchase price, and the ability to build upon existing organization training, development and capital investments in Windows and applications designed for Windows. Some manufacturers are committed to delivering a NetPC solution in 1997. The NetPC reference platform will specify industry-standard components (i.e., processor, memory, hard drive, video, and audio) with an integrated network adapter or modem in a locked case with limited expandability to prevent user modification.

The NetPC family is based on the Pentium processor at 100 MHz or greater, with a minimum of 16 MB system memory, the capability to support one or more TLC access (Ethernet, token ring, 28.8 Kbps modem, ISDN, T1, ATM), VGA-compatible display adapter with a minimum 640x480 resolution, unique Plug and Play device identification for each system device and add-on device.

NetPC device drivers meet the Windows and Windows NT specifications, but the operating system is a new one, named Windows CE and described in section 6.

Besides the NetPC family, there will also be handheld PCs, or HPCs. These are mobile-computing devices such as the thin client system, "wallet" PCs, and purpose-built Internet digital set-top boxes.

HPC is based on the WinCE operating system that provides an easy-to-learn user interface incorporating many elements of the familiar

Windows environment and can be implemented on different 32-bit RISC microprocessors. The first CPUs will be supplied by Hitachi, NEC Electronics and Philips Semiconductor.

The first HPC devices will be available commercially before the end of the 1996, with street prices for base configurations expected to start at around $ 500.

3.5.3. Network Station

IBM is bringing to market a thin client designed to provide a universal "access device", able to support browser, 3270 and 5750 terminal emulation, X-terminal emulation, and Windows emulation. The browser is built-in and in PC mode runs applications on a Windows NT server and in X-terminal mode on a Unix server. All these different modes can operate simultaneously in different windows on the client. The Network Station uses a PowerPC CPU and memory can be expanded up to 64 MB; it also supports PCMCIA slots and smart card interface for security.

4. Telecommunications

As explained in previous EITO reports, the technological evolution of TLC is driven by three main factors:

- greater speed: ATM, SHD, Digital Subscriber Lines, Frame Relay, Fast LAN and Virtual LAN are the leading technologies (see p. 143-168 of [EITO95] for the description of all these technologies).
- increasing intelligence in the network: the Internet and Intranet phenomena will actually create the reality that "the network is the computer" within a network-centred, mobile and multimedia context.
- greater ubiquity and mobility: mobile communication and computing are changing both business and consumer ICT architectures, as well as the reference media, in relation to the present band allocation: either for the interactive and short exchange of messages (GSM, PCNs, DECT, satellite); cables for all of the other services, including TV and movies.

As discussed in the chapter on "The Future of the Internet", the Internet is profoundly affecting this world and is establishing a number of new logics and *de facto* standards: and therefore is introducing technical innovations in this field.

The first meaningful result of the TCP/IP logic proliferation, both at Internet and LAN levels, is that the Internet/IP logics and addressing schemes are unifying (and therefore standardizing) TLC architectures and services. Both public and private networks and all new protocols are converting to and/or assuming the IP addressing scheme.

Routers, switches and access devices are the most innovative gear for WAN and LAN offered on the market in a myriad of products: from very high-end routers to routers on a card, the main goal is "more for less" and to increase the capacity of internetworking. The "total cost of ownership" is not only a problem for the IT manager, but also for the TLC manager: his networks grow faster than ever, but his budgets do not.

The liberalisation of the market allows (where deployed) transport service alternatives, often combining voice and data for cost reduction. Even if monopolies will be dismantled (in some countries they already have been), the incumbent carrier still dominates the market and owns most transmission media (cables in the ground and undersea, satellite channels, etc.) and therefore can control prices.

The most innovative solutions, services and products are listed below:

- High-speed: at the WAN level, Sonet (Synchronous Optical Network), SDH (Synchronous Digital Hierarchy) and ATM are the leaders; Sonet/SDH can support 51.84 Mbit/s (OC1), 155 Mbit/s (OC3/STM-1), 622 Mbit/s (OC12/STM-4), and 2.488 Gbit/s (OC48/STM-16): the possibility to reach 10 Gbit/s; ATM supports a wide range of speeds, from 1.544 Mbit/s (T1) to 155 Mbit/s (OC3): higher speeds are under study. At the LAN level, the 100 Mbps is presently the top speed on the market, but 1G Mbps LANs will be offered;
- ATM, Frame Relay, ISDN, ADSL/SDSL (Asymmetric Digital Subscriber Line/Asymmetric Digital Subscriber Line) are the main alternative in switching technology to classic leased lines, both at the local and international level;
- High-speed LANs working at 100 Mbps are increasingly widespread; 100VG-Any-LAN is gaining some advantages over the 100 base-T, in particular for the support of Ethernet and Token Ring frames and does not require frame segmentation between different networks;
- These trends lead to the diffusion of products for access, switch and router devices, in particular:

  central-office FRAD, frame relay access devices, which encapsulate frames at a central site and avoid the need to install FRADs in remote offices;

  modular IAD, Integrated Access Devices;

  10/100 Lan switches;

  multi-protocol integrated routers and gateways that provide the networking capacity to interface all the "old" and "new" services, from FR to ATM, from ISDN to SMDS and SNA. Besides "traditional" and/or "proprietary" routing protocols, such as IPX, AppleTalk, IP, new ones are utilised, for instance, the Novell RIP, Routing Information Protocol, NLSP, Netware Link State Protocol, OSPF (open shortest path first);

  routers, hubs and switches are also provided as "stackable" units;

  the definition by IETF of the ISA (Integrated Services Architecture), which is still underway, will allow QOS (quality of service) transport over IP net; ISA will have a strong impact on switches and routers that will able to handle packets associated with a particular flow and with a QOS established for each;
- IEEE is introducing new standards on:

  1 Gbps LANs

  ISO-Ethernet (IEEE 802.9a);

  data access over cable at 10 Mbps (IEEE 802.14);
- Internet/Intranet dominance imposes the TCP/IP architecture and addressing schemes for all old and new TLC solutions: that implies:

  improvement of the IP with a new version IPv6;

  new TCP/IP addressing tools, in particular these based on DHCP, Dynamic Host Configuration Protocol, X.500, DNS, Domain Name Service, LDAP, Lightweight Directory Access Protocol: this last proposed standard, already accepted by several manufacturers and vendors, facilitates the WEB server directory-orientated service accesses via browser and TCP/IP protocols;
- the needs of new system and network management systems causes the diffusion and the improvement of SNMP (simple Network Management Protocol), and the evolution into the RMON (Remote Monitoring) II MIB; this last recommendation has been accepted by IETF;

- voice communication over Internet and Frame Relay;
- the development of CATV networks that are evolving from entertainment broadcasting networks towards interactive digital networks. Cablephone technology and broadband modems allow these networks to be used also for telephony and for Ethernet-like services;
- the digital subscriber lines for multimedia and the DVB, Digital Video Broadcast;
- the PC dish for satellite and broadcasting communications.

4.1. The IP Next Generation

IPng is the new version of IP (Internet Protocol) which is designed to be an evolutionary step from the actual IP. The formal name of this protocol is IPv6 (where the "6" refers to version number 6). The current version of the Internet protocol is version 4 (referred to as IPv4). IPv6 is a natural evolution to IPv4. It can be installed as a normal software upgrade in Internet devices and is inter-operable with the current IPv4. IPng is designed to run well on high performance networks (e. g., ATM) and at the same time is still efficient for low bandwidth networks (e. g., wireless). In addition, it provides a platform for new Internet functionality that will be required in the near future. It does this in a evolutionary way which reduces the risk of architectural problems.

The basic issue which caused the need for a next generation IP is growth: global Internet routing based on the 32-bit addresses of IPv4 is becoming increasingly strained. The deployment of Classless Inter-Domain Routing is extending the life time of IPv4 routing by a number of years, but the effort to manage the routing will continue to increase.

The challenge for IPng is to provide a solution which solves today's problems and can respond in advance to the emerging needs of the information age. IPng increases the IP address size from 32 bits to 128 bits, to support more levels of addressing hierarchy and a much greater number of addressable nodes, and simpler auto-configuration of addresses. Even though the IPng addresses are four times longer than the IPv4 addresses, the IPng header is only twice the size of the IPv4 header. IPng improves support for options, and provides capabilities for delivering quality-of-service and security.

4.2. ATM

The ATM development is following two different directions which are closely related: ATM for public nets and ATM for private nets (see *Figure 2*).

For public networks ATM is the kernel technology and architecture of the digital backbone for broad-band digital networks. The key innovations include:

- networking based on classical IP over ATM;
- the classes of constant and variable bit rate services, named ATM COS, Class Of Service:

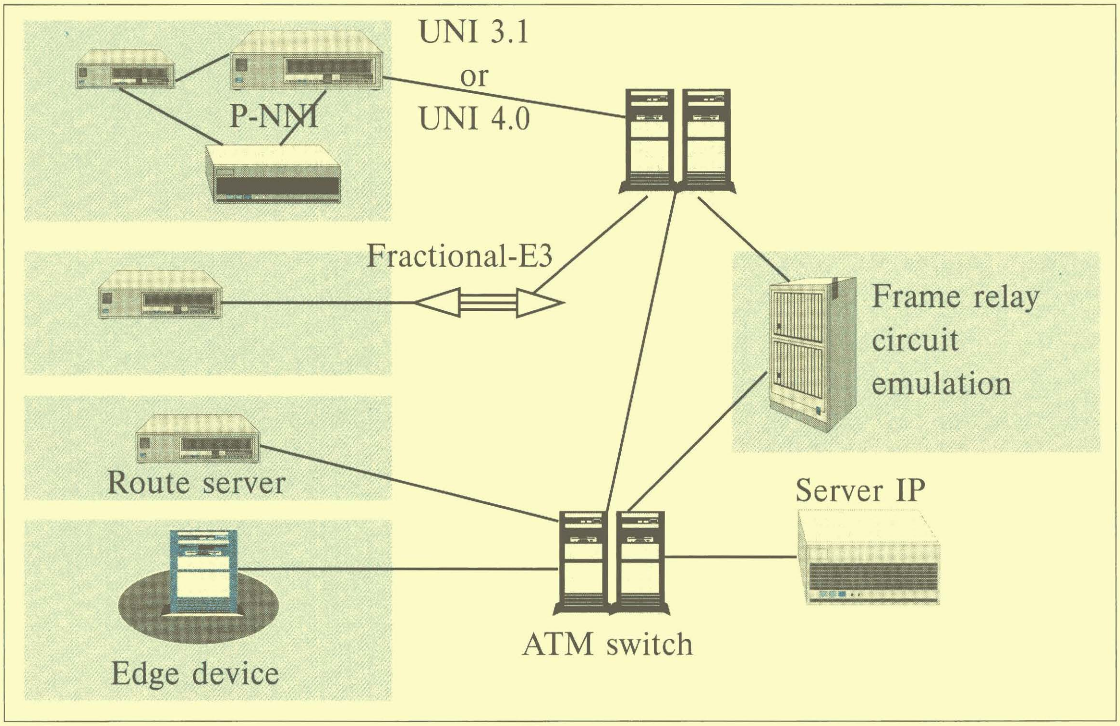
  Cbr, Constant bit rate, (Class A) for traffic with low and stable delay, such as voice;

  Vbr, Variable bit rate (Class C), for bursty data generated at irregular intervals: it is considered connection-oriented, with a distinction between real time and non real time traffic, and it is not appropriate for voice;

  Abr, Available bit rate (Class Y) for sporadic non-critical traffic allows bandwidth on-demand from end-users who ask for the suitable bandwidth and class service required;

  Ubr, Unspecified bit rate (Class X), for low-priority traffic that does not require throughput or delivery guarantees;

Figure 2
ATM Network
New Functions



two other classes, Classes B and D, are in progress: Class B for packetized voice and video, Class D for connection-less VBR traffic;

- IMA, Inverse Multiplexing on ATM (fractional E3), defined by ATM Forum, which allows a single high-speed stream of ATM cells to be split up and the traffic to be distributed over different connections at lower speeds and the original order of the cells to be reconstructed at the other end.

For private networks the key innovations include:

- moving from UNI 3.0 to UNI 3.1 and UNI 4.0 for signalling: the user can specify the parameters that characterize real time connections, in particular the COS and the CTD (cell transfer delay);
- I-PNNI, Integrated Private Network to Node Interface, provides topology distribution mechanisms and supports COS sensitive routing at call set-up;
- mapping the RSVP, Resource reSerVation Protocol, to ATM-COS, in progress by IEFT and ATM Forum;
- Winsock 2.0, an API (application program interface) interfaces application and ATM services: the application can request the particular type of services (COS) needed;
- CES, Circuit Emulation Service, for emulating T1/E1 and T3/E3 circuits over ATM;
- LANE, LAN Emulation (see 4.2.1);
- MPOA, Multiprotocol over ATM (see 4.2.2).

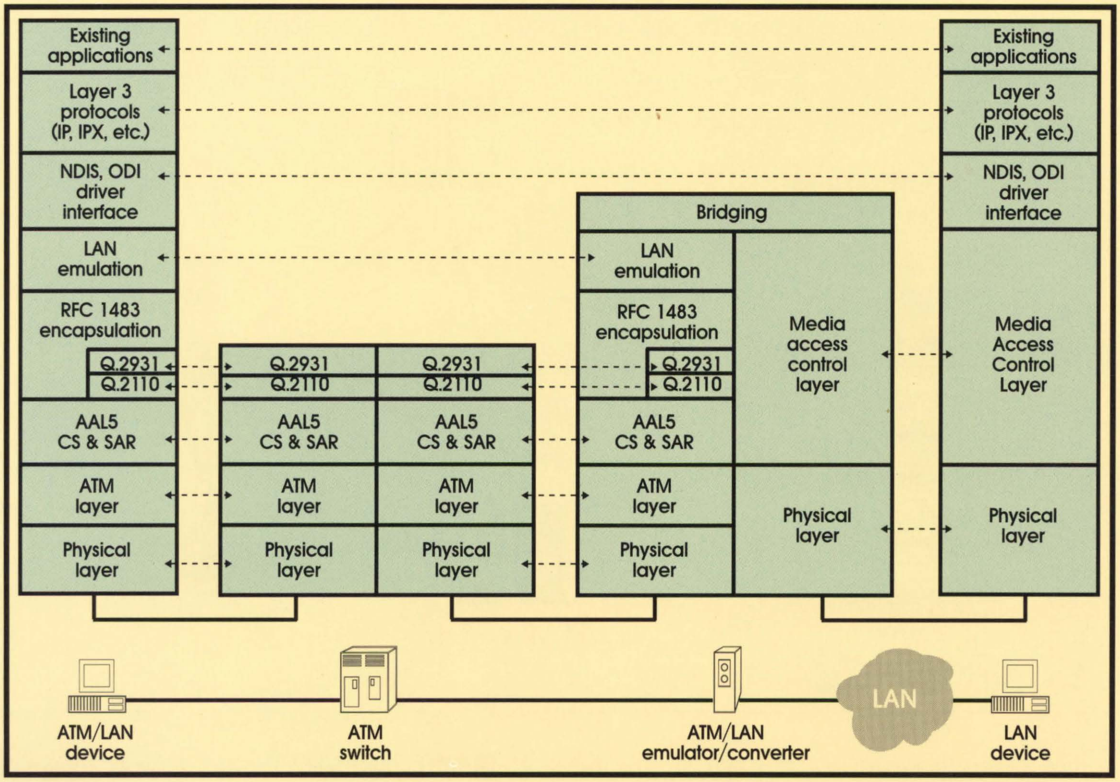


Figure 3
Layered Structure of a LANE over ATM

4.2.1. LANE

The interconnection among LANs and among servers and clients via ATM backbones (see *Figure 3*) requires the connection-less environment typical of LANs to be emulated in the ATM connection-oriented environment. This is provided by suitable mechanisms and protocols defined as standard by RFC 1483 and ATM Forum. LAN emulation protocols generally are implemented as server software or in the driver software of ATM network adapters and switches. The ATM Forum is currently working on version 2.0.

4.2.2. MPOA

MPOA, Multi Protocol over ATM, is a standard in development from the ATM Forum which aims to solve the present problems of designing, deploying and managing scalable internetworks by integrating ATM with existing Ethernet, token ring, and TCP/IP infrastructures. MPOA is based on LANE, and adopts an evolution of NHRP, Next Hop Resolution Protocol, approved by IEFT, of IP over ATM and multicast address resolution server (Mars). In short, the MPOA approach is divided into three main functions:

- It defines a high-performance, low-latency way to route IP and other protocols across an ATM switching fabric.

- It allows the definition of virtual subnets in order to group users regardless of where they are physically located.
- It uses the ATM's quality-of-service.

MPOA introduces the concept of virtual routers, a set of MPOA devices operating over an ATM fabric that collectively provide the functionality of a multiprotocol router.

Also IPNNI is dealing with the problem of how to route traffic among VLANs that operate with different layer 3 protocols, but MPOA and IPNNI are not mutually exclusive, but rather complementary. MPOA does not deal with how routers exchange routing information. IPNNI provides the specific protocol for exchange information among router servers and switches.

4.3. Virtual LAN and LAN Switch

The concept of Virtual LAN (VLAN) has different meanings and is strictly related to the introduction of the LAN switch equipment. As a general reference, a Virtual LAN put the intelligence of the network layer (L 3 of the ISO model) into the link layer (L 2), so that it is possible to use the network resources efficiently and to facilitate moves, additions and changes independent of the physical location and address of each LAN unit. The first examples of Virtual LAN introduced few years ago were based on grouping the physical port around a switch or on the MAC (Medium Access Control, the lowest sublayer of the link layer) address of the physical port. Such a solution required a "traditional" management of configurations and the interconnection among different VLAN required stand-alone routers.

The LAN switch is the device that allows the creation of a VLAN: it is an "hybrid" between a bridge and a router: it looks at the first packet to find the right outgoing port; all following packets are "switched" at layer 2 and are bound for the same address. Note that the LAN switch is not an actual "router"; in fact it does not provide L 3 protocol conversion and does not support all the possible L 3 routing protocols.

Several LAN switches are now available on the market which provide different maximum configurations, protocol types and addressing, number of concurrent LANs per switch, management functions and RMON, Remote Monitoring. Some of them support the IETF IGMP, Internet Group Management Protocol, which can support a multicast transmission only to requested ports rather than to every port (as multicast and broadcast packets do), saving bandwidth and increasing performance. Others provide DHCP, Dynamic Host Configuration Protocol, which can dynamically assign new IP addresses to end-users.

4.4. High-speed LAN

In the world of high-speed LANs three different technological directions are converging to compete in an area where the distinctions among SubLAN, LAN and MAN still exist only from a geographical point of view:

- the evolution from the "traditional" Ethernet and Token Ring LAN and from the mature FDDI Born for MANs and campus networks into the 100Base (TX, T4, FX) and 100 G-AnyLAN at 100 Mbps and in the very high speed of the new 1G Ethernet LAN specifications, all framed into the IEEE 802 recommendations family;
- the evolution of the ANSI "channel extension" techniques that are exceeding the "subLAN" boundaries, namely HPPI (High Performance Parallel Interface) and Fibre Channel;

- the use of integrated techniques in order to be able to accommodate real-time "interactive multimedia" traffic (like videoconferencing) also for LANs and MANs: one example is ATM at 155 Mbps.

4.4.1. Fast Ethernet

The first IEEE emerging standard for 100 Mbps LAN is 100Base-T, also named Fast Ethernet, defined by the IEEE 802.3u subcommittee on the base of the work of the Fast Ethernet Alliance, an industry group with more than 60 industrial members.

The logic scheme of Fast Ethernet is the same as for 10-Mbit/s Ethernet: it retains the same MAC, Media Access Control sub-layer, since most MAC specifications are speed-independent. IEEE also defined a media-independent interface (MII), analogous to the attachment unit interface (AUI) is used on most 10-Mbit/s Ethernet, which can support various cabling types. The IEEE standard defines three media options: 100Base-T4 for half-duplex operation on four pairs of Category 3 UTP (unshielded twisted pair) or Category 5 UTP, 100Base-TX for half- or full-duplex operation on two pairs of data-grade Category 5 UTP or STP (shielded twisted pair), and finally 100Base-FX for half- or full-duplex transmission over fibre optic cable. 100-Mbit/s fast Ethernet can be configured in switched or shared-media implementations and can support half- or full-duplex connections. Full-duplex operation requires a switch to allow individual nodes to transmit and receive data simultaneously.

The Fast Ethernet standard also includes an optional auto-detection and configuration mechanism known as Nway. Implemented in hardware on the adapter card, Nway gives adapter cards the ability to detect whether a switch, shared-media hub, or another network adapter is capable of 10- or 100-Mbit/s communication.

4.4.2. 100VG-AnyLAN

The 100VG-AnyLAN standard was developed by the IEEE 802.12 Committee. Like its 100-Mbit/s rival, Fast Ethernet, it can be deployed in both shared-media and switched implementations.

100VG offers the following primary advantages over 100Base-T:

- support for both Ethernet and token ring, although not on the same network - a router has to be used between 100VG Ethernet and 100VG token ring;
- elimination of packet collisions and more efficient use of network bandwidth, using a demand-priority access scheme instead of CSMA/CD (carrier-sense multiple access with collision detection). Demand priority also permits a simple prioritisation of time-sensitive traffic, such as real-time voice and video, that is necessary for multimedia applications.

Demand priority uses a round-robin polling scheme so that every single-port node on a 100VG network can send one packet. If a multi-port hub or switch serves as a node on the network, it must request access from the "root hub" at the next higher level. Multi-port nodes can transmit one packet for each of their ports.

4.4.3. HPPI and Fibre Channel

Both standards were designed by ANSI, American National Standards Institute, with the original goal to provide gigabit-per-second channel extension for mainframe communication with one another, and with directly attached storage devices.

HPPI standard has been extended and the key characteristics now include:

- very high-speed data transfers: HPPI can be configured for either of two speeds-800 Mbit/s or 1.6 Gbit/s, both either simplex or full duplex;
- very simple signalling sequences: HPPI uses for connections only three messages: Request (to ask for a connection), Connect (to indicate that the connection has been established), and Ready (to indicate that it's ready to accept a stream of packets);
- protocol independence: HPPI channels can handle Raw HPPI (data formatted with the framing protocol, without any upper-layer protocols), TCP-IP datagrams, and IPI-3 (Intelligent Peripheral Interface) framed data. IPI-3 is the protocol used to connect peripherals like RAID, redundant array of inexpensive disks;
- physical-layer flow control based on a credit-mechanism for reliable and efficient communications between devices operating at different speeds;
- connection-oriented circuit switching: Non-blocking circuit switches allow multiple conversations to take place concurrently;
- compatibility with copper and fibre: HPPI uses 50-pair STPs (shielded twisted pairs) for short distances. It works with single-mode and multimode optic fibres and it is Sonet compatible for long-distance communication;
- RFC (Request for Comment) 1347 from the IETF (Internet Engineering Task Force) specifies how HPPI switches are to be used on IP networks for Intranet, and several vendors of computers with HPPI channels offer software drivers for TCP/IP.

Fibre Channel is an ANSI standard and is also near completion at ISO.

In comparison with HPPI, it is complex, due to the goal to include very rich functional features. It specifies four data rates, from 100 Mbit/s to 800 Mbit/s, and runs on both fibre and copper media at distances of up to 10 kilometres. The main goal is to provide a plug-and-play channel extension interface for mainframes and supercomputers as well as for numerous peripherals, providing multiple classes of service to accommodate different network applications and data types: Fibre Channel is able to support transparently different protocols, from TCP/IP to ATM. Its specifications are based on five sub-layers OSI-like stack *(Figure 4)*, that defines transmission rates (FC-0); data encoding and decoding (FC-1); framing, flow control, and service classes (FC-2); common services (FC-3); and protocol and application interfaces (FC-4). Service classes characterize distinct types of Fibre Channel transmissions. FC-2 defines four classes of service which include dedicated, uninterruptible links, like telephone connections, (Class 1), connection-less, frame-switched transmission (Class 2), one-to-many connectionless frame-switched (Class 3), connection-based service which offers guaranteed fractional bandwidth and guaranteed latency levels (Class 4).

Despite their differences, HPPI and Fibre Channel are considered complementary technologies. An ANSI standard has already been defined that specifies how to send upper-layer Fibre Channel protocol over the lower-layer HPPI media. The complementary ANSI standard (defining how to ship HPPI upper-layer protocol over Fibre Channel lower-layer media) is in process.

IP-level routing offers another way to map HPPI to Fibre Channel, and vice versa.

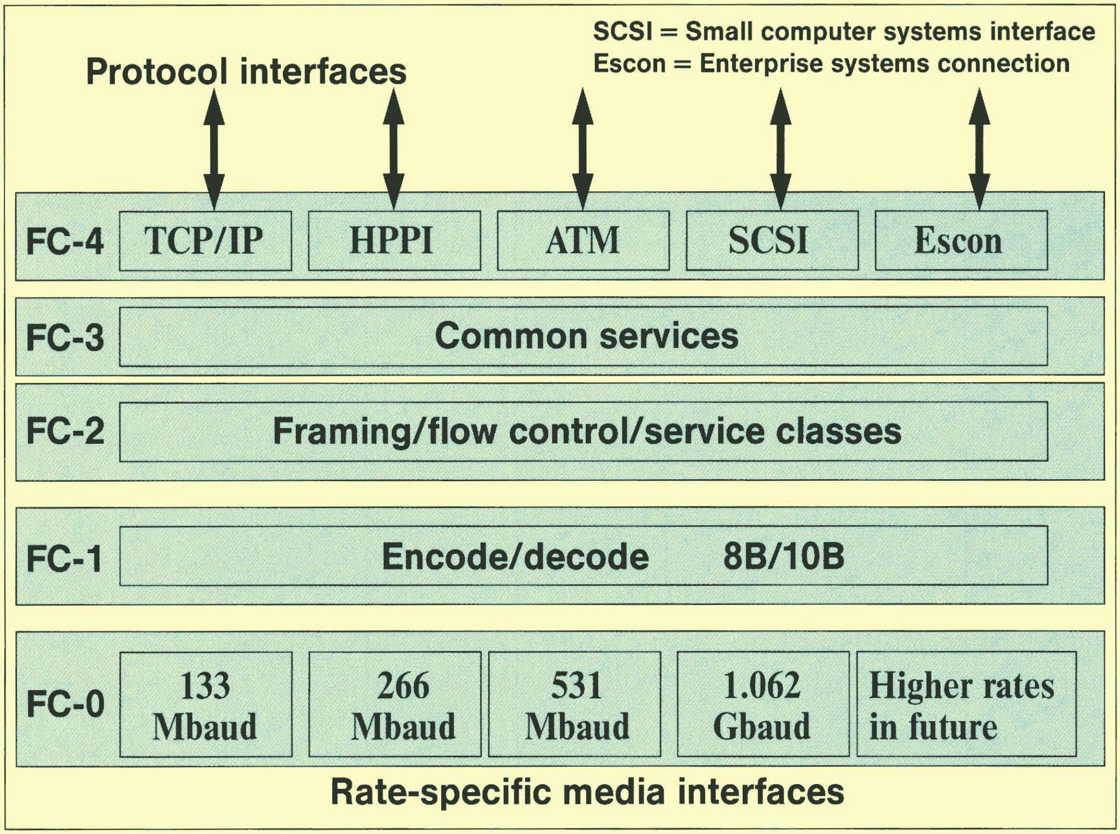


Figure 4
Fibre Channel Layered Structure

4.4.4. IEEE 802.14

The IEEE 802.14 specification defines standards for data transport over traditional cable TV networks. The reference architecture specifies a hybrid fibre/coax plant with an 80 kilometre radius from the head end. The primary thrust of the design of the network protocol is to transport IEEE 802.2 LLC traffic types, initially exemplified by Ethernet; the network should also support ATM networking to carry various types of multimedia traffic.

4.4.5. Iso-Ethernet

"Iso-Ethernet" stands for Isochronous Ethernet Integrated Services and is an IEEE 802.9a specification which supports both the multimedia capabilities of ISDN and the data packet approach of Ethernet 10Base-T in order to integrate real-time voice, video, and Ethernet traffic on a single network. Iso-Ethernet provides 6.144 Mbit/s of switched ISDN C channel dedicated to isochronous services for multimedia applications and ISDN Q.931 signalling, plus the Ethernet 10-Mbit/s as a ISDN P channel for Ethernet traffic.

4.4.6. Gigabit LANs

IEEE started to define two 1-Gbit/s versions, as it did in 1993 when it decided to define a 100-Mbit/s LAN with the two version 100Base-T and 100VG-AnyLAN. The aim is to create standards which can support so-called scalable Ethernets which operate over copper and fibre (both based on parts of the ANSI Fibre Channel spec) and using at MAC level the demand-priority mechanism. The 802.12 working group has already received an IEEE Project Authorization Request (PAR) to define a gigabit version of 100VG with "full and final approval" expected by the summer of 1997. The plan is to define transmissions of 500 Mbit/s and 1 Gbit/s, with 4 Gbit/s possibly coming in the future, operating both with Ethernet and token ring frames, and with the possibility of full-duplex handling.

The 802.3 working group is still waiting to receive its PAR for the gigabit version of 100Base-T; the planned technical approach includes the utilisation of minimum and maximum frame sizes defined by the 802.3 specification, the full-duplex communications for point-to-point switched connections, the possibility of flow control, the MAC addressing scheme based on CSMA/CD.

For the transmission media, both fibre and copper might be used: multimode fibre should be able to carry gigabit transmissions to 500 metres; with single-mode fibre, that distance should reach 2 kilometres. For twisted pair, Gigabit 100Base-T over UTP will require less then 50 metres from the local switch to the end-station.

4.5. RMON

RMON (Remote MONitoring) standards are specified in IETF RFCs 1757 and 1513, that are focused on centralised network management for Ethernet and token ring segments, and now further efforts are in progress for addressing Fast Ethernet. RMON is conceptually based on the OSI NMS (Open System Interconnection – Network Management System) logic and uses the SNMP, Simple Network Management Protocol, commands.

RMON defines a two-entity, agent-server, scheme: the "agent" is a monitor or probe on each segment, the server is the "centralised" management application, which configures the remote probes to collect information which is then sent to the management station either when specific events occur or upon request. A RMON-MIB (management information base) includes all the above information which can also be structured in statistical tables, named "groups", accessible using SNMP commands.

RMON II presents several enhancements, in particular for enterprise network management, which include: protocol distribution, higher-layer protocol support, and the monitoring of end-to-end traffic advanced filtering features.

Due to the fact it is "packet/frame oriented", the monitoring of VG100 and ATM is not allowed under the present specifications, and this extension has to be still proposed.

RMON can be deployed as stand-alone RMON Probe, as RMON embedded in the switch, as RMON on a PC or workstation.

4.6. Voice Communication over Internet and Frame Relay

Internet and Frame Relay were not originally designed for voice communications and for voice/data integration, as ISDN and ATM, but an increasing number of products offers such features for both. For Internet the basic motivation is very simple: to try to make an intercontinental voice call via the Internet at the price of a local call. The first problem for a "web phone" is to guarantee over the Internet a real-time, constant rate, uninterrupted audio connection: the present TCP/IP protocols cannot guarantee these features and the solutions offered on the market introduce proprietary protocols able to stream audio transmissions.

The voice is digitally coded and transported to the interlocutors via the TCP/IP addressing scheme. For the "transport", one approach is based on the "datagram" connection-less UDP (User Datagram Protocol) that can provide a continuous stream due to the absence of overhead. A higher level proprietary algorithm is necessary for error recovery at both the interlocutor ends.

The second approach is based on the TCP connection-oriented protocol that provides end-to-end flow control, avoiding possible network congestion, but without interrupting transmission as UDP can do.

Other problems derive from the low speed and half-duplex access to Internet of the majority of the users, and from the dynamic IP addressing that can foil the voice routing. In fact, many ISPs, Internet Service Providers, do not give dedicated IP addresses to their customers, but assign dynamic addresses for each session. The basic solution for limited bandwidth is compression/decompression of the digital voice at the two (or more) ends, and the solution for the IP addresses is to fix them at the ISP server that will maintain a dedicated allocation and directory for the "voice" users.

An analogous situation occurs with voice over frame relay. The quality of the voice communication cannot always be guaranteed at the same level and is barely good enough. Different products are available on the market, and special FRADs (Frame Relay Access Devices) can digitize and compress voice signals. Normally these products can interface PABX, fax, telephone sets and LANs, provide integrated bridging and/or routing capabilities, and support different compression algorithms, with ratios ranging from 2:1 (32 Kbps/channel) to 16:1 (4 Kbps/channel), and SNMP for network management.

4.7. Cable and Broadband Modems

The increasing need for high speeds at the subscriber loop level in order to access Internet, LANs and WANs with a large bandwidth able to manage multimedia contexts has been satisfied using new modems that operate over cable TV and the normal phone lines. These broadband modems allow access to the Internet or to WANs at 1-5 Mbps using already existing TV cabling (if any), which avoids leasing expensive dedicated lines.

These modems can be grouped in two classes: the ADSL modems that use existing twisted-pair coppers, and cable modems that use the coaxial TV cables. As with a normal modem, modulation-demodulation is accomplished between the digital signals and the RF signals.

The capacity to deal with high speeds is provided by exploiting a wider portion of the spectral bandwidth: a cable modem uses the 6 MHz or 8 MHz bandwidth of NTSC or PAL respectively: the interface with the DTE, Data Terminal Equipment, is at high speed too, and therefore is normally provided by an Ethernet port.

4.8. Digital Subscriber Lines for Multimedia

Besides fibre optics and CATVs, the digital subscriber line (DSL) technology is the most promising solution for the ultimate high speed connection (subscriber loop) in order to support multimedia and in particular video communications. The following *Table 7* shows the available variations of DSL technology that utilise multiple twisted pairs.

Broadband modems have to be used for the connection of the subscriber loop with the MAN/WAN.

Table 7
DSL, Digital Subscriber Line Techniques

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

The main goal is to provide a full-duplex video communication anywhere-to-anywhere, and several projects and field trials are in progress both in the United States and Europe.

4.9. Satellite and Wireless Communications

The main innovations in this area concern the introduction of new techniques for high speed multimedia communications.

The first step has been voice communications that produced the widespread use of cellular telephony, in particular with the GSM standard.

The second step, which occurred close to the first, was the introduction of techniques in order to transmit data wireless, techniques that are shown in *Table 8*. Some carriers also began to offer some of them in some countries, even if with geographically limited coverage. As pointed out in *Table 8*, the speeds are limited and the available throughput cannot provide multimedia communications, in particular for video, films, etc.

Satellite communication is already consolidated also for TV and radio broadcasting, and small dish antennae which can be directly connected to a PC as a normal peripheral are now available, for instance via a traditional ISA bus. These capabilities are promoting new "high speed" wireless solutions: one asymmetric solution (see *Figure 5*) uses a dish antenna as the receiver from the satellite in the range of 400 Kbps as downstream; the "sender" is a satellite ground station accessible via VANs or via Internet service providers, with an upstream in the range of 14.4-33.6 Kbps. Another solution is the local multi-point distribution service (LMDS) also based on a dish antenna that acts both as receiver and sender, but with a hub station (see *Figure 6*). LMDS will use a 1 GHz chunk spectrum at very high frequency (around 28 GHz). This solution too is asymmetric, splitting the 1 GHz band in 850 MHz for downstream, and the other in 150 MHz for upstream. The two paths are shared by all the users on a hub, with separate channels of 20-40 MHz wide. The final end-user throughput is in the range of 10 Mbps for both up and downstream.

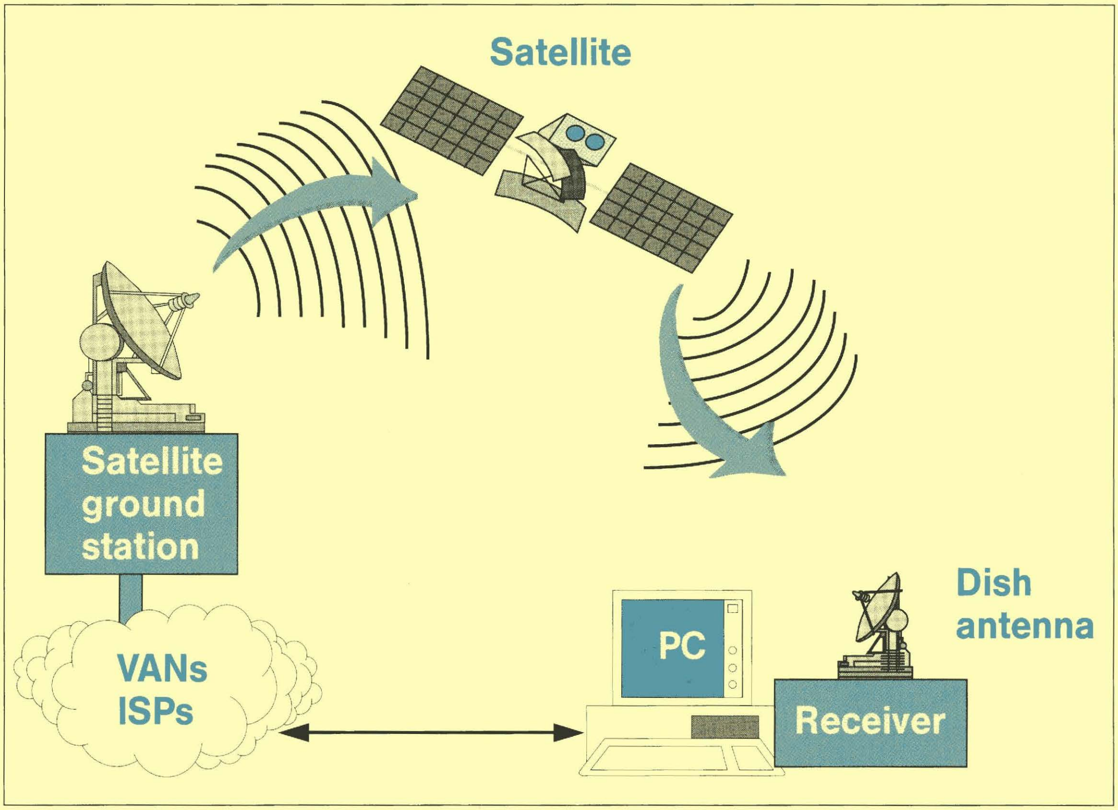


Figure 5
Example of High-speed Communication via Satellite and PC with Dish Antenna

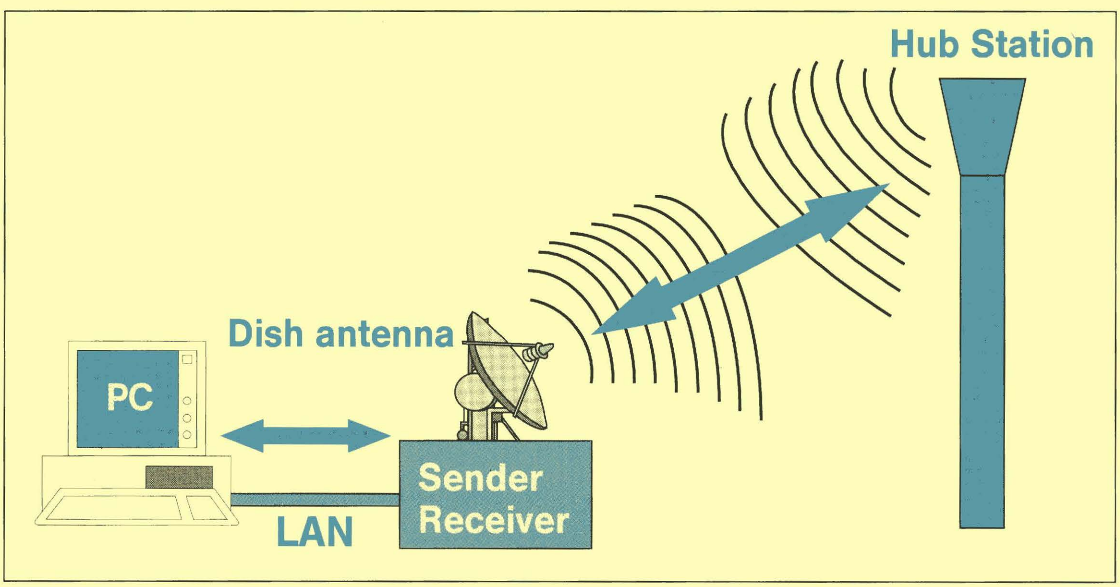


Figure 6
LMDS, Local Multipoint Distribution Service

Table 7
Wireless Data Transmission Techniques

Technology	Description	Usage	Throughput	Comments
CDPD, Cellular Digital Packet Data	Packetized data sent over idle capacity on cellular voice network; cellular base station forwards data onto public network	Bursty data files from 2 to 5 Kbytes	19.2 Kbps overhead reduces actual throughput	Low price; limited coverage (now)
Private packet radio	Packetized data sent to radio base stations, which transmit it over private terrestrial network	Bursty data files from 2 to 5 Kbytes	from 4.8 to 19.2 Kbps overhead reduces actual throughput	Proprietary technology; (now) higher prices than CDPD
Circuit-switched cellular	Circuit data stream sent to cellular base stations and transmitted over public network	File transfers facsimile; images	Depending on modem, up to 14.4 Kbps	Error-correcting modems
ESMR, Enhanced Specialised Mobile Radio	Digital data stream sent to radio base stations, which transmits it to public network	Integrated voice/data; paging; short e-mail	4.8 Kbps	Integrated voice/data; all-digital network
Bi-directional satellite	Data sent from subscriber unit to low-earth-orbit satellites, which transmit it to public network	Short messages	from 55 bps to 9.6 Kbps	
PCS	Digital data stream sent to digital base stations, which transmits it to public network	Short messages	from 4.8 Kbps to 25.6 Kbps	

5. Architectures

The growth and the diffusion of World Wide Web technologies are leading us to rethink current concepts of client/server computing, particularly in the context of the "enterprise architectures". TCP/IP protocol piles, together with the HTML page and browsers, are now the world-wide reference standards. This new paradigm shift has a strong impact both on the evolution of operating systems, in particular for the web-server and for thin clients, and on the concept of distributed application as related to how applications will be developed. These topics will be analysed in the next section on software. In this context it is of interest to note the new standard proposal on application architecture, OSE, Open System Environment, and the work in progress by OAG, Open Application Group.

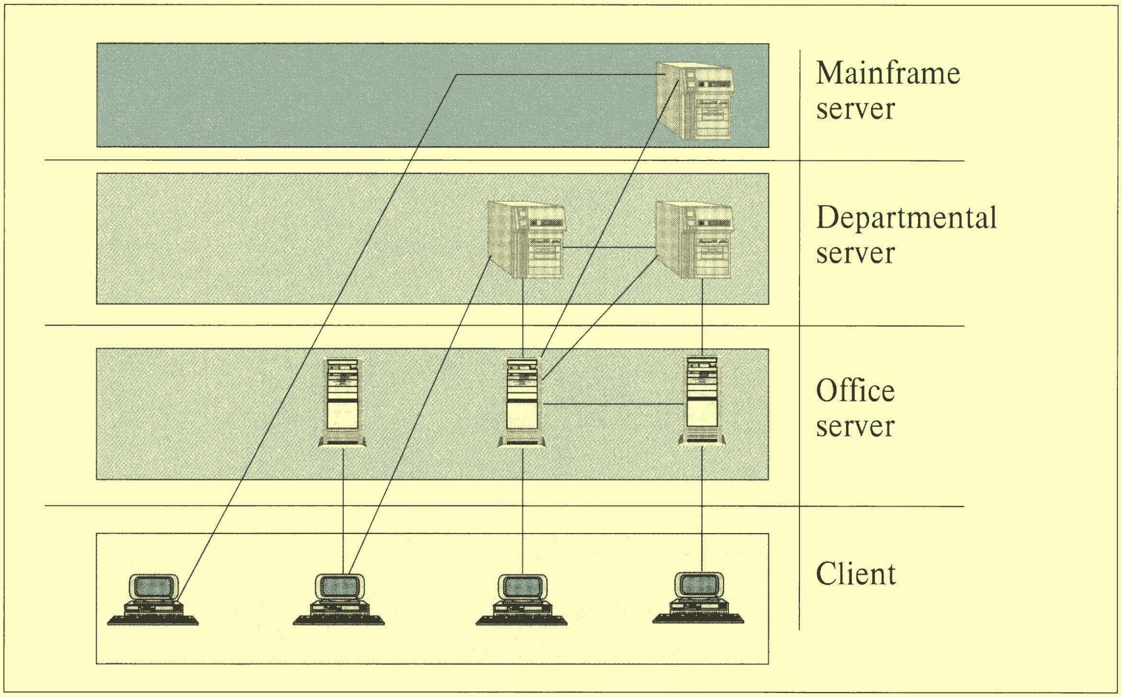


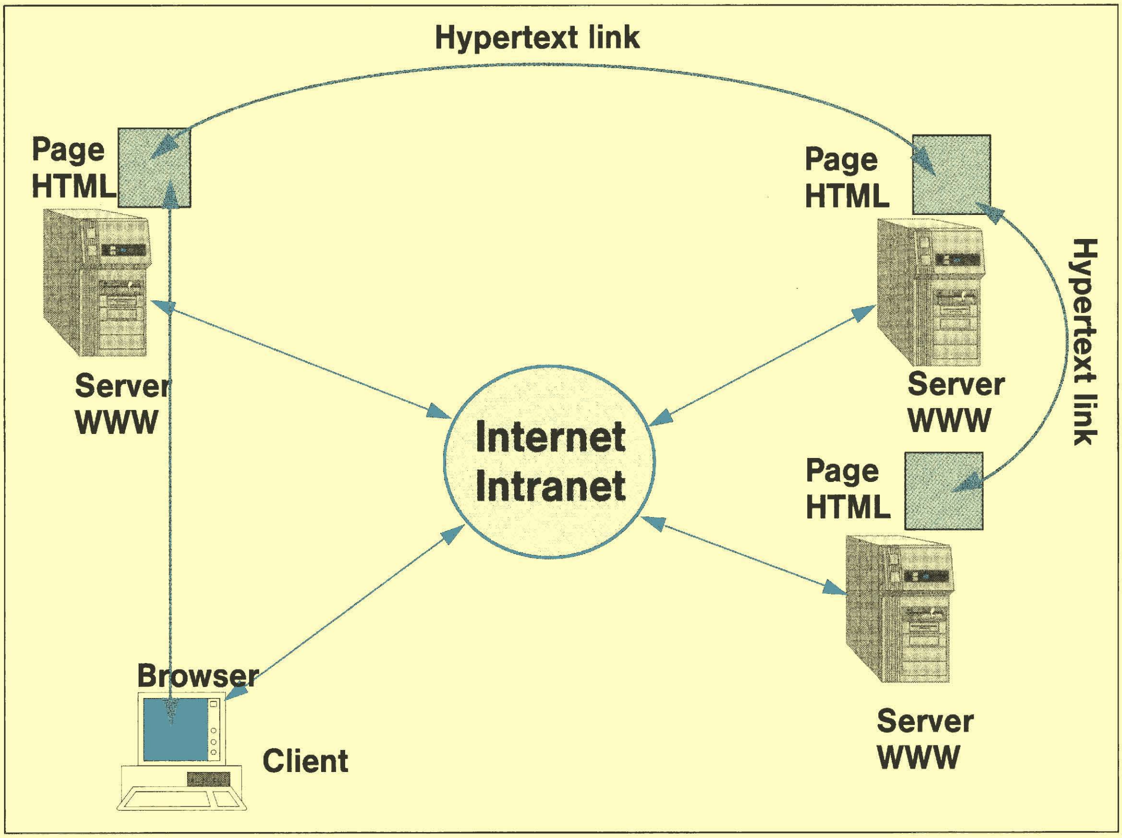
Figure 7
An Example of 4-tier Client/Server Architecture

5.1. The Intranet Impact on Enterprise Architectures

Intranet is the descriptive term applied to the use of Internet standards and technologies within an enterprise or organization. Internet and Intranet use the same tools and techniques, protocols and products, based on the standard of the TCP/IP world. What is implemented on Internet can be implemented on the Intranet too.

The model which has been preferred up to now for client-server architecture (see [EITO 96]) was based on a hybrid three/four-layer client-server architecture. This is changing in a web-client-server environment. The previous model consisted and still does of a host (often a mainframe) at the centre, a middle layer of database and application servers (on the same or different platforms), and desktop PCs, connected with a NOS (Network Operating System) running GUI (Graphic User Interface) client environments, EUC (End User Computing), tools and applications *(Figure 7)*. The new architecture is reduced to a simpler two-layer structure, a PC or "thin client" with browser capacities and a web-server. The client can access different webs via a hypertext link without needing to know the type and the location of the other webs *(Figure 8)*: note that the "internal" (Intranet) world of the enterprise can interact with the "external" world (Internet) using the same interfaces and tools and the only limits in both directions of such interaction are set by the security policies and mechanisms in use.

Figure 8
The Hypertext Link Among Pages



The extraordinary growth of Internet and therefore of Intranet is driven by the information-sharing capabilities of the World Wide Web. These *de facto* standards offer two advantages:

- to share pages containing multimedia information across any TCP/IP-based network;
- to navigate through pages by just pointing and clicking independent of hardware and software platforms.

The need to reshape the whole information system (in its broadest sense and in every context of use), while taking into consideration assets, investments and organisational aspects, will take advantage of Intranet as a "personalised" reference model based on a robust ICT infrastructure and infrastructure capable of dealing economically and effectively with today's continuous and highly dynamic evolution of products, services, distribution channels, prices, competencies, skills and user needs.

Intranet represents therefore a new model for internal information management, distribution and collaborative computing and offers a simple and powerful implementation context for client/server computing. It changes how systems are interfaced; with HTML and the present authoring tools it is possible to build an actual "End-user-comfortable Interface".

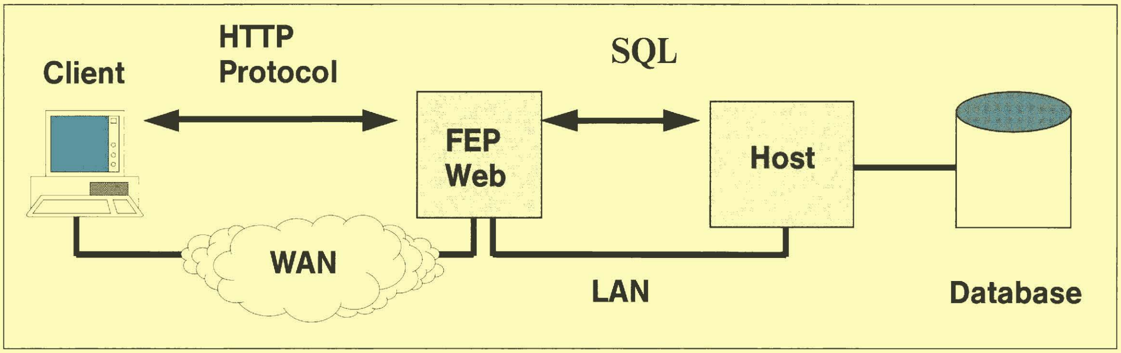


Figure 9
An Example of a Web-front End

Within Internet/Intranet, applications are *de facto* client/server applications where the server is not unique but includes the entire space of the World Wide Web. Indeed, when a browser, as one client, is connected to a World Wide Web server, the connection is like a client/server connection where, with the browser, it is possible to ask any question the actual server. If the browsers need some other information, it is also possible to stop the actual connection and start a new connection with another server where the information is on line.

With Internet many servers can exist where a client with a browser can ask for and obtain information.

This technology implementation is performed to deliver transparently the immense information resources of an organization to each individual's desktop with minimal time and effort.

Software and files are stored on a server rather than on an individual PC so it is possible to get the most recent version of everything – from data to application software – virtually eliminating the complicated, costly tasks of software acquisition, installation, administration, and maintenance.

This means that a user never needs to be concerned about disk backups or file recoveries, and the user can access information from anywhere.

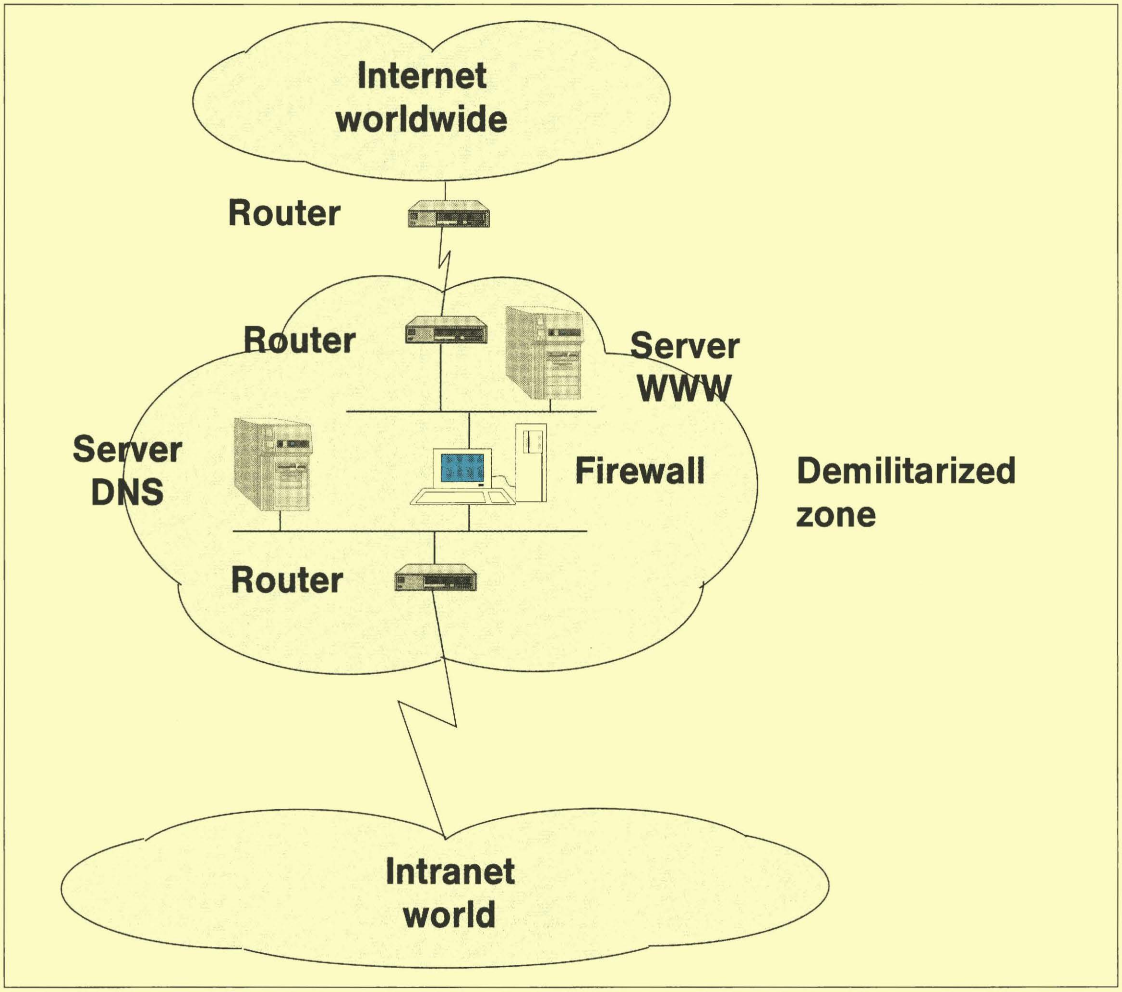
More and more, web logic allows previous technologies and applications (often called "legacy systems") to be integrated. The introduction of Intranet can be done gradually, maintaining, if convenient, systems already in operation.

At present, most enterprise data reside on host-based applications and systems and it is now possible to provide efficient access to them via a browser. The market offers products that act as web (HTML)-like front ends and that enable data still residing on host-based applications databases, such as CICS and DB2 (see *Figure 9*), to be accessed.

It is possible to access an existing SQL database server and access a subset of this information using a web browser.

There are a number of products in this area and more appear every day. Some of them are gateways that connect existing SQL database servers to web servers, so that clients using web browsers can query the data. Others support a variety of database formats and have more extensive development environments that allow more involved forms creation and can retrieve indices of documents that are generated on the fly.

Figure 10
An Example of a Demilitarized Zone Based on Firewalls



However, functionality that has long been available in client/server systems, such as data validation at the client end and the ability to tab across the dialog box while scrolling down the screen, are more difficult to implement with HTML forms.

Database extensions allow data queries to work over Internet connections and can take existing databases and publish them on the web so that ordinary web browsers can view the same data.

There are also a number of products that extend the office environment to include Intranet awareness. This includes the ability to save files in HTML format or collaborate over the Internet using a variety of word processing and spreadsheet tools.

The issues of "global" security will play an increasingly key role in Intranet applications.

A first security function deals with providing secure accesses to the systems and to the requested information by personnel who have the necessary authority. Most popular web servers today provide such access facilities, while limiting access rights for a specific IP address for individual pages. A specific security barrier between the Intranet world and the external Internet world, and also between different areas (addressing and management dominions) of the same Intranet is provided by "Firewalls". Simple firewalls control and filter network traffic at the packet level; packets are allowed or denied based on the source/destination address of the port number. Most sophisticated and high-level firewalls create a "demilitarised zone" between different networks in order to do not allow a direct connection and to prevent traffic from passing directly (see *Figure 10*). These firewalls also log all access for tighter security audits.

Secure and confidential communication over Intranet/Internet environments can be guaranteed by effective authentication of the interlocutors, and by encrypting and signing the messages: in section 7 these mechanisms will be explained, and some of them are conceived and designed specifically for Internet protocols, such as SSL (Secure Socket Layer), S-HTTP and SET.

The PPTP, point-to-point tunnelling protocol, is another way to operate secure business processes on Internet.

The focus on Intranet is so high that several leading manufacturers have created a consortium named WBEM, Web-Based Enterprise Management. The main aim is to develop standards for web-based information systems. The first technical goals include the definition of:

- HMMS, HyperMedia Management Scheme, a model for data presentation;
- HMMP, HyperMedia Management Protocol, for delivering HMMS by means of HTTP;
- HMOM, HyperMedia Object Manager, based on Microsoft OLE;
- VDOLive: Video on Internet Protocols.

5.2. Posix.0 OSE: A Standard Reference Model for the Open Systems Environment

Posix and ISO recently introduced OSE, Open System Environment, the new ISO reference Model for Software Environments. OSE extends the classical model of Open System Interconnection (OSI) to the full software environment, thus providing a general framework also for standards less formal than ISO documents while considering also private standardization initiatives.

5.2.1. Posix

Posix is a standardization initiative started by IEEE and then supported by ISO. It covers the operating system and the middleware, i. e., most of the software which today can be standardized. Posix plans to define about ten new standards (see *Table 9*); today only Posix 1003.1 and 1003.2 are fully developed and approved by ISO.

Posix is developed in IEEE by TCOS (Technical Committee on Operating Systems and Application Environments) with the support of NIST (i. e. Posix. 3, the validation procedure, was defined by NIST, National Institute of Standard and Technology). OSI is mostly involved with the formal phases of the approval process. NIST is also suggesting Posix be a requirement for systems purchased by US government agencies ("Open" branding).

This modifies partially a previous guideline called Gosip (Gosip: Government OSI Procurement). Similar Gosip specifications, strictly OSI

Table 9
POSIX Main Projects

Project	Standard/Profile
p1003.1	System interfaces (1a),
	Real-time (1b, 1d)
	Threads (1c)
	Security API (1e)
	Transparent file access (1f)
	Protocol independent Network API (1g)
p1003.2	Shell and Utilities
	Security Utilities (2b)
	Batch queuing extension (2d)
p1003.5	Ada bindings
	Ada real-time bindings (5b)
p1003.9	Fortran bindings
p1003.10	Supercomputing Profile
p1003.13	Real-time Profile
p1003.14	Multiprocessing Profile
p1003.16	C language Bindings

compliant, from some European governments (UK, Sweden, etc.) and Japan never found acceptance.

On the private side the Posix standards were included in the X/Open (now "The Open Group") formal definition, called Spec 1270, of the Unix trademark. As a consequence Unix operating systems include the approved Posix standards and also most of the proposed Posix specifications, such as Xti, are already included in Spec1270. As stated before, MVS, OS/400, VMS and GCOS also include a Posix compliant interface and WinNT will be, with a third party addendum, "open" systems. Therefore, most of the server OS can be used in the Open style while the Workstation OS (MacOs, Os/2, Win3.1 . . . Win95) do not conform to those guidelines but some of them (MacOs, Win95 WinNT ws version) can be created in order to include what is needed to support full interoperation with Open Systems.

The Posix Reference Model finds support in the European Union: EWOS, the European workshop for open systems and Ephos, a UE initiative for the European procurement handbook for open systems, define their profiles within the Posix framework.

The relations with highly standardized platforms like DCE by OSF and Corba by OMG are more complex since DCE includes most of the standards included in Posix but DCE, as a composite standard, is not included in Posix. While the DCE initiative is still a niche solution, the Corba one and its proprietary competitor Dcom by Microsoft are rapidly gaining acceptance.

According to NIST, an operating system is open only if it conforms to the approved Posix standards. This is largely accepted by the market and Posix Os. include both Unix systems and the Open versions of MVS, OS/400 of IBM and VMS of Digital.

WinNT is the only Microsoft OS which will have "open" branding if Microsoft adds the Posix 1003.1c specification and P1003.2 is installed from MKS.

The Posix documents suite is preceded by "Posix.0" and specifies the Reference Model for the Open System Environments.

5.2.2. OSE (Posix.0)

Within OSE standard software is modelled as a set of components which enable the interaction between the application software and the external environment *(Figure 11)*.

Note that:

- a "reference model" is a means for classifying standards according to the technical areas they refer to. The reference model then identifies the general framework whose components are the technical areas subject to standardization;
- a "software environment" is the set of software products used to develop and run an application;

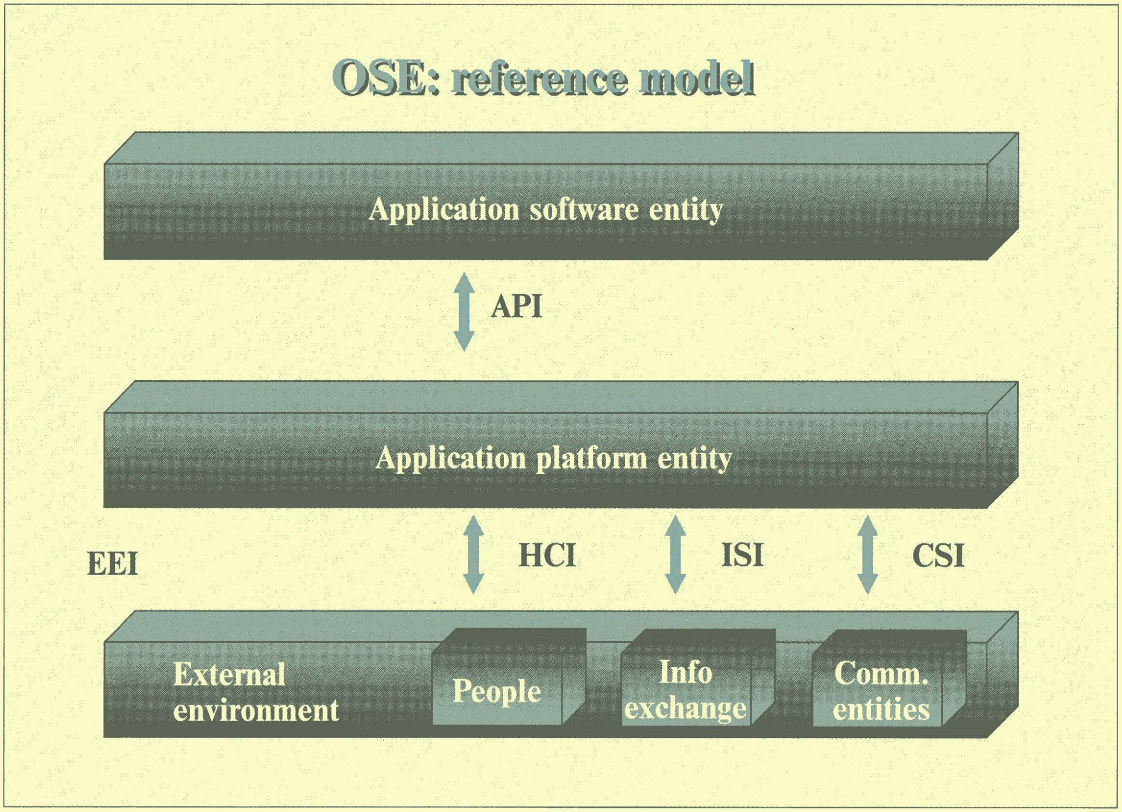


Figure 11
The Reference Model for the Open System Environments

- the environment is "open" if the products are built and behave according to standards and allow for modularity and interchangeability of a set of building-blocks in the environment without interfering with unaffected components.

The external environment includes the operator, the peripheral devices and the interconnection with other systems. This defines three groups of interfaces (their generic name is External Environment Interfaces [EEI]) namely:

- HCI: Human/Computer Interface;
- ISI: Information Service Interface;
- CSI: Communication Service Interface.

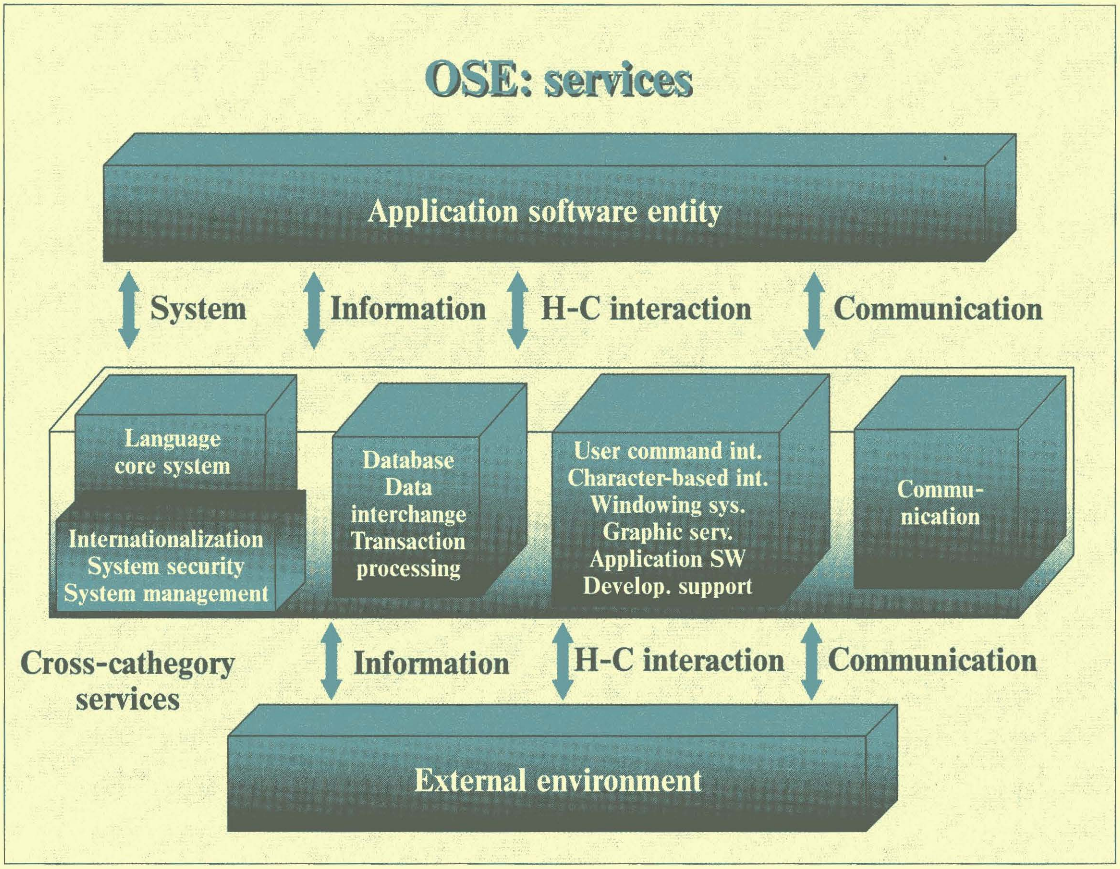
The application software is the software which is not yet standardized or which cannot be standardized, since it includes *ad hoc* specifications for the single user.

The standardized software is interfaced with the application software through the well-known API, Application Programming Interfaces.

The software environment is then decomposed, at interface level, in the following components:

- Human/Computer Interface: Software including the various types of HCI (alphanumeric, graphic, windowing, command, etc.) and software development environments;

Figure 12
OSE Services



- information service elements including database management systems, transaction processors and standard data interchange formats;
- communication service elements correspond to the ISO or TCP/IP suites.

Two other entities are not interfaced with the external environment:

- operating system services including the basic operating system services and the programming languages;
- cross-category services include internationalisation standards, security and management issues.

The integration of OSE and the OSI models provides a reference model for distributed systems *(Figure 13)*.

Posix.0 specifies the interfaces (API and EEI) for each OSE entity and the identification of the relevant (official and non-official) standards, thus pointing out the areas not covered by standards or targets or active initiatives.

The OSE reference model, standards and profiles, defined according to needs of specific classes of users, provide strong guidelines for the design of the required software architecture and provide the procurement specifications for each component. With such specifications one

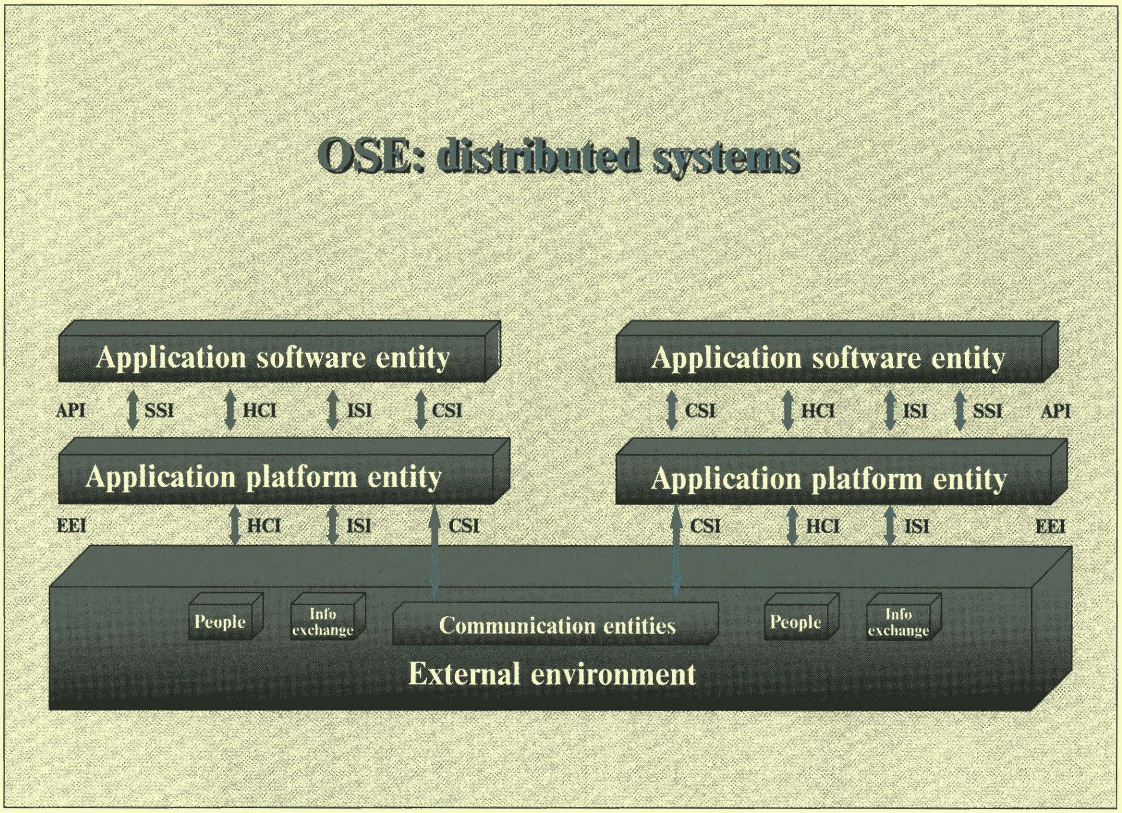


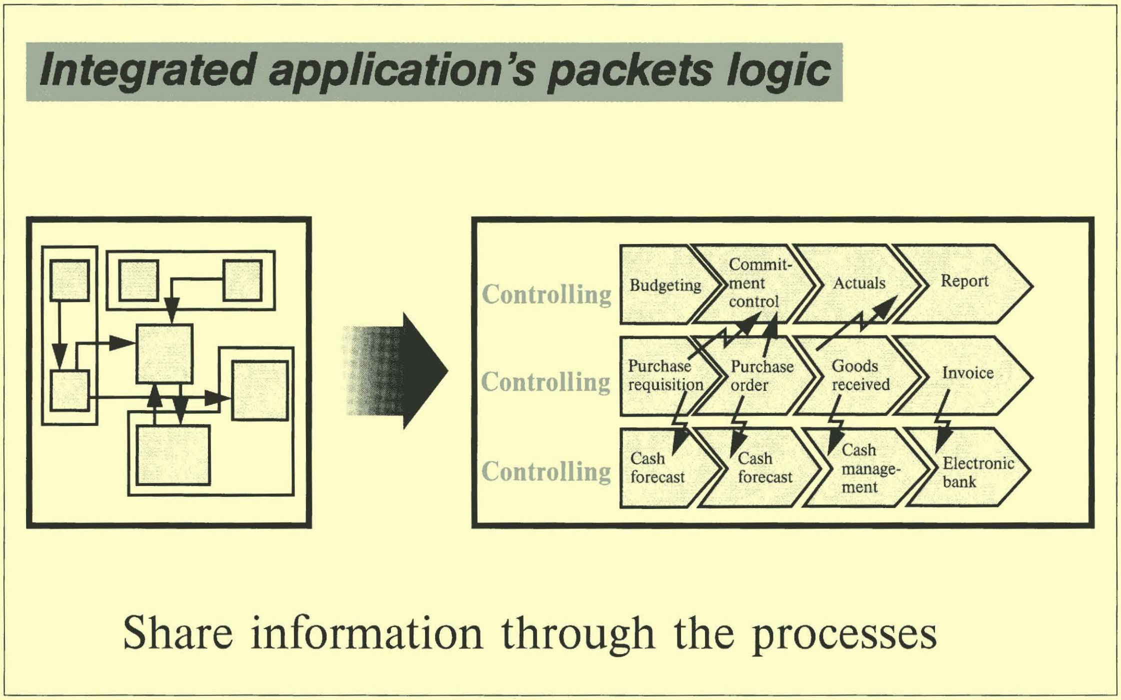
Figure 13
OSE Logic for Distributed Systems

can organize the procurement process in the following, clearly identified, phases:

- listing the products adopting the selected set of standards;
- evaluation of the products according to technical criteria such as performance, required resources, etc.;
- selection of the product to be purchased following economic and commercial criteria.

This kind of process provides cost saving and flexibility to the user and adds transparency for the providers. The adherence of a product to the declared set of standards can be verified only by means of complex and formal procedures and tests. This cannot be executed by users, but must be delegated to specialised labs such as NIST or "The Open Group" (former X/Open). Posix is not a theoretical exercise; it is gaining considerable market acceptance also under the pressure of Internet. Internet is not driven by official standards, but is backed by its own standardization process and is stressing standardization of communication, human/computer interfaces and of the features of the OS kernel. This is an area where the standardization process is still in its first stages, but more can be done taking into account initiatives, such as CDE (Common Desktop Environment) or OAG (Open Application Group), which are preliminary work to enable interoperation between components of the Enterprise Resource Planning (ERP) systems.

Figure 14
The Logic of an ERP System



5.3. Enterprise Application Architectures, ERPs and OAG

As already pointed out in previous EITO reports, the connection between ICT architectures, business processes and the organization of enterprises is increasingly closer. The deployment of distributed and web-oriented information systems, the need to review legacy systems before the year 2000 (besides their possible obsolescence), and the high cost of developing customer applications all find a possible answer with integrated packages, named also ERP, Enterprise Resource Planning. The key issues of the integrated packages approach include *(Figure 14)*:

- information is common and shared by different processes;
- detailed elaboration and/or synthesis from a single or from a set of processes;
- global and integrated vision.

Different packages offer a global coverage of the main processes of an enterprise, from human resources to administrative operation, from planning to distribution and marketing, from project management to logistical and material management, but only a few are emerging, thanks to a wider coverage of processes and a greater acceptance by the market, with a larger diffusion in corporations as well as in smaller companies.

And very often these new packages have to, or should have to interoperate with previous applications. With the aim to solve such a complex and crucial problem, the main application software developers created a non-profit consortium, the OAG, Open Applications Group. This is a non-profit consortium of enterprise application software developers, formed in February 1995 to create common standards for the integration of enterprise business applications.

Member companies are building specifications to standardise integration between enterprise business applications. The scope of this work includes integration from enterprise planning & managing to extra-enterprise systems, between enterprise planning & managing systems, and from enterprise planning & managing to enterprise execution systems.

OAG started with the following parallel projects, and with the objective to provide recommendations consistent with these of OMG (Object Management Group) and of "open Group"(ex X/Open):

- Project A - Outside The Enterprise: this project will specify the integration of enterprise business software systems with the systems of other enterprises, for example, enterprise accounting systems to bank systems. Electronic Data Interchange (EDI) and Electronic Funds Transfer (EFT) are examples of the areas that Project A will focus on.
- Project B - Managing Within The Enterprise: project B focuses on integration between enterprise business software applications, for example, Vendor X's Accounting systems to Vendor Y's Manufacturing system, or Vendor Y's H/R to Vendor Z's Accounting systems. These types of applications generally address the planning and managing functions of an enterprise. Some of the applications that Project B is defining standards for include; Inventory, Customer Order Management, Purchasing, Manufacturing, Maintenance Management, Payroll, Personnel, Benefits, and Treasury.
- Project C - Executing Within The Enterprise: project C focuses on the integration of enterprise execution applications and enterprise business software applications. Execution systems are mostly of complementary nature to the enterprise business software applications. Project C's first target application to integrate with enterprise business software applications will be plant data collection (PDC). Other execution applications that are included in the scope for Project C are; Plant Maintenance, Finite Scheduling, Shop Floor Control Project Management, Bar-Coding, and Transportation.

6. Software Technologies

The Internet/Intranet phenomenon is strongly affecting software. In some cases, software innovation is due to graphical browsers and to the webs that began this phenomenon.

The most innovative areas include:

- the evolution of the "static" web page into the "dynamic" page with plug-in codes, scripts and components;
- "multimedia" on the web and in dynamic pages able to manage files like Jpeg, Dib, Quiktime, Wav, AVI;
- the use of object-oriented technologies and of visual-oriented development environments also in the web and hypertext contexts;
- the introduction of light operating systems for thin clients;
- the introduction of webs as front-end for traditional applications (often named legacy systems);
- the evolution of database and data warehouses object and web-oriented.

Real availability, correctness and security related to the reusability of software components (objects, applets, etc.) have been resolved in some cases, so that the ability to develop application programs by assembling modules selected from among those available world-wide is now a reality. Current trends will allow for software to be developed with new methods and techniques, with greatly reduced expenditures of time and money.

6.1. Systems Software and Utilities

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

6.1.1. Operating Systems

Key trends in technical evolution which have been discussed in previous EITO reports, including the microkernel approach, the use of object technology, a greater independence from hardware platforms, the conversion from 16 to 32 and from 32 to 64 bit CPUs, and scalability. Stronger effort is needed to optimise the inclusion of browser/web-page functions and the support of the Internet/Intranet protocols. Therefore nearly all key manufacturers have focused on implementing thin clients and web-server operating systems.

The Internet/Intranet logic reinforces the concept of "open system" (also discussed in previous EITO reports), which evolved from the initial ideas of the OSI (Open System Interconnection) reference model and of the Posix, X/Open XPG, OSF DCE (see also Posix.0 in section 5).

PC and NOS (Network Operating Systems)

On one hand, the Windows environment is increasing its dominance in the traditional PC environment and is aggressively attacking the NOS segment. On the other, the Internet/Intranet logics are trying to develop light OS for thin clients and for the best integration/conversion of NOSes into web servers.

Operating systems for thin clients are commonly characterized by an open architecture, with multitasking, multi-threaded, multimedia support, able to manage 32 or 64 bit CPU and with the possibility to handle a broad range of peripheral devices. The TCP/IP protocol pile, browser, a script and a components interpreter (typical examples Javascript and Vbscript, Java and ActiveX) are built-in. Some of the new OSes are derived from Windows, others from Unix, while others are built up around the browser itself.

All the market leaders already have their own products, such as the Microsoft Pegasus Win CE, Ncos of Oracle, Riscos Acorn, and Nc/Os of Sco (subset of Unix).

Unix World

The Intranet/Internet phenomenon is reinforcing the consolidation and the role of Unix, acting as a web-server. It is important to emphasise that Unix is now a brand name for a group of similar operating systems: all these have a common reference to the standard System V, at the basis of the current X/Open standards.

The best known and most used Unix systems on the market are normally optimised for the specific family of platforms of the manufacturer.

The main enhancements on Unix "products" support all the most used DBMS, and provide compatibility with Windows OLE (Object Linking and Embedding), graphic interfaces, and user-friendly system management and security.

Operating Systems for Medium/Large Systems

The evolutionary trend for proprietary operating systems is very similar to that pointed out for the Unix world, where each OS tries to optimise proprietary hardware platforms.

The differences between systems are disappearing from a technological point of view, but different configurations, dimensions, number and types of peripheral equipment, etc., still exist.

Innovation continues in order to try to maintain (or acquire) market share and compete with increasing spread of NOSes and Unix.

To compete better, one characteristic that is emphasised is the support of multiprocessor/ parallel processor architectures, besides the "high-level" availability, reliability, and security.

6.1.2. System Management

In the network/web-centric age, system management and network management are more and more integrated. In the future the distinction between system management and network management will no longer exist. The need to have homogeneous global management for all ICT resources is still far from being realized: the ISO standards for NMS, Network Management System, produced a valid common understanding of the problems and created a common approach, but were not implemented. TCP/IP SNMP (Simple Network Management Protocol) is still the main reference point. Innovations in this area are mainly related to the widespread use of:

- graphic interfaces and high quality geographic maps;
- "intelligent logic", such as expert systems and fuzzy logic, for problem determination and problem solving;
- logical and functional integration of network and systems management;
- the key role of centralised or distributed directories that allow end users to search for the required information on remote users and resources: the reference standard is the X.500 Recommendation;
- powerful and increasingly automated help desks.

6.2. Application Tools

The Internet/Intranet approach is driving further web-centric innovation within the always dynamic and changing world of application development. Previous efforts were directed to object-orientation, visual programming, client/server architectures, support of relational databases, tool integration, interoperability, reuse, and maintainability. Now software development must deal with the need to manage effectively Internet/Intranet architectures which offer the capability to convert and integrate previous applications and information into web pages.

All key manufacturers can provide suitable interfaces and ways to convert their own proprietary and legacy environments into Internet/Intranet systems.

6.2.1. Languages

The only real example of innovation is the growing interest and acceptance of the Java Language and of its "applet" and of ActiveX, triggered by the Internet/Intranet phenomenon. ActiveX cannot really be compared to Java, because it is not a programming language, but a component framework: ActiveX is discussed below in section 6.2.2. Java applications are called "applets" and the only difference from ordinary applications is that they reside on the network in centralized servers and are downloaded when the remote computer connected with that server asks to use it. This feature actually represents the key issue for rethinking application architecture in a web-centric environment which might better balance the load of ICT resources, CPU, memories, applications, etc. in distributed environments.

This "write once/run anywhere" capability should reduce the difficulty and time of mastering many different programming environments and tools and will increase software portability on multiple platforms.

Java is a high level interpreted object-oriented programming language and is the reference element for network computing, even if some other languages, such as Visual Basic Script and Telescript, could be considered. Based on C++, Java was designed in order to be platform-independent, to require limited memory, and to allow programmers more easily to support dynamic, changeable hardware.

When Java source code is compiled, the result is Java bytecode. Java bytecode consists of machine-independent instructions which can be interpreted efficiently by the Java run-time system. The Java run-time system operates like a virtual machine (Java Virtual Machine). As an interpreter, performance is slower if compared with compiled code; in order to improve performance, Java "bytecode" can be compiled, the Java format interpreted by the run-time engine and compiled when Java objects are downloaded by the network.

A subset of Java is called JavaScript, a new scripting language that can be embedded into HTML (Hyper Text Mark-up Language) pages. With JavaScript is possible to respond to user-initiated events and manage the simple programming structures used in Java. With Javascript some typical HTML operations, like a validation form, can be done on the machine where the bytecode is interpreted. When a user writes something on a form, it is not necessary to transmit it to the Server, verify it and then send it back. The input is verified by the client application and can be transmitted after that. A program can be run also on the client system. Since JavaScript is meant to be an easy to understand language, some elements of Java are not supported in JavaScript.

6.2.2. Object Technologies

[EITO 95] contained a detailed analysis of object-oriented technology and made a technical comparison of the different approaches adopted by several manufacturers. Two years later, the situation has not radically changed. No winner has emerged, even if all the leaders are concentrating on two models: Microsoft COM/DCOM and CORBA, supported also by IBM SOM/DSOM and by Sun HotJava. The Microsoft OLE interface for Windows and client server applications has been widely accepted. It is important to emphasise that several application developers and ERP package manufacturers are announcing the compatibility of their applications with both models, which means they are able to support both the libraries and the APIs.

Microsoft Active X is the component framework for the Web, used by the Microsoft browser Explorer: Active X is the successor of VBX and OCX, and, like them, it is not able to support inheritance. ActiveX should in the near future support not only JavaScript but also full-blown Java. At the present ActiveX can use Access and Visual Basic, it is easy to use and can integrate desktop and Internet/Intranet resources.

The evolution of the Corba specs has been recently ratified with Corba 2.0 which introduces a standard for an ORB interoperability protocol: with the precedent release, ORBs from different vendors do not interoperate unless there have agreed on joint developments. Corba 2.0 avoids being locked into a particular development context or solution.

6.2.3. Databases and Datawarehouses

The development of relational databases is following three main trends: integration with multi-dimensional technology, integration with web technology, and integration with object technology (ORDBMS). The first two trends concern the improvement of data access and analysis: the Multi-dimensional OLAP technology (MOLAP) provides meaningful advantages in comparison with the Relational OLAP technology (ROLAP), and web technology allows a simple, world-wide standard access also for multimedia information. The third trend is certainly the most innovative and concerns the increase of data types which a database can manage. ORDBMS allows the definition of new data structures and new functions which can be manipulated by suitable APIs, congruent with SQL 3 standard.

These new objects, named Data Blade modules or Data Cartridge modules, can handle different information structures, such as images, sounds, etc., and different functions. For example, object functions can be used to produce HTML pages to answer a query, or map a multidimensional Star Scheme or Snow Flake Scheme, or carry out traditional information retrieval.

The OLAP Council, the *ad hoc* standardization Forum, is delivering the Multi-dimension Application Program Interface MD-API OLAP v.5.

A new standard for global connectivity is OLE DB, a set of interfaces being developed at Microsoft, whose goal is to enable applications to have uniform access to data stored in DBMS and non-DBMS information containers. This includes storage media such as relational databases, documents, spreadsheets, files, and electronic mail. Applications will be able to take advantage of the benefits of database technology without having to transfer data from its place of origin to a DBMS. OLE DB is expected to lead new database products which are assembled from the best components rather than from the monolithic products available today. With OLE technology, the database as we know it today becomes a component called a data provider. In fact, any component that directly exposes functionality through an OLE DB interface over a native data format is an OLE DB data provider. For data storage in a DBMS, OLE DB uses ODBC connectivity with an OLE DB provider (code named Kagera).

OLE DB defines interfaces for accessing and manipulating all types of data. These interfaces will be used not just by data-consuming applications, but also by database providers. By breaking databases down, the resulting components can be used in a more efficient manner. The OLE DB functional areas include data access and updates (rowsets), query processing, scheme information, notifications, transactions, security, and access to remote data.

7. New Services and Applications

Internet is stimulating innovation in applications and services for domestic markets and consumers and also for businesses and enterprises.

In the first area, the main development trends are focused on CD-ROM, cable and satellite TV (video on demand, pay TV, pay per view, etc.), entertainments, educational programming, and citizen services from central and local public administrations. Many technologies are available and low cost devices such as thin clients and set-top boxes are going to appear on the market, but the cost of communication is still high and the still limited spread of ICT basic knowledgement are delaying the ICT mass market.

In the second area, change is increasingly rapid, but companies need to evaluate the actual return on ICT investment and in some way reduce the total cost of ownership of the systems. As explained in section 5 and in the rest of the present EITO 97 report, the Internet/Intranet orientation and electronic commerce are the two main innovation areas and they are closely related.

At the business level, many innovative niches exist in both horizontal and vertical services. In the first group, Office automation, Workflow and Groupware, Executive Information and Decision Support Systems, Personal Agent, Intelligent Data Mining, Education and training. In the second group, for specific industry segments, ERP packages try to integrate all the software applications, from administrative areas to logistic from human resources to process control, CIM, etc.

The following paragraphs focus on security mechanisms and virtual realities.

7.1. ICT Security Mechanisms and Services

The OSI Security Architecture (IS7498-2) defines the services that can be provided within the framework of the OSI Reference Model and the mechanisms for implementing them.

The security services are grouped into five classes:

1) authentication: a guarantee that an entity is not attempting a masquerade or an unauthorized replay of a previous connection;
2) access control: provision of protection against unauthorized use of resources;
3) confidentiality: protection of data from unauthorized use;
4) integrity: a guarantee of protection against unauthorized modification of information;
5) non-repudiation: protection against any attempt of the sender/recipient to deny sending/receiving data or its contents.

All the above services are called "specific services". Other security services are considered by OSI as "pervasive" to the entire open system; these pervasive services are trusted functionality, security labelling, event detection, security audit-trail and security recovery.

The mechanisms are: encipherment, digital signature, access control, data integrity, authentication exchange, traffic padding, routing control and notarization.

This conceptual framework is the basis of all the emerging techniques necessary to deal with network-centric and web-centric paradigms and related applications, especially electronic commerce.

In this context the main innovations now on the market include:

- S-HTTP, Secure-HTTP: several security functions have been added by NCSA (National Centre for Supercomputer Applications) to the HTTP (Hyper-Text Transport Protocol) in order to provide strong authentication both at server and client side, and confidentiality to the messages in the fly; S-HTTP can use different types of encrypted algorithms, from PGP to PEM and PKCS-7.
- SSL (Secure Sockets Layer): proposed by Netscape, this is application protocol independent and provides a secure channel between a client and a server application over a TCP/IP network, allowing a high degree of authentication and data confidentiality, the negotiation of encryption methods and session keys.
- SET (Secure Electronic Transaction): this derives from the integration of two different proposals for secure payment, the SEP (IBM, Mastercard, Europey) and the STT (Microsoft, Visa), now supported also by American Express, GTE and Netscape.

7.1.1. Identification of Users and Authentication

The identification of a user can be achieved by referring, separately or jointly, to:

- what the user knows (i. e., password);
- what the user has (i. e., electronic card);
- physical and/or behavioural features of the user (i. e., fingerprint or way of speaking or writing).

In the first two cases, the type of identification is "indirect" and implies that possession or knowledge of objects or information constitutes an "identity proof".

All the problems related to possible theft or to transferring such objects and information to third parties are quite obvious.

In the third case "biometrics" techniques are used, which make reference to an individual's inherent features and which, from a conceptual point of view, are considered safer and more correct.

The use of "smart badges" (chip cards, smart cards) equipped with microprocessors aimed at preventing duplication and tampering, associated with encryption-based authentication techniques, provides for excellent levels of "personal identification", especially in a commercial and industrial environment.

The logic behind identification and authentication consists of the exchange of authentication information, referred to as "AC, Authentication Certificate", in the standards, between the person who is to be authenticated and his/her partner. That information is "electronically signed" by adequate encryption techniques which differ according to whether symmetric or asymmetric algorithms are used.

Symmetric Encryption Mechanisms

The encryption/decryption devices, when using symmetric algorithms, must know the same key used by the two partners.

The weak point of symmetric encryption is represented by the need for the key used for encryption to be known, and therefore communicated, to the equipment which has to perform decryption, since the key may be detected by intercepting the communication. In order partially to make up for that, normally at least two levels of keys are used, a "master key" and a "session key". Session keys are generated when needed and are used to encrypt/decrypt the messages exchanged during normal activity. "Master keys", on the other hand, are used to protect the session key which is exchanged between session partners.

There are several algorithms for symmetric encryption; among the best-established is the Data Encryption Standard (DES), one of the most widespread standardized algorithms worldwide.

Asymmetric Encryption Mechanisms

Asymmetric algorithms use two different keys, one for encryption and the other one for decryption, which have no relation to each other, in the sense that one key cannot be obtained from the other.

Every user is associated to two keys: the first one is "secret" and known only to the user, the other one is "public" and known by all his/her possible partners. Through them, besides the basic confidentiality feature, sender and/or recipient authentication can be achieved. As a matter of fact, messages encrypted with a public key can be decrypted only by the holder of the corresponding secret key, therefore assuring recipient authentication. Sender authentication is performed by encrypting the whole message, or a part of it, through the secret key: the recipient, through the corresponding public key, can check that the sender is the presumed one. In this manner there is no need to communicate any key and the problems of symmetric encryption are therefore overcome.

Recommendation X.509 of the ITU-T presents asymmetric algorithm RSA, which is protected by US copyrights, as the reference standard; its "exportable" equivalent is Pretty Good Privacy (PGP).

7.2. Virtual Realities and VRML

The term "virtual reality" refers to a "computer-simulated world" where the "user" can interactively operate with the senses of sight, touch and hearing. The first applications of "virtual worlds" arose in the 1960s in space and atomic-centre simulators and were used for pilot and operator training. These applications increased the functional and performance level of high-end packages with large use of 3-D graphic screens and interfaces and very high-end platforms based on parallel systems, in particular for aircraft and combat simulations, but also in several other fields, from aeronautics to space, from chemical plants to atomic laboratories, from architectural walk-throughs to training and education, etc.

The parallel evolution of videogames, increasingly interactive, and multimedia, now allows the user to "enter" the virtual world and to see, hear and touch all of its components. Two different types of interactive interface are followed:

- "traditional" I/O devices, such as the keyboard, stick, camera, microphone, loudspeaker, screen;
- the "encumbering" interface, which requires *ad hoc* devices, such as an electronic glove, three-dimensional glasses, electronic helmet, overalls, and which allows for "human" interface to the system and assures global perception and interaction.

Begun in 1995 as a standard for simulation and virtual reality, the VRML (Virtual Reality Mark-up Language) is strictly tied to HTML and therefore to the web-centric logic. With this language users, in the World Wide Web space, will be able to take a virtual tour of a place, inspect virtual catalogues or create things in a virtual space with virtual objects.

While scientists are expected to be the first users, developers have high hopes that adding a third dimension will be the key to the WWW's growth as a medium which can challenge television.

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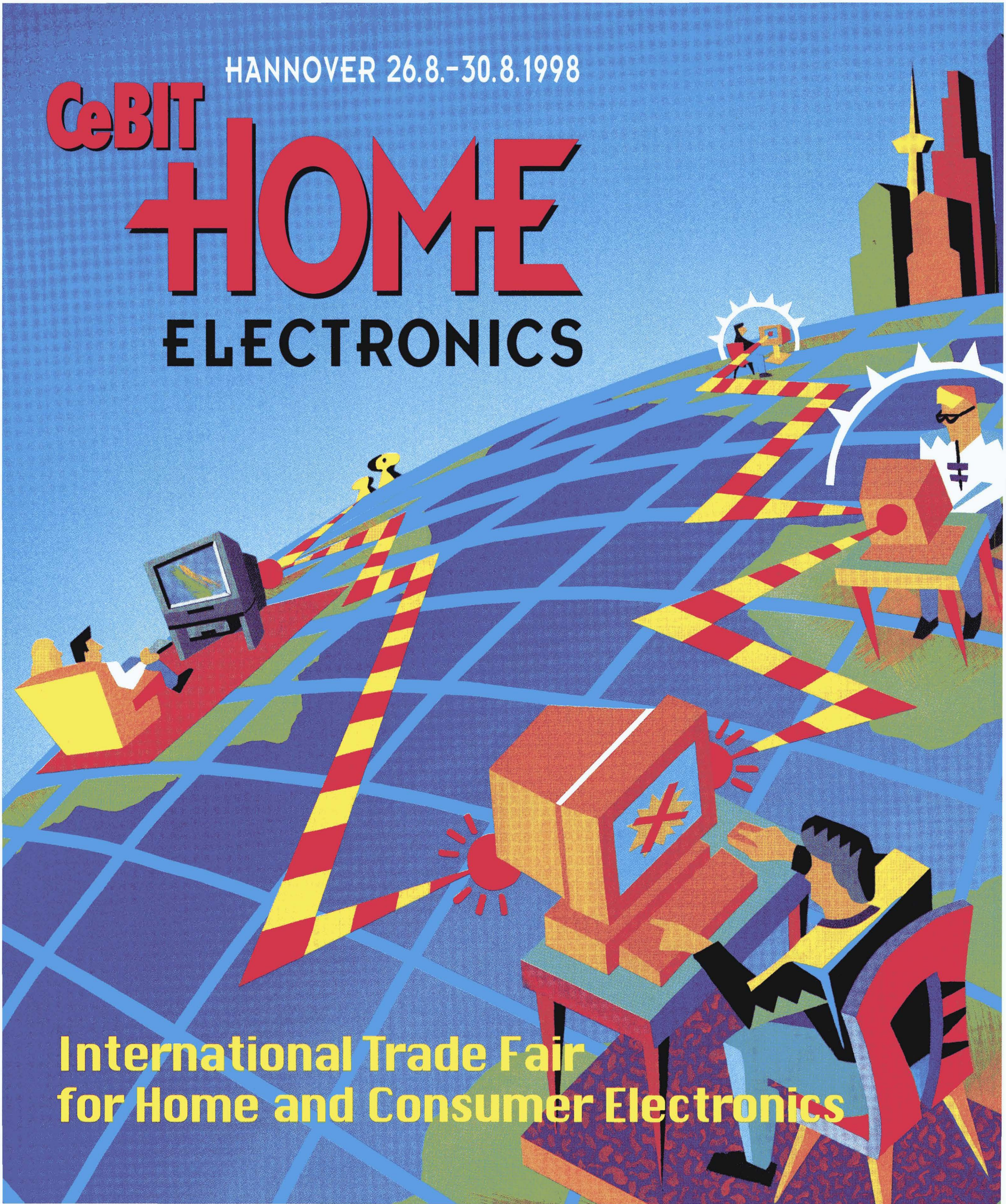
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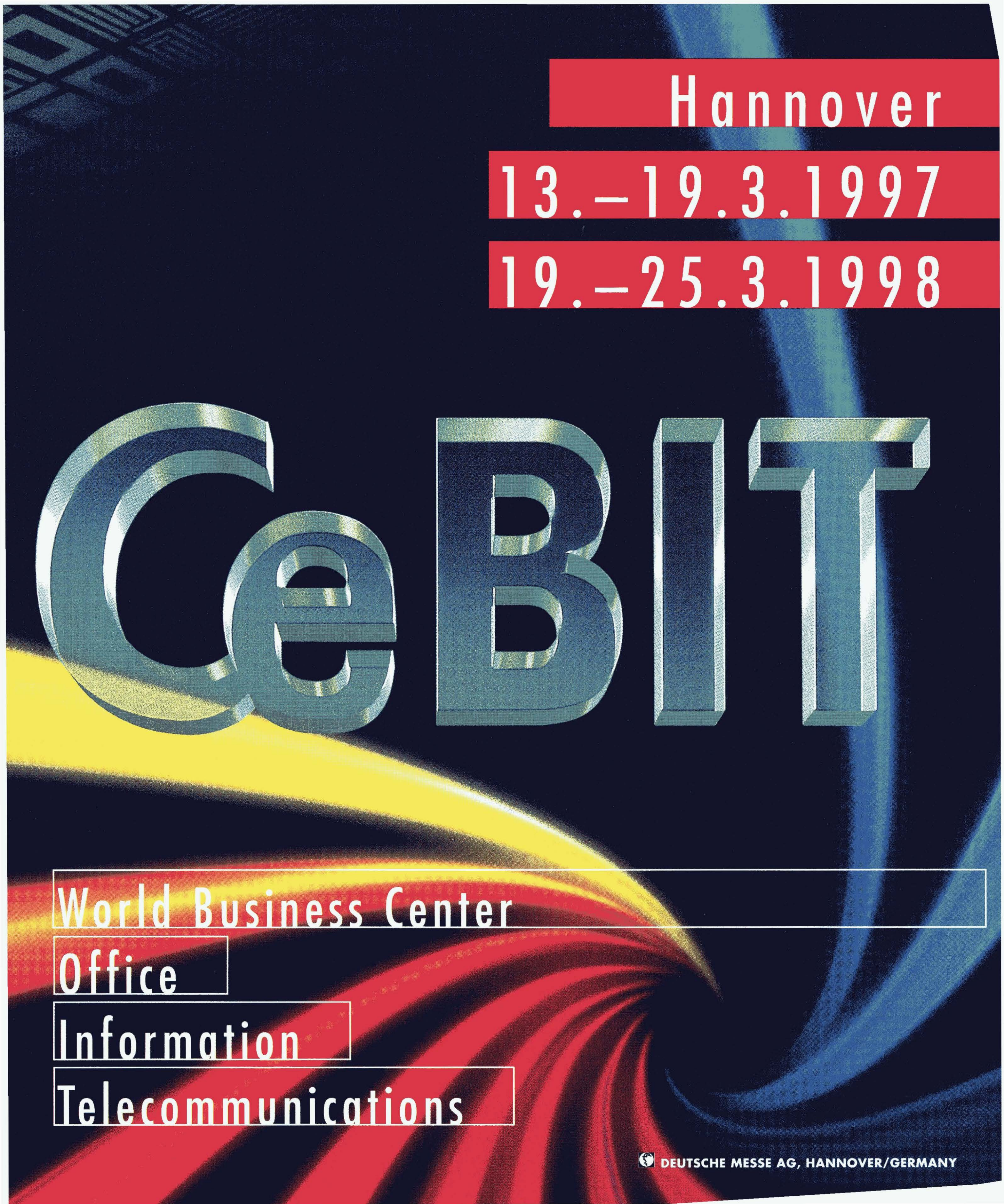
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CeBIT
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Part Two

The Future of the Internet

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1. Introduction

Approximately 68 million people worldwide were estimated to be using the Internet and online services by the end of 1996 and this number has doubled in size every year for the past five years (although precise estimates vary widely). A direct estimate of the size of the Internet, which is related to the number of users, is the number of hosts or computers connected to the Internet. *Figure 1* shows how the size of the Internet in terms of this measure has grown since 1993; the growth in the number of users in the same period is very similar. The Internet has been one of the fastest growing areas of the information and telecommunications technology market. The potential impact of the Internet on society and the economy has captured the imagination of the media, the public and politicians alike.

The Internet is a loose confederation of data transmission networks using a protocol called TCP/IP (Transmission Control Protocol/Internet Protocol). The Internet began as a military network with the creation of the US ARPAnet (Advanced Projects Research Agency) in 1969, then expanded to include US and, later, global academic institutions. However, it was not until the commercial Internet providers emerged at the end of the 1980s that growth really began to take off.

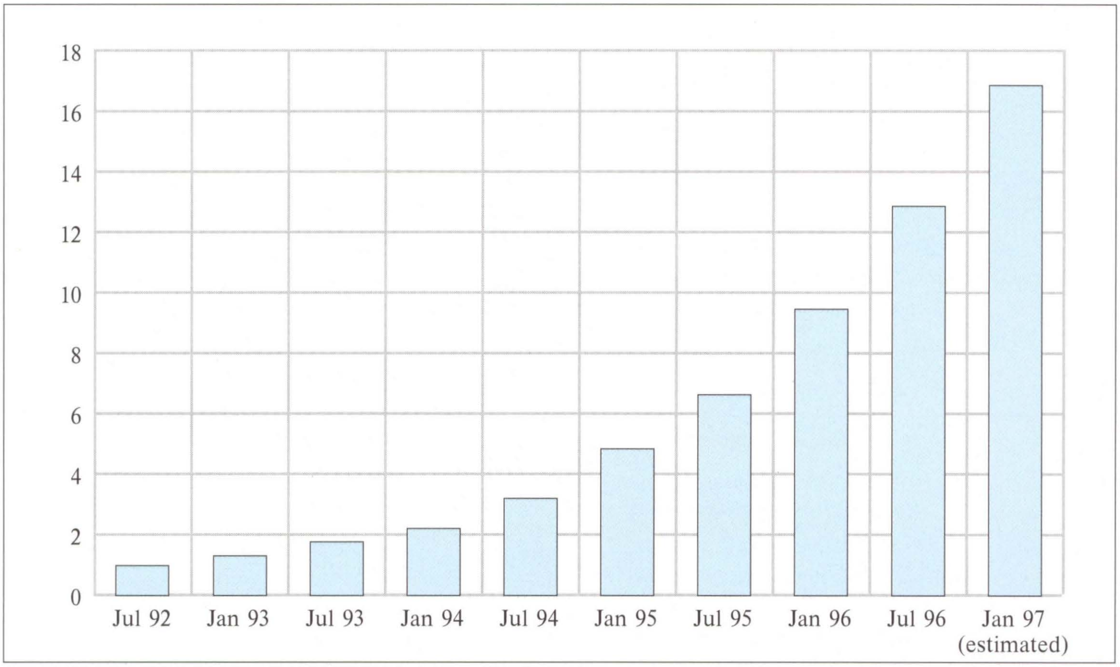
Growth is expected to continue at the same rapid rate in the short term, although in the medium term the growth rate will fall. Moreover, a number of important changes are happening in key areas of the market that will lead to a complete transformation of the Internet market:

- Internet software is becoming increasingly easy to use - World Wide Web (WWW) browsers offered a great improvement over previous text-based information retrieval software such as "gopher";
- new users from outside the academic and computing sectors, whose expectations have been raised by the media hype, are coming onto the Internet, and new types of applications are being developed;
- commercial transactions on the Internet are becoming more common, through applications of security software and the development of electronic payment systems;
- a commercial market structure for the Internet is emerging, and the roles of service providers and software developers are changing.

As *Figure 2* shows, the range of applications is constantly growing: early use was for e-mail and document exchange, using file transfer protocol (FTP), although the latter was only possible through a command-line interface; more recently the development of the WWW, with its easy-to-use windows-based browsers has led to dramatic growth in both numbers of users and traffic as *Figure 4* shows.

This chapter examines how the patterns of Internet use are changing, and considers the driving forces, who is caught up in this transformation and the technological limitations on its development. It then looks at some key aspects in detail: corporate use of the Internet,

Figure 1
Worldwide Growth in the Use of the Internet: Number of Internet Hosts (Millions), 1992–1997



Source: Network Wizards, http://www.nw.com and Analysys

Figure 2
Evolution of Internet Services

E-mail Telnet FTP	WWW	GOPHER WAIS (Wide area searching)	Mbone (Multicast video network)	WWW browsers	VRML (Virtual reality) Java Voice over the Internet	Internet to PSTN telephony
1972	1989	1991	1992	1993	1995	1996

existing pricing structures and the need to change them, and security - concerns about which are currently limiting growth - and the convergence of the information technology (IT), telecommunications and media markets. Finally, the likely patterns of growth to the year 2000, the potential for the development of a mass market, and the use to which the Internet is being put in different sectors of the economy are discussed.

2. Internet Segments and Trends

In spite of its spectacular growth over the past few years the Internet is still only at the beginning of its development. This section considers the factors which have contributed to the development so far, the constraints which now have to be overcome and the forces which will drive future development.

The Internet industry can be divided into three segments:

- infrastructure (including Internet service provision and servers);

Table 1
US Internet Revenue by Category, 1995 and 2000 (Million ECU)

Internet Segment	Service/Product	1995	2000
Infrastructure (direct revenue)	Data networking equipment	1,300	6,300
	Internet security	160	800
	Internet service provision	300	4,000
Infrastructure (indirect revenue)	Telecommunications services	600	1,600
	Telecommunications equipment	200	800
Software	Applications software	500	2,000
	Enterprise and networking software	160	1,600
	Online services, consulting, etc.	80	500
Content	Content aggregation	1,200	4,800
	Information and advertising	80	4,000
	Publishing (print and electronic)	40	800
	Commerce and transaction processing	160	4,000

Source: Morgan Stanley, February 1996

- software and services (including WWW clients, Java, and search engines);
- content origination and organization.

These segments can be divided further into the classes shown in *Table 1,* which demonstrates the estimated Internet-related revenue in the USA for these categories in 1995 and 2000.

Until as recently as 1995 the development of the Internet was dominated by the provision of its infrastructure. Since then, software and services have developed dramatically, but the provision of content is lagging behind in terms of maturity and commercialisation.

However, in future content will become one of the most important parts of the Internet market. Infrastructure will remain important but its products will become commodities with low profit margins. Similarly, software and services will become standard offerings and margins will fall, though not as far as for infrastructure.

2.1. Initial Drivers of the Internet Industry

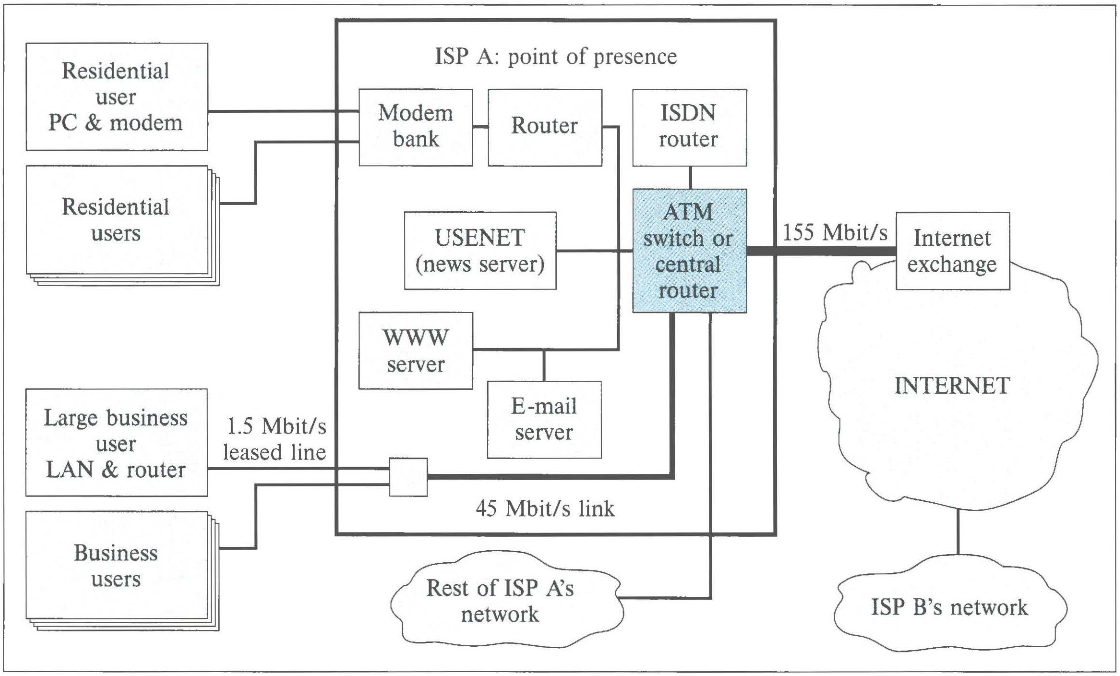
Initial growth was driven by the rapid development of Internet infrastructure, which depended on:

- the cost both of becoming an Internet service provider and using the Internet;
- open network interconnection and an open standards development process.

These factors also led to the initial development of software and services, but are no longer sufficient for this to continue.

The low cost of entrance into the Internet market, and for new Internet service providers (ISPs) in particular, is one of the major reasons for the phenomenal growth of the Internet. Barriers to entry and exit were very low in the early stages of the commercial development of the Internet and this encouraged a proliferation of service providers who promoted Internet

Figure 3
Architecture of a Typical US ISP



usage and passed on their low costs in the form of low flat rate charges. The Internet also benefited from its origins in the academic community, with much of the development of the initial backbone infrastructure being funded through government subsidy of the academic community. This also created low performance expectations.

The architecture of a typical ISP is shown in *Figure 3*. The major costs for ISPs are IT hardware (servers, routers and modems), and telecommunications costs (usually a leased line or virtual network). One of the prime reasons for their low costs is open network interconnection and resource sharing: each network transports the traffic from neighbouring networks free of charge, thus eliminating the costs of measuring interconnect traffic and billing other ISPs. Networks exchange traffic at an Internet exchange and connect to Internet backbones, and pay a relatively small annual fee for this service.

However, the institutional arrangements for the provision of Internet exchange facilities and backbone capacity have changed over the past two years. The US government used to sponsor the main Internet exchange and backbone facilities in the USA through the NSFNET (National Science Foundation Network), and these facilities were therefore provided on a non-profit basis until decommissioning began in 1995. They are now provided by commercial public network operators (PNOs), leading to an increase in the capacity of the main Internet backbone. For example, in the USA in 1986, when the NSFNET was set up, this capacity was 56 kbits/s and had reached 45 Mbits/s in 1993; it was then increased to 155 Mbit/s by the commercial operators who took over running the backbone in 1996.

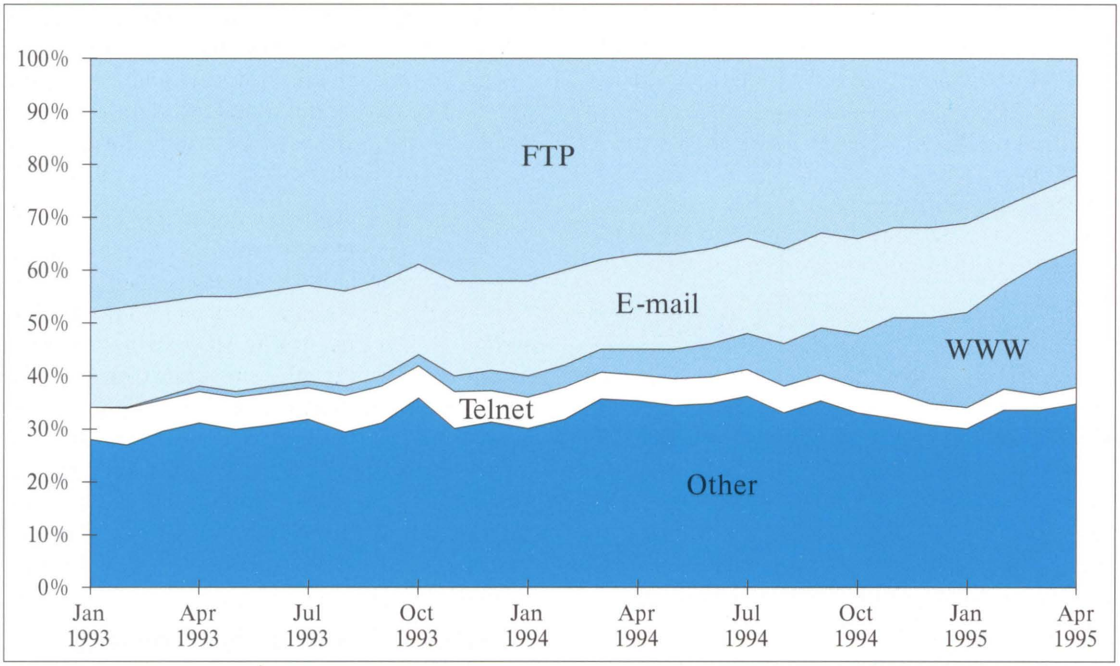


Figure 4
Percentage Share of Internet Traffic by Application, 1993-95

Source: Merit, May 1995

Note: data post-April is not available because the information has not been collected by the commercial companies who took over the provision of Internet backbone capacity in the USA following the decommissioning of the NSFNET backbone.

In a short space of time, the Internet has been transformed from a network servicing mainly the academic and research community to a commercial communications network. Performance expectations have risen and the industry is becoming more concentrated as the larger firms take a higher share of the market. Barriers to entry into the market are rising, as are the barriers to exit. At a general level the interconnect framework may stay the same, but the PNOs may also offer special access to facilities guaranteeing, for example, greater reliability and functionality, but at a higher price.

2.2. Current Constraints

In the previous phase of the Internet's development (1990-95), several aspects of its performance were underdeveloped because at that stage the factors affecting those aspects were not perceived as being important. Now, however, the Internet is moving into a new phase and these aspects are becoming constraints, in particular:

- network reliability and quality of service, due to congestion and inherent design features;
- lack of a charging framework to allocate resources efficiently;
- poor facilities for commerce over the Internet, such as security and validation.

2.2.1. Network Capacity and Reliability

As Internet applications become more exciting and easier to use, they require more bandwidth. In particular, multimedia applications need more local-access bandwidth than is currently considered affordable by an average consumer. As users integrate the Internet into their lives and become more dependent on it, they become less tolerant of not being able to make the connections they need.

In the space of two years, since the development of the first windows-based WWW browser, the volume of WWW-related traffic on the US Internet backbone overtook that of e-mail and FTP traffic (see *Figure 4*). New software applications for the WWW are emerging rapidly and browser functionality increases every month as competing software providers battle for market dominance. New software developments from other companies are quickly incorporated by the leading browser producers.

The latest WWW browsers incorporate formats for interactive graphics and video, while Virtual Reality Modelling Language (VRML) allows browsers to view three-dimensional landscapes. The next generation of browsers will have Internet telephony built in, and commercial services allowing Internet telephony users to call ordinary telephone subscribers are emerging (see Section 3).

Internet networks are currently designed for congestion - that is, provisioned on the basis of average use - unlike telephony networks which are designed to cope with peak demand. The new developments listed above will increase the traffic generated by each WWW user, and so the incidence of congestion in Internet backbone networks will rise. ISPs do not make quality of service guarantees and will only upgrade their networks if it makes commercial sense. One way of dealing with congestion is to move to a more usage-sensitive charging system. The issues surrounding this are discussed in more detail in Section 6.

2.2.2. Framework for Resource Allocation

The mechanism for ensuring appropriate investment in the Internet backbone is not yet in place, although the transition from publicly-funded academic networks bartering resources to commercial networks operating on free market principles is under way. Major long-distance operators in the USA are providing an Internet backbone as a means of establishing a leading position in a new marketplace, and more and more commercial ISPs are arranging their own, leased backbone links independently of the major Internet backbone providers, for example high bandwidth lines from the UK to the USA.

In addition, some of the major players are discussing mechanisms for calculating transfer payments, particularly for transatlantic traffic. This would allow greater capacity on the busiest routes for Internet traffic to be provided on a more economically efficient basis. Currently the majority of transatlantic traffic is from Europe to the US giving US ISPs little incentive to invest in additional capacity. This will change, however, when most hosts and content are established in Europe, and will add impetus to the movement towards a system of transfer payments.

2.2.3. A Framework for Commerce

It is taking time to establish a framework for conducting business and commerce using the Internet, chiefly for the following reasons:

- As a result of the Internet's military and academic origins, early Internet users expect information to be free. Only recently have users started to demand software and services for commercial use and, as a result of the commercialisation of the Internet, the industry may move from flat-rate to usage-based charging, and therefore heavier users of services may have to pay more in the future.
- Electronic financial transactions have been slow to develop, as there has been no reliable mechanism for trading on the WWW. The perceived risk is higher than for traditional transactions and that must be addressed, whatever the real risk may be. One potential solution is for the credit card companies and banks to guarantee the user against loss due to Internet fraud.

- The unreliability of the network discourages serious commercial use. While the network is mainly for recreation and academic research, the problems are tolerable, but if the Internet is to be the centre of a business strategy, its reliability must be perceived to be much higher.
- The current charging mechanism for Internet use is too inflexible for real-time applications, which can use Internet resources more efficiently through time- or usage-based charging.
- Despite the Internet's long history, it is still a relatively recent phenomenon as a mass communications medium and, as yet, it has not established a reputation for reliability, capacity and security. However, there have been substantial advances in all these areas recently and the Internet will have to demonstrate that it can sustain this improved level of performance in order to change public perceptions and engender public confidence.

2.3. Future Drivers

Future development of the Internet will be greatly facilitated once these constraints are overcome. The most important driver of the Internet in the residential market is likely to be the convergence of the IT, media and telecommunications industries and, in the business market, the development of intranets.

The convergence of the IT, media and telecommunications industries is occurring as a result of the use of digital technologies. There is, potentially, a huge market for the delivery of existing products such as books, records, and films over telecommunications networks and new services such as collaborative work, remote delivery of expertise and interactive videogames. The Internet will act as a catalyst for convergence because it already allows the electronic distribution of digital media. For example, a number of companies in the IT and consumer electronics fields have introduced terminals which combine Internet-capable personal computers (PCs) with TVs, video cassette recorders (VCRs) or video games consoles.

Intranets are currently seen as another major growth area, as companies take advantage of the comparative cheapness and simplicity of Internet related equipment and software to provide corporate network facilities. This technique also allows a small or medium-sized enterprise (SME) to afford corporate network services, where previously it would not have been able to.

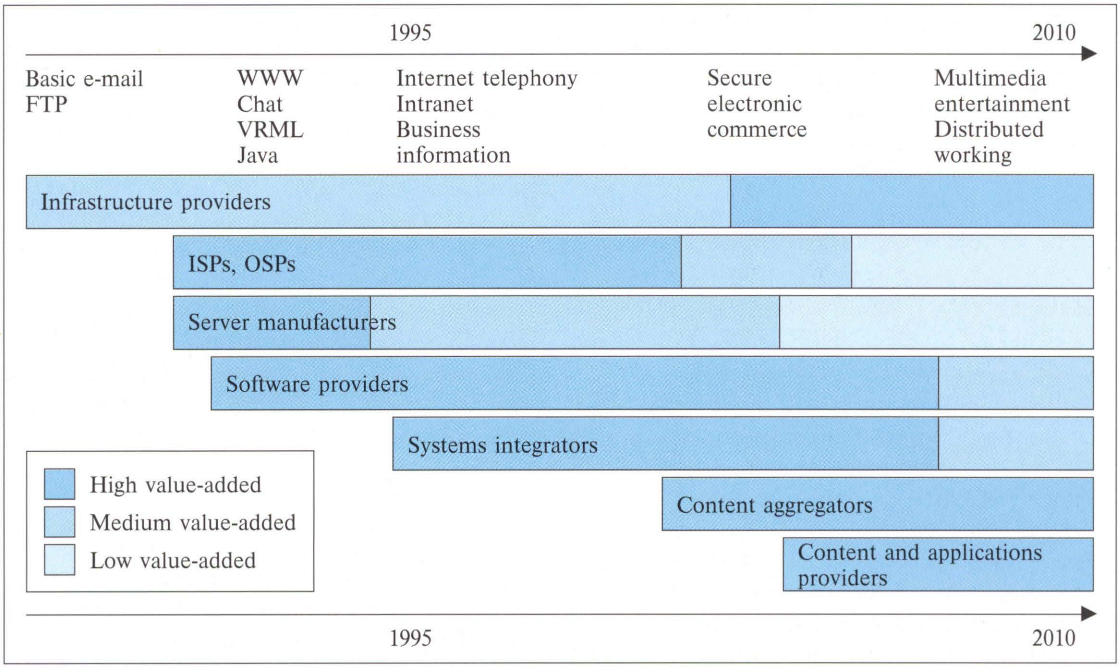
3. Key Players

Because the commercial Internet is only just beginning, the structure of the market for infrastructure and Internet service provision is still fluid. The key areas for adding value and making profits will change as the Internet and its services develop. The companies which are currently dominating the market will need to redirect their efforts as the market structure changes, if they are to maintain market leadership.

As a result of the fluid structure and the low barriers to entry, it is currently easy to move into higher-value business areas. For example, skills are easily transferred between technical areas such as telephony and Internet service provision. Markets for content aggregation and provision are in their infancy, which offers great potential for early movers, particularly those which already have access to content. However, the rapid innovation in each market segment will start to raise barriers, and it will become increasingly difficult to switch specialisms.

Figure 5 illustrates how market dominance will move between players, in response to the development of new applications and the development of electronic commerce.

Figure 5
Importance of Internet Segments at the Internet Develops



PNOs and cable TV companies are currently the main providers of infrastructure. These companies are moving into Internet service provision, providing competition for the ISPs and online service providers (OSPs). The main Internet segments open to equipment vendors are infrastructure and service provision, providing markets for telecommunications equipment, servers and terminals.

The rest of this section looks at the different existing players, although their roles in the Internet market may change in the future.

3.1. Public Network Operators

Until recently, PNOs played a passive role in the Internet: ISPs leased PNO lines to form the networks that made up the Internet, and dial-up users made local phone calls to connect to their ISPs.

The Internet represents both a strategic threat and a potential opportunity for PNOs. They are faced with a choice of cannibalising existing revenue streams now or failing to establish a position in the new Internet market. On the one hand, the cost-based, low-margin pricing structure of the Internet will put pressure on their high margins for long-distance calls, which they have managed to maintain in spite of falling prices due to increased competition and falling unit costs. On the other hand, many PNOs have realised that the Internet may be a high growth, high value market and are now providing both backbone Internet transmission and Internet service.

For example, in the USA, the Regional Bell Operating Companies and long-distance providers have started providing Internet access services. One service gained 300,000 customers in four months with a particularly attractive discount deal. Similarly, in Europe six national

Table 2
Telecommunications Main Lines (Thousands), 1995–2000

	1995	1996	1997	1998	1999	2000	CAGR '95-2000 %
France	31,825	32,652	33,480	34,332	35,195	36,082	2.5
Germany	43,144	45,816	47,626	49,323	50,910	52,376	4.0
Italy	24,854	25,483	26,142	26,917	27,815	28,842	3.0
Spain	15,095	15,651	16,231	16,861	17,542	18,273	3.9
UK	29,488	30,416	31,324	32,206	33,069	33,920	2.8
Rest of Western Europe	59,642	61,828	64,349	66,962	69,595	72,248	3.9
Western Europe	**204,049**	**211,847**	**219,151**	**226,603**	**234,124**	**241,741**	**3.4**
Eastern Europe	61,121	64,780	68,736	72,670	76,789	81,043	5.8
Total Europe	**265,170**	**276,627**	**287,888**	**299,273**	**310,913**	**322,784**	**4.0**
USA	152,893	159,608	165,589	173,503	180,895	187,402	4.2
Japan	61,663	62,677	63,817	65,130	66,650	68,420	2.1
Rest of World	207,292	243,585	277,390	312,557	349,644	387,851	13.3
Total World	**687,018**	**742,497**	**794,684**	**850,463**	**908,102**	**966,457**	**7.1**

Source: EITO Task Force

PNOs began to provide residential Internet access in 1996. PNOs are also announcing plans to provide "high-quality" Internet transport services to ISPs, for whom quality is becoming an important differentiator.

If the Internet does become a mass market service, there is a great opportunity for PNOs because of the large number of lines already installed, (estimated to be five times the forecast number of Internet users in 2000) as shown in *Tables 2* and *3*.

The dilemma for PNOs has been thrown into sharp relief by the development of Internet telephony. Using Internet telephony, a subscriber connected to the Internet can make long-distance and international calls for the price of a local call plus the subscription to the Internet telephony service provider. Given improvements in quality and standardization, Internet telephony could therefore represent a major threat to the PNOs and their current price structure for telecommunications. To encourage Internet telephony would directly undermine roughly 80% of PNO revenues, yet to ignore it would risk losing this market to competitors.

However the threat to PNOs from Internet telephony may have been overstated. First, if usage-based charging is introduced for basic Internet access, the cost of Internet telephony will rise. Secondly, as Internet telephony grows, it will increase the traffic load on the Internet. New capacity will have to be introduced to maintain a reasonable quality of service, so the price of Internet access and, as a result, Internet telephony will rise to be nearer to telephony prices. While there is no doubt that the PNOs' long-distance telephony prices are much higher

Table 3
Telecommunications Digital Main Lines (Thousands), 1995–2000

	1995	1996	1997	1998	1999	2000	CAGR '95-2000 %
France	29,890	32,652	33,480	34,332	35,195	36,082	3.8
Germany	28,235	39,553	47,592	49,323	50,910	52,376	13.2
Italy	18,787	20,951	22,391	24,191	25,991	27,791	8.1
Spain	8,559	9,610	10,710	12,060	13,500	14,940	11.8
UK	26,153	28,583	31,103	32,206	33,069	33,920	5.3
Rest of Western Europe	41,306	46,719	52,100	57,321	61,838	65,745	9.7
Western Europe	**152,930**	**177,707**	**197,375**	**209,434**	**220,503**	**230,854**	**8.6**
Eastern Europe	10,971	15,723	20,973	26,357	32,003	37,850	28.1
Total Europe	**163,901**	**193,430**	**218,348**	**235,790**	**252,506**	**268,704**	**10.4**
USA	123,996	136,624	147,871	160,491	171,488	181,593	7.9
Japan	56,535	61,215	63,817	65,130	66,650	68,420	3.9
Rest of World	151,008	187,838	226,068	265,412	305,870	347,645	18.1
Total World	**495,440**	**579,107**	**656,105**	**726,822**	**796,514**	**866,362**	**11.8**

Source: EITO Task Force

than their costs, this only creates a short-term advantage for Internet telephony. In the long term, its success will depend on whether the underlying costs are lower than those of the traditional telecommunications network, and this is difficult to judge at present.

3.2. Cable TV Companies

Many cable TV companies face an uncertain future because of competition in their core business from digital broadcasting and satellite technology. Some have therefore embraced the Internet as another source of revenue growth by becoming ISPs, and the development of cable modems has reinforced this trend. Cable modems allow information to be downloaded from the Internet at speeds of, for example, 10 Mbit/s, which is sufficient for video and multimedia.

A number of cable companies in the US and Europe will offer high-speed Internet access by 1997, at which time standardized cable modems are expected to be available. Although some technical problems still need to be overcome (as discussed in Section 4), the high speed of the cable modems could give cable companies a significant advantage at the moment, although all service providers are currently experimenting with high speed access technologies.

The cable companies plan to offer packaged content together with Internet access, in the same way as the current online service providers (OSPs), as described in the next section. The potential market for Internet access over cable TV networks is much smaller than that over PNO networks and is illustrated in *Table 4.*

Table 4
Cable Television Subscribers (Thousands), 1995–2000

	1995	1996	1997	1998	1999	2000	CAGR '95-2000 %
France	1,950	2,153	2,377	2,625	2,898	3,199	10.4
Germany	16,800	17,600	18,300	19,100	19,900	20,800	4.4
Italy	0	30	38	48	60	76	N/A
Spain	300	384	492	629	806	1,031	28.0
UK	1,420	1,700	2,000	2,300	2,600	2,900	15.4
Rest of Western Europe	18,640	19,469	20,171	20,778	21,319	21,830	3.2
Western Europe	**39,110**	**41,336**	**43,377**	**45,479**	**47,582**	**49,836**	**5.0**
Eastern Europe	7,040	8,237	9,504	10,781	12,105	13,602	14.1
Total Europe	**46,150**	**49,573**	**52,881**	**56,260**	**59,688**	**63,438**	**6.6**
USA	62,956	63,000	63,300	63,900	64,400	64,800	0.6
Japan	2,680	3,220	4,290	5,910	8,060	10,000	30.1
Rest of World	63,986	72,657	83,064	94,996	108,722	120,574	13.5
Total World	**175,772**	**188,450**	**203,535**	**221,067**	**240,870**	**258,812**	**8.0**

Source: EITO Task Force

3.3. Online Service Providers

For many years, from the early 1980s, OSPs offered a variety of services online over proprietary networks. They provided content (news, entertainment and information) and online discussion fora which were open to subscribers to their services, but closed to the rest of the Internet. Users had special software and dialled a local node to make a connection to the OSP server on which all mail and content was stored. Following the dramatic rise of the WWW, this business model became outdated and OSPs now provide full access to Internet including e-mail and the WWW and have switched to using WWW browsers as their interface to content. In doing so they have effectively become ISPs.

However, the OSPs do still retain some advantages over the ISPs. They have the only established business in commercial content provision on the Internet, and have been very successful in building customer-generated content through private newsgroups and discussion fora. They are now positioning themselves both as communities of interest within the Internet through content aggregation and as ISPs. Moreover, their subscriber growth is still very strong and likely to remain so for a few years. However, OSPs face threats in two main areas: as electronic commerce develops, the big publishing and media companies will enter the market; and PNOs have a cost advantage in providing Internet access. OSPs are in danger of being squeezed out of an increasingly competitive market.

3.4. Internet Service Providers

ISPs offer connectivity to the Internet to individual and corporate users. They do not provide their own content like the OSPs, but many of them are now offering WWW space for their subscribers. (A typical ISP network was illustrated in *Figure 3*.)

Internet service is a high growth market with low barriers to entry - set-up costs can be as low as 60,000 ECU. This attracted many, typically small, companies into the market at the beginning of the commercial Internet. Currently there are an estimated 4,000 ISPs worldwide, and this number is still growing. The enormous growth rate meant little competitive pressure and some companies have focused more on growth rather than quality of service.

However, the structure of the market is now changing:

- PNOs and OSPs are becoming Internet service providers;
- ISPs are merging and the industry is consolidating;
- new charging systems between ISPs are being established which favour larger companies.

The most important threat to ISPs comes from the PNOs who are becoming ISPs, as discussed in Section 3.1. The PNOs' strengths lie in their ubiquitous networks, established customer relationships and billing systems, and their economies of scale in backbone network provision. The OSPs are particularly strong on customer support for new users. The two market leaders have a total of over 11 million customers worldwide, although their system of charging for time online discourages heavy users.

Some ISPs are consolidating through takeovers and mergers with other companies in the sector to gain economies of scale, and are offering global Internet access: for example, the leading ISP worldwide merged with a PNO in June 1996. Quality of service is becoming an important selling point as users become more demanding. Small ISPs are cultivating local Internet communities and forming alliances to buy backbone transmission at lower rates, while some large ISPs are cutting off smaller rivals which depend on their networks.

ISPs' costs are changing, as the Internet becomes more commercial. A major change is the trend away from bartering network capacity, instead establishing a system of settlement payments based on the cost of transporting each other's traffic. This is favouring the larger ISPs who can get access to backbone network transport (or build their own) at a lower unit cost than the smaller ISPs.

3.5. Software Developers

The three most important types of company in this category produce:

- client and server software (web browsers, VRML viewers, Internet telephony software, etc.);
- software for Internet security, particularly for secure electronic commerce and for protecting sensitive company information;
- software for organizing the enormous variety of content on the WWW.

Software development is a highly innovative and risky section of the market. Both Netscape and Microsoft aim to provide a platform for everything done on the WWW, and have established a lead in providing browsers for people to "surf" the WWW and software to run servers to publish information on it. However, the tremendous pace of change and the open standards of the Internet mean that, to maintain their lead, these companies are having to spend heavily on development and on buying-in innovations, while being uncertain about which ideas will be successful.

For example, an important innovation in client/server software is the development of Java, which allows programs to be downloaded as required. This was developed by Sun Microsystems, a workstation manufacturer, and was originally seen as a challenge to the dominance of client/server computing and the PC. However, PC software manufacturers have licensed Java and will try to incorporate the approach into their existing portfolio of products.

The leading WWW software companies are also licensing existing technology for secure (encrypted) transmission of information over the WWW, and a number of smaller companies are developing firewall software to protect corporate information centres. Security is discussed further in Section 7.

3.6. Equipment Vendors

For equipment vendors the Internet is an important opportunity, with the rate of growth of Internet subscribers creating a fast-growing market for Internet-related equipment. A few providers have dominated the equipment market for Internet infrastructure such as routers, servers, and networking equipment. However, the market has developed so quickly since the beginning of the decade that many typically small companies have become established through pioneering new technologies and exploiting market niches.

In the past two years, two further trends have become apparent. First, many larger companies have become aggressive acquirers of smaller companies in order to expand their product range and maintain their technological lead in the market. Secondly, manufacturers which previously specialised in Internet-related equipment are developing products for the wider telecommunications market. The main driver of this has been the deployment of telecommunications switching technology, in particular ATM-based routing in ISP networks. The leading vendors in this segment of the market are now gaining market share in the telecommunications switching market.

Currently, the principal areas of the Internet equipment market are:

- **routers,** one of the largest parts of the Internet equipment market. Router manufacturers are now increasing the capabilities of their equipment, in response to customer demand and the threat of asynchronous transfer mode (ATM) technology. Some ISPs installed ATM products because the existing generation of routers was unable to match their immediate needs for capacity;
- **servers,** a market dominated by UNIX™ machines. PC-based servers are now increasing in popularity because of the installed base of PCs and the fact that they have stronger security features than UNIX servers. Even so, PC-based servers represented less than 2% of the market in 1996;
- **network computers,** minimal PCs with no hard disk or installed software (apart from the WWW browser), with programs being downloaded on demand. However, these depend on cheap, reliable downloading which is not yet available to those users who might want to save on the cost of a PC;
- **specialized terminal equipment** for the mass market, based on either PCs or TVs. A number of companies are developing integrated PC-TVs which can display broadcast television and Internet applications simultaneously, while others are developing set-top boxes to provide the same functionality with ordinary TVs;

- **services.** Some vendors which had established network services before the rise of the Internet are developing a range of services: Internet access, Internet systems integration, providing software and services for electronic money systems.

3.7. Content Providers

The very low barriers to entry in content provision make this segment very open, so the key players of the future may be unknown at present. Moreover, the low barriers to entry will enable a huge number of small content providers to co-exist with the large traditional publishers and OSPs who may play major parts in the future market.

OSPs have been providing content for their subscribers on proprietary networks, but content creators are now using the WWW instead. The OSPs are trying to reposition themselves as content programmers open to the whole Internet, hoping their brand image will give them an advantage in this market over traditional publishers.

Traditional publishers are experimenting with WWW distribution, although they are more cautious, as they want to develop their WWW products without damaging their existing markets. However, the fact that they have already adapted to new technologies such as video and CD-ROM shows that they are responsive to new technologies.

The growth of the WWW is leading to a new type of content provider. Companies using software to "crawl" over the WWW (i. e. cataloguing WWW sites) and index its content are currently being floated on the stock markets for phenomenal sums, far higher than their revenues (which come from advertising) seem to warrant. It is clear that organizing information tailored to each user is likely to become a major business area in the future.

4. Access Technologies

As discussed in Section 2.2, as the range of multimedia content on the WWW develops, the constraints of conventional access methods become a problem. This, rather than the capacity of the backbone network, is the limiting factor on the development of multimedia over the Internet. Ordinary modems on the telephone network are capable of dealing with e-mail and text-based applications, but the graphics on WWW pages are already causing problems for such users. Access speeds of between 9.6 kbit/s and 28.8 kbit/s are sufficient for most current uses, but video and high resolution image transfer is likely to require 2 Mbit/s or more, although this does depend on the relative progress in the development of video compression compared with high-speed access.

Currently most residential users dial up their ISP over the public telephony network using a modem at speeds of 14.4 kbit/s to 56 kbit/s. Those prepared to pay more can use Basic Rate Integrated Services Digital Network (BR-ISDN), increasing the speed to 64 kbit/s or 128 kbit/s. Companies with local area networks (LANs) usually access the Internet via a much faster leased line, but this is shared between users – individuals may only see similar response times to residential users. Other access technology alternatives which have not been widely deployed at present are Asymmetric Digital Subscriber Loop (ADSL), cable modems and fibre access. These technologies are supplied by different types of provider and will be largely user specific. *Table 5* shows the suppliers and user types associated with different access technologies. A more recent development is the deployment of different systems for Internet access using satellite technology, beginning in the USA and now being introduced in Europe.

Table 5
Suppliers and Users of Different Access Technologies

Technology	Suppliers	Typical User	Typical Access Speed
Optical fibre	PNOs	Business and residential	2 Mbit/s and above
Wireless	PNOs, mobile communications operators	Residential, mobile workforce	128 kbit/s
Cable TV modems	Cable TV operators	Residential	2 Mbit/s to 10 Mbit/s (one-way)
ADSL	PNOs	Business	2 Mbit/s to 6 Mbit/s (one-way)
BR-ISDN	PNOs, cable TV operators	Business and residential	64 kbit/s to 128 kbit/s
Dial-up PSTN + modem	PNOs, cable TV operators	Residential	9.6 kbit/s to 33.6 kbit/s

Local access speeds are not the only constraint. Often the bottlenecks arise somewhere else in the Internet, for example at the point of interconnection with another network. For multimedia over the Internet to be a commercial proposition, affordable high-speed access for users, and investment in high-speed routers and communications links by ISPs are both required. However, the increasing capacity of ISP networks would have a much smaller impact on end-user charges than increasing access capacity.

Figure 6 shows the main existing alternatives for Internet access technologies and their telecommunications costs in relation to dial-up access (including installation and annual running costs).

4.1. Asymmetric Digital Subscriber Loop (ADSL)

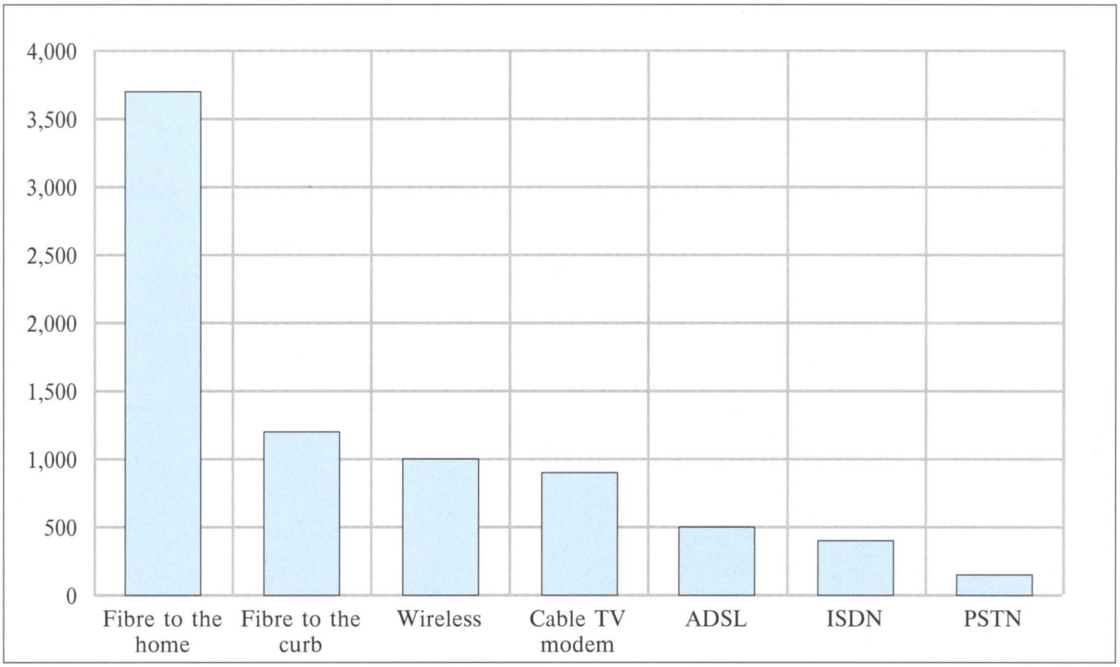
ADSL allows delivery of up to 6 Mbit/s over ordinary phone lines (compared to a potential 128 kbit/s using BR-ISDN). However, this increase in capacity is asymmetric – it only applies to traffic flowing to the customer – as it was developed to deliver interactive TV. Its advantage for the Internet is that it can be deployed quickly, and can deliver the bandwidth to users who want it, without the need to upgrade the whole network. However, ADSL is subject to certain technical limitations and therefore is not available everywhere.

ADSL uses higher frequencies than ordinary voice telephony, therefore allowing a higher transmission rate, and a special modem is installed at each end of the line. These are currently expensive but would become much cheaper if they were mass produced. However, not all phone lines are suitable for the technique: long or poor quality lines cannot carry the high frequencies. Nevertheless, ADSL offers a low-risk technology for developing the market for high speed services until the network can be upgraded.

4.2. Cable Modems

Coaxial cable TV networks are already broadband in one direction (to the customer), and cable modems allow them to be used for the Internet. Speeds of 10 Mbit/s from network to user is possible, while users can send data at 64 kbit/s to 1 Mbit/s. Currently, cable modems can be produced for $ 300, about the same price as ADSL modems. This covers the cost of both

Figure 6
Annualised Cost of Internet Access Technologies, 1995 (ECU)



Note: annualised cost is the sum of operation costs, maintenance costs and average annual capital costs.

the subscriber equipment and the additional equipment (including modems) needed by the cable operator which will be shared among many users.

Cable TV companies offering high-speed Internet access can benefit from a synergy with their expertise as content distributors. Some cable TV companies have announced a full commercial offering from late 1996 or early 1997.

However, there are a number of disadvantages. The penetration of cable TV networks varies greatly from country to country, as does the amount of upgrading needed to offer Internet services. Cable TV networks are designed to work in one direction only and have to be restructured to handle the two-way traffic. Even networks which are already capable of offering voice telephony would need more capacity because of the extra volume of traffic.

4.3. Optical Fibre and Hybrid Optical Fibre Local Access

Optical fibres are generally considered to be the long-term solution for high-speed local access, as they can deliver access at speeds of 2 Mbit/s or above. However, they are expensive, mainly because of the cost of physically replacing existing copper wires with fibres. This cost varies tremendously depending on local conditions. Some parts of Europe have invested heavily in experimental optical fibre networks and they can offer high-speed Internet access over these networks. Some cable operators building new networks have used hybrid optical fibre networks. Nevertheless, most operators are unlikely to invest in such radical changes without a proven market to justify it.

4.4. Wireless Internet Access

Wireless networks can currently support access rates higher than 64 kbit/s for voice telephony services through statistical multiplexing - several users can share the same "channel" transmission link because they do not generally all want to use the channel at the same time. However, the calling patterns of Internet users are different to those of voice telephony callers, with Internet user calls being, on average, much longer than voice telephony calls. For example, in a recent study by a US local exchange carrier the average length of an Internet user call was measured at 19 minutes, compared with 4 minutes for a telephony call. This means that the potential to multiplex statistically, or share resources between users, on wireless networks is much lower for Internet services than for voice telephony services.

Therefore, although high-speed Internet wireless access is technically possible, it is unlikely to be affordable to the average user in the foreseeable future, unless a technical solution is found to this hurdle. However, there are still opportunities for wireless Internet access in the near future, for two main reasons. First, it may be an economical alternative to other forms of Internet access both in areas with relatively low population density and where geographical features make the cost of providing fixed-link telecommunications access lines high. Secondly, consumers may be prepared to pay a premium for mobility, while accepting lower access speeds. This will be augmented by developments such as the expected adoption of a standard for data transmission at 64 kbit/s over GSM (Global System for Mobile communications) in early 1997. The number of mobile communications subscribers worldwide is forecast to grow to 320 million in 2000, as shown in *Table 6,* faster than the growth of fixed telecommunications services

4.5. ISDN

The use of BR-ISDN for Internet access - typically at 64 kbit/s, although 128 kbit/s is also possible - by the business and residential sectors is highly dependent on the total price users have to pay to access the Internet using BR-ISDN. This varies greatly across Europe, in line with the variation in PNO charges for BR-ISDN lines; the main variation is usually in fixed charges such as rental and connection. As a result, the use of BR-ISDN for Internet access has been strongest in countries like Germany, where rental and usage charges for BR-ISDN are most attractively priced. In the near future, the availability of modems giving access to the Internet at 56 kbit/s over the PSTN is likely to force PNOs to re-assess their ISDN pricing strategies.

In those European countries where pricing has promoted the take-up of BR-ISDN, the business market is mainly composed of SMEs, for which BR-ISDN represents a very cost-effective solution. By attaching or installing a router to the user's network, a LAN supporting many users can be connected to the Internet via ISDN.

High-usage residential Internet subscribers are also beginning to use ISDN to access the Internet. Until recently BR-ISDN had a considerable speed advantage over PSTN dial-up access, because the latter rate was limited to 28.8 kbit/s. However, Internet access rates of 56 kbit/s are now possible using the latest generation of modem technology and this may slow down the take-up of ISDN in the residential sector. The success of BR-ISDN will also depend on how other Internet access technologies, particularly ADSL and cable modems, develop, and on its price competitiveness.

Alternatively, the role of BR-ISDN access may be as a short-term transitional technology for Internet access, between dial-up PSTN

Table 6
Digital and Analogue Mobile Communications Subscribers (Thousands), 1995–2000

	1995	1996	1997	1998	1999	2000	CAGR '95-2000 %
France	1,375	2,300	3,800	5,500	7,300	9,000	45.6
Germany	3,767	5,600	7,550	9,600	11,800	14,100	30.2
Italy	3,923	5,820	7,400	8,800	10,200	11,500	24.0
Spain	944	2,550	3,800	4,800	5,700	6,500	47.1
UK	5,410	6,850	8,250	9,600	10,900	12,100	17.5
Rest of Western Europe	7,658	11,557	15,302	18,979	22,563	26,028	27.7
Western Europe	**23,077**	**34,677**	**46,102**	**57,279**	**68,463**	**79,228**	**28.0**
Eastern Europe	642	1,124	1,970	3,159	4,606	6,224	57.5
Total Europe	**23,719**	**35,801**	**48,072**	**60,438**	**73,069**	**85,452**	**29.2**
USA	33,786	43,500	54,000	65,500	77,500	90,000	21.6
Japan	8,053	18,000	24,000	28,000	31,000	34,000	33.4
Rest of World	21,916	36,250	52,528	70,565	90,105	110,887	38.3
World	**87,474**	**133,551**	**178,600**	**224,503**	**271,674**	**320,339**	**29.6**

Source: EITO Task Force

access and dedicated leased line access, as is the position of BR-ISDN in the UK. However, by 2000 the bandwidth requirements of an average business user are likely to exceed that of BR-ISDN. Despite the fact that the number of basic and primary rate ISDN connections may be equivalent to as much as a quarter of all existing telephony lines in the major western economies, most of these connections will be BR-ISDN connections. Primary rate ISDN (PR-ISDN) with 2 Mbit/s access may be too expensive for many businesses, which will look to other technologies such as ADSL for high-speed Internet access.

4.6. Satellite Internet Access

A number of different satellite communications systems exist which can all provide higher capacity alternatives than dial-up PSTN and BR-ISDN Internet access. These satellite communications services are geared to either the business market or the residential market.

Very small aperture terminal (VSAT) systems have been used for some time in the business market. Their principal benefit is that, for certain applications (particularly data transmission to multiple sites) and situations, they represent a lower-cost alternative for broadband communications than fibre optic cable. VSATs can be set up to provide one- or two-way communication; in Europe there are currently twice as many one-way VSAT systems as two-way systems. The bandwidth used depends on both the application and the price the user is willing to pay, but could range from 128 kbit/s to 40 Mbit/s.

VSATs were introduced more recently into the residential market, first for satellite TV broadcasting systems and then as a communications link for PCs, providing high bandwidth for the user in one direction. The PC system can already be used for Internet access. In the USA, 400 kbit/s access to the Internet is offered and the telecommunications charges typically amount to 500 ECU a year, while the Internet access charge is typically the same as for a dial-up PSTN and the price of the equipment is between 600 ECU and 800 ECU. Satellite Internet access can also be provided at 20 Mbit/s or more over these systems, although the telecommunications and Internet access charges would be correspondingly higher.

In the near future, some satellite TV broadcasters have announced plans to offer Internet access at bandwidth in excess of 10 Mbit/s over existing satellite TV systems using specially developed set-top boxes to decode the signals. This service may have similar characteristics to the direct satellite Internet access via PC service, except that subscribers will be able to access the Internet using a TV and the price of the service can be shared with the satellite TV service.

In both these examples, the bandwidth quoted applies only to data sent to the customer. The return channel from the customer to the ISP must be provided through the terrestrial telecommunications network, currently at a much lower bandwidth.

5. Intranets

In 1996, the focus of attention on Internet issues moved from the WWW to intranets. "Intranet" is the term used to describe companies using the Internet Protocol (IP) for their internal communication, sometimes by deploying a private network using Internet technology, but with their own lines and routers, and sometimes by creating a closed user group on the public network. A survey by IDC Research found that 57% of the Fortune 500 companies in the US had private network intranets in 1996.

The intranet market has tremendous potential, because it could be a replacement for the business datacommunications market, currently estimated to be 50% of all traffic on telecommunications networks and growing faster than voice. This makes predictions (by Zona Research) that the intranet server market will develop from $ 500 million in 1996 to $ 8 billion (600 million ECU to 9.6 billion ECU) in 1998 credible. However, the long-term potential of intranets will also be affected by the way in which the public Internet develops and what services are offered over it.

5.1. Benefits of Using Intranets

Intranets can be a cheap way of providing private corporate networks: open standards and strong competition in public Internet software and hardware have led to low-cost browsers and servers which can be used on a private network. WWW browsers work on all computer platforms and are easy to use, which makes the development of management information systems cheaper and reduces software maintenance costs. For example, it is estimated that in the future distributing software using Java has the potential to reduce the cost of running a LAN by at least 25%. SMEs which cannot afford a corporate network can now set up closed user groups on the public Internet.

Intranets also open up new possibilities for information sharing and distribution within a company. Using IP-related products on a private network provides the reliability and security which the Internet currently lacks. More importantly, because private networks can offer much faster access speeds than the public telecommunications network, distributed programming, videocommunication and group working can be fully exploited for intranet applications. The potential of the intranet market is now seen as one of the major drivers in the development of advanced software and protocols for the Internet as a whole.

Intranets can also be linked to the public Internet without compromising their security, by using proxy servers and firewalls. This allows users access to the public Internet and outside users access to information designated as non-confidential on the company network.

Already, a number of companies, typically large national or international multi-site corporations, are reporting benefits from implementing intranets. Although these benefits are not unique to intranets, it would have been difficult to construct similar infrastructures as quickly and as cheaply using other technologies. The most common benefits arise from:

- creating structured, easy-to-use systems which radically alter the ease and extent to which information can be shared within the company, focusing particularly on product information and the knowledge capital possessed by individual employees or groups within the company;
- giving employees the power to help themselves - eliminating standard manual information processing tasks, allowing employees to carry out these functions automatically and online;
- giving managers the tools to co-ordinate and better control widely-dispersed resources, in terms of gathering complex information both on the distributed knowledge and skills base of personnel, and relating to products and production processes located in different parts of the company.

As the above shows, most of the current benefits derived from intranets have relied on fairly basic functionality, exploiting the centralized information storage and indexing, information retrieval and text communication functions. As intranets take as a more important role in these types of companies, it is likely that more complicated software and applications will be developed which use more advanced communications functionality such as collaborative working, application-sharing, and multimedia e-mail/file transfer.

5.2. Future Intranet Provision

Some ISPs have seen the potential of intranets to become the corporate networks of the future, particularly in the USA. In order to maintain their share of the corporate communications market they have begun to offer complete intranet solutions over their own networks in order to capture the business of those large corporations which are running intranets over their own private networks.

In order to match the reliability and security of existing private networks, ISPs are following one of two approaches. Some will route traffic over their own public Internet, rather than relying on other ISPs. They hope to be able to implement a new protocol, the point-to-point tunnelling protocol (PPTP), which has been developed for the purpose, allowing secure transmission of company data over the public Internet. This technique is claimed to be 50% cheaper than using traditional datacommunications networks.

Other ISPs are building IP networks, parallel to their public IP networks, but exclusively for carrying intranet traffic. They believe that they need to deliver a more reliable and secure service for corporate networking than they can deliver over their public IP networks.

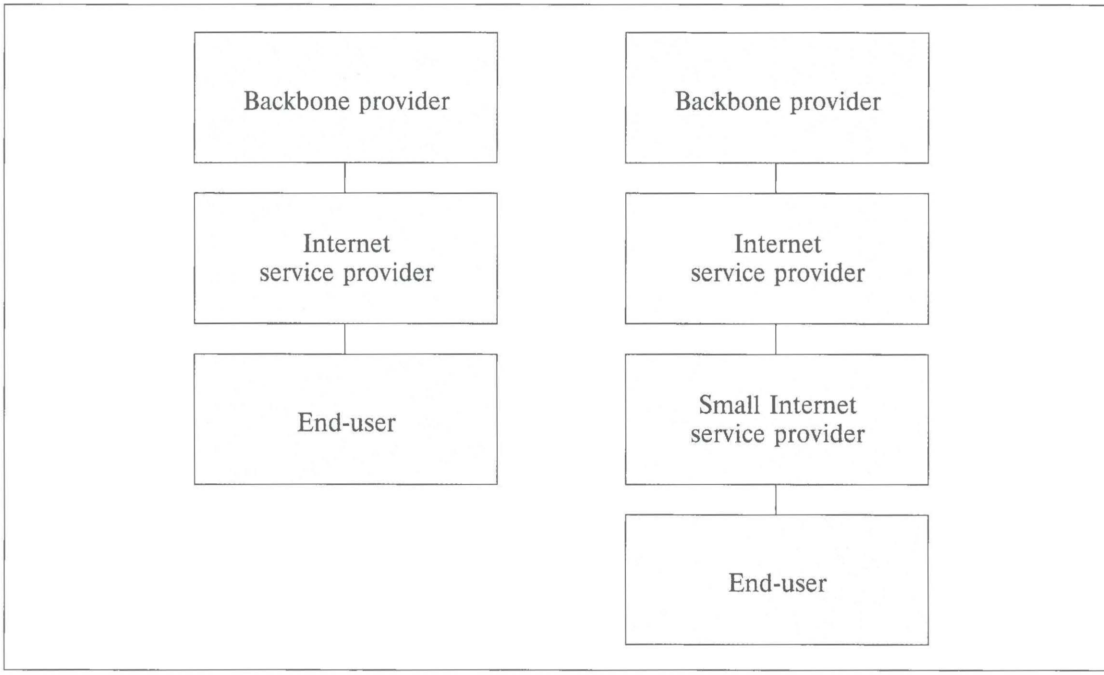


Figure 7
Value Chain of Internet Service Provision

Planned developments of the Internet will allow prioritised traffic and the reservation of capacity. In time, this will make it feasible for corporate communications to move back to the public Internet, as long as customers are confident of the quality of service they will receive.

6. Pricing

Figure 7 illustrates the value chain between the backbone provider, ISPs and end-users: the end-user normally buys service from an ISP, which in turn buys service from a backbone provider, although there may sometimes be a smaller ISP involved as well. (Content provision is also part of the value chain, but is excluded from this diagram as this section focuses on the pricing of Internet access and not content.)

Low price to end-users has been one of the key factors driving the phenomenal growth in Internet users – a typical charge is a flat rate of between 10 ECU and 15 ECU per month for access through an ISP, although in Europe local telephony charges have to be added. This compares with an average domestic phone bill of around 300 ECU per year, and the typical charge for cable TV between 15 ECU and 30 ECU per month. The prices to end-users have also been kept low as a result of reciprocal arrangements between different ISPs.

6.1. Options for Pricing Services Between ISPs and Backbone Providers

Until very recently, ISPs exchanged traffic on a system of barter, with an agreement to carry each other's traffic without involving an exchange of cash. The original Internet backbone was government funded, and there was therefore no charge to ISPs. However, as the Internet becomes more commercial, commercial considerations will become more important at every level of the value chain.

Backbone providers are starting to charge ISPs on the basis of the volume of traffic they offer to the network. At the moment this is often done after the fact - the contract is re-negotiated each year on the basis of traffic offered last year - but in future ISPs may well receive bills based on the measured volume of traffic in the same way as PNOs bill data network users now. When the ISPs have to pay for volume, this is likely to be passed on to the users in the form of usage charges of some sort.

As illustrated in *Figure 7,* some small ISPs connect via a larger ISP, rather than connecting directly to a backbone provider at an Internet exchange. However, with increasing commercialism in the ISP market, some large ISPs are refusing to continue to connect such ISPs, while others are starting to levy charges on a usage basis rather than using, for example, a flat rate.

6.2. Options for Pricing Services to End-users

Flat-rate or rental pricing for end-users has allowed traffic to grow rapidly because users are free to experiment with new applications such as the WWW without fear of large bills. As a result of these massive increases in Internet traffic, both access and backbone providers have struggled to keep up with demand, resulting in noticeable problems for users, such as slow downloading of items on the WWW. The industry is therefore being forced to consider a number of options for pricing services with the aim of allocating Internet resources (transmission and routing capacity) more efficiently, while still promoting the growth of new services.

The aim is to ensure that users pay in proportion to the load they place on the network, so that when the load increases there is the money to pay for the upgrades. The three most favoured options are:

- rental;
- rental plus usage (per unit of connect time);
- priority-based charging.

Rental alone provides only a very crude mechanism for charging for network use, with the price increasing with the capacity of the connection: for example, 2 Mbit/s leased line access costs more than 64 kbit/s BR-ISDN access, which in turn costs more than 28.8 kbit/s dial-up access. However, there is nothing to deter users from spending long periods connected and this causes congestion.

Combining rental with a charge for the time spent online removes this problem, and OSPs use this approach now. Should ISPs adopt this model, their charges are likely to remain lower than OSP charges because the peer exchange system and cost-based pricing of the Internet means that unit costs are lower. This scheme would allow lower rentals, so low-usage customers would pay less and high-usage customers pay more than under a rental-only system.

Usage costs could also be varied according to traffic destination, but increasing the complexity of the system increases the cost of implementing it. A destination-based system would also add to the complexity of the settlement system for payments between ISPs.

New applications - such as graphics use on the WWW, and delay-dependent services such as voice telephony and videoconferencing - may require new approaches. The new version of the Internet Protocol, IPv6, will allow traffic from different applications to be given different priorities and these could incur different charges. Users could also be charged for reserving resources using the new Resource Reservation Protocol (RSVP) which allows bandwidth to be reserved along a specified route through the Internet. This issue is discussed more fully in Part One "The Technological Evolution of ICT and Standards".

6.3. Comparison of Pricing Systems

The main basis for comparing pricing options is the cost of implementation and benefit to users. Monitoring time spent online or priority traffic incurs costs, but they may be incurred anyway because this information is required for the newly established settlement systems for traffic exchanged between ISPs.

The benefits of charging for usage or priority are likely to be the development of new services, efficient resource allocation and a consequent reduction in congestion. Priority-based charging will lead to resources being deployed to meet the demands of time-critical applications such as voice and video, and so help to facilitate the growth of new services. Both usage- and priority-based pricing relieve congestion in two ways:

- by providing funds for increased investment in infrastructure, the resources are being allocated dynamically, investment is made and demand grows;
- by rationing existing capacity to those willing to pay for using it, short-term congestion is reduced but the potential for growth is hidden.

Which pricing method is most appropriate for the predicted growth and use of the Internet is still being hotly debated. It seems likely that the outcome will be a mixture of all three options, as ISPs develop tariff packages targeted at different markets.

PNOs and larger ISPs are likely to start charging smaller ISPs on a traffic volume basis, because they place disproportionate demands on their networks for the bandwidth reserved, and this is likely to be passed on to users in the form of charges for time spent online. Any volume-based charging is likely to include incoming as well as outgoing traffic.

Priority-based charging is likely to be introduced because both PNOs and ISPs are powerful players and will want compensation for the extra bandwidth which has to be deployed for bandwidth-hungry and time-critical services involving voice and video.

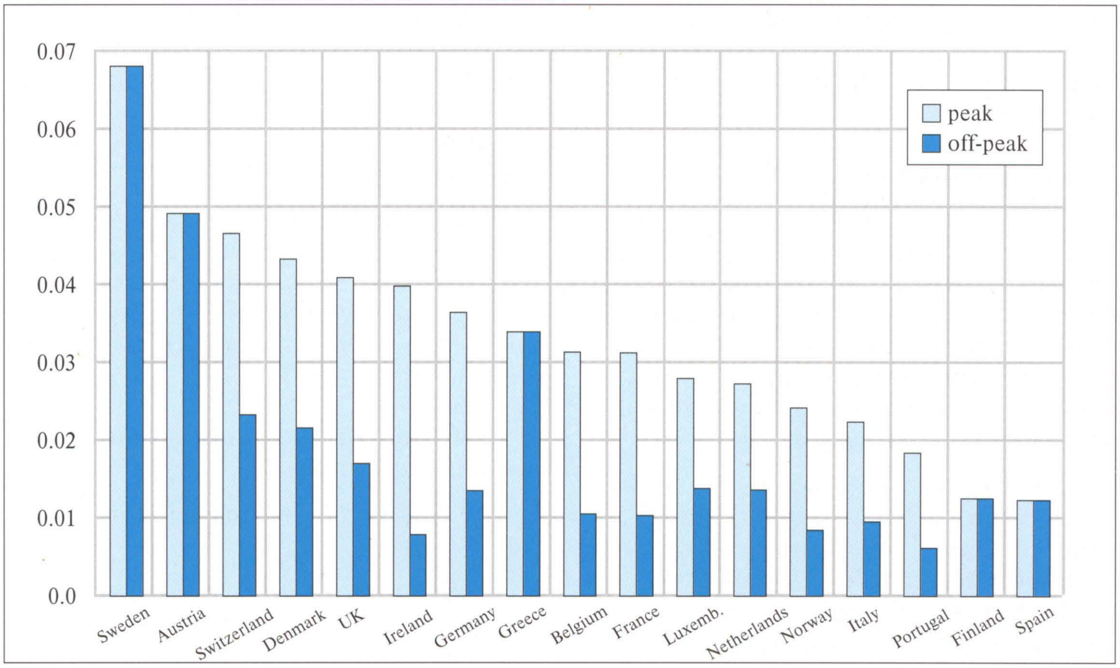
6.4. Telecommunications and Terminal Prices

6.4.1. Connection Costs for Users

The price of telecommunications services is another important aspect of the overall price users pay. In the USA, local calls are often free, and this has helped to encourage the huge growth in Internet use there. Home office users can log into their local ISP's point-of-presence (POP) by modem and stay logged in all day. As a result, the average duration of an Internet session is now ten times that of an average voice telephony call. This is causing problems for some local telephony operators in the USA who will have to upgrade their local exchanges much earlier than planned because of the impact of the Internet on their total traffic. However, because local calls are free, the local telephone companies receive no extra revenue from the Internet-related traffic. As a result, they are worried that the revenues they receive may not be sufficient to cover the cost of upgrading their network.

In Europe, local call prices vary considerably from country to country (see *Figure 8*), and the introduction of competition in telecommunications is likely to result in local call charges converging to a level which reflects the PNOs' costs. In some countries, local call charges have

Figure 8
Average Local Cost per Call Minute for Residential Users in Europe (ECU), July 1996



Source: Phillips Tarifica Ltd./London, July 1996

been subsidised from long-distance and international revenues and may therefore rise in the future.

A user paying 0.03 ECU per minute for local calls and spending 2 hours per week online (which is not a lot) will pay an additional 15 ECU per month to the PNO.

Some users cannot reach their ISP's POP within the local call charge area, and this can make Internet use significantly more expensive. To eliminate this problem, ISPs are increasingly making use of "virtual POPs" where they are allocated a special number to which all calls, from anywhere in the country, are charged as local calls. However, this service is not yet available throughout Europe.

6.4.2. Terminal Costs for Users

As the Internet develops a mass market, there will start to be users who are not already PC users and the cost of terminals will also become an issue. The network computer is expected to retail for about 400 ECU, but leading PC manufacturers have recently announced plans to produce a reduced-capability PC which will compete on price terms with the network computer. Integrated Internet and TV terminals (PC-TVs) are expected to retail at similar prices to high-end TVs.

6.4.3. Leased Line Costs for ISPs

ISPs connect their networks using facilities, usually leased lines, provided by the PNOs. The price of telecommunications infrastructure is particularly important in Europe because leased line prices vary widely, as *Figure 9* shows. The gap will be closed, however, when the provision of telecommunications infrastructure is liberalised in 1998, creating competition which will drive down prices.

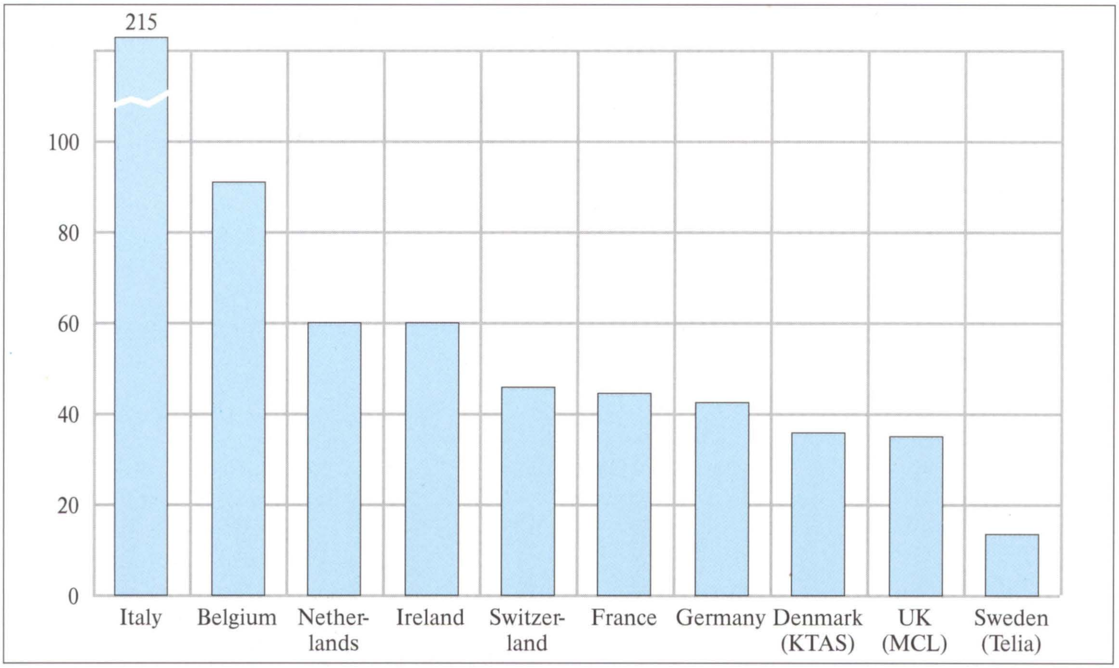


Figure 9
Comparison of Annual Leased Line Prices – 100 km, 2 Mbit/s (Thousand ECU), 1996

7. Security

As businesses start to use the Internet, and electronic commerce develops, users are concerned about security. These concerns are not always justified: for example, the greatest risk to a corporate network is someone logging in and then leaving their terminal unattended. Credit card numbers can easily be stolen when a card is handed over in a restaurant or when the number is quoted over the phone. However, the perceived risk is restricting development. The main fears are:

- interception of confidential personal or company information during transmission over the Internet;
- outsiders gaining access to confidential information stored on local networks or computers connected to the Internet;
- other parties impersonating the identity of the sender or receiver to receive information meant for others.

The software approaches which have been developed to address these issues are:

- authorization, controlling who gets access to which stored data or services;
- authentication, verifying that a communication or authorization comes from the claimed source;
- encryption, allowing information to be transmitted in a form which requires a key to decode it;
- firewall software, enabling server administrators to isolate most of the corporate network, and limit its visibility to the Internet.

On the whole, all of these technical solutions have been available for some time, but they need to be incorporated into widely-used packages. Encryption is now part of some e-mail systems - banking is a mass market at the moment - and based on a user storing a key on their computer. However, keys can be stored on smart cards for additional security and this may become more common. Most WWW browsers now have proprietary protocols such as Secure Sockets Layer (SSL) and Secure Hypertext Transfer Protocol (S-HTTP) built into them, which can be used to encrypt any sensitive data that may be sent or received via a WWW browser.

Standards will be necessary if different companies' products are to interoperate efficiently with each other, and the International Telecommunications Union (ITU) has developed standards which have been endorsed by some companies. However, other companies have been very active in developing their own secure protocols for the WWW.

7.1. Business Communication

The development of technology for intranets is the main focus of activity in this area. Large private networks running TCP/IP need to take special care to limit their accessibility to intruders. Firewalls allow the system administrator to connect only one or two servers or routers to the public Internet and force all traffic from the intranet to the Internet to take this route. Firewall and encryption technology may be offered as a package if the intranet is being provided by a service provider or systems integrator. Web server software manufacturers are also producing intranet-related tools which provide company network managers with a range of tools to configure their own secure intranets. (See Section 5 for more details on intranets.)

7.2. Regulation of Security Technology

Most governments want to regulate the use of encryption technology, because it can make criminal activities harder to detect and prevent. For example, in the USA the export of "strong encryption" technology is forbidden. In some countries, encryption systems are allowed if the user files a copy of their key with the government. However, governments have to achieve a trade-off between the needs of the police and security services, and the needs of commerce. As the previous sections illustrate, security technology is an important part of the development of services carried over the Internet. Limitations on the use of security technology will delay the growth of commerce and business communication.

8. The Internet and Convergence

The Internet has created a platform for offering multimedia services, through which the convergence of the IT, telecommunications and media markets can move forward, after several years of slow progress. Over the next 10 to 15 years, a new communications market will emerge in which the current IT, telecommunications and publishing/broadcasting markets are integrated. It is already technically possible to carry the whole range of multimedia communications services, such as voice, videoconferencing and broadcasting services (including radio and multicast video), on the Internet. However, it will take time to develop commercial services and substantial markets, and regulation will play a role in shaping this development.

8.1. Future Applications

Several services are exploiting convergence and using the Internet now. These can be broadly grouped into communications (such as voice over the Internet and videoconferencing) and broadcasting (both audio and video). These services are at a very early stage of development, and most have yet to establish a sound commercial footing. Nevertheless, they indicate the way forward for convergence.

8.1.1. Voice and Videoconferencing over the Internet

It is currently possible for an Internet user to hold voice conversations or videoconferences over the Internet. However, both users must have compatible software, and for video they must be directly linked to one of the high-speed backbones or be using an intranet over a private network. As there are some disadvantages to using IP, which is designed for data, to carry time-critical traffic like speech and video, the software currently introduces a constant delay in order to compensate for the fact that data packets from the same communication may arrive at different times.

The quality of voice over the Internet is usually comparable to a low-grade mobile telephony call, and videoconferencing can be provided at 10 frames per second (one third of TV speed) over a BR-ISDN connection. However, performance does deteriorate as the level of traffic on the Internet increases. New protocols such as RSVP, which allows resources to be reserved, and IPv6, which allows time-critical traffic to be given higher priority, could help to ensure reasonable quality for telephone calls when the Internet is busy.

In 1996, 500,000 (475,000 residential and 25,000 business users) people were estimated to be using voice over the Internet on a regular basis and this is forecast to rise to 16 million (6 million residential and 10 million business users) by 1999 (source: IDC). The latest release of the leading WWW browser software is bundled with an Internet telephony package, and its main competitor is giving its Internet telephony software away free. These packages include shared whiteboard facilities, so they offer practical advantages over normal phones.

Until now, these systems have not used recognised standards, so users had to arrange to have the same software as the person they wanted to talk to. Recently, however, leading software companies have produced systems which use the H.320 videoconferencing standard and the T.120 application sharing standard, so this problem may soon be overcome.

A number of providers are starting to offer services that allow people to make calls to ordinary phones via their servers, and a smaller number are offering calls to Internet users from ordinary phones. The provider installs a switch which interconnects with the public telecommunications network. This could allow Internet telephony to become much more widespread.

If voice over the Internet is to be a major force in the future it must remain significantly cheaper than ordinary phone calls while offering similar levels of quality. Mass-market Internet telephony operators would find themselves deploying special Internet connections to carry their traffic, as well as making interconnect agreements in order to reach normal phone users. Their business would therefore be much the same as that of existing resellers of telephone network capacity.

8.1.2 Broadcasting

There are problems in the broadcasting of audio and video over the Internet. Delays can arise, and video signals require much more bandwidth than is typically available on the Internet backbone, but special systems have been developed to deal with these. These have been used for conferences, special events (e. g. the Olympics), and in the academic community. The systems are designed to minimise the traffic on the net by establishing a fixed path for the traffic stream between designated servers, from which ordinary IP traffic is sent to local sites which are listening or watching. Servers and audience both need special software tools.

Sound broadcasting is more feasible than video, simply because it requires less bandwidth. A number of systems are available which allow anyone to set up their server to broadcast sound, and a variety of sites offering both software and content. As with Internet telephony, standards are not yet established, and the user needs to install the right software for the service they want to listen to.

A separate initiative, Intercast, uses existing cable and satellite TV systems to deliver television programmes and WWW content to a multimedia PC. The Intercast service provider transmits a range of WWW content which the user can either view along with a television programme as it is being broadcast or can download to the hard disk of their PC for later viewing. Although users will only be able to view WWW content broadcast by the service provider, much of which may be related to the television programming, this material will be transmitted at broadband speeds, giving a significant performance improvement over typical WWW access.

8.2. Regulating the Internet

Telecommunications, broadcasting, and the news media are sectors which are tightly controlled by governments through licensing of operators and ownership restrictions. The Internet is not currently a target of regulation, which is leading to problems with pornography and other offensive material. Most countries have separate regulators for the different sectors, so it is not clear whose job it is to regulate the Internet. In addition, because the industry structure is still developing, with large numbers of small content and service providers in existence, it is neither so much in need of competition regulation nor so easy to regulate as industries dominated by a few large companies.

Some telecommunications companies are already putting pressure on regulators to take action on voice over the Internet. For example, in the USA, local operators are demanding that ISPs pay them in the same way that long-distance operators do, and in the UK Oftel is considering how to classify ISPs in telecommunications terms. This will determine what licensing is required and what interconnection charges must be paid.

In terms of regulating content, it is difficult on the Internet to decide which companies are publishers and which are not. ISPs and OSPs may both offer content services separately from Internet access and they may edit or censor information stored or transmitted by their users, which leads to the question, "Are they publishing it?" The ISPs and OSPs argue that they are just like PNOs, passive transmitters of information. However, some regulators argue that when ISPs censor discussion fora and disconnect servers of pornography, they become responsible for all the content stored on or transmitted over their networks. These arguments informed the drafting of the 1996 US Communications Decency Act which was subsequently declared unconstitutional by a US court in June 1996.

The type of cross-ownership restrictions which currently exist between publishing and broadcasting may not make sense on the Internet, as it is in the public interest that there continues to be an enormous variety of information sources on the WWW. The ease of access to the medium means that no further action is required to ensure this. Limiting the participation of the major content providers could restrict the growth of the new sector.

Table 7
Definitions of Market Size Measures

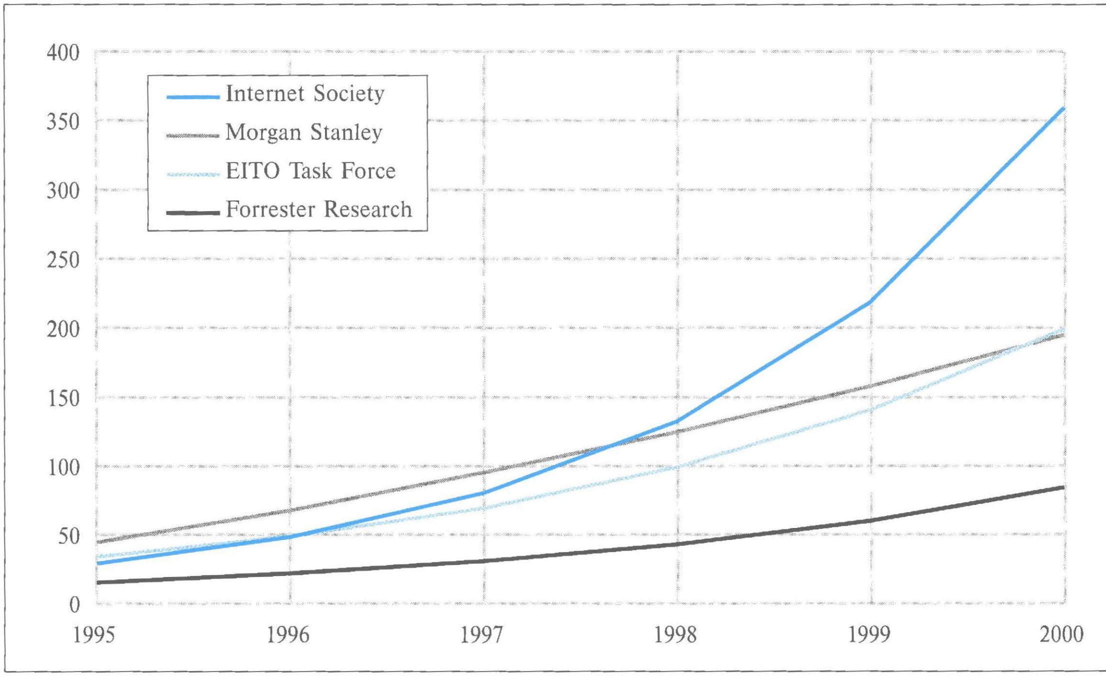
Measure	Definition
User	An individual using the Internet who may or may not have paid for the subscription used to access the Internet.
Remote user	A user only having access to their parent company's resources, e. g. a teleworker, and not directly connected to the Internet.
Subscriber	An individual or organization which has paid for its own Internet access subscription and may subscribe to more than one provider.
Host	A computer connected to the Internet; a host may be used by, for example, 1 or 100 users to access the Internet.
Port	The point at which a subscriber line (e. g. a PSTN modem line or a company's leased line) accesses the Internet via its service provider.

Table 8
Estimated Internet/ Online Users (Thousands), 1995–200

	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**CAGR '95-2000 %**
France	3,692	4,571	5,758	7,416	8,588	9,959	22.0
Germany	2,524	4,123	6,215	7,768	9,851	12,727	38.2
Italy	318	734	1,359	2,153	3,227	4,038	66.2
Spain	193	451	844	1,349	2,035	2,558	67.6
UK	2,654	3,969	4,933	6,232	8,036	9,311	28.5
Rest of Western Europe	2,945	4,527	6,269	8,274	10,987	13,855	36.3
Western Europe	**12,326**	**18,376**	**25,380**	**33,193**	**42,722**	**52,448**	**33.6**
Eastern Europe	236	861	1,947	3,552	5,798	8,874	106.6
Total Europe	**12,562**	**19,237**	**27,327**	**36,744**	**48,520**	**61,322**	**37.3**
USA	26,522	37,208	48,707	58,070	66,648	75,721	23.3
Japan	1,776	3,259	5,105	7,555	9,331	11,768	46.0
Rest of World	4,581	8,458	14,614	22,962	33,871	46,398	58.9
Total World	**45,440**	**68,162**	**95,754**	**125,332**	**158,370**	**195,209**	**33.8**

Source: EITO Task Force

Figure 10
Forecast Growth in the Number of Internet/Online Users (Million)



Source: Internet Society, Morgan Stanley, EITO Task Force, Forrester Research

9. Market Developments to 2000

There are a number of different measures of the Internet market and market size. The ones used in this section are defined in *Table 7.*

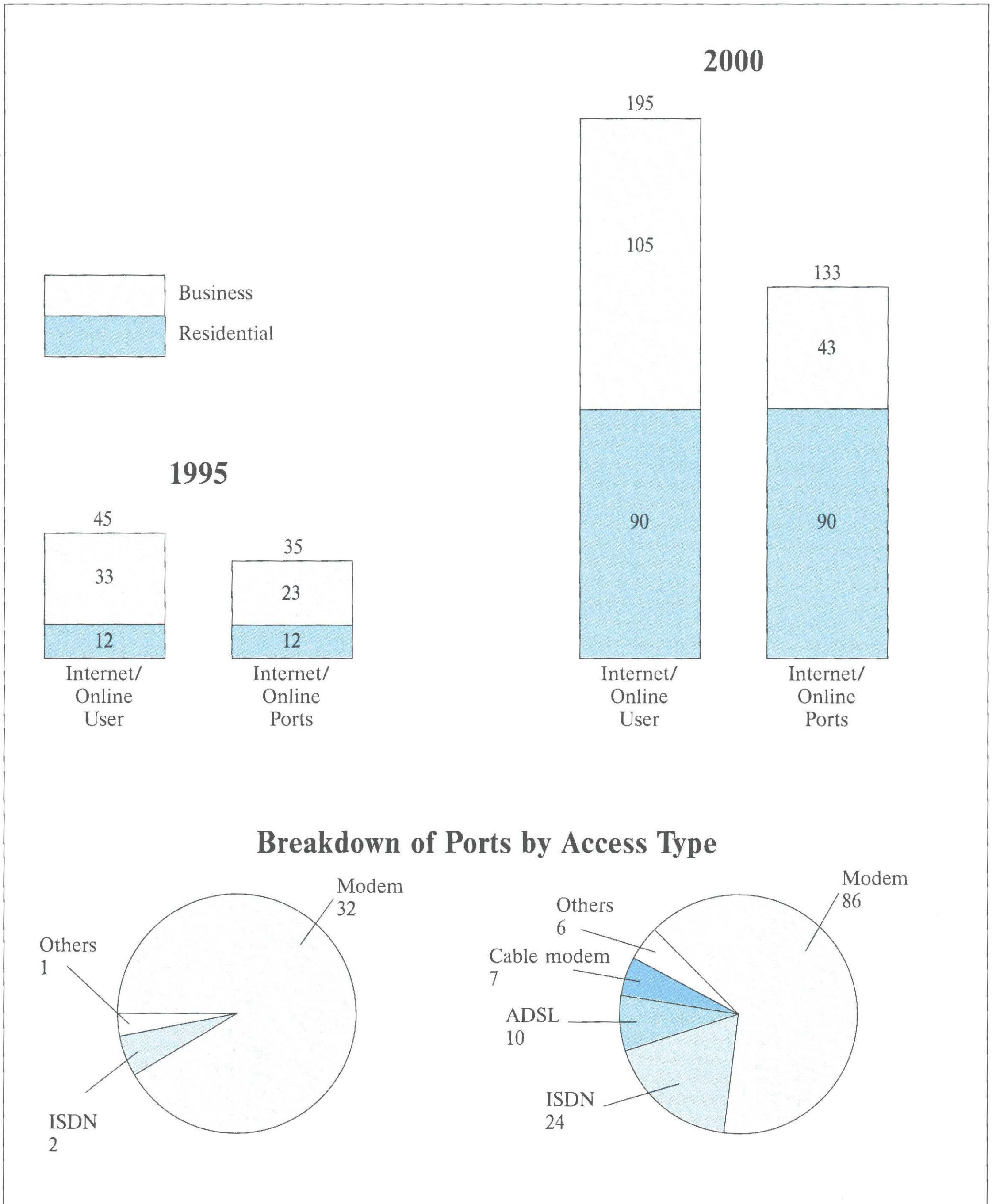
9.1. Forecasts of the Internet Market

For the past three years the Internet has been doubling its number of hosts and tripling its traffic every year, and this looks set to continue. The number of Internet users cannot be measured directly, which leads to variations in the estimated number of users. *Table 8* contains a detailed forecast of the number of Internet users, while *Figure 10* shows how this compares to a number of other forecasts of the worldwide number of Internet users over the next five years.

Until the development of user-friendly WWW clients in 1994, the Internet had been mainly used for e-mail and file transfer. However, by 1995 WWW traffic had overtaken e-mail and FTP traffic to become the main use of the Internet (as discussed earlier in Section 2.2). A WWW user downloads far more images, audio and video than an e-mail or FTP user, and consequently generates significantly more traffic. As electronic commerce develops and the Internet continues to grow, the WWW will become even more important, so that by 2000 three-quarters of Internet users are expected to be WWW users (source: Morgan Stanley).

9.2. Access Forecasts

The availability of suitable communications access technology will also influence the rate at which the Internet develops. In the short term, residential users in Europe are likely to have a choice of 56 kbit/s dial-up PSTN (due to



Source: EITO Task Force

Figure 11
Business and Residential Use of the Internet and Online Services (Million), 1995 and 2000

advances in modem technology) or BR-ISDN at 64 kbit/s or 128 kbit/s. In the medium term, ADSL and cable modems will offer substantially better access speeds (given that operators also make the necessary network investment) and will become more price-competitive as they are more widely used.

9.2.1. Breakdown of Internet Access by Technology

Figure 11 shows how access to the Internet by both business and residential users is expected to grow between 1995 and 2000. Ports are points of access to the Internet, and a single port - in the form of a leased line from their site to the local ISP - may provide Internet access to many hundreds of corporate or academic users. The predominance of modem access shown in the pie chart is therefore due to the fact that a small user is more likely to use a modem, and each of these users has a port. Of the other forms of dial-up access, ISDN already accounts for a measurable proportion of access, and is expected to grow substantially over the next five years. ADSL and cable modems are also expected to become significant over that period. In addition, a substantial number of organizations will move from dial-up access to leased lines, as their need for Internet connectivity increases.

9.2.2. ISDN Forecasts

Tables 9 and *10* show ISDN forecasts based on current ISDN tariffs. Although ISDN is likely to be a sizeable proportion of the means used for Internet access, it will not be of major importance in the next few years. For the number of Internet users predicted, either ADSL or cable modems will have to be available, or most users will still be relying on PSTN dial-up.

9.3 The European Dimension

Roughly 20% to 25% of Internet hosts are in Europe; the evolution of Internet hosts in Europe, together with that in the USA and Japan, is shown in *Table 11*.

Internet development in Europe is estimated to be about three years behind the USA in terms of the maturity of the Internet market, which accounts for approximately 65% of Internet hosts and is where most leading Internet companies are situated. *Figure 12* shows the penetration of Internet hosts in the USA and Europe per 1,000 people. Further evidence of the difference between the USA and Europe is given by the different rates of home PC penetration in the two regions, with the most advanced European countries now reaching levels of PC penetration achieved in the USA two years ago.

The slower development of the mass market Internet in Europe is mainly due to two factors:

- Telecommunications prices in Europe are higher than in the USA: European ISPs have to charge their users more because their telecommunications infrastructure bills are higher, and European users have to pay for local calls, unlike most US users. The liberalisation of telecommunications infrastructure in the EU in 1998 will help, but the effects of competition may take some time to appear.
- Most information on the Internet being in English, which non-English speakers can find discouraging. Non-English versions of Internet software are often delayed and most of the information on the WWW is in English. This problem is resolving itself gradually as more European users create content in their own languages. OSPs have already established sizeable client bases in some European countries.

Table 9
Forecasts of BR-ISDN Connections (Thousands), 1995-2000

	1995	1996	1997	1998	1999	2000	CAGR '95-2000 %
France	260	450	900	2,000	3,000	4,000	72.7
Germany	846	2,000	3,600	5,005	6,390	7,150	53.2
Italy	60	150	300	500	1,000	1,500	90.4
Spain	70	120	180	240	300	350	38.0
UK	111	300	600	1,200	2,000	2,500	86.4
Rest of Western Europe	195	393	806	1,538	2,411	3,322	76.3
Western Europe	**1,542**	**3,413**	**6,386**	**10,483**	**15,101**	**18,822**	**64.9**
Eastern Europe	1	6	14	41	98	209	191.1
Total Europe	**1,543**	**3,419**	**6,400**	**10,524**	**15,199**	**19,031**	**65.3**
USA	605	1,045	1,500	2,500	4,000	6,500	60.8
Japan	450	800	1,500	2,500	3,500	4,500	58.5
Rest of World	45	123	274	542	963	1,978	113.1
Total World	**2,643**	**5,387**	**9,674**	**16,066**	**23,662**	**32,009**	**64.7**

Source: EITO Task Force

However, Internet usage is currently growing faster in Europe than in the USA. Over the next five years, Europe and the rest of the world are expected to catch up with the USA as its dominance in the Internet diminishes, as shown in *Figure 13.* (Note: The split of users is slightly different from that for hosts shown in *Table 11.*)

9.4. The Development of the Mass Market for the Internet

By 2000, the Internet will be a mass market service in the developed Western economies. US Internet penetration in 2000 will be halfway between the level of penetration of compact disc players (50%) and VCRs (90%) today. This will lead to changes in the type of users on the Internet.

9.4.1. Phases of Adoption of New Technology

In the evolution of any new IT product, there are three phases: early adopters; computer literate users and the mass market. In the latest phase of WWW growth, the fastest-growing group of users is the computer literate rather than early adopters and the Internet is clearly becoming quite broadly based. The education and computing sectors each account for almost 30% of Internet users, but managerial and professional workers are now well represented as shown in *Figure 14.* This broader user base will lead to companies offering a wider range of services, which will make the Internet more attractive to new users.

Table 10
Forecasts of PR-ISDN Connections (Thousands), 1995–2000

	1995	1996	1997	1998	1999	2000	CAGR '95-2000 %
France	22	30	40	50	55	60	22.2
Germany	35	54	66	79	91	97	22.6
Italy	2	4	8	16	25	30	71.9
Spain	3	6	10	150	20	22	49.0
UK	28	40	48	55	61	62	17.2
Rest of Western Europe	9	17	30	-93	54	67	49.4
Western Europe	**99**	**151**	**202**	**257**	**306**	**338**	**27.8**
Eastern Europe	0	1	2	4	8	14	N/A
Total Europe	**99**	**152**	**204**	**261**	**314**	**352**	**28.9**
USA	11	15	20	30	40	60	40.4
Japan	10	15	25	40	60	80	51.6
Rest of World	5	6	11	21	43	84	75.8
Total World	**125**	**188**	**260**	**352**	**457**	**576**	**35.7**

Source: EITO Task Force

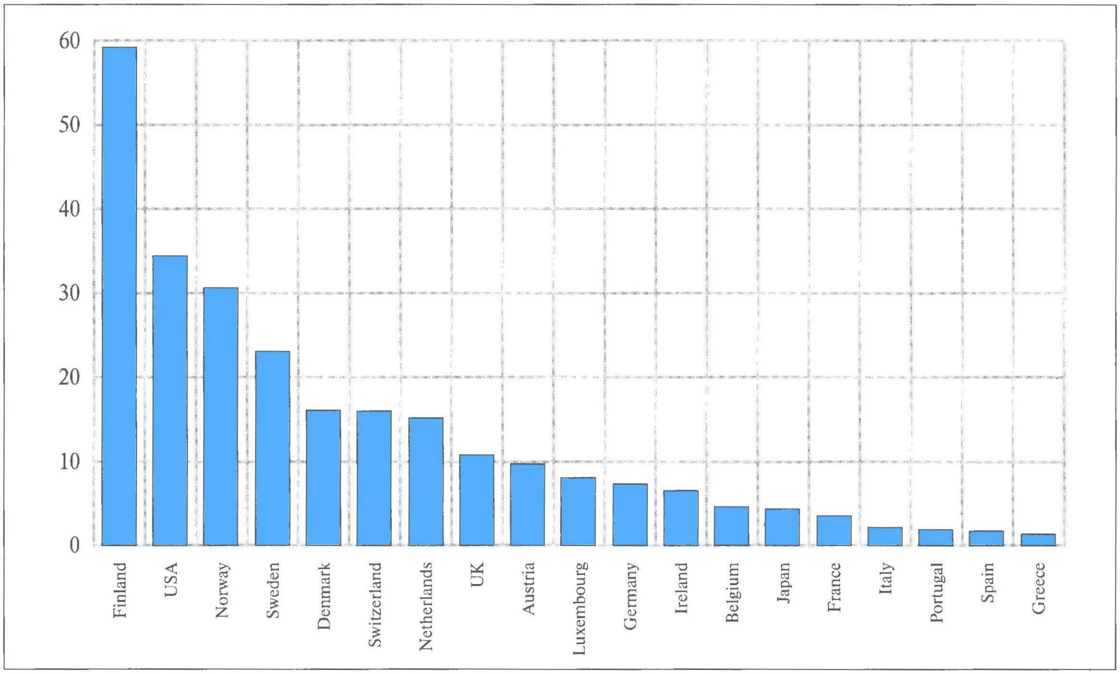
Note: we have assumed that PR-ISDN in the UK is equivalent to 20 B-channels, and that in all other cases it is equivalent to 30 B-channels.

Table 11
Evolution of Internet Hosts (Thousands), 1992–1996

	Jul 1992	Jan 1993	Jul 1993	Jan 1994	Jul 1994	Jan 1995	Jul 1995	Jan 1996	Jul 1996
France	19	26	40	48	72	93	114	137	190
Germany	38	58	90	99	149	209	291	452	548
Italy	5	8	15	17	24	31	46	73	114
Spain	4	6	9	12	21	28	40	54	62
UK	44	67	92	114	156	241	351	453	580
Rest of Western Europe*	103	134	178	184	309	438	622	892	1,168
Western Europe	**213**	**299**	**424**	**474**	**731**	**1,040**	**1,464**	**2,061**	**2,662**
Eastern Europe	1	2	9	11	28	41	60	90	169
Total Europe	**214**	**301**	**433**	**485**	**759**	**1,081**	**1,524**	**2,152**	**2,831**
USA	733	943	1,257	1,475	2,044	3,178	4,269	6,053	8,224
Japan	16	23	36	43	72	97	160	269	496
Rest of World	29	46	50	214	337	496	689	998	1,330
Total World	**992**	**1,313**	**1,776**	**2,217**	**3,212**	**4,852**	**6,642**	**9,472**	**12,881**

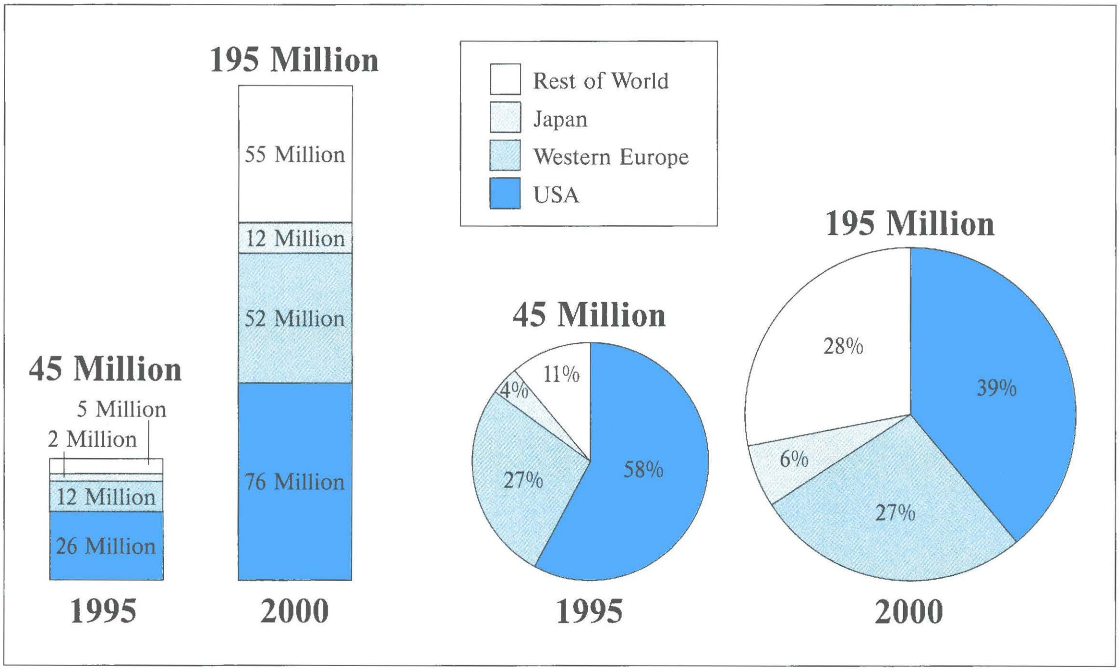
Source: Network Wizards, http://www.nw.com and EITO Task Force

* Comprises Austria, Belgium, Luxembourg, Denmark, Finland, the Netherlands, Norway, Sweden, and Switzerland.



Source: Network Wizards, http://www.nw.com and Analysys

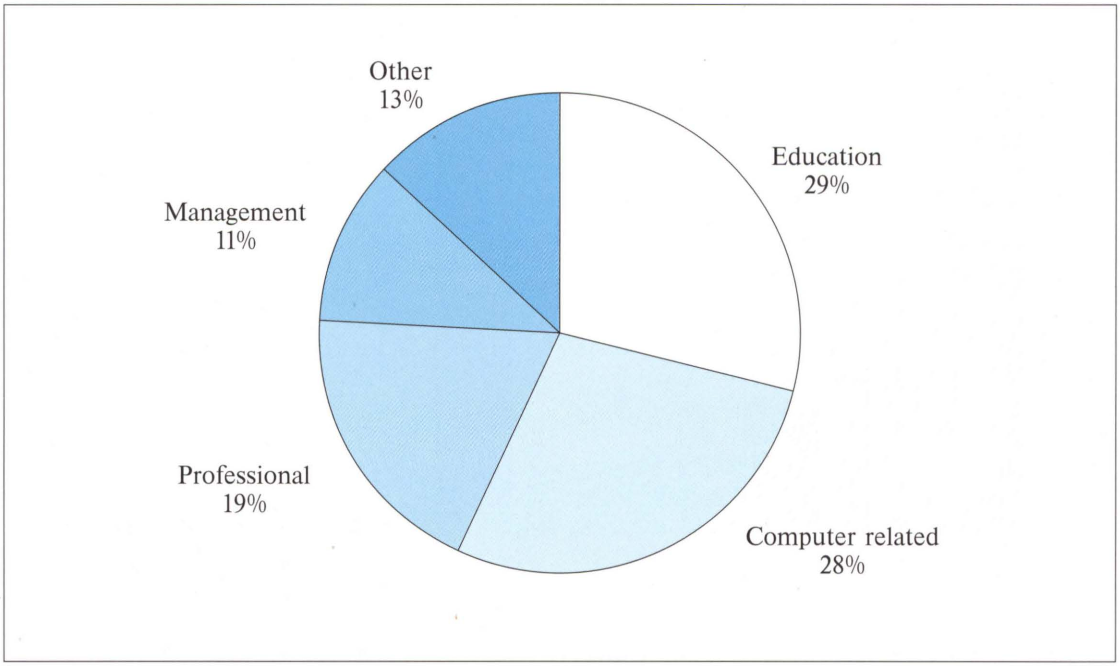
Figure 12
Penetration of Internet Hosts per 1,000 People, July 1996



Source: EITO Task Force

Figure 13
Customer Distribution by Regions, 1995 and 2000

Figure 14
Professions of US Internet Users, 1996



Source: GVU's Fourth WWW user survey, URL:http://www.cc.gatech.edu/gvu/user_surveys/

9.4.2. Forecasts of Data Users

Figure 15 shows the breakdown of all interactive data users in 1995 and 2000 into three segments:

- Remote access users are those who only have access to their parent company, such as teleworkers or field sales staff, and are not connected to the Internet.
- Online users are those who have subscriptions to OSPs; they will mostly be able to access the Internet through this connection. There will be a mixture of residential and business users in this category.
- All other users of the public Internet are divided into residential and business users. In addition, there are some users of private intranets who do not have access to the public Internet, and some users of the public Internet who also have access to private intranets.

Growth in online services is expected to continue, but with growth rates falling from over 30% per year to less than 10%. The number of remote access users is expected to grow at similar rates to combined residential and business Internet access, but both are expected to slow down from the current rates of over 100% a year to under 20% by 2000. The segment which is currently the smallest is the residential market. However, this is forecast to have the greatest growth - predicted to exceed, on average, 100% per year - which will create a mass market for Internet technology.

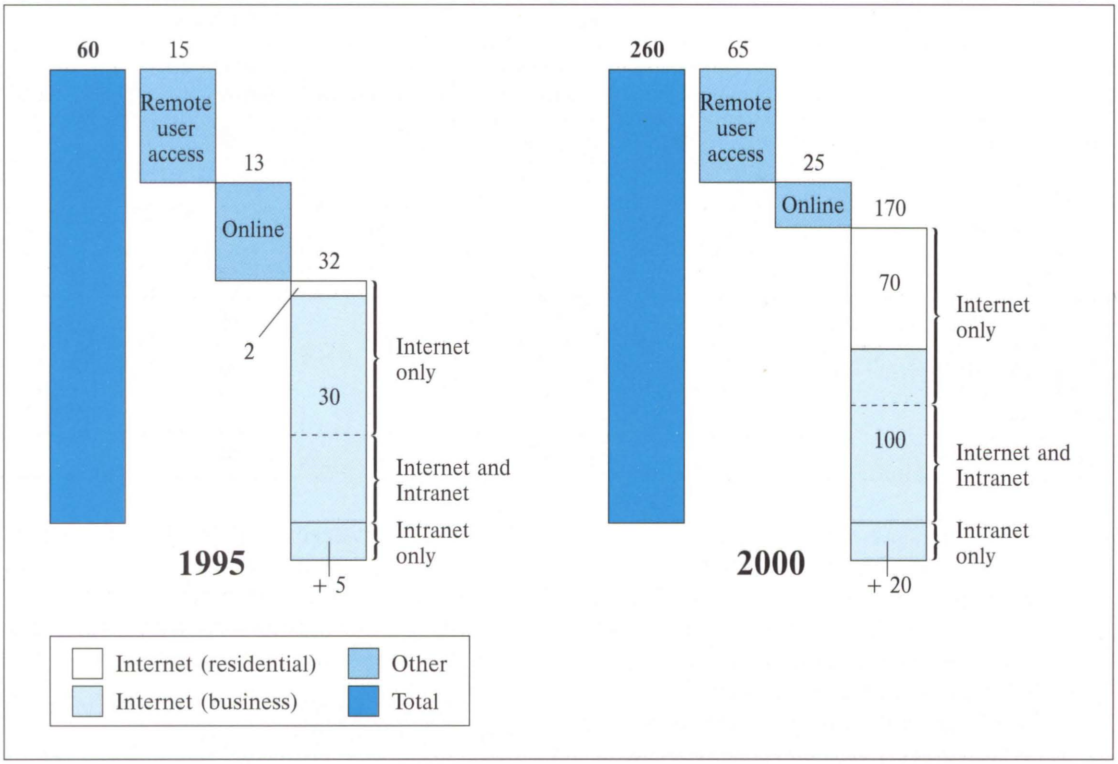


Figure 15
Breakdown of Customers by User Type (Million), 1995 and 2000

Source: EITO Task Force

9.4.3. Conditions for Development of a Mass Market

In order to reach a mass market, Internet terminals must be affordable and secure electronic transactions must be available. Terminal prices are very important, as PCs are much more expensive than many consumer durables. Developers of network computers aim to reduce this price to a more acceptable level by having lower specifications than current PCs. Other approaches coming to market are the PC-TV, the TV-top Internet decoder, and the combined videogame-Internet terminal.

10. The Benefits of the Internet for Different Industrial Sectors

10.1. General Impact on Industrial Sectors

The Internet is expected to have a profound effect on industry, with the use of information within and between organizations becoming much more important. These will be radical changes, and may take a decade or longer. Although some Internet applications will be developed for specific sectors, a core set of benefits can be identified which apply to several sectors:

- Product and service innovation: the Internet allows companies to find new market niches in a global marketplace. New players will emerge in interactive entertainment and multimedia.

Table 12
Relative Strengths of Different Internet Impacts in Different Sectors

	Revenue Benefits		Cost Benefits		
	Product Innovation	**Market Innovation**	**Process Management**	**Relationship Management**	**Resource Management**
Information and entertainment	●	●		●	
Education		●			●
Retail, transport and distribution			●	●	
Finance		●	●	●	●
Manufacturing, engineering	●		●	●	
Chemical, pharmaceutical & oil	●		●	●	●
Healthcare			●		●
Other government			●	●	

- Market innovation: the Internet provides a completely new channel for marketing and distributing products, especially for products which can actually be transferred on the Internet. SMEs will find it easier to reach global markets because the barriers to entry will be lower, which in turn will reduce the minimum efficient scale for an industry.
- Process management: better communications can reduce costs and provide competitive advantage, as has been demonstrated in industries which can afford traditional types of global communications. The Internet and intranets are making these advantages available to a much wider range of companies.
- Relationship management: electronic data interchange (EDI) on the Internet will widen the use of electronic ordering and invoicing, and "just-in-time" production, particularly in the manufacturing, transport and distribution sectors. Closer links between companies will be possible, for example making collaborative working easier.
- Resource management: the Internet will be particularly useful in providing expertise from a distance. Examples are remote consultation, diagnostics in health care, and multicasting courses in education.

Table 12 indicates which core benefits are likely to apply to which sectors.

10.2. Impact of the Internet on Key Sectors

In the following subsections, we have briefly summarised the impact of the Internet on industrial sectors below.

10.2.1. Information and Entertainment

The Internet is likely to have a major impact on the market structure in telecommunications. If the Internet becomes the main route for multimedia PNOs may maintain control only over basic voice and data services. As the volume of Internet traffic overtakes that on the PNOs' traditional public networks, PNOs could become mainly wholesalers of infrastructure to ISPs, which will be less profitable than their current business. They are already planning to reduce the risks of these developments by becoming ISPs themselves.

Publishing has traditionally been dominated by a few large firms, because of the high cost of mass market distribution. However, desktop publishing made it economic for independent companies to produce low circulation items. The Internet takes this further, and makes it very cheap to reach a huge market. The challenge will be to make one product stand out from the crowd; traditional publishers will have the advantage of their brand, but with their expertise in new distribution channels established software or computer firms could become big players in publishing.

10.2.2. Education

The development of multimedia and multicasting technologies will have a profound effect on the education sector. The Internet represents an excellent opportunity to overcome the current resource constraints faced by many universities and schools. Schools will be able to avoid the problems of out-of-date textbooks by accessing the latest information on the WWW. This needs greater numbers of computers in schools and more educational resources on the WWW, but because the benefits are so clear both areas are likely to be addressed.

At university level, distance teaching over the Internet will enable courses to be given to a far wider audience at very low additional cost. This would allow students access to leading experts in their field regardless of their location, and would also enable university-level education to be given to a much greater number of people.

10.2.3. Retail, Transport and Distribution

The use of the Internet as an interface to customers possesses several advantages for the retail sector: the cost of access to Internet-based shopping services is relatively low services can be widely distributed and the Internet already has sufficient functionality to provide electronic commerce at a reasonable level of quality. In time, the Internet could become the dominant medium through which a wide variety of goods and services are sold and, as a result, could transform the retail sector. There are several technical hurdles to be overcome, including security, as discussed in Section 7. Consumers will also have to be persuaded to change their buying habits. Additionally, retail companies will face a dilemma: although the cost of selling goods and services through the Internet will be much lower than through traditional retail outlets, they will also want to protect the investments they have made in the existing retail networks.

Managing the logistics of distribution networks is an area where IT systems, particularly EDI, are increasingly being used. Better information on where goods are in the system is valuable to both distributors and customers, and haulage companies are therefore increasingly using satellite positioning systems to track their vehicles. The Internet makes it possible to make this information available to all their depots at low cost. An example of pioneering use of the Internet is the Federal Express system which allows customers to check the location and status of their package on the Internet. The Internet offers tremendous potential to extend this concept throughout world distribution systems, but is likely to be hampered by a reluctance to expose performance so completely to other organizations.

10.2.4. Finance

The finance sector is one of the first industrial sectors to see the potential of the Internet for offering services. In retail banking, change is already underway with the spread of telephone banking and the increasing use of IT to automate some banking functions. Many retail banks have now established WWW sites and a few already allow customers to perform simple transactions over the Internet. User-friendly banking applications can be created for the WWW and banking services can be provided at a far lower cost than is possible with either traditional or phone banking. If current trends continue, the way in which retail banking operates may change radically. In particular, the need for counter staff and facilities may fall to a fraction of its current level.

10.2.5. Manufacturing and Engineering

There are a wide range of benefits which can be obtained by integration of IT systems, EDI and 'just-in-time' manufacturing ideas. The Internet makes the implementation of such systems much more accessible to smaller organizations, thus enabling these systems eventually to become the norm in the sector. The Internet also makes it much easier for different organizations involved in the design-to-production process to collaborate with each other. Similarly, where manufacturing is located in low-cost regions, the Internet will make it possible to have much closer collaboration with designers and marketing people in the target markets. This will make the geographical location of specific functions much more flexible for a wider range of organizations, allowing, for example, programmers in India and marketing and manufacturing teams in Bulgaria to work with designers in Holland and end-user organizations in the UK.

10.2.6. Chemical, Pharmaceutical and Oil

These are all areas where innovation is important, and, as described for the design/production teams in the manufacturing sector, the Internet can facilitate collaborative work between researchers. It can also be used to provide remote information about process control and to facilitate co-ordination between plants, and between plants and sales and distribution teams. In addition, the Internet can provide a new channel for interaction with customers.

10.2.7. Healthcare

There are huge savings to be made in healthcare from managing information electronically, and from using computerized patient records, or even from simple things such as eliminating duplicate tests. There are also a number of experiments under way in transferring images such as X-rays or NMR scans electronically to get assistance with diagnosis from a specialist in the field. However, as security is paramount in healthcare, it is the main obstacle to the introduction of such schemes, and the public is unlikely to place sufficient confidence in Internet security in the near future. In addition, the way in which healthcare tends to be organized is likely to make the widespread adoption of information sharing over networks a slow process. Nevertheless, since the cost benefits from using readily available terminals and software based on IP are significant and there often seem to be problems in the funding of healthcare, private intranets seem to be the most likely means of implementing healthcare networks once they become acceptable.

10.2.8. Other Government

In addition to the possibilities for use of the Internet in education and healthcare, a number of ideas have been put forward for other government use of the Internet, including online submission of tax returns, electronic voting, and publication of public information, including information ranging from welfare benefits to reports of commissioned research studies. The US government seems to be taking these options seriously: there is a wide range of government information published on the Internet, and trials of online voting and submission of tax returns are taking place.

Finally, the Internet can make it much easier for citizens to interact directly with their representatives on issues which concern them.

Table 13
Typical Internet Applications, 1996 and 2000

	1996		2000	
General Application	**Typical Application**	**Bandwidth Required**	**Typical Application**	**Bandwidth Required**
Communi-cations	Text e-mail, bulletin boards, newsnet, voice telephony, videoconferencing	14.4 kbit/s to 128 kbit/s	Multimedia e-mail, (video, sound, text, voice messaging), corporate networking, video telephony, company MIS	64 kbit/s to 2 Mbit/s
Information access	Bulletin boards, static WWW (image & text), newsnet, limited online services	14.4 kbit/s to 28.8 kbit/s	Distributed teaching by multicast video, interactive multimedia, comprehensive resource indexing	2 Mbit/s
Entertain-ment	Audio on demand, music and games download	14.4 kbit/s to 28.8 kbit/s	Video on demand, direct broadcasting, music, games, other services with online transactions	128 kbit/s to 8 Mbit/s
Publishing	Music, literature over WWW with credit card or phone transactions	14.4 kbit/s to 28.8 kbit/s	Online billing for content (multimedia)	64 kbit/s to 2 Mbit/s
Trade	Limited online shopping, information on services	14.4 kbit/s to 64 kbit/s	Combined marketing and selling via WWW, collaborative work, business information exchange	64 kbit/s to 8 Mbit/s

11. Applications Today and in 2000

Current use of the Internet can be grouped into five general areas, which are likely to remain the same for the foreseeable future. Within these areas, the difference between current and future applications is the growing range of functions and the correspondingly higher bandwidth that will be needed. These differences are illustrated in *Table 13.*

The technology for all these services is already available, but the commercial products are either not yet available or still too expensive for the mass market. However, between now and 2000, standards must be agreed and adopted by Internet service providers, software and hardware manufacturers.

New applications will mostly need higher-speed access than PSTN lines can support. In the residential and small business markets, this will depend on the rate at which PNOs and cable TV companies deploy ADSL and networks capable of supporting cable modems at prices consumers can afford, and the necessary investment will take some time. However, for larger businesses private network intranets will circumvent this problem.

The new applications will increase the value that users get from the Internet and may start to initiate profound effects on the economy, particularly in the areas of marketing, distribution, and business communication. The Internet could be the catalyst for the creation of the Information Society.

Glossary

ADSL	Asymmetric Digital Subscriber Loop, a technique for transmitting data at high speed (2 Mbit/s or higher) over copper exchange lines
ARPA	Advanced Research Projects Agency, the sponsors of the research that led to the creation of the Internet
ATM	Asynchronous Transfer Mode, a standard for high-speed packet switching, providing quality of service and bandwidth management features
Backbone network	High-speed series of lines which form a major pathway across the Internet
B-Channel	Unit of capacity equal to 64 kbit/s used to denote the capacity of an ISDN connection, e. g. a PR-ISDN connection has 32 B-channels
BR-ISDN	Basic Rate ISDN (64 kbit/s to 128 kbit/s)
Browser	Programme used to search and retrieve information from the WWW
Cable modem	Modem used for sending data at broadband speeds over cable TV networks. The system requires installation of modems at the customer premises and at the routing point in the network
CATV	Cable TV
CD-ROM	Mass storage medium for data on a CD
Client	User-operated software which requests data from a server running compatible software and therefore provides the user interface to Internet applications, e. g. a browser is a WWW client which draws information from a WWW server
Client/ server streaming	Method of sending a continuous flow of data from a server to a client, allowing real-time playback of audio and/or video
CPE	Customer Premises Equipment
FAQ	Frequently Asked Questions
Firewall	Security device used to control access to a company's networks and information
FTP	File Transfer Protocol, a means of transferring documents and programmes from one Internet host to another under user control
Gopher	System of information resources on the Internet allowing documents to be linked by hypertext
Host	Computer or server connected to the Internet, which provides information or services to Internet users
HTML	HyperText Markup Language, the language for writing hypertext documents viewed by a WWW browser
HTTP	HyperText Transfer Protocol, the protocol for transmitting multimedia information over the WWW
Hypertext	Means of linking documents by highlighted text
Intranet	Corporate or enterprise network using IP, not necessarily connected to the public Internet
Intelligent Agent	Software designed to make using the Internet easier, e. g. by automatically performing a sequence of routine tasks or customising information delivered to a user
Internet Exchange	Neutral point for interconnection between ISPs, where traffic is routed onto Internet backbone between ISPs
IP	Internet Protocol, defining the addressing scheme, packet information and routing information for transmission of data over the Internet
IPv6	The latest version of the Internet Protocol, providing both a much larger range of addresses than its predecessor and support for transmitting traffic according to priority
ISDN	Integrated Services Digital Network
ISP	Internet Service Provider
ITU	International Telecommunications Union
Java	Object-oriented programming language for creating software applications which are independent of operating systems and can be uploaded from servers to clients allowing, for example, the functionality of WWW browsers to be increased
kbit/s	Kilobits per second
Mbit/s	Megabits per second
MIME	Multipurpose Internet Mail Extensions, allowing multimedia information to be sent in a similar way to e-mail

MIS	Management Information System
MSN	Microsoft Network, proprietary online service
Multi-casting	Communication from one to many sites over a network, but only routing the information to specified sites involved in the communication instead of all sites on the network
NAP	Network Access Point, major Internet exchanges in the USA set up to take over from the NSFNet when it was disbanded
Network Computer	A less powerful version of a personal computer, which downloads software applications from the Internet instead of storing them on the hard disc
NSF	National Science Foundation
NSFNET	Main Internet backbone serving the US academic community, sponsored up by the NSF, decommissioned in 1995
OSI	Open Systems Interconnection, a set of standards for data networking drawn up under the auspices of the International Standards Organization
OSP	Online Service Provider, a company providing restricted access to content and information, in addition to basic Internet access
PC	Personal Computer
PNO	Public Network Operator
POP	Point of Presence, a node providing local access (dial-up and fixed link) to an ISP's network and routing Internet traffic over the ISP's network and onto the global Internet
PPTP	Point-to-Point Tunnelling Protocol, a proposed standard for enabling secure transmission of data between two hosts on the Internet for corporate data transmission
PR-ISDN	Primary Rate ISDN (2 Mbit/s)
PSTN	Public Switched Telephone Network
RBOC	Regional Bell Operating Company, US local telecommunications operator
Router	Specialised computer dedicated to the reception and queuing of TCP/IP packets and responsible for sending them on towards their final destination
RSVP	Resource Reservation Protocol, a protocol allowing the establishment of virtual routes over the Internet providing more efficient transmission for real-time communication over the Internet
Search engine	Searchable databases continually updated by software which categorises and classifies information stored on the WWW
Server	Computer, not necessarily on the Internet, connected to other computers via a network
S-HTTP	Secure HyperText Transfer Protocol, a proprietary system for secure transmission over the WWW
SME	Small or Medium-sized Enterprise
SMTP	Simple Mail Transfer Protocol, the basic Internet protocol for transporting e-mail messages
SSL	Secure Sockets Layer: a proprietary security protocol
TCP	Transmission Control Protocol, governs transport of data between networks, including the sequencing of IP packets, error correction
TCP/IP	The common term for the set of protocols which underlies the basic transmission of data on the Internet
URL	Uniform Resource Locator, the address given to a document of information stored on a server connected to the Internet
USENET	A decentralised system giving access to discussion groups (or newsgroups) over the Internet
VPOP	Virtual Point of Presence
VRML	Virtual Reality Modelling Language, a language for simulating three-dimensional environments that can be accessed over the Internet
WAIS	Wide Area Information Servers, allow keyword searching capability of information resources on the Internet
WWW	World Wide Web, a system linking information (text, audio and video) by hypertext stored on servers connected to the Internet running HTTP
X.25	ITU-defined standard for packet switching

Electronic Commerce over the Internet

1. Introduction

This paper has been provided by Romtec in close cooperation with the EITO Task Force.

The broadest definition of electronic commerce (E-commerce) is shown in *Table 1.*

Table 1
The Definition of E-commerce

E-commerce is the carrying out of business activities that lead to an exchange of value across telecommunications networks.

Traditionally, E-commerce activities have been narrowly defined as those directly leading to, or involving, payment, for example sales and purchase ordering, invoicing and funds transfer. However, over the past decade, businesses have been reappraising what the trading process involves. They have realised that all business activities contribute, in some way, to the production of goods and services that have a market value. Therefore, in this chapter, we adopt the broader definition of E-commerce.

The European Commission in its Esprit research and development programme suggests that the following business activities are just some of those that can be considered as part of the E-commerce trading cycle: the advertising and promotion of goods and services; communications between traders; the acquisition of market intelligence from consumers; the delivery of goods; and the provision of pre- and post-sales support. These business processes can be networked-enabled, at which point they become part of E-commerce.

The networks used for E-commerce have historically been private rather than public ones. Businesses are attracted by the public Internet as an enabling medium for E-commerce because it is a truly "open" system, widely available at very low cost. The technology opens up new opportunities for commerce just as the use of the telephone as a business tool has created new markets. The Internet is more powerful than voice telephony because of its potential to support many different kinds of communication in digital format. Voice, data, still and moving images can all be sent across it. The Internet has the potential to integrate multimedia communications within organizations and between organizations, within and beyond national boundaries. This integration is the starting point for new commercial ventures.

Internet E-commerce should appeal strongly to the consumer markets. These are the markets that can potentially take advantage of the Internet's greatest strengths: its ubiquity and low cost. Here, E-commerce is being used to support sales and marketing functions. Supply chains may undergo radical surgery as businesses cut out distributors responsible for selling their goods and services in a particular market and go direct to their customers. Consumers may no longer be constrained by the geographical location of the merchant whose products they enjoy.

Internet E-commerce also has the potential to revolutionize business-to-business trading links. Today's organization needs to be "agile" to compete successfully. This means it must be able to create business relationships very rapidly between new partners and suppliers in order to bring innovative products or services to the market in a timely fashion. These business relationships need to be supported by the IT systems and communications technologies of the organizations concerned.

Current ways of doing business electronically are cumbersome. They are slow and costly to implement. They depend on detailed agreement between trading partners, which means that such trading communities are generally localised and closed to outsiders. The technology works for long-standing relationships between very small numbers of partners, but the resulting interdependence between such organizations hampers their agility.

The Internet replaces private, proprietary and expensive networking environments with a single, universally-endorsed public network over which to conduct business with trading partners. This is likely to encourage an increasing number of businesses, including small and medium-sized enterprises (SMEs), priced out of the private network market, to carry out commerce electronically. Such businesses may begin to benefit from accelerated and cheaper business processes, increased agility and competitive edge.

E-commerce will work effectively only when it is endorsed by a critical mass of businesses and consumers. The Internet is already demonstrating its ability to attract participants in large numbers precisely because it is open, widely available and relatively inexpensive compared with other commerce solutions. If the phenomenal interest in the Internet continues, and the market inhibitors are overcome, it is conceivable that the Internet will be embedded into the majority of commercial transactions worldwide early into the next century.

This paper looks at the development of E-commerce to date and the new opportunities that the Internet can provide in this context. It considers some of the critical issues and barriers to the adoption of E-commerce over the Internet. Specific Internet E-commerce projects and merchant case studies are then described. Finally, a scenario for the future development of E-commerce in Europe over the next five years is described. This is supported by projections of revenues flowing from commercial Web sites.

2. The History of E-commerce

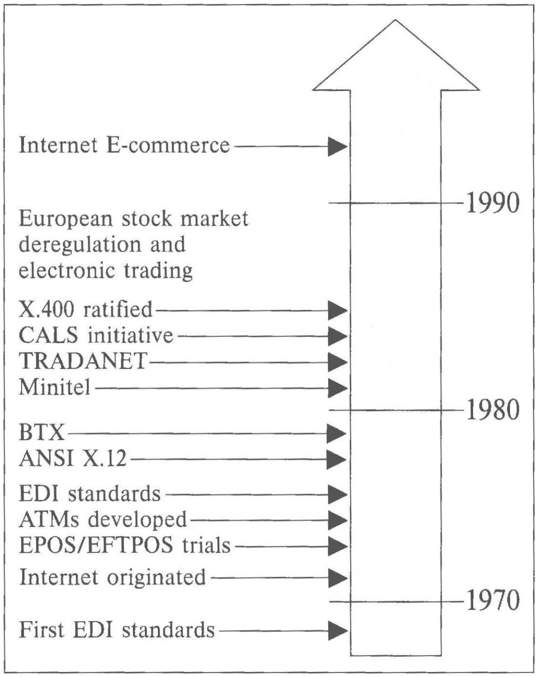
E-commerce is not a new phenomenon, any more than the Internet itself is a new network. Technology companies and user organizations were working on ways of automating commerce processes 20 years ago, at the same time as academic and research users in the US were laying down the foundations for today's Internet by experimenting with a US Department of Defense network called ARPAnet.

2.1. EDI

As *Figure 1* shows, Electronic Data Interchange (EDI) can be considered the oldest enabling technology for E-commerce. EDI is a business-to-business E-commerce solution, for the delivery of structured messages. The first EDI standards were devised by the US transportation industry in 1968. In 1979, the American National Standards Institute (ANSI) charged a committee with developing EDI standards for business documents, which became known as the ANSI X.12 standards.

Also in the 1970s, a group of UK retailers set up an *ad hoc* standard for the presentation of invoices, which were, at the time, transferred on magnetic tape. Their efforts were eventually consolidated into the Tradacoms EDI standards. In the early 1980s, the world's first dedicated EDI network, Tradanet, was set up to support the use of Tradacoms standards.

Figure 1
The History of E-commerce



Today there are three dominant EDI standards in the world:

- ANSI (ASC) X.12;
- EDIFACT (EDI for Administration, Commerce and Transport), a joint International Standards Organization (ISO) and United Nations Economic Commission for Europe project;
- UN/GTDI (United Nations Guidelines for Trade Data Interchange) based on Tradacoms.

In addition, there are around 10 further semi-proprietary EDI standards used in specific industries, such as Odette in the European automotive industry and Dish in the shipping industry. The best-known is SWIFT (Society for Worldwide Interbank Financial Telecommunications) which was formed in 1977. SWIFT is the largest financial communications network in the world used by some 3,600 financial institutions in 100 countries including banks and more recently brokers, dealers and fund managers. In fact, SWIFT is now moving towards conformance with EDIFACT.

The US Department of Defense's Computer-aided Acquisition and Logistic Support (CALS) initiative is addressing the issue of electronic support for supply chains, particularly in the areas of electronic document interchange and collaborative working ("concurrent engineering"). CALS has a military focus since it was set up to make the procurement and development of weapons systems more cost-effective, but many of its lessons can be applied to E-commerce between civil trading partners. The language of the Web, HTML, has borrowed a number of concepts from SGML, the document mark-up language that has become a CALS standard.

2.2. E-mail

Until the arrival of the Internet, support for unstructured messaging was confined to the commercial arena for cost reasons. The X.400 messaging standard was adopted by ISO in 1984. It has formed the basis of messaging services offered by a number of European network operators and private network services providers, as well as being incorporated into IT suppliers' electronic mail, office automation products and workflow products. There are other *de facto* messaging standards, such as cc:mail, which also support E-commerce business-to-business processes.

2.3. Automated Teller Machines (ATMs)

In the late 1970s, ways of using networks to reach consumers began to emerge. Automated teller machines (ATMs) are now in widespread use across the world to deliver information and cash to customers.

2.4. EPOS and EFTPOS

At the same time, information on consumer purchases began to be gathered at the point-of-sale by networked, electronic tills. This electronic point-of-sale (EPOS) data is now used by many large retailers to drive their replenishment processes electronically. A parallel development, electronic funds transfer at point-of-sale (EFTPOS), paved the way for greater choice in consumer payment methods, supporting credit and debit cards and, in the future, payments with digital money stored on smart cards and shopper loyalty cards.

2.5. Videotex

Videotex services were developed in Europe in the late 1970s and early 1980s and can be regarded as the original interactive online services, offering visual and text information to a screen-based terminal. They have proved to be successful in some countries, paricularly in France, with the mass introduction of the Minitel services, and in Germany, with Deutsche Telekom's BTX service.

2.6. The Emergence of Internet E-commerce

Internet E-commerce is the result of a technology maturation process. The forerunners of Internet E-commerce have tended to address the electronic trading concerns of particular market segments as described above. Such technologies did show a return on investment, but the initial investment threshold was too high for widespread adoption.

For example, EDI has a bright future in Internet E-commerce, providing Internet EDI suppliers can guarantee the same levels of security, auditability and accountability as private EDI network service providers and providing that EDI can also be implemented easily and quickly – "on the fly" – between trading partners. At present, trading partners have to spend considerable time and effort setting up EDI communications.

One solution, EDI forms software, is beginning to appear on the market. This enables a company that has implemented EDI internally to publish an interactive form on the Web. The business partner fills in the form which is translated into EDI messages which can then be processed immediately and automatically by the company's internal systems.

Thus, the various technologies and the concepts behind the Internet and E-commerce have reached a point where they can be used in conjunction with one another to drive down the cost and widen the scope of doing business across networks.

3. Internet and E-commerce: New Opportunities

3.1. Introduction

This section looks at the way business may change over the next 10 to 15 years, driven by the new imperatives of E-commerce over the Internet. Such change will bring new opportunities in both the business-to-business and business-to-consumer markets.

3.2. Defining the Opportunities

Businesses are faced with two types of opportunity for E-commerce over the Internet: an opportunity to streamline business-to-business relationships and an opportunity to address the consumer market.

3.2.1. Business-to-business Opportunities

The business-to-business opportunity largely concerns companies participating in a supply chain, where each member of the chain adds value to a product and sells it on to the next supplier until it reaches the end-customer.

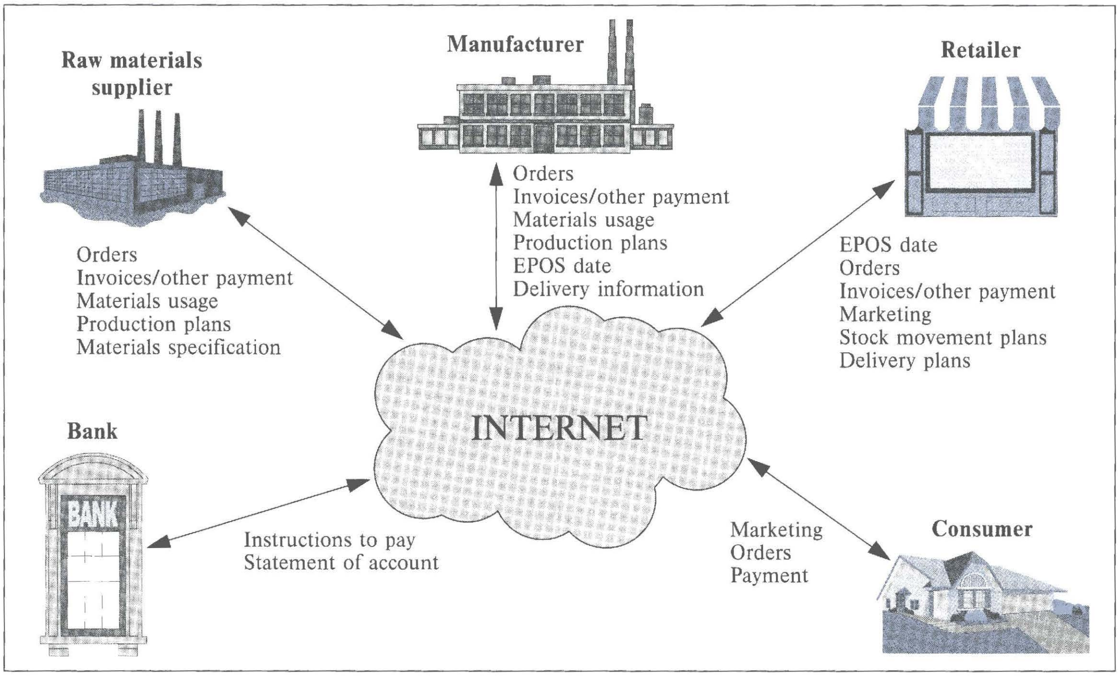


Figure 2
Types of Information Potentially Sent Electronically in a Supply Chain

Today's supply chains are becoming less order-driven and more proactive and dynamic in response to increased competition. All the partners in the supply chain need to understand, simultaneously, end-customer market trends, the impact these are likely to have on their customer's business and the likely consequence this will have for their own ability to supply their customer accurately and in time.

To facilitate this understanding, information must flow transparently, and in real time, up and down the supply chain. Electronic point-of-sale (EPOS) and marketing information is used to forecast consumer trends, logistics information (inventory and delivery data) supports the fulfilment of customer orders, and financial information is needed for the settlement of accounts. Today, much of this information is sent by post or fax, if it is exchanged with trading partners at all. Electronic links exist only in parts of supply chains, typically between large and powerful organizations, such as retailers and their closest suppliers, which have the resources to implement them. Such businesses have received partial benefits from electronic links but are beginning to realize that further improvement is impossible while large areas further up the chain are invisible and unaccountable to the others. E-commerce over the Internet promises to satisfy supply chain requirements for instant and transparent access to such information by providing a low-cost electronic link between partners as shown in *Figure 2*.

3.2.2. Business-to-consumer Opportunities

Business-to-consumer opportunities arise because the Internet provides merchants with a new sales and marketing channel to customers.

Type of business	Business need	Conventional process	E-commerce process
Advertising agency	To deliver multimedia mock-ups of advertising campaign to overseas client in timely fashion	Send CD-ROM by courier to client Time taken: 24 hours	Send file over the Internet Time taken: 10 minutes
Manufacturer	To make a range of specialist products available to 6,000 distributors just-in-time	Distributors phone or fax order and await confirmation and delivery date Time taken: 1-2 days	Distributors place orders across the Internet and get immediate feedback from system about products available and delivery schedule Time taken: few minutes
Manufacturer	To collaborate with suppliers overseas on engineering design	Computer-aided design model sent by supplier to manufacturer at end of his day; manufacturer amends and sends back to supplier with comments at end of his day Time taken: 12-16 hours	Both parties obtain copy of the model and use Internet telephony and white-boarding facilities to discuss changes Time taken: real time

Table 2
Three Illustrations of Time Savings Created by Internet E-commerce

The Internet can extend merchants' global reach. The current trend in Internet shopping malls, for example, is to market the luxury items strongly associated with a particular country to overseas audiences.

The Internet can also be used for more specific targeting of consumer groups than conventional marketing techniques. Merchants are beginning to build databases of information about the potential consumers who access their Web sites, taking note of what they look at, how long they stay logged on, and their demographic details, which they are encouraged to enter on interactive pages. Through the use of such information in the future, and with consumers' consent, merchants will be able to offer individual customers the exact package of goods or services that appeals to them.

3.3. Drivers for the Uptake of E-commerce over the Internet

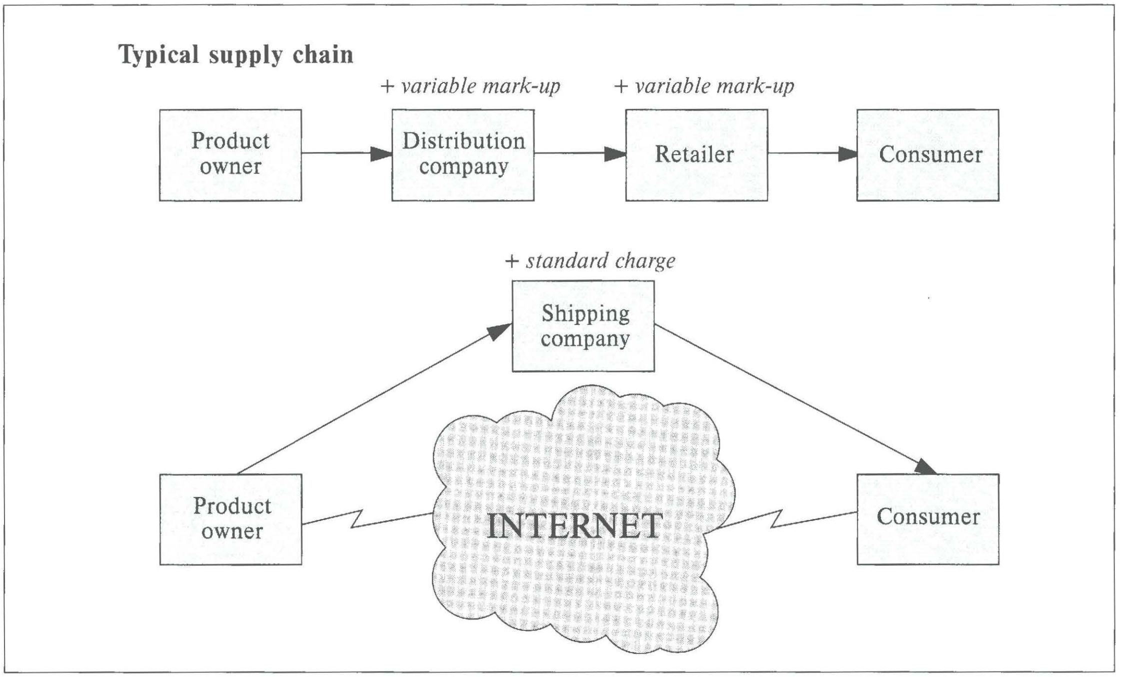
These opportunities arise because E-commerce over the Internet addresses four issues that most businesses agree create competitive edge today:

- time-to-market for new products and services;
- customer relationships;
- reduced costs;
- access to the global market.

3.3.1. Time-to-Market

A supply chain consists of a number of links, all of which affect the time it takes to deliver a product to the end-consumer. The more proactive and agile the supply chain, the less time it will take from delivery of raw material, through manufacture of the finished

Figure 3
Reducing Costs Through Disintermediation



goods, to delivery to the customer. The most advanced supply chains are using electronic capture and delivery of information to operate "just-in-time". The Internet is beginning to play a vital role in just-in-time information delivery in three areas:

- in simple supply chains;
- in areas where confidentiality of information is non-critical;
- between small suppliers that cannot afford the expense of proprietary E-commerce links and larger businesses;
- collaborative working.

Table 2 gives three examples of how Internet E-commerce can dramatically reduce the time-to-market.

3.3.2. Customer Relationships

As markets become more competitive, businesses need to develop strong customer relationships to keep their customers loyal.

The service industries are particularly concerned with issues of customer loyalty and are already early users of the Internet. For example, couriers are already working on ways of letting customers have direct access to their account information across the Internet, to look at their bills on demand, track goods in transit, etc.

3.3.3. Reduced Costs

There are two distinct cost issues involved in Internet E-commerce: one concerning the business-to-business market and the other the business-to-consumer market.

Every time materials or goods are stored on their way down the supply chain to the customer, repayment is delayed and the supplier incurs interest charges. These costs - of storage, premises, warehouse management, stock control and damage through handling - can have a severe impact on a company's profitability.

E-commerce links between trading partners enable the timely delivery of information to optimise the supply chain. Inventory is minimised, storage and handling costs reduced, the time between committing money for raw materials and receiving money from the customer to cover this outlay is shortened and communicating with customers electronically can save professional printing and postage costs. Customers may access a supplier's Web page to retrieve the information they need on a product. This saves both the customer and supplier time.

In the business-to-consumer market, E-commerce can reduce the cost of sales through disintermediation, the removal of third parties such as distributors which intervene between merchant and consumer and charge for handling the product. This is illustrated in *Figure 3* and promises a more direct, less costly relationship between merchant and consumer enabled by the Internet.

Disintermediation is likely to occur first in markets where the Internet can be both a promotional/sales vehicle and a delivery mechanism for digital content, that is, in the publishing, entertainment and music industries. In the publishing and music businesses, the distributor and retail outlet may take up to 60% of the retail price of the product. By selling to consumers directly, publishers can pass on a lower percentage of this mark-up, achieving higher profits while appearing to offer cheaper products.

3.3.4. Access to the Global Market

E-commerce over the Internet will allow merchants access to the worldwide market where previously the cost of setting up an overseas operation was too expensive.

Therefore, it offers the prospect of a more level playing field, in which SMEs will have a better opportunity of competing with multinationals in a global market than they do today.

3.4. How Organizations will Change

Within 15 years, by the year 2010, E-commerce over the Internet can be expected to have had a major impact on four key aspects of business shown in *Table 3.*

3.5. Making the Transition

Business adoption of E-commerce over the Internet has been so recent that the market is still very much in an experimentation period. It is likely that organisations will evolve through positioning and re-engineering phases before they reach the 2010 scenario described above.

3.5.1. Positioning for E-commerce

In the positioning phase, organizations will improve their internal communications and experimenting with Internet technology through the implementation of an Intranet. An Intranet supports communications between a business and its employees, such as staff bulletins, administrative communications over timesheets and holiday schedules, access to personnel information, such as pension rights and company benefits, collaborative working and workflow. At the same time, the organization may be experimenting with electronic advertising through a Web site on the Internet. It may progress from having a stand-alone site to one that is linked to its legacy databases, providing customers with continually updated information, for example, on price and availability of goods or services.

Also in the positioning phase, companies may begin to forge links with new suppliers of complementary goods and services. An investment house or pensions group may team with a retailer which attracts a particular customer profile, for example, to offer a special package of services across the Internet. However, there

Table 3
The Impact of Internet E-commerce Today

Key business aspect	Commerce today	Internet commerce
Market presence	Physical presence Brandname	Cyberpresence Brandname
Organization and structure	Restructuring to focus on identifying the core business	Re-definition will lead to the emergence of the virtual company
Pricing	Price differentials maintained because of limited consumer access to pricing information	Ease of price comparison will encourage competitive pricing
Distribution	Large supply of goods to retail outlets	Flexible distribution systems to cope with delivery to customer addresses worldwide within short timescales

may be a portion of the potential market which would favour a link between the same retailer but a different financial services company. Businesses will start experimenting with such links, gathering information on the preferences of target markets which they can use when marketing the results of new collaborations.

3.5.2. Re-engineering the Business

These positioning activities – introducing an Intranet, making business information in legacy systems available to external customers, creating new commercial relationships – will have a fundamental effect on the way the organization functions. As a result, it will move into the re-engineering phase. During this phase, it will look at ways of adapting its processes to an E-commerce environment. This will involve stripping out processes that are no longer necessary, automating others through the use of E-commerce technologies such as EDI and tightly integrating such technologies with its business systems.

3.5.3. Re-defining the Business

Company restructuring in the 1990s has focussed on identifying an organization's "core business" and stripping away all activities that do not directly contribute to it. In the next century, the definition of "core business" will shrink further. Leading-edge organizations are already considering a time when their "business" will consist of owning and controlling their name and trademarks, with all other business functions bought in as needed under stringent terms and conditions and quality controls. IT and distribution are today perceived by some companies as "non-core" services that can be outsourced. There is no reason why, in the future, administrative functions, such as personnel and finance, and even production, should not be outsourced in the same way.

E-commerce over the Internet will become the "glue technology" in such a scenario. Electronic trading links support the concept of a "virtual company", in which many organizations with different kinds of expertise may choose to collaborate in a seamless way to serve an end-customer. Some virtual companies may be established for a long time while others may disband after a few weeks. E-commerce technology and the ubiquity of the Internet will give organizations the flexibility to acquire new partners to meet new market opportunities, or to change partners if another offers a better price or quality of service.

3.6. Opportunities for E-commerce Enablers

Businesses providing goods and services in an E-commerce/Internet environment will want to focus on business issues, not the technology infrastructure. This gives rise to a potentially huge opportunity in the converging IT/telecommunications sector for businesses that want to provide infrastructure services.

The Internet is a complex set of technologies and services that both enables commerce and also gets in the way of it. In theory, the Internet should connect everyone. In practice there are subtle hardware and software incompatibilities between buyers and sellers. In theory, the Internet should be available 24 hours a day every day of the year. In practice, the fact that no organization has overall visibility of or control over the Internet means that there are frequent and inexplicable communications failures which can badly disrupt the trading process. A customer often has no way of knowing whether a technical fault has prevented delivery of his merchandise or whether he has been the victim of an Internet fraud.

There is the need for a technically competent intermediary - or value-added service supplier - to provide services that protect E-commerce on the Internet. The race is on between companies who want to dominate this market.

The main contenders are the network operators, which see the Internet as a natural extension of their existing business and which own most of the network infrastructure over which it operates, the Internet Service Providers (ISPs) which currently provide Internet dial-up access, and the large IT systems integrators. All are taking a central role in Internet-based E-commerce, hosting merchant Web sites and putting in place technology to handle secure payments, sometimes in partnership with financial institutions.

4. Critical Issues and Barriers to Adoption

4.1. What are the Critical Issues?

E-commerce over the Internet is being held back by six major barriers:

- security;
- acceptance of new payment methods;
- availability of infrastructure and bandwidth;
- cost to businesses and consumers;
- legal and regulatory issues;
- linguistic and cultural issues.

Sections 4.2 to 4.7 discuss each of these in detail.

4.2. Security

The Internet was designed as an open environment, not a secure one. Its great strength - the fact that is it based on the widely-supported TCP/IP suite of network protocols - is also its greatest weakness: TCP/IP lacks basic security services. As a result, the Internet is vulnerable to attacks that may seriously compromise the integrity of commercial transactions.

Such attacks may include "eavesdropping" on traffic as it passes, "sniffing" out passwords; altering the content of data packets across the network, "spoofing", or impersonating another party in a transaction, and repudiating, or denying participation in a transaction after the event.

In an Internet E-commerce transaction, merchants and consumers need to know:

- who each other is - are both parties genuine? Can their identities be authenticated?
- will the transaction leave an audit trail so that neither party can pretend it didn't happen? Will non-repudiation be guaranteed?

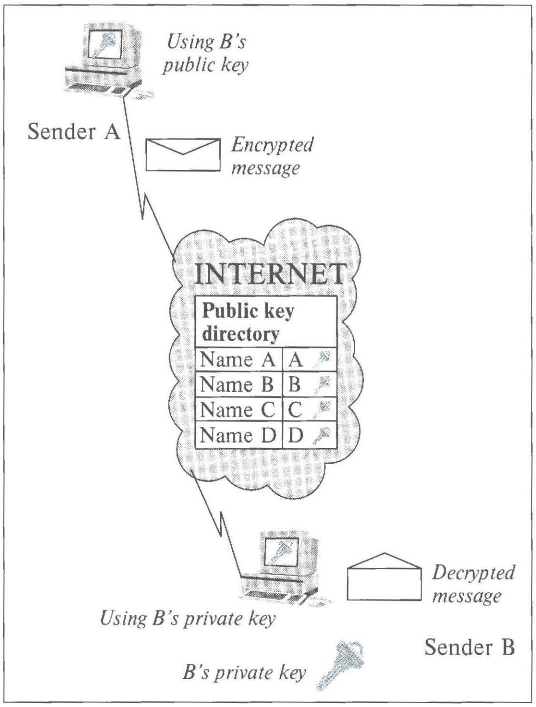


Figure 4
Internet Public Key Encryption

- will the information passed between them of financial or personal value, such as credit card details, or electronic cash, be done privately, with no possibility of theft or tampering? Will it be encrypted?

4.2.1. Encryption

Encryption technology is the foundation for safe Internet commerce. It supports authentication as well as the secure transmission of information between parties. It is based on the concept of a mathematical algorithm using a key that turns data into an apparently meaningless sequence of characters, useless to anyone but the intended recipient with the key to decode it.

A popular form of encryption on the Internet is public-key encryption. This uses a pair of non-identical, unique, but matched keys, one public and published freely in an Internet directory and the other a private key which is only known to its owner. Thus, two people can share encrypted data without having to exchange private keys, with all the attendant security risks. One has to be careful and take into account that the directory does not tell the truth.

Figure 4 shows how the sender of a confidential message will encrypt it using the intended recipient's public key, as published in an Internet directory. The resulting message can only be decoded using the recipient's private key. The same technology can be used to verify the sender's identity when he encrypts it using his private key. It can then only be decoded using his matching public key. Encryption algorithms can also be used to create "digital signatures", which can further authenticate the identities of parties involved in commercial transactions.

Parties participating in E-commerce may make their own arrangements to support public key encryption, or they may use the services of a Trusted Third Party (TTP). The TTP will generate and distributing key pairs, in a similar way much as banks provide Personal Identification Numbers to verify bankcards. Financial institutions - in particular, the credit card companies - network providers, and specialist trade and professional bodies are already seizing the commercial opportunity associated with becoming a TTP.

There is much debate over the length of keys and how frequently they should be replaced in order to provide commercial transactions with maximum security. Many organizations want to use adequate key-lengths and methods they can trust.

In some countries, encryption technology is classified for reasons of national security and is subject to export controls. This situation is

Market segment	Information to be kept secure
End consumers	Personal data, e. g. address, telephone number, bank details, credit card information, private key for digital signature, electronic cash
Entertainment	Revenue-generating product sent in digital form, e. g. video games
Publishing	Revenue-generating product sent in digital form, e. g. newspaper, journal, electronic book, multimedia
Financial	Financial information, funds transfer, payments
Manufacturing	Competitive information on, e. g. raw materials specification, designs, production plans, financial information, orders, offers
Retail	Competitive information on consumer data, product specifications, inventory, financial information
Tourism	Payment transactions
Healthcare	Patient confidential records
Education	Individual pupil records
Public administration	Public administration records, financial information
Utilities	Competitive information (in deregulated environments) on demand and supply plans, financial information
Transport	Competitive delivery and distribution information, financial information

Table 4
Security in Market Segments

changing fast because suppliers in such countries do not want to be cut out of the global market for a key E-commerce technology. They are putting pressure on their governments to remove export controls.

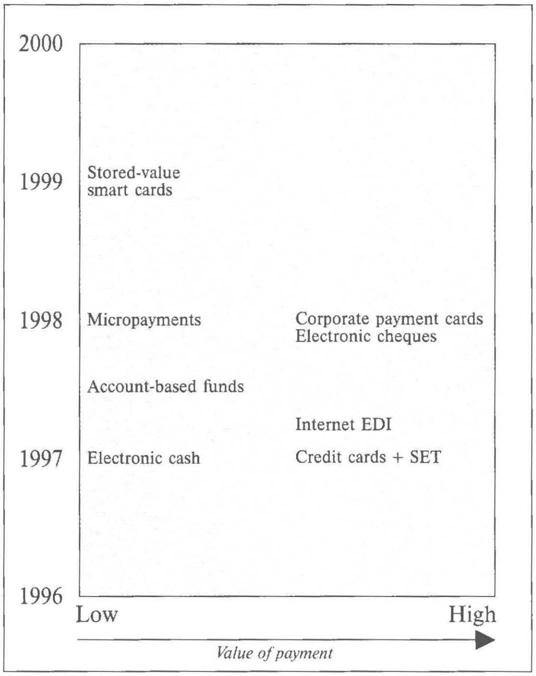
The best-known public key encryption standard is the Secure Electronic Transactions (SET) standard. SET is the creation of a consortium of companies led by Visa and Mastercard and including IBM, Microsoft and Netscape, to encrypt credit card information sent across the Internet. E-commerce software products incorporating SET, such as secure payment systems, are now beginning to appear in the market.

4.2.2. Other Security Technologies

The encryption of credit card information is just the tip of the security iceberg, especially as security specialists estimate that 80% of all security attacks come from inside the organisation. Other key security technologies that need to be in place include:

- trusted operating systems that limit access to data that needs to be securely held, both to organisational outsiders and to staff. Such operating systems implement a set of secure protocols developed for military applications: the Orange Book Protocols;
- firewalls: hardware and software products that sit on Internet servers or stand alone, restricting outsider access to non-customer-facing corporate information systems. Firewall technology is still very new and complex and does not provide a standard set of security features;

Figure 5
Market Acceptance of Internet Payment Methods



- protocols, such as SSL and S-HTTP that compensate for the security capabilities missing in TCP/IP, supporting confidentiality and integrity of data and authentication;
- smart card technology, to hold private keys for digital signatures and/or encryption keys. This information can be vulnerable if it is left on unsecured personal computer disks.

The types of information that need to be secured in different market sectors are shown in *Table 4*.

4.3. Acceptance of New Payment Methods

Closely related to security issues are the methods of paying for goods and services across the Internet. *Figure 5* summarises proposed Internet payment methods and how close they are to market acceptance.

Fears about security in first generation Internet payment systems have kept sensitive financial information off the Net altogether. They have been provided by new intermediaries, with whom consumers register their credit card details. Every time consumers carry out an Internet transaction, they inform the intermediary, which charges their cards on behalf of participating merchants. This is a cumbersome solution which does not support instant confirmation of transactions or immediate exchange of value. Consumers need more direct methods of payment if Internet commerce is to prosper.

The availability of SET to support direct credit card transactions between merchant and consumer will now begin to replace first-generation Internet payment solutions. The SET standard is important because it allows customers to use a familiar form of payment with the same security they are used to in traditional areas of commerce. The backing of Visa and MasterCard aids acceptance and encourages consumer trust.

The Joint Electronic Payments Initiative (JEPI) is a multi-industry project which is developing protocols for multiple payment instruments (e. g. credit cards, debit cards, electronic cash and cheques) over the Internet. These protocols are intended to become standards for E-commerce, allowing E-merchants to accept payment from customers in a variety of forms.

Electronic "cash", a virtual coinage which has value only on the Internet, is an important development, particularly for the consumer market where privacy and flexibility of payment are likely to be important factors. There are ongoing market trials of secure "cyberwallets", which can be charged up with electronic cash via a credit card and sent securely across the Internet to merchants. Other E-commerce payment solutions include micropayment schemes (supporting very low-value payments over the Internet) and smartcard-based electronic cash schemes. Acceptance of such schemes will depend on issues such as:

- their interoperability with other non-virtual payment systems: at present there are no official mechanisms for issuing electronic cash or for exchanging it for hard currency;
- widespread international support among financial institutions so that electronic cash does have worldwide currency.

4.4. Availability of Infrastructure and Bandwidth

The use of the Internet for E-commerce has implications for its infrastructure, including its accessibility, reliability, charging mechanisms and capacity.

As the type of consumer carrying out E-commerce over the Internet changes from the computer literate to the mass market, ease of access and acceptable response times will become increasingly important. The majority of consumers will expect to access the Internet first time every time from an intuitive interface. They will expect 24-hour availability of the services they wish to use. When they pay for the multimedia services of the future, they will expect them to arrive instantaneously, without distortion caused by routing delays.

As businesses begin to rely on the Internet to support critical business processes, they will expect the same reliability as many now experience from their internal private networks. They will become increasingly intolerant of delays in access to and delivery over the Internet. Such delays may have cost implications. For example, organizations may lose business if a tender fails to arrive in time for a deadline, or customers may become dissatisfied with the apparently slow way in which orders have been handled and turn elsewhere.

From a business point of view, it is important that customers share reliable, high-bandwidth access to the Internet. Merchants will increasingly want and need to use the latest technology, which today includes sophisticated graphics and virtual reality sequences, to attract consumers to their sites. However, taking this approach may rebound on the merchants' image if a significant proportion of consumers are not equipped to take advantage of these innovations.

The chapter on "The Future of the Internet" looks in detail at current constraints on the Internet's capacity and reliability (Section 2.2) and at the access technologies that will boost E-commerce over the Internet in the future (Section 4).

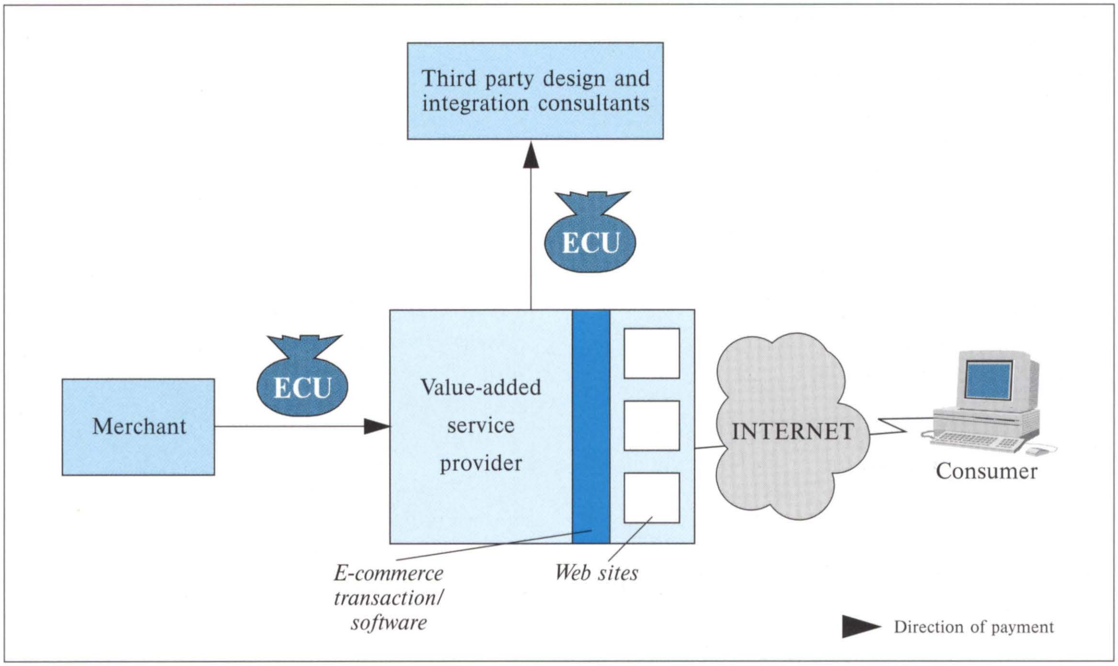
4.5. Cost of Investment

There are three perspectives on the cost of investing in Internet E-commerce: the merchant's, the value-added service provider's, and the consumer's. The value-added service provider's (VASP's) role is critical in the positioning phase described in Section 3: it provides the enabling technology that makes it easy for the merchant and consumer to do business (and, indeed, to facilitate business-to-business transactions).

4.5.1. The Merchant's Cost of Investment

Figure 6 shows the merchant's investment costs in the positioning phase. A typical merchant will carry out Internet E-commerce through a VASP, whether this is an ISP, or a cyberspace property developer, such as an electronic mall or business park owner.

Figure 6
Merchant Costs in the Positioning Phase



The merchant will pay the VASP a joining fee, usually to cover integration work between the VASP's systems and its own. The merchant may independently pay a design company to design its Web site (which will be hosted on the VASP Web server), or, if the merchant is joining an electronic mall or business park, the VASP may take over the design, so that the merchant's site is integrated with the other participating sites and promotes the mall's "brand image".

The merchant will then pay the VASP a monthly fee, depending on the space used or the number of products offered, and a transaction fee based either on a percentage of the value (for transactions) or on the number of hits (for advertising).

From the merchant's point of view, carrying out Internet E-commerce through a VASP is a much lower risk approach than putting all of the infrastructure in place itself. The cost of investment is likely to be in the thousands of ECUs, rather than in the hundreds of thousands or millions.

One of the largest costs can be the Web site design, depending on the site's level of sophistication and the value of the product it is trying to sell. Large multinationals and merchants with "luxury" goods, such as cars, typically spend hundreds of thousands of ECUs on their sites. However, it is possible to create a basic site for a few hundred ECUs.

Once merchants find that a significant enough proportion of their business is coming from the Net, they may bring the technology in-house (see *Figure 7*). This will mean investing in:

- servers, which will need to scale as the volume of business grows;

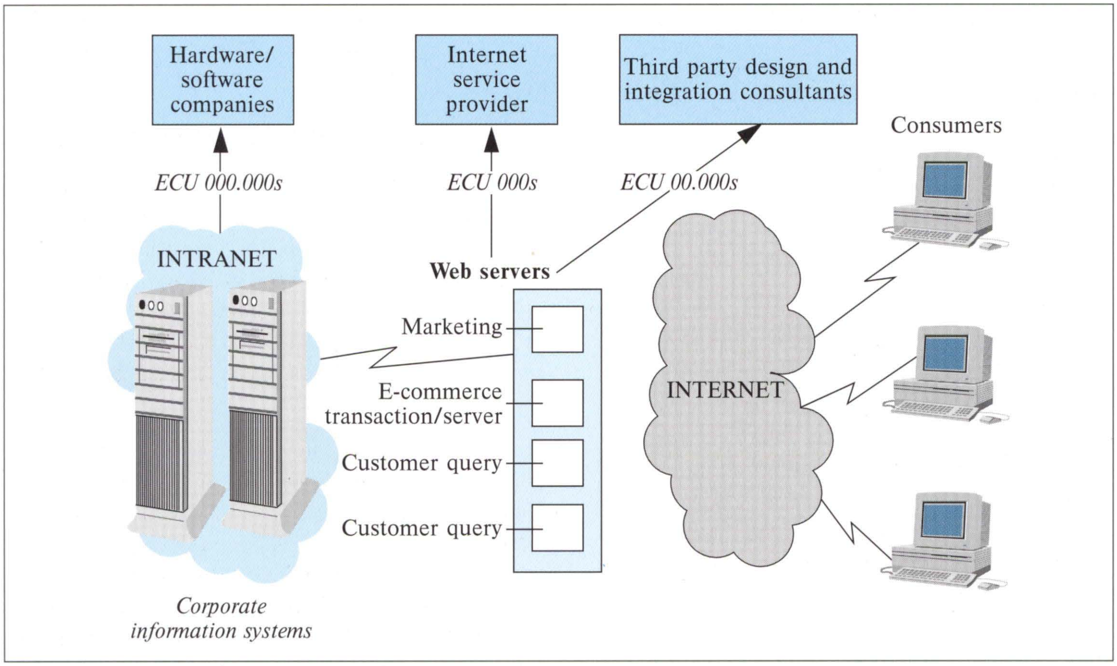


Figure 7
Merchant Costs in the Re-engineering Phase

- bandwidth, the demand for which will also increase in line with business growth;
- commerce software to handle transactions;
- security technology, such as firewalls;
- a support organization.

Entry-level E-commerce software, including online transaction and security capability, is now available for as little as 20,000 ECU. Over time, these costs will continue to fall as E-commerce software becomes a commodity item and security technology is built into servers at operating system level. This will affect the uptake of Internet E-commerce in two ways. First, it will encourage organizations to move from the positioning phase to the re-engineering phase. Second, it will provide entry level solutions for smaller businesses, thereby encouraging mass market uptake.

4.5.2. The VASP's Cost of Investment

The VASP's investment costs are similar to those of other organizations in the re-engineering phase.

There are a few key differences: the merchant will have to bear the costs of business process re-engineering and integrating corporate systems with its Web front-end systems. The VASP will have greater support costs because of the greater variety of hardware and software to which it will inevitably have to link, and because it will have to keep to service level agreements with key customers.

This is reflected in the cost of E-commerce software to this group. Today, such software alone can cost between 125,000 ECU and 625,000 ECU. The investment needed to set up an electronic mall, for example, is estimated at between 625,000 ECU and 1.25 million ECU.

4.5.3. The Consumer's Cost of Access

Consumers need to have access to the Internet before they can participate in E-commerce. In order to gain access, consumers must incur three different types of cost: the cost of terminal equipment, ISP subscriptions and additional telecoms charges.

The largest of these is the initial cost of terminal equipment. This represents perhaps 80% of expenditure on Internet services in the first 12 months: an entry-level PC (including modem) will cost upwards of 1,250 ECUs.

In addition, consumers must pay a subscription to an ISP. Typically, this is around 125 ECUs per annum. At the moment, this market is very competitive and prices are under considerable downward pressure. Furthermore, the true cost is not passed on fully to the consumer because of the way the ISPs and backbone providers price services between themselves. Therefore, it can be expected that prices may rise for heavy users as the industry moves to more appropriate pricing models for a commercially-oriented Internet.

Finally, consumers will have to pay the cost of the local call whilst they are logged on. Local call charges vary significantly from country to country but for moderate usage (two hours off-peak usage per week), a consumer in France would expect to pay an additional 190 ECUs per annum in telephone charges.

The consumer market for Internet services remains in its infancy. Terminal cost is one of the main reasons for this. Whilst the first wave of E-commerce consumers will come from existing PC owners, many of whom are not yet connected to the Internet, the mass market will require significantly lower-cost terminals. Network computers and PC-TVs are expected to address this need.

The chapter on "The Future of the Internet" looks in detail at issues related to the cost of consumer access.

4.6. Legal and Regulatory Issues

The open and global nature of the Internet potentially makes it easy for merchants and consumers to sell and buy across the world. This section looks at the regulatory implications of most concern to national governments, as well as to merchants and consumers themselves and how these relate to the critical issues described above.

In the case of the Internet, the appropriate level for any regulatory framework should be global. In the European Union, authorities are aware of the difficulties for creating an homogeneous and coherent regulatory framework on a European scale, while the rapid development of new services is pushing national legislative and regulatory initiatives. For this reason, the European Commission has put forward a proposal for a directive which will require that the Commission and other Member States be notified of any draft national regulation concerning the information society services, including the Internet. The objective of this directive is to improve the transparency in the legislative process, avoiding unnecessary blocks but ensuring at the same time that national initiatives remain consistent with the general EU interest.

The European Commission has put in place an action plan in order to develop a broad set of common rules regarding several aspects of the new services of the information society, including those concerning access to networks, the protection of intellectual property, the harmful or illegal use of Internet, security and privacy of information.

4.6.1. Intellectual Property Rights (IPR)

Products and services to be provided via networks such as the Internet will, in many cases, contain or be based on material protected by copyright and related rights, e.g. software, databases, audio-visual and musical works or multimedia products. New methods for utilizing content will arise as users access and process material obtained through the network. An environment of this kind raises concerns for the owners of intellectual property rights over the use of content in ways that are unauthorized or not anticipated under the current law. To promote the necessary investment in creative and innovative activity it is therefore critical to ensure adequate and effective IPR protection when products and services are disseminated via the information infrastructure.

This problem needs to be addressed on two fronts: through legal protection, by extending copyright laws to cover situations arising from Internet e-commerce, and on the technology side, by developing identification and protection schemes for individual copyright management.

The European Commission is aware of the importance of these aspects which are already dealt with in the regulatory provisions currently in force in the Community (e.g. directives 91/250/EEC and 96/9/EEC on the legal protection of computer programmes and databases). The development of copyright management systems for individual rights management is financed by the Commission under the ESPRIT programme.

As a result of the consultation process that has followed the publication of the Green Paper on Copyright and Related Rights in the Information Society, the Commission has identified four priority copyright issues for further legislative action at Community level.

- Reproduction right: Harmonized measures will be proposed in order to define the scope of the acts protected by the reproduction right, including the limitations to it.
- Communication to the public right: Digital "on-demand" transmissions will be protected on the basis of a further harmonized right of communication to the public.
- Legal protection of the integrity of technical identification and protection schemes: Legal protection of such schemes will be harmonized at Community level, defining in particular the precise scope of protection, including the infringers liability.
- Distribution right: The distribution right will be harmonized. The principle of exhaustion shall apply to the distribution of goods only and not to the provision of services, including on-line services.

At international level, the Berne Convention provides for minimum standards of copyright protection. Most countries are party to this convention which can well serve the needs of global e-commerce. Obligations under this Convention have been confirmed by the GATT TRIPs Agreement. A WIPO (World Intellectual Property Organization) diplomatic conference held in December 1996 adopted two multilateral treaties updating individual copyright norms to ensure the functioning of the copyright system in the digital environment.

In mid-1996, the EC proposed to link the Community trademark registration system with the international trademark system of the WIPO. This would enable European companies to make a single application to register their trademarks both within the EU and also in the non-EU countries which are, or will shortly become, members of the Madrid Protocol.

4.6.2. Consumer Protection

Most consumers will only buy over the Internet if they know they are protected by the same laws of contract that govern their everyday transactions in the physical world. Overseas purchases may be affected by the different laws of contract operated in different countries, for example, national policies on exchange or return of faulty or unwanted goods. It may not always be clear which country's law applies to a commercial transaction. There is a need to harmonize national laws to support global E-commerce over the Internet.

Legislation concerning consumer privacy is being harmonized within Europe. A recent EC Directive on personal data held on computers empowers the Data Protection Registrars in European countries to prevent the unauthorized use of personal data. It also emphasises the need to obtain the express consent of the data subject for the processing and disclosure of personal data. This may inhibit the rise of electronic "junk" mail - advertisement shots that may result from the Web-based personal data collection systems which many companies are now putting in place.

4.6.3. Security Regulation

In 1996, the EC published a Green Paper on the legal protection of encrypted services. Encrypted services in the context of the Green Paper are those whose signals are encrypted in order to ensure payment of a fee. The paper seeks to harmonize Community laws against the unlawful decoding of encrypted services and the unlawful manufacture of decoding services.

In 1997, the OECD plans to publish guidelines for a common set of international encryption control policies after consultation with international business associations and multinational companies.

The European Commission is also preparing proposals for a European framework for trusted third parties (TTPs) and is exploring the issues involved in the Semper project (see Section 5). To safeguard public interest, there needs to be some means of accrediting and regulating TTPs. This may involve an appropriate regulatory body checking their liability cover and the capabilities of employees. The legal liability of TTPs is another issue that needs to be resolved.

4.6.4. Content Regulation

There are two main aspects to content regulation:

- the control of trade in illegal content, such as pornography;
- the conformance of trade in content to GATT agreements.

While publishing and other media sectors are regulated in many countries, the Internet has not yet been included in the same regulatory framework. There is debate over who should be responsible for monitoring content over the Internet. Some countries, notably in Asia, have treated regulation as a government matter and have set up what amount to national "firewalls". These monitor the Internet feeds in and out of the country in an attempt to prevent access to forbidden sites.

A number of Western countries are trying to shift regulatory responsibility to commercial organizations, namely the ISPs and Online service providers (OSPs), on the grounds that, by delivering such content - however unknowingly - they are, in fact, publishing it. The ISPs and OSPs are strongly resisting this argument (see the chapter on "The Future of the Internet", Section 8.2). A leading OSP recently threatened to withdraw its administrative operations from Germany because of government moves requiring Internet service providers to block access to obscene material.

An EC paper on harmful and illegal content on the Internet is seeking ways to strengthen legal protection, encourage parental control systems and improve international cooperation.

The Uruguay round of GATT talks highlighted content quotas, particularly in countries concerned with the protection of their audiovisual industry, such as France. Such countries have produced quotas that restrict the amount of foreign-produced content shown, for example, in cinemas and on television. It is unclear how these quotas will apply to multimedia material over the Internet and whether they can be legislated for in such a dynamic, global environment.

4.6.5. Telecoms Market Issues

European legislation is underway to complete the liberalisation of the European telecoms market in 1998. This will create competition that will drive down prices, both of infrastructure and access, encouraging more businesses and consumers to participate in E-commerce over the Internet. An OECD study of Internet pricing, published in June 1996, showed that Internet access was far greater in competitive telecommunications markets than uncompetitive ones, due in part to lower leased-line costs and the structure of local call charges.

4.6.6. Cross-border Regulation

There is a need to harmonize individual nations' tax and customs regulations to facilitate E-commerce across borders. Issues include the level of Value-added Tax (VAT) attracted by an Internet purchase and the importing of goods that may be bought legally in one country but which cannot be owned in another. Such regulation also needs to extend to the transfer of financial assets to tax havens.

4.7. Linguistic and Cultural Issues

As with so many technologies before it, E-commerce over the Internet is dominated by US companies. This can disadvantage merchants and consumers from non-English-speaking countries in a number of ways:

- A merchant's market may be limited to the region that shares its language, particularly if it does not put up information on its Web site in English. The merchant may need to incur the additional expense of translating information into English in order to widen its market.
- Conversely, consumers who do not have a good working knowledge of English may find it difficult to "shop" in other areas of the globe: they will ultimately have less choice than other consumers.
- Web search engines are largely US-based, so they do not pick up many European references and cannot always cope with different European character sets. The information sources and merchants selected are therefore more likely to be from the English-speaking world, rendering large numbers of sources invisible.

These problems are being recognized in certain countries: the French government, for example, is keen to encourage the development of French language information sources that can be used by the worldwide Francophone community. To participate successfully in Internet E-commerce, European merchants may have to develop multi-lingual front-ends to their Web sites and pay attention to the presentation of information (for example, for sales and marketing purposes) in different cultural contexts.

5. Projects to Facilitate E-commerce

Such is the interest in Internet E-commerce that new initiatives to promote and support it seem to emerge weekly. They range from well-established fora with a high market profile and blue-chip membership, such as CommerceNet and Integrion in the US, to small-scale projects aimed at generating new business opportunities for small and medium sized enterprises (SMEs) in a variety of regions, from Scotland to Southern Spain.

Europe's two flagship E-commerce projects are SEMPER, which is focusing on secure electronic trading and a European cryptographic framework, and E2S. Funded under the European Commission's Esprit research and development programme, E2S involves a number of European supplier and user organizations in developing a secure infrastructure for information access and delivery, and transactions. Several of the EU E-commerce initiatives come under E2S.

Europe is also the natural home to projects that support SMEs. These projects are being co-ordinated by commercial umbrella organisations or government-funded bodies, such as Chambers of Commerce, the European Commission and national governments.

Well-publicised regional projects are enjoying rather more success at the moment than some of the international efforts, such as the Global Marketplace for Small and Medium Enterprises initiative, sponsored by the G7 countries. For example, an Internet Business Park run by a major IT systems integrator, initially as an E-commerce testbed, is in such demand by local businesses that the company hopes to roll out similar facilities in other locations across the UK in the near future.

Sweden is also active in setting up E-commerce projects: Swebizz is a partly government-funded body which maintains active links with CommerceNet. France and Italy are tending to set up projects that address E-commerce from an EDI perspective, sponsored by existing EDI organizations such as EDIFRANCE and EDIforum Italia.

It is likely that there will be more announcements of initiatives to support E-commerce along the lines of the Integrion Financial Network, announced in September 1996, which uses Internet technology within a secured and private network environment. Integrion will be run by a consortium consisting of a major IT systems integrator and 15 US retail banks. By addressing the security issue, Integrion hopes to take a major share of the projected 75% per annum growth in US home banking users. European banks are taking note of Integrion as they, too, move into the online banking market: as yet, there are no signs of such concerted activity in Europe, where the Internet E-commerce market is still highly fragmented.

Descriptions of the major commercial and research programmes addressing aspects of E-commerce can be found in Appendix A.

6. Merchant and Industry Sector Case Studies

This section is in two parts. Six E-merchant case studies across Europe are followed by analysis of the business case for using Internet E-commerce in two specific market sectors: banking and recruitment.

6.1. E-commerce Case Studies

Prospective E-merchants can either choose to set up a Web site on their own, or they can join an electronic mall. As some of the case studies show, there are advantages and disadvantages in both these applications (see *Table 5*).

Table 5
Web Site vs Electronic Mall

Electronic mall	Web site
Merchants may share a more sophisticated set of E-commerce facilities, such as multicurrency payments, shopping cart, better graphics.	Costs may be lower as there are no sales-related charges payable to the value-added service provider.
Merchants may gain higher visibility by being associated with a mall which is often easier to find and widely advertised.	Merchants have more flexibility to promote themselves with a variety of partners across the Internet.
Merchants may benefit from the market targeting of the mall, attracting a large proportion of customers that want their type of goods.	Merchants control their market focus and avoid unfortunate associations, for example with malls that fail or attract the wrong type of consumer.

6.1.1. Buckingham Gate – http://www.buckinghamgate.com

Buckingham Gate is an electronic shopping mall for merchants who want to sell British goods to consumers in the USA, Japan and the UK. The mall is a joint venture by ICL and the National Westminster Bank and was set up in the fourth quarter of 1995.

Merchants have signed up with Buckingham Gate to gain incremental sales by extending their product range to outlying regions of the UK as well as overseas. The first range of products offered were stable lines, such as men's fashions. The increasing number of women using the Internet will change this bias in future.

Because the system is online, the information provided to customers can be kept in line with stocks. Merchants do not have to maintain stocks for long periods as they would with mail order catalogues which may attract orders up to six months after they were sent out.

The success of the venture depends upon Buckingham Gate's ability to establish itself as a brand and on providing a good range of merchants and products. Buckingham Gate provides a brand image across merchants' sites while preserving the images and identities of individual merchants. The venture employed a design company to help with the brand image and usability of the site and a logistics consultancy to give advice on fulfilment and delivery overseas.

The technology platform is based on Netscape's Merchant System extended with multicurrency capabilities supporting payment in dollars, yen or sterling. Exchange rates are handled by real-time links with the National Westminster Bank. Consumers access the system preferably using the Netscape Navigator browser. The other servers – the transaction server, which connects to the bank's transaction systems, and the staging server containing merchant information on products, prices and options – are protected by a firewall. In the future, the merchant server may be mirrored on sites in the USA and Japan. It will also incorporate the SET standard for credit card payments.

The partners in Buckingham Gate are not seeking a short term return on investment. It is difficult to assess when the mall will be profitable: this is unlikely before early 1998. The site receives around 10,000 hits per day, representing around 200 visitors. Very few visits result in transactions: the total so far can be measured in dozens.

6.1.2. Ottica Meloni – http://www.meloni.com/

Ottica Meloni is an opticians business established in 1928 based in Rome. It has wanted to expand its market for some time but has been held back from mail order sales because of the high cost of printing, posting and advertising mail order catalogues.

In 1995, Ottica Meloni began to explore the potential of the Internet as a new channel to the market. It found that the Internet would enable it to reach international markets with minimal investment and no need for an expensive overseas distribution and sales structure. The benefit to consumers anticipated by the company was that they would be able to find all the well-known brands of designer sunglasses in a single location. This would be attractive to consumers who lived outside large cities and had difficulty finding the most fashionable products. In September 1996, Ottica Meloni went live with its Web "store" which is targeted at the international market: mainly consumers in the USA and Asia.

Each pair of sunglasses listed in Ottica Meloni's Web catalogue is accompanied by a full-size image and a second picture showing the available colours as well as the price of the frame in US dollars. The descriptions contain technical information. The company also provides advice over the Internet on prescription frames and contact lenses and deals with special requests.

Various payment methods are supported, both offline – international cheques, bank transfers and cash on delivery in European countries – and online, with Visa, MasterCard or American Express credit cards. Credit card transactions are protected with the SET protocol.

The company estimates it invested 7,050 ECU in developing the system. It carried out the development work in-house using a Pentium PC and a colour scanner it had already bought. The Web pages were developed using off-the-shelf development tools and some public domain and shareware utilities. Ottica Meloni wrote an application to ease the process of updating Web pages. The company's site is hosted on a Web server in the USA and Ottica Meloni estimates that its annual maintenance costs for the site (including telephone bills and rent for the Web space) will be around 2,350 ECU. Of course, these costs relate to a small company offering a specialist service with a very small product range. The initial outlay for a larger E-merchant with a wider range of products would be considerably more.

During the company's first two months on the Internet, its site received nearly 100,000 hits, with traffic growth of 220% in the second month over the first. First sales took place in September 1996 and the company had sold 40 pairs of sunglasses after six weeks of trading. It plans to promote growth significantly through a joint venture with a North American company involved in fashion promotion and retailing on the Internet.

6.1.3. El Mercadillo – http://www.mercadillo.com

El Mercadillo, or "Little Marketplace", is a Web home page service operated by Spanish ISP, Internet Total. The company was formed in April 1996 to provide Web hosting services in Southern Spain, particularly in the province of Cadiz. Later in June, the company became a franchise of AirAstur, an ISP in the northern province of Oviedo, and began the sale of Internet connections under the trademark of AirCadiz.

El Mercadillo was set up to publish Spanish shopping services on the Web. It publishes merchant Web home pages for a one-off design charge and a monthly fee for a 2 Mb site of 31 ECU. The idea behind El Mercadillo is that it should be a one-stop bilingual advertising site for Spanish merchants who want an Internet presence, particularly as the language barrier prevents existing sites from being registered with the best-known English language search engines. Internet Total is planning to add a directory listing of companies with Web sites to El Mercadillo. Merchants would pay 12 ECU a year to be listed with hot links to the merchants "individual" Web home pages.

El Mercadillo does not use transactional capabilities. When a merchant's site receives an E-mail inquiry, orders and payments take place offline. Internet Total does not believe Spain has enough of a "credit card culture" to support the cost of online transactions just yet. Spanish consumers and businesses tend to pay by bank transfer or postal order, rather than by credit card. The lack of secure payment facilities keeps costs down from the merchant's point of view: the likely volume of sales does not yet justify the higher costs involved in selling online.

So far, El Mercadillo has hosted a local golf course and Harley Davidson, with some six further prospects still to make up their minds. Harley Davidson wanted a means of promoting its uniquely branded "Harley Davidson of Cadiz" items, such as T-shirts and coffee mugs, to collectors overseas. El Mercadillo is hosted on a server in the USA and provides an excellent way of achieving this.

As a franchisee, Internet Total is obliged to refer merchants who do want these facilities to AirAstur, which went live with a new electronic shopping mall at the end of October 1996. The mall - a test case for similar developments in Spain - is linked into the Spanish banking system and is thus equipped with the means to handle secure transactions. Merchants pay 368 ECU - 552 ECU a year for space in the mall, including a customised shopping cart facility. The first participants are merchants in the northern city of Gijon. Their annual fees are being subsidised by up to 70% by the Spanish government under a scheme available to areas of high unemployment. As Cadiz also qualifies, Internet Total is beginning to contact local merchants to assess their level of interest in such an exercise.

Internet Total has found it difficult to raise interest in El Mercadillo. City government and tourism have been heavily targeted by all ISPs in Spain but they show great reluctance to put up Web pages. As the number of consumer connections is still very low in Spain, merchants cannot see any benefit in an Internet marketing presence at the moment. Those who do, like Harley Davidson, want to tap into overseas markets.

The main promotion of the Internet at the moment is by government initiatives for E-mail. These initiatives suggest that companies with a high volume of telephone calls and faxes could save up to 1,840 ECU by using the Internet. In contrast, the benefits of services such as El Mercadillo are less quantifiable to prospective merchants.

6.1.4. Cerberus – http://www.cdj.co.uk

Cerberus is a start-up UK company which sells music tracks across the Internet. The Cerberus Digital Juke Box (CDJ) was launched commercially in January 1996.

The consumer selects digitally compressed tracks from the Digital Juke Box, paying 0.73 ECU for each track. A six-minute track takes around two minutes to download. To prevent piracy, each transaction is uniquely encoded using a proprietary disposable key technology so that any fraud is limited to a single transaction. The consumer downloads the Cerberus Player, the piece of encrypted software containing the track, from the company's Web site to his hard disk. He can then play the track back, using his PC's sound system, as many times as he wants.

Consumers must register with the Cercure online transaction system which encodes their credit card numbers and generates a Cercure Identification Number (CID). This number is used for transactions so that consumers do not have to send credit card numbers repeatedly over the Internet.

The CDJ provides an outlet for independent and unsigned artists who might otherwise go unheard. It also addresses the issue of music piracy, which costs the music industry around 11.5 billion ECU a year, by linking consumers' credit card numbers with their players.

Artists provide their music on cassette together with background information, an image and a logo to be used on the Web page as well as in the player. Cerberus then compresses each track. The CDJ is cleared by the Mechanical Copyright Protection Society and the Performing Rights Society in the UK, by BMI and ASCAP in the USA and by JASRAC in Japan. Cerberus is currently in discussion with other copyright agencies in Australia, Canada and Germany.

The company developed its own software for the service and has patents to the technology used to transmit music tracks across the Internet.

The number of downloads is increasing rapidly from 40,000 in the first quarter of 1996 to an estimated 160,000 in the second quarter. Cerberus estimates its investment cost at over 4.9 million ECU, and believes it will reach break-even point at between one and two years.

6.1.5. Electronic Mall Bodensee (EMB) – http://www.emb.net

The Electronic Mall Bodensee is a regional electronic marketplace initiated by universities, chambers of commerce and commercial organizations in the Euroregion of Bodensee. The Bodensee region spans Germany, Switzerland and Austria. The aim of the marketplace is to facilitate electronic business and contacts between the two to three million people in the region. EMB hosts 150 commercial organizations and around 100 non-commercial sites. The latter group is subsidised from EC and national government budgets: the former pay to be represented in the marketplace and for commerce facilities, such as secure transaction capabilities. To date, EMB has represented an investment of 1.6 million ECU by the eight partners involved.

EMB went live at the end of June 1995. It now receives 350,000 hits a month, although it estimates that 80-90% of hits are just "surfing", while 10% result in real business. EMB is finding it increasingly difficult to recruit the region's small and medium enterprises (SMEs), the target hosts for the marketplace. It believes greater competition is creating market confusion with the result that SMEs are deferring decisions to come online for another six months or so.

EMB has faced a number of transnational obstacles:

- Non-credit card transactions can be complicated by the fact that each country has its own banking system and fees are incurred for currency exchange. EMB partners are working on a multicurrency solution.
- Traffic between the three EMB servers, one in each country, cannot be directly routed because of the prohibitive charging structures of the three different network operators. A direct line between servers in Konstanz and St Gall, a distance of 35 km, would cost 2,139 ECU from Germany to Switzerland (compared to 214 ECU within Germany).

EMB cannot afford these charges, so the Konstanz-St Gall traffic is routed through 21 hubs all over Europe, slowing down access to the marketplace.

- Taxes and custom regulations in electronic cross-border commerce are a major barrier.

6.1.6. PeopleBank – http://www.peoplebank.com

PeopleBank is a UK Internet-based recruitment provider which recruits candidates through traditional advertising media but makes its database available to employers over the Internet. Thus, its database is populated with a wide cross-section of candidates, not simply the small subset of the population with Internet access.

Employers have more control over the recruitment process by proactively searching the database for suitable candidates and costs are lower than going through a conventional recruitment consultancy because employers pay by CV, rather than incurring large advertising costs. An online search of the database will produce a shortlist of candidates within three to four minutes. This is in contrast to the four to six week process for traditional methods.

A traditional recruitment agency's charges will typically be 15-20% of the successfully placed candidate's starting salary. PeopleBank's charges are paid up front: 12.20 ECU to retrieve a CV plus a further 61 ECU for each candidate called for interview. The company finds that the average employer retrieves eight CVs and asks for contact details for three candidates, incurring recruitment charges of 305 ECU. The average position filled commands a salary of 24,000 ECU, so this charge works out at 1.25% of salary compared to the percentage charged by the recruitment agency.

PeopleBank spent 2.4 million ECU on marketing from February to October 1996 to boost the size of its database. It has produced 25 million inserts in the national press, has taken full page advertisements in 60 different market publications and advertised on the London Underground and on the radio. From a starting position of 6,000 candidates in January 1996, the database now holds 75,000 CVs and is growing at a rate of 1,000 a week.

The recruitment sector's use of the Internet is discussed more fully in 6.2.2.

6.1.7. La Redoute – http://www.redoute.fr

La Redoute is a French mail-order retailer located in Roubaix in Northern France. In terms of volume, it is the largest mail-order operation in the country and third largest in the world. The company claims to be an E-commerce pioneer as it joined France Telecom to pilot a Minitel service in the early 1980s. Today, over 20% of the company's revenues are generated by online services: 17% from Minitel, which receives more than 40,000 accesses daily; and around 3% from Audiotel.

The company set up a Web site in 1995 primarily to sell its clothing collection, with around 100 general items from its catalogue. La Redoute felt it necessary to have a presence on the Web, even if it is not yet used widely within France. The Web site also gives La Redoute an opportunity to export its products to other EU countries and Switzerland. It is looking for a secure payment mechanism to support expansion into non-French-speaking markets. At present, customers can order online but payment takes place offline.

La Redoute finds it difficult to quantify its investment in its Web site. All the catalogue images had already been digitised so its investment was mainly in terms of time rather than money.

6.1.8. Key Messages of the Case Studies

The case studies show that merchants are benefiting from E-commerce over the Internet in several ways. It enables them to:

- find a broader market for their goods and services, particularly to affluent consumers overseas (Ottica Meloni, Buckingham Gate, El Mercadillo);
- create markets for new goods and services that would not exist without the Internet (Cerberus);
- reduce the costs of doing business (PeopleBank);
- stimulate commerce within a regional economy (EMB).

However, the drawbacks experienced by the pioneer merchants include: lack of a critical mass of consumers, cross-border regulatory issues (concerning tax, customs and telecommunications costs), the need for traditional advertising to support an Internet E-commerce presence, the need to establish links with commercial partners and Internet directory services to maximise presence on the Internet.

6.2. Market Sector Case Studies

This section examines the case for using the Internet to support the business activities of two market sectors: banking and recruitment. These sectors were selected because they are among the most active Internet E-commerce markets today.

6.2.1. Internet Banking

Electronic banking over the Internet is, quite simply, the most inexpensive way of delivering banking services to customers available today. It can be thought of as introducing the third wave of self-service to banking, following on from automated teller machines (ATMs) in the 1970s and telephone banking in the 1980s.

Table 6
Cost of Different Banking Transactions

Delivery mechanism	Cost of transaction
Internet	0.16 ECU
Proprietary network (point-to-point dial-up access)	0.33 ECU
Telephone	0.68 ECU
Branch	1.58 ECU

Source: Booz Allen – A survey of 37 European banks with Web sites (1996)

As *Table 6* shows, when a customer carries out a banking transaction over the Internet it is nearly four times cheaper than using the telephone while the same transaction in a branch costs the bank over nine times as much. Banks are acting quickly to meet the challenge of the Internet. In a recent survey of Europe's banks, over half were planning or piloting home-based banking systems connected over the Internet, while one in 13 banks already has a system in place.

Electronic banking over the Internet incurs lower overheads than traditional banking, assuming banks can take out the fixed infrastructure costs associated with staffing and maintaining branches. The world's first Internet-only bank, Security First National Bank (SFNB), based in Kentucky, USA, reports overhead costs of less than 1%, compared with the typical 3.5% sustained by traditional banks.

The cost structures may be lower for Internet-only banks but they will have to establish a market presence and brand image to compete with traditional banks, particularly if those banks are moving aggressively into the Internet space. New banks will need to advertise widely both on the Net and off it to attract customers, at a probable cost of several million ECUs.

Although they may attract new customers fairly quickly – SFNB expected to have 12,000 customers by the end of 1996, up from 6,000 in

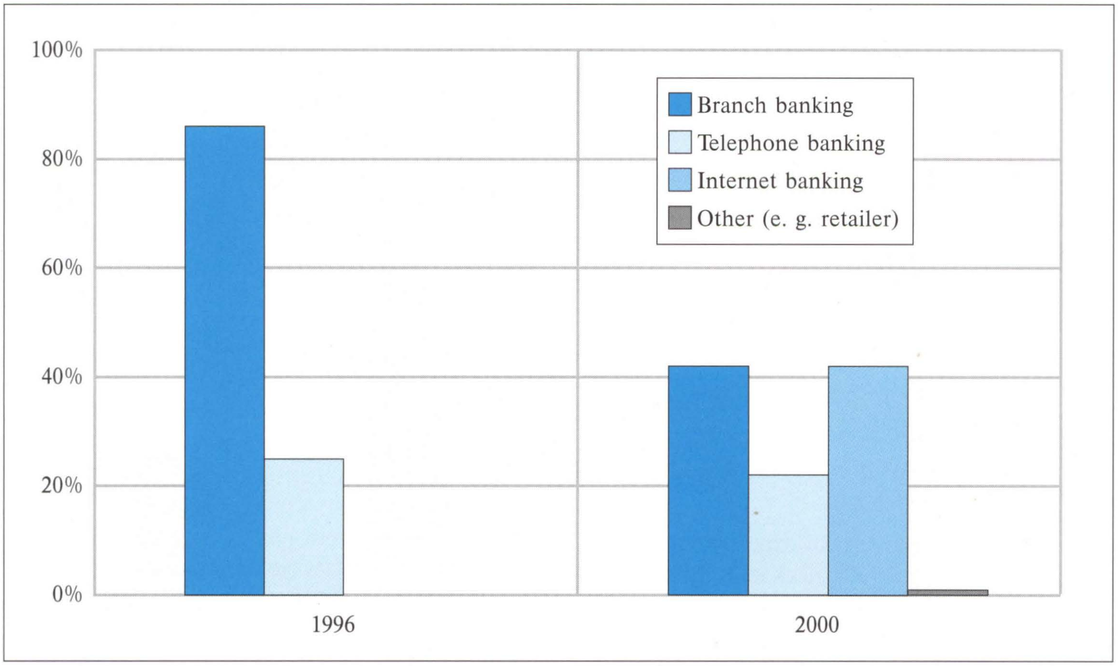


Figure 8
Proportion of High Net Worth Customers Doing Internet Banking, 1996 and 2000

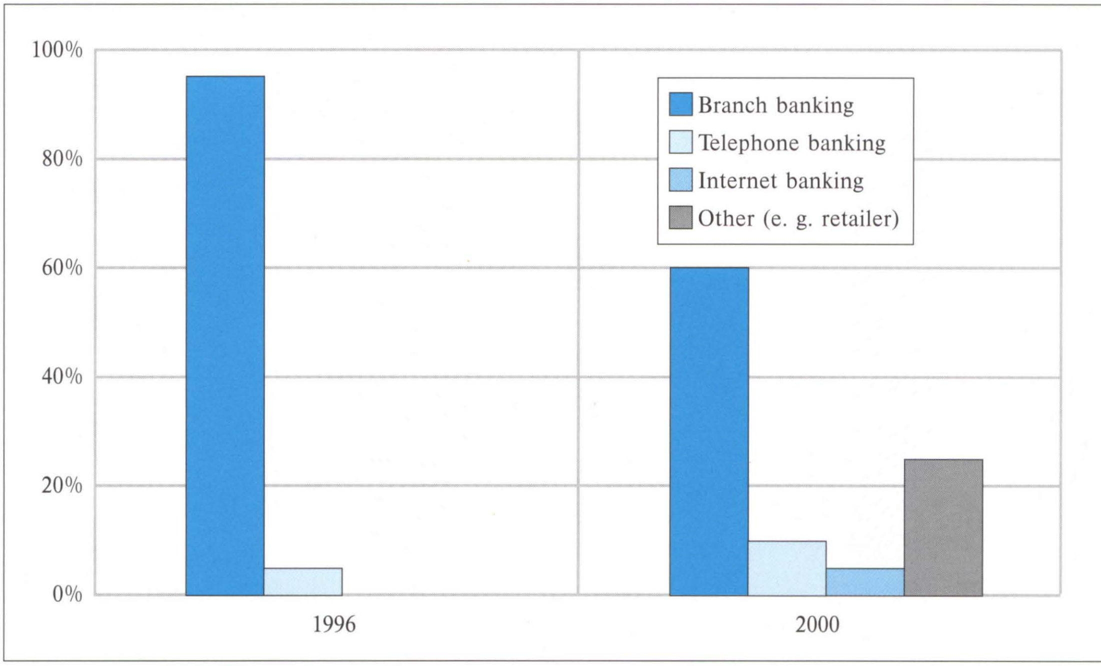
the middle of the year - they will have to retain them for a period of time before they recoup the cost of recruitment and the customer becomes profitable. In telephone banking, this period can be as long as 18 months. The lower overheads incurred in electronic banking over the Internet suggests that the payback period will be much less than a year. However, the Internet is a volatile market where change is easy and customer loyalty is difficult to build. Banks that offer only electronic services over the Internet will have to work hard on their appeal to customers over existing banks.

To traditional banks, electronic banking over the Internet is currently regarded as simply an extension to their existing commerce channels. Over time, they assume that a proportion of customers will move from costly traditional banking, which they can further scale down, to cheaper Internet banking, recouping their investment costs and increasing profitability.

As they found with telephone banking earlier in the decade, the banks believe that Internet banking is most attractive to "high net worth" individuals. These are the consumers most likely to have home access to the Internet and a high proportion of disposable income to place in savings, investment and personal pension schemes. It is this group that banks cannot afford to lose and which, they believe, are likely to move most quickly to Internet banking.

Figure 8 suggests that up to 40% of a bank's significant revenue generating customers and those with large investment portfolios, the high net worth customers, may take up electronic banking over the Internet over the next two to three years. The proportions are approximate and illustrative, rather than rigid, as there will be occasional crossover between delivery mechanisms. Internet banking users may occasionally need to telephone their bank or withdraw cash from a branch.

Figure 9
Proportion of Mass-market Customers Doing Internet Banking, 1996 and 2000



As well as its lower cost, Internet banking has the potential advantage over the telephone of offering a much richer environment both to banks and to customers. The key concept here is "cross-selling". For example, software sitting on the Web server will be able to suggest investment options to customers, providing illustrative projections of investment growth and enabling customers to open new accounts online.

In this electronic banking scenario, mass market customers will be less well-served by banks. A higher proportion today use branch banking compared to high net worth customers. As we have seen in section 4.5.3., only a tiny percentage of mass-market customers today have access to the Internet to take advantage of electronic banking and in the future they have limited cross-selling potential from the bank's point of view. *Figure 9* suggests that over the next four years only 5% of this market may migrate to Internet banking.

If the banks focus more on the affluent sector of their customer base, the mass market segment may be an opportunity for retailers. A number of retailers have been diversifying into the financial services market, providing store cards and personal finance products. They already have the outlets that people visit each week - their stores - and a relationship with the customer. They project a more consumer-friendly image than the banks. Some retailers, such as a large UK supermarket chain, are already moving into banking. As they develop their retailing activities over the Internet in the future, they may become serious competitors to the established banks in the Internet banking market.

Banks currently are spending between 800,000 ECU and 1.5 million ECU on developing Internet banking systems. The largest spend is on integrating customer-facing Web-based applications with back-end corporate systems that store the customer data. This cost is highest for large banks operating the older mainframe-based systems and lower for banks that have more recently re-engineered banking applications onto open platforms. Of course, some of the very large E-commerce projects are spending significantly more than this.

Integration costs (see *Figure 10*) include both the cost of staff and the cost of integration technology, such as software "middleware" and security products. Just under a third of the investment is incurred in the development of the customer-facing application software that sits on the Web server. The cost of entry into the Internet banking market is therefore relatively low from the banks' perspective compared to the potential gains through lower transaction costs and cross-selling.

6.2.2. Internet Recruitment

The recruitment sector is moving rapidly towards the Internet because it depends on advertising and the Internet is primarily seen as an advertising medium at the moment. Recruitment is not a complex E-commerce application and financial security is not a critical issue. As a result, agencies have been able to experiment with the Internet cheaply and easily. In return, they have had dramatic results in cutting recruitment costs and accelerating the recruitment process, as *Table 7* illustrates.

The cost of recruitment consultant time is excluded from the table. It is difficult to assess the impact of the Internet on this cost: many agencies believe that staff overheads will remain the same, but throughput will increase; or that they will need to take on more staff to cope with a higher volume of business brought about by an Internet presence.

The drivers for Internet recruitment are more often about customer service - to the job seeker and the client - than they are about cost. The Internet is:

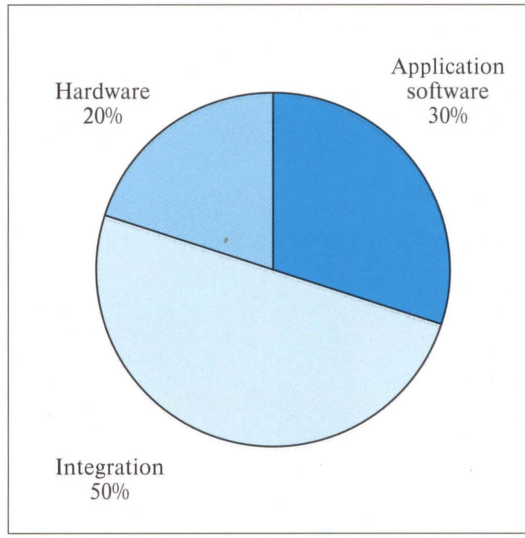


Figure 10
Integration Costs

- fast: job details can be disseminated immediately without the delays associated with print deadlines;
- cheap: print advertising is expensive, space on the Web inexpensive. From the candidate's point of view, it is cheaper to pay the cost of a local telephone call and be able to find all the jobs in one place than to have to buy or subscribe to a number of publications just in case one will have the right job;
- direct yet non-intrusive: agencies and candidates are able to communicate more quickly and easily using the Internet, yet without pressurising potential candidates. Postal communications can be remote and dissatisfying from the candidate's point of view, while the telephone can be over-direct in the early stages of a job-hunting campaign. Internet-based videoconferencing will further enhance communication between the agency, clients and candidates. The Internet is also available after business hours when the recruitment agency is closed;

Table 7
Comparative Costs of Recruitment Methods

Traditional recruitment process	Internet recruitment process	Quantifiable benefit	Unquantifiable benefit
Preparing and delivering advertisement for print: one day.	Preparing advertisement for Web page: one hour.	Labour costs saved @ 12.5 ECU an hour = 87.5 ECU per job vacancy.	Electronic version appears almost immediately on the Web, increasing chances of a likely candidate seeing it quickly.
Placing the advertisement: quarter of a page advertisement in a national newspaper 1,560 ECU for one, or at most two days' appearance.	Placing the advertisement on the Web: cost depends on service, but approximately 625 ECU for two months.	Direct cost difference of 2,190 ECU per job vacancy.	Advertisement appears for longer on the Web, maximising the chances that the best candidate will see it. She/he may not have bought the paper on the day of advertisement appeared. Candidates can find all the advertisements in one place rather than incur the expense of buying several publications. This attracts them to the Internet.
Attracting candidate CVs: cost of advertising for and administration of paper CVs approximately 87-100 ECU per candidate.	Attracting candidate CVs: cost of advertising for and administration of electronic CVs approximately 5 ECU per candidate.	Direct cost difference of around 82-95 ECU per candidate CV.	The Internet is a medium of immediate response: if agency provides facilities that makes it easy for candidates to submit and update CVs electronically, they will send them in quickly, further speeding up the recruitment process. The more CVs an agency has, the more it can attract clients.
Total cost of handling 500 job vacancies and 3,000 candidate CVs: 878,000 ECU.	Total cost of handling 500 job vacancies and 3,000 candidate CV's: 327,500 ECU.	Time saving: using print media, it may be over a week before the client receives candidate's CVs in response to his advertisement. Using the Web, it may be 24 hours.	Job vacancies are filled more quickly saving the customer time and money and increasing satisfaction. Repeat business is assured.

- likely to encourage accuracy: it can provide people with more information about jobs, so they are more likely to select only those that exactly match their requirements;
- global, so that people will be able to find the right job opportunities wherever they are in the world.

As *Table 8* shows, there are currently three business models for Internet recruitment, each with different characteristics and cost structures. In addition to the competition between the three types of Internet recruitment agency, some customers are advertising vacancies on their own Web site, the Internet equivalent of a shop or restaurant; putting a notice in their window saying "Staff required, apply within".

Table 8
The Business Models for Internet Recruitment

Web service providers	Existing recruitment agencies	Internet-based recruitment providers
Web service providers provide similar service on the Internet as newspapers do through classified advertisement pages. Web space providers may be new entrants to the Internet recruitment market or established newspaper and magazine publishers who want to extend electronic advertising options to their print advertisement customers. To date, those customers Clients pay a sum per week/month for each job vacancy advertised have mainly been recruitment agencies on their Web site. Respondents' CVs are passed on to the client, or can be sorted and sifted at the provider's site it is a sophisticated one.	These are increasingly seeing the Internet as another service they can offer to the clients which have retained them and a further communications channel with their target market. Many are building their own Web sites to advertise their job vacancies themselves, rather than go through the Web space providers, which can dilute their brand image. Any job advertisement placed in print is automatically published on the agency's Web site at no additional charge to the client.	A new type of recruitment organization that makes available an electronic bank of candidate CVs to employers. Most are sector-specific and aimed at high-earning individuals most likely to have Internet access. Clients pay to access candidate CVs. Charges depend on services rendered: For example, for a monthly sum, clients receive copies of all new CVs or they can download summaries of selected CVs for a one-off charge that will vary depending on the speed of the service required. There may be an additional charge when a CV search results in an interview.
Site investment: 2,500-6,250 ECU	Site investment: 2,500-6,250 ECU	Site investment: 2,500-6,250 ECU
Little advertising expenditure because either own print medium, e. g. newspaper, or target Internet-literate audience, such as IT specialists.	No advertising expenditure because site address can be displayed in high street branches or on printed job advertisements.	Advertising expenditure if populating candidate through traditional media: 1.25 million to 2.5 million ECU.

7. Electronic Consumers

Internet E-commerce badly needs consumers, not simply surfers. At present, this is particularly the case in Europe. A study carried out by MasterCard for the US National Retail Federation at the end of 1995 showed that 19% of US consumers had used the Internet and 27% of those had actually bought goods or services. A study of UK consumers in the same timeframe conducted by Healey & Baker suggests that only 0.3% of them have shopped electronically. A study of UK households carried out by Romtec in 1996 also suggests that only 0.3% use the Internet for shopping or financial services.

In the US, as in European countries, typical Internet users would seem to have an ideal profile as far as merchants are concerned: they are young, well-educated, sophisticated and affluent. However, this demographic group only comprises around 10% of the US population and the percentage is likely to be similar in other Western countries. This is hardly the mass market that persuades merchants to invest heavily in Internet E-commerce. In contrast, the largest portion of the consumer market consists of individuals who are less educated, less well-off and an increasingly high proportion of which are older. This group is unlikely to have the means to access, or interest in joining, the Net.

Another problem facing E-merchants is that the Internet is dominated by men. Estimates vary as to the proportion of male Internet users, from 68% to 88% of all users. It is still true in the general population that women do most of the shopping and are also 75% of mail order users. Therefore, the most obvious targets for Internet merchants are female. Current trends suggest that it is unlikely that this section of the consumer population will buy Internet-enabled home computers in large numbers. It is more probable that they will gain access to Internet merchants once television set-top boxes become widely available at low cost.

At present, a large proportion of European merchant sites appear to be targeted at the 10% of "high net worth" consumers, though not necessarily those within their own country markets. Many of the sites target high-rated consumers overseas - especially in the US and Asia - with the luxury products for which their country has a reputation: Italian designer sunglasses, French perfumes, Scotch whisky and English classic clothes are examples. Shopping on the Internet is still geared away from the mass market, although survey results suggest that less affluent, educated demographic groups show more interest in electronic purchase than today's Internet users at whom it is currently aimed.

8. Internet E-commerce; Market Size and Scenario for Market Growth

8.1. By Geographic Region

Global revenues generated by commercial Web sites (revenues include both offline and online transactions and Web advertising revenues) have been estimated to be 363 million ECU in 1995. Of this, 333 million ECU was derived from online and offline sales generated by these Web sites. A further 30 million ECU is attributable to advertising on Web sites (Source: ActivMedia).

Figure 11 shows how this global market is forecast to grow in four geographic regions. European revenues (CAGR 263%) are expected to grow faster than the more mature USA (CAGR 245%), but not as fast as the less mature Asia-Pacific region (CAGR 270%) and the rest of the world (CAGR 280%). On these trends, Europe will account for 20% of all Web-generated revenues in 2001 compared with 11% in Asia-Pacific and 68% in the USA.

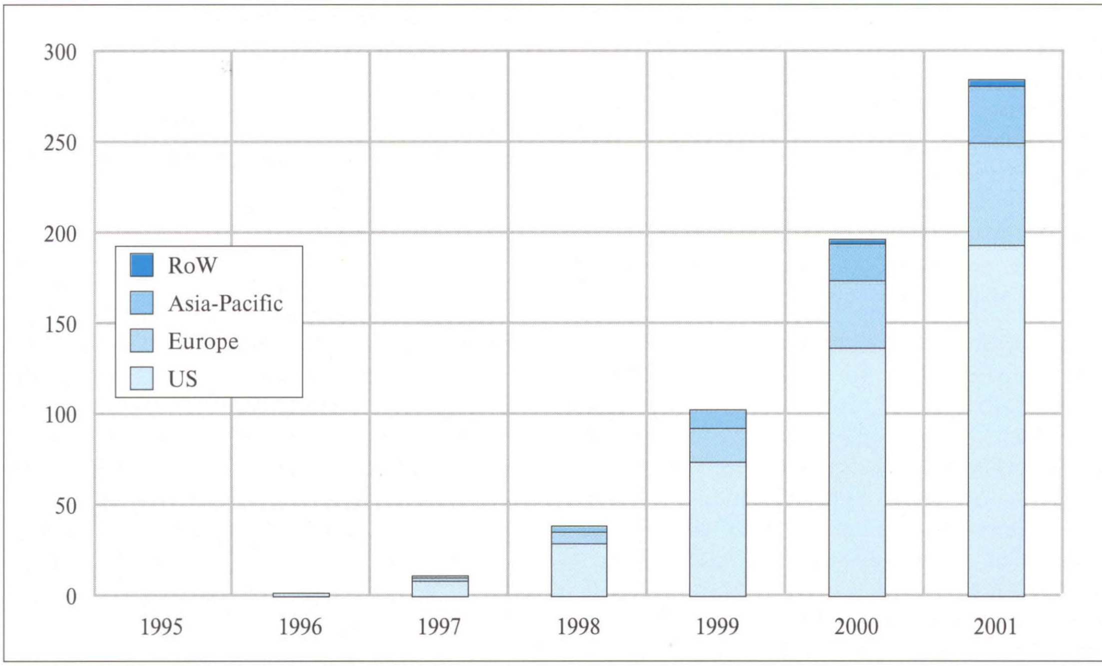
Table 9 shows the expected sales and advertising revenues generated by commercial Web sites in Europe, by eight countries or groups of countries. The Nordic group includes Sweden, Denmark, Norway and Finland.

The UK is by far the largest Internet E-commerce market in Europe today and is forecast to remain so until 2000, although by then it is expected that the other countries will be generating significant revenues. Germany is predicted to put on a growth spurt in 1997/1998 and overtake the UK market early in the next century.

The UK, Benelux and Nordic markets have embraced Internet E-commerce earlier than other European country markets, largely for cultural reasons. They tend to have outward-looking, mercantile-oriented cultures, a history of entrepreneurial ventures and a willingness to operate on credit. The English-language domination of the Internet is also in their favour as these country markets are either native English-speaking or have a high proportion of their populations able to speak English.

Together, these three markets accounted for over 75% of Web generated revenues in 1995. By 2001, this share will have fallen to 40%, as other markets, notably France and Germany, fulfil their potential.

The German and French E-commerce markets have not developed as rapidly to date, largely for structural reasons. On the consumer



Source: ActivMedia, Romtec

Figure 11
Global Revenues Generated by Commercial Web Sites (Billion ECU)

	1995	1996	1997	1998	1999	2000	2001
Benelux	0.01	0.05	0.22	0.70	1.92	3.69	5.32
France	0.00	0.01	0.11	0.51	1.89	4.64	8.29
Germany	0.00	0.02	0.18	0.83	3.03	7.42	13.20
Italy	0.00	0.03	0.16	0.53	1.50	3.00	4.52
Nordic	0.01	0.08	0.38	1.15	2.93	5.15	6.71
Spain	0.00	0.01	0.04	0.15	0.51	1.17	2.01
UK	0.02	0.15	0.65	1.97	4.90	8.42	10.58
ROE	0.01	0.04	0.21	0.69	1.95	3.85	5.72
Total	0.05	0.39	1.93	6.53	18.63	37.34	56.36

Table 9
Revenues Generated by Commercial Web Sites in Europe by Country (Billion ECU)

side, French customers have access to the Minitel system and currently see no real advantages in moving to E-commerce over the Internet. On the business side, organizations in Germany and France have begun the process of downsizing and restructuring generally later than in the UK. This change is a pre-cursor to effective business process engineering, which in turn is a necessary condition for the uptake of E-commerce in large organizations.

However, this situation is changing, particularly in Germany. Germany has a large number of Internet hosts today, an affluent, well-educated and widely-travelled population and a telecommunications infrastructure conducive to Internet E-commerce. Together, these elements provide a solid basis for rapid growth in both business and consumer markets. The German market will be worth 13.2 billion ECU in 2001. French growth is predicted to begin later, in the 1998/1999 timeframe, but will overtake Italy by the year 2000 with revenues of 4.64 billion ECU.

The Spanish and Italian markets are proving resistant to E-commerce over the Internet at the moment in both the consumer and business markets. It is expected that, for cultural and linguistic reasons, the market will grow less rapidly in Italy, Spain and the rest of Europe, with the exceptions of Finland and Switzerland.

Finland has the highest penetration of Internet hosts per head of population, markedly higher than that of the USA and well ahead of its Scandinavian neighbours, which are leading Europe in terms of penetration (see the chapter on "The Future of the Internet" *Figure 12*). The geographical remoteness of Finland may continue to drive widespread acceptance of E-commerce. Penetration of Internet hosts in Switzerland is one of the highest in Europe and growth here is likely to follow the German pattern.

8.2. Growth in Europe by Product Segment

Table 11 shows the expected revenues generated by Web sites in Europe, targeted at nine product and service segments, which are described in *Table 10*.

8.2.1. Computers and Software

For historical reasons, Web sites selling computers and software have accounted for the largest share of commercial sites – they have the kinds of goods and services wanted by computer-owning, Internet-literate customers. In the US, this application category, which is the most mature on the Internet, has been losing share to other applications which are maturing. This pattern is expected to happen over time in Europe as well, although in 2001 this segment will still generate predicted revenues of 9 billion ECU (16% of the total).

8.2.2. Consumer Products

This is a growing market and is forecast to be worth 8 billion ECU in 2001. However, this represents less than 1% of total European retail sales and reflects the fact that European countries appear to be less interested in the consumer market opportunity than elsewhere, particularly in relation to their home markets. For example, those European merchants who do advertise on the Internet typically target themselves at overseas consumers in Asia and the USA.

8.2.3. Finance and Insurance

Revenues from finance and insurance Web sites will not be generated by growth in online banking *per se* because although some US banks do charge for the operation of Internet-based bank accounts, this is unlikely to be the norm.

Table 10
Definitions of Product and Service Segments

Web generating revenue segment	Description
Computers and software	Includes both manufacturers and resellers of hardware and software, network integrators and designers, and companies providing training, maintenance and security services.
Consumer products	Includes every conceivable product, from fashion items to music, videos, gifts, health care and home furnishing products.
Finance and insurance	Includes category and financial services such as stocks and shares, investment opportunities, insurance and reinsurance services.
Manufacturing and industry	Includes production-oriented business, including producers of raw materials, and applications such as construction and transportation.
Publications and information	Includes newspapers, magazines, books, journals and newsletters, as well as information services and advertising placement.
Travel	Includes a range of tourism products, including holiday packages, restaurants and tourist board information sites.
Business and professional	Includes marketing and PR, consultancy services, recruitment, professional services such as legal advice and accountancy, and office equipment and supplies.
Advertising	Includes advertising on search engines and directories, in publications and information resources and by speciality retailers.
Other	Includes applications such as property sales, Internet host provision and Web design and consultancy.

Table 11
Revenues Generated by Commercial Web Sites in Europe by Segment (Billion ECU)

	1995	1996	1997	1998	1999	2000	2001
Computers and software	0.02	0.12	0.55	1.67	4.16	7.16	9.02
Consumer products	0.01	0.06	0.31	1.01	2.80	5.41	7.89
Finance and insurance	0.00	0.01	0.07	0.23	0.62	1.18	1.69
Manufacturing and industry	0.00	0.02	0.11	0.46	1.55	3.61	6.20
Publications and information	0.01	0.04	0.19	0.65	1.86	3.73	5.64
Travel	0.00	0.02	0.10	0.33	0.87	1.62	2.25
Business and professional	0.01	0.06	0.32	1.21	3.79	8.28	13.53
Advertising	0.01	0.04	0.23	0.78	2.30	4.73	7.33
Other	0.00	0.01	0.05	0.20	0.68	1.62	2.82
Total	0.05	0.39	1.93	6.53	18.63	37.34	56.36

Furthermore, the perceived complexity of products in this category is likely to make them the least appealing online application to the mass market. Typically, consumers in this category will comprise the more sophisticated user who uses the PC as a business tool. Added to this, businesses, such as insurance companies, which invest heavily in developing close personal relationships with customers are unlikely to divert many products or services in the Internet E-commerce arena.

The real growth will be stimulated by new cyber-companies and traditional brands capitalising on their brand strength to move into new markets. However, these will not be established players and will have to overcome this perception amongst consumers and their resistance to change. Therefore this will remain a relatively small market for the foreseeable future worth around 1.7 billion ECU in 2001 (3% of total revenues).

8.2.4. Manufacturing and Industry

This market segment is set to grow dramatically as Web sites are used for increasingly complex inter-company interaction. As an early example, many manufacturers are putting up catalogues on the Internet to support customer parts ordering. Global competition will encourage manufacturers to put in place electronic communications up and down the supply chain. As we have seen in Section 3, the Internet will provide one of the simplest and most cost-effective ways of doing this.

8.2.5. Publications and Information

Europe has a strong publishing industry which is continuing to invest in the online market, despite slow consumer acceptance and significant production costs. This investment is expected to pay off with growth fuelled by take-up in market segments such as education and government.

8.2.6. Travel

Although a good fit with the Internet, the uptake of travel applications on the Internet will be affected by the slow consumer market in Europe and the presence of existing value-added network services, such as those operated by the airlines, and those proposed by pan-European and international tourism consortia, which will take business away from the Internet in the short term.

8.2.7. Business and Professional

Business-to-business applications in the US services sector have seen rapid growth and are forecast to take the largest share of the Web-generated revenues by the end of the century (some 24%). The European business and professional market sector, encouraged particularly by national government-funded schemes to promote E-commerce over the Internet in local areas, is expected to mirror this.

8.2.8. Advertising

Revenues from Web site advertising are expected to rise to around 11% of worldwide advertising revenues by 2001. At present the bulk of these revenues come from a small number of very popular sites in the USA and are typically based on the number of viewers, measured by hits. However, there are signs of a more competitive approach based on click-through rates, which are often no more than 5% of all hits. This move should benefit other advertising platforms that are less US-biased, such as publications and specialist retailers. In Europe, revenues from Web advertising will account for 13% of all revenues generated by Web sites by 2001.

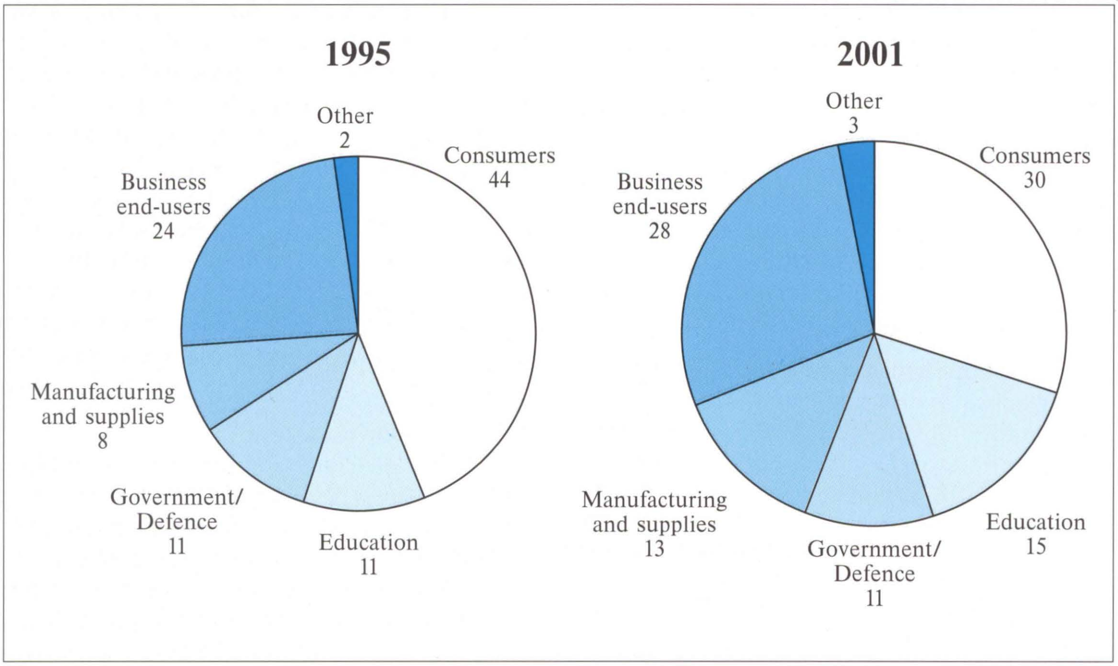


Figure 12
Take-up of E-commerce by the Different Markets in %

8.3. Growth by Customer Market Segments

Figure 12 shows the take-up of applications by different customer market segments in the years 1995 and 2001.

At the present embryonic stage of the Internet E-commerce market, it is often difficult to separate consumers from business users. Similarly, consumers may appear to be home-based, but are actually teleworkers buying for business use. Revenues have been segmented by customer type using the applications mapping summarised in the Appendix B.

The market segments shown in *Figure 12* are the target markets for organizations with Web sites. The highest proportion of sites are currently targeted at consumers, with much smaller numbers of sites targeted at the other sectors.

However, over the next five years, the number of sites targeting business end-users will grow to reflect the demand identified in the business and professional categories above. Thus, consumer revenue will decline in market share from 44% to 30% by 2001. Education particularly will gain market share as Internet-literacy, already present in higher education institutions, extends downwards.

In Europe, consumer market growth is constrained, not only by lack of faith in the market, but also by the following issues:

- the cost and difficulty of access, which can be exacerbated by tightly regulated telecommunications markets. It is likely that the mass market will not be tapped until cheaper and more user-friendly access through set-top boxes becomes available. Such technology is not expected to be taken up widely until the next century;

- cultural and linguistic barriers, including a "credit" mentality, an openness to new technology and support for different languages;
- the availability of products that consumers want to buy. Current products on the Internet are aimed at high net worth individuals, and/or are luxury items aimed at export markets. They are the wrong fit for the mass consumer market in Europe.

8.4. Merchant Markets

Small businesses represent the largest share of companies with Web sites for a number of reasons:

- they account for the largest share of all businesses;
- they include the entrepreneurs and start-ups that have been set up solely to exploit new opportunities provided by the Internet. These companies are typically very small, with fewer than 10 employees;
- they are the business most likely to be constrained by lack of capital and human resources to sell into new markets.

However, the large and medium-sized companies on the Web have a disproportionately large presence, considering the proportion of small to large business. This is likely to change when the mass market begins to take up E-commerce over the Internet.

9. Conclusions

E-commerce over the Internet is an embryonic market in Europe but one that is now growing faster than the more mature US market. In 2001, Europe will account for 20% of all Web-generated sales worldwide. Germany will lead Europe with an E-commerce market worth 13.2 billion ECU, followed by the UK with an 10.6 billion ECU market and France which will generate sales of 8.3 billion ECU.

Web-generated revenues include both offline and online transactions and Web advertising revenues. As secure payment systems become more widely available and the costs of implementing and using them fall, online transactions will become the norm. Today, online transactions are synonymous with credit card transactions. By 2001, a globally-acceptable form of "electronic cash" is likely to have emerged. This could even be the preferred method of E-commerce payment in those countries which have not embraced credit cards for reasons of consumer privacy or where small payment amounts are involved.

In Europe, revenues from Web advertising will account for 13% of all revenues generated by Web sites by 2001. Such revenues are likely to be based on click-throughs to an advertiser's site, rather than based on the number of hits an advertisement attracts as they generally are today. This suggests that Internet advertising in the future will be highly-targeted and may benefit European advertising platforms, such as publications and specialist retailers, over more general sites.

Business-to-business uptake of E-commerce over the Internet will show the most promising growth. The business and professional services sector will grow from 0.06 billion ECU in 1996 to 13.5 billion ECU in 2001. This sector will use E-commerce over the Internet as the most cost-effective and timely way to procure a range of business services, including accountancy, the supply of office equipment and recruitment. The manufacturing and industry sector will grow from 0.02 billion ECU to 6.2 billion ECU over the same period. E-commerce over the Internet will be used to streamline supply chain communications between manufacturers, their suppliers and customers. However, it will only gradually replace existing communications, such as EDI over closed networks, which accounts for its slower growth in this sector.

The consumer market will grow from 0.06 billion ECU in 1996 to 7.9 billion ECU in 2001. The consumer share of the total market will stay around 15%. At present, European E-merchants are targeting mainly luxury products at up-market audiences overseas, while indigenous populations are held back from becoming E-commerce consumers by issues such as language, attitude to spending, and cost of access. This will take time, and probably government effort, to change.

Indeed, there are considerable barriers to E-commerce over the Internet. The market perception is that security is the greatest of these, although, as it is largely a technology issue, it is likely to be one of the most straightforward to resolve. Regulatory issues, such as establishing internationally-binding laws for consumer protection, copyright, privacy and against cyber-crime, may prove more difficult to address.

Finally, E-commerce over the Internet will change the nature of business itself. Companies that establish their names and trademarks on the Internet may become "shop windows" for a range of disparate goods and services to which they have lent their brand image. They may be tiny compared to the multinational companies that dominate global markets today. They will outsource the production of goods, the logistics of physically supplying them and the provision of support services to other, highly focused businesses in a radically altered supply chain.

E-commerce over the Internet will begin to break down barriers within and between organizations. By 2010, it may have given rise to the "virtual company" in which a number of independent profit-and-loss organizations may participate in a highly integrated way to deliver a product or service to an end-customer.

Appendix A – Projects to facilitate E-commerce

Name of Project	Participants/partners	Notes
ArcheNet/AFCEE http://www.atelier.fr/afcee	Initiative of AFCEE, the French Association for E-commerce. It was founded by: - Club de l'Arche – a group of individuals committed to E-commerce - EDIFRANCE – the French EDI organization which includes many large corporations as its members - Mercatel – an organization of retail companies - AFTEL- telematics companies, Minitel and audiotel service providers. Participants include: IT users, operators and service providers, government organizations, local organizations and research institutes.	AFCEE was announced on 1/2/96 at a symposium in Paris, it is not officially created yet but has a Web site at: http://www2.atelier.fr/afcee/ ArcheNet and AFCEE intend to organize workshops and act as a liaison between the E-commerce participants and the French government. Its goals are to: - organize awareness and information dissemination on E-commerce, - stimulate and support E-commerce pilots and trials, - offer an open space for exchange and co-operation.
CommerceNet http://www.commerce.net	The US commerce association for the Internet. It was founded by BellSouth, Digital, Federal Express, Harbinger, Hewlett Packard, Tribune and Wachovia in 1994. By September 1996, the CommerceNet membership comprised more than 150 companies and organizations worldwide, including: - IBM's Inet, a consortium of banks that provide home banking services on the Internet - the National Automated Clearing House Association - ANSI, the US EDI standards body - the Internet Engineering Task Force - the Object Management Group Special Interest Groups (SIGs) are forums that meet monthly. These are: - CALS - Collaboration Tools - Catalogues - EDI - Marketing - Public Key Infrastructure (PKI)/Payments. The first annual conference for its members was held on 15-17 October 1996.	It was founded in April 1994 in California's Silicon Valley as a non-profit consortium to accelerate E-commerce over the Internet in a 10-state area of south and east in the USA. It is funded by a $ 6 million, three year grant from the US government's Technology Reinvestment Project, with a matching contribution from the State of California and member companies including Xerox Corp., Apple Computer Inc. and BankAmerica Corp. It is industry-led, with some government participation and is currently restructuring itself to work on a more global level. Since the beginning of 1996, global chapters have been launched in Japan and Canada with more due to be launched in Europe, Canada and the east coast of the USA by the end of 1996. Its aim is to create a "new global business development paradigm" combining an international E-commerce infrastructure with local connections through the local chapters. Its stated mission is to accelerate Internet-based E-commerce by: - identifying and working to resolve key industry issues, - providing a global, multi-industry forum for collaboration, - serving as an advocate through public policy and education. Membership fees for the US chapter are calculated by the size of the member's annual revenues, ranging from $ 1,500 to $ 12,500 per year for businesses and $ 1,000 per year for local government organizations and $ 2,500 per year for state government organizations.

Name of Project	Participants/partners	Notes
Commerce 2000	An EU initiative. The pilot of the Commerce 2000 initiative is led by the Esprit DG XXIII.	Commerce 2000 is funded by the EU. It aims to create networks of co-operation between trading partners, including large companies and SMEs. These networks will also serve as a communications forum in which particular needs of SMEs are identified.
EFFECT http://www.ansa.co.uk/e2s/4_	A European forum for E-commerce and Trade supported by the European Messaging Association (EEMA). The chair is jointly provided by: - France - Claude Chiaramonti, DG of EDIFRANCE - the UK - Roger Till, CEO of the UK E-commerce Association and the members are a core group of organizations from Belgium, Greece, Sweden, Italy and the Netherlands. It does not have direct enterprise membership.	EFFECT was formed on the 2 February 1996 as a European initiative to facilitate the use of E-commerce in Europe. It has some funding from the CEC and its objectives are to: - provide a forum for groups involved in E-commerce, - be a clearinghouse for projects amongst European bodies, - harmonize the European position in E-commerce.
G7 Global Marketplace for SMEs http://www.ispo.cel.be:81	A pilot project set up by the G7 group nations - US, Canada, UK, Germany, France, Japan and Italy.	The G7 pilot "A Global Marketplace for SMEs" was launched in February 1995. The project is structured around three themes: - to create a Global Information Network for SMEs in order to facilitate increased industrial efficiency and participation in global trade; - SME requirements - these include globalisation, legal and regulatory frameworks (for data security, electronic transactions, privacy and IPR), interconnectivity and financial issues; - international testbeds for E-commerce.
Hewlett-Packard E-commerce testbeds http://www.ansa.co.uk/e2s/19_	The initiative has three testbeds. Each includes Hewlett Packard, the other participants are: - Connect: the CEC and the University of Liverpool - Avon Internet Business Park: Hewlett Packard only - Grenoble Network Initiative: 1,000 SME users, the CEC, local and regional authorities and local businesses.	There are three Hewlett Packard E-commerce testbeds: - "Connect" in Liverpool, UK - this is funded by the European regional development fund and the University of Liverpool with the aim of developing the region as a major hub on the information superhighway. It has social as well as business aims, the region suffers from a high level of unemployment and there is a training programme included in the testbed specifically for the unemployed. It also supports the Merseyside Shopping Mall, helping SMEs exploit the Internet and E-commerce. - Avon Internet Business Park in Bristol, UK - this is located near H-P's European Research Lab and is a testbed for security issues. - The Grenoble Network Initiative in Grenoble, France - this has over 1,000 SME members representing 30 different services and is funded by the CEC, local and regional authorities and local businesses.

Name of Project	Participants/partners	Notes
IBCC-Net – the Consortium of the IBCC Network for Global Commerce http://www.icc/ibcc.	Founder members are: – CCI Paris – the Chamber of Commerce & Industry of Paris – G-77 TIN – the Global Management Centre of the G-77 Network of CCIs and China – IBCC – the World Forum of Chambers of Commerce – IBNet Corporation. Chambers of Commerce from over 130 countries make up the membership of the IBCC. There are six IBCC-Net Member Chambers: Africa, the Americas, Asia, Europe, Middle East, and Oceania (Australia and the Pacific).	IBCC-Net's stated mission is to allow chambers of commerce and industry to extend the range of practical services offered to businesses within their constituencies. Amongst the objectives of IBCC-Net are the commitments to: – manage the IBCC-Net system, which is designed to provide electronic facilities for international trading and information-sharing between Chambers of Commerce worldwide, – promote greater involvement of Chambers of Commerce in E-commerce and EDI issues, – expand technical assistance and training for Chambers of Commerce in developing countries, this is to be carried out in conjunction with other intergovernmental organizations, such as UNCTAD. Specific IBCC-Net brand products and services are being developed to promote business contacts and trade. Organizations participating in IBCC-Net must adhere to a set of quality standards to ensure that these products and services, which carry the IBCC-Net System brandname, offer the global business community solid value. These products and services are distributed around the world via the global network of IBCC-Net's member Chambers of Commerce.
IBEX http://www.ibex_gba.com	The IBEX Global Business Alliance (GBA) partners are each described as a world leader in an industry sector essential to the widespread adoption of IBEX as a universal platform for business-to-business E-commerce. The GBA partners are the United States Chamber of Commerce, AT&T, Chase Manhattan Bank, Dun & Bradstreet, Digital Equipment, GE Information Services, Simon & Shuster and SHL Systemhouse.	IBEX is a PC/Windows-based E-commerce system (a "virtual agent") that allows businesses worldwide to find, qualify and negotiate with other businesses. IBEX automatically locates qualified business partners to buy and sell goods and services, to establish partnerships, or to seek or place investments. IBEX has X.400 E-mail-based architecture, it supports credit card transactions and other EFT and EDI applications are expected to be available in future releases. It supports Internet E-mail, but its functionality does not run over the Internet as yet although the GBA is working with major Internet players, including Microsoft, to create a version of IBEX that will operate over the Internet. IBEX has a registration fee of US $ 250 in the US and C $ 350 in Canada and a typical usage fee is US $ 5 per functional transaction. Internationally, IBEX is sold for the equivalent of US $ 250.

Name of Project	Participants/partners	Notes
Imprimatur http://www.imprimatur.alcs.co.uk	Imprimatur is co-ordinated by the UK Authors Licensing and Collecting Society and brings together major European and US organizations with an interest in protecting intellectual property rights (IPR). The Full Partners are the UK Authors Licensing and Collecting Society, EUSIDIC, IFPI, ILC, the Interactive Multimedia Association. There are also Associate Partners who comment on the direction of the project but do not have a vote and Affiliate Partners who are not official members but who wish to be included in the business of the project and have allied themselves with its broad aims.	Imprimatur is a three year, 6.6 million ECU project, started in December 1995, and funded by CEC DG III under the ESPRIT programme. It is an international electronic copyright management project focusing on Intellectual Property Rights (IPR). Initially, the main issue was protecting IPR, but trading IPR has now become the primary issue for the project. Imprimatur's objective is to develop international consensus on practices for managing and protecting IPR. Until now there has been no common rules and standards for the conduct of E-commerce in copyright material. Imprimatur aims to build a consensus between the key interest groups with an interest in this area – the IPR owners, IPR users, IT companies and telecommunications companies. Its objective is to create interoperable systems around the world, with separate companies communicating via a common infrastructure. It is developing a prototype Internet server in order to conduct trials and experiments with electronic copyright management systems.
International Commerce Exchange (ICX) http://www.ansa.co.uk/e2s/8_	The International Commerce Exchange is a business consortium. Its founders are: Shell International, Sweden Post, X/Open, ICL, the UK MoD, ASE Consulting and the UK Post Office.	ICX aims to promote global co-operation on security issues, such as a public key infrastructure and digital signatures. The project's overall objective is to establish an open global trading market using secure electronic means of exchange. This will include: – establishing an international forum for consensus, – providing pragmatic open standards and solutions, – piloting and demonstrating, – guidance on operational, best practice and regulatory issues, – supporting a secure integrated E-commerce framework.
Open Applications Group	The Open Applications Group is a consortium comprising 19 members, including: American Software, Baan Company, CGI Informatiques, Computer Associates, Dun & Bradstreet, IBM, J.D. Edwards & Co, Marcam Corp., NEC, Oracle, Peoplesoft, QAD, SAP, Siemens Nixdorf Information Systems, Software 2000, Texas Instruments and TSW International.	The Open Applications Group is an international consortium, founded in February 1995. It is defining the OAG Integration Specification, which includes 12 types of E-commerce transactions, such as order management, purchasing, purchase orders and statistical data. It is funded by the members in the form of an annual fee.

Name of Project	Participants/partners	Notes
SEMPER http://www.zurich.ibm.com/technology/security/extern/semper	The SEMPER project is led by IBM Zurich and includes cryptography specialists, payments organizations and services providers. Sponsoring partners include: - Banksys (Belgium) - Banque Generale du Luxembourg - Telekurs (Switzerland).	The main objective of SEMPER (Secure Electronic Marketplace for Europe) is to create a comprehensive solution for secure E-commerce. It is developing a generic model and open platform for secure commerce for the whole trading cycle. It also plans to offer specification, implementation and evaluation for basic and advanced E-commerce services. It is a European R&D project with funding provided by the CEC ACTS programme (with a contribution of 9 million ECU), the partner organizations and the Swiss Federal Department for Education and Science. It will be executed by an interdisciplinary consortium, made up of experts from the fields of the social sciences, finance, retail, publishing, IT and telecommunications selected from European academic, industrial and SME bodies. A basic Internet trial was started in 1996, ATM broadband multimedia trials are due at a later date. Development will be driven by market requirements. SEMPER will establish a special interest group on E-commerce that will be open to all interested parties.
SIMAP http://www.194.78.31.74:8087/src/ intro	A CEC pan-European project with 80 contracting entities.	SIMAP is a CEC DG XV electronic procurement project. The pilot began in November 1995 and is divided into four sectors dealing with notification, diffusion, monitoring and information exchange. SIMAP's objective is to link purchasers and the contracting entities with suppliers and business advisory services. 80 of these contracting entities are participating in SIMAP, which represents about 50% of the European market. The final architecture aims to provide a virtual procurement via VANs, public networks and the WWW.
SPAN - Smart Partnerships Across Networks http://www.ansa.co.uk/e2s/13_	SPAN is a Scottish Enterprise Network initiative. The Scottish Enterprise Network is a public body, co-ordinating a national programme and working with 13 Local Enterprise Companies, Highlands and Islands Enterprise and other public and private sector organizations.	SPAN is a regional project with funding from the public and private sectors in Scotland as well as from the CEC. Its objectives are to: - raise awareness of E-commerce and the Internet in Scottish SMEs, - give impartial advice, - demonstrate projects, - be a focal point for information society architectures.

Name of Project	Participants/partners	Notes
Swebizz http://www.ansa.co.uk/e2s/14_	Swedish Government	Swebizz is a Swedish initiative that emphasises the sales and marketing aspects of E-commerce. It works closely with CommerceNet, the US E-Commerce project. At the moment, it is setting up pilots in three areas: legal, technical and business. It is financed by the Swedish government and membership fees. In the long term, it will be completely supported by membership fees.
UN Global Trade-Point Network http://www.ansa.co.uk/e2s/11_	UN	The UN Global TradePoint Network, which was started in 1992, is one of the two initiatives of the UN's Electronic Trading Efficiency Programme. It is an Internet-based network which links 100 trade points in 70 countries. It is targeted at SMEs and aims to: - broaden participation in trade, - lower transaction costs, - promote effective trade practices, - expand global information super-highways, - provide access to electronic trade opportunities worldwide, - provide access to trade-related databases which will provide information on trade regulations, financing, company registers, state and regional authorities, etc., - give SMEs of developing countries immediate global visibility.
SET (Secure Electronic Transaction) Initiative http://www.mastercard.com	The SET initiative was set up by Visa and MasterCard. Other participants include: GTE, IBM, Microsoft, Netscape, SAIC, Terisa Systems and Versign.	The SET initiative aims to establish an industry standard for secure transactions using credit card data. It was published on WWW sites in mid-February 1996 and software solutions incorporating SET, which is based on encryption technology from RSA Data Security, should begin to be released toward the end of 1996. The global network of Trusted Third Parties, which will hold registries of public and private keys, has still to be set up.
E2S http://www.ansa.co.uk/e2s	The E2S project partners are: APM Ltd, Gemplus, GMD, Hewlett Packard, Octacon Ltd, Technische Universität Berlin, Swiss Bank Corp., Smart Card Forum (International) and Visa International	The objective of the E2S project is to contribute to the growth of E-commerce on the Internet by developing and installing end-to-end security mechanisms for commercial transactions using the Internet. It is funded by the EU under its Esprit Fourth Framework Programme. The project began on the 1 September 1995, and is scheduled to complete on the 30 November 1997.

Name of Project	Participants/partners	Notes
RegionLink http://www.ansa.co.uk/e2s/17_	EU and local business partners in EU member states	RegionLink aims to use the Internet and other IT technologies to raise awareness of E-commerce to the business market and create economic activities in Europe. RegionLink provides co-ordination, the server network and the connections and the local business partners provide the content. The network's technical features include Web browser access and the use of Sun's Java software. The network offers three services: – "Being there" – multimedia information on tourism and culture; – "Mercator" – a retail "shopping mall" service for low value goods; – "Netrader" – business to business E-commerce, including transaction processing. It is funded by the EU under its Esprit Fourth Framework Programme.
Integrion http://www.ramresearch.com/crdflash	IBM, ABN Amro, Banc One, Bank of America, Barnett Bank, Comerica, First Bank Systems, First Chicago NBD, Fleet Financial Group, KeyCorp, Mellon Bank, Michigan National Bank, NationsBank, PNC Bank, Royal Bank of Canada and Washington Mutual Inc.	Integrion's objective is to ensure that banks can rapidly deliver secure, convenient and reliable electronic banking services for the fast-growing segment of the population expecting to participate in E-commerce over the Internet and other electronic channels. Initially, Integrion will serve households in Canada and the US. The initial pilots will be launch by Banc One and NationsBank in early 1997. Other partner banks will roll out Integrion-based services later in 1997. The project is funded by partner banks through a fee system. By sharing Integrion's development, marketing and operating costs, banks will avoid duplication of the same basic infrastructure.

Appendix B

Background to the forecasts

Several studies have attempted to forecast market revenues for E-commerce over the Internet, based mainly on US experience.

Forrester Research forecasts revenues from online shopping that grow from 395 million ECU in 1996 to 5.0 billion ECU in 2000 (http://www.forrester.com). Forrester expects to see "slow but steady growth". Its compound annual growth rate (CAGR) of 90% over the four year period is much lower than other analysts. The forecasts seem to concentrate on some rather limited consumer categories (e. g. travel, adult entertainment, CDs, gifts and flowers) that appeal to the current Web users (i. e. young males with plenty of disposable income).

In contrast Input's forecasts show a much more dramatic increase for the worldwide sale of goods and services traded over the Internet, rising from 53 million ECU in 1995 to 195 billion ECU in 2000 - a CAGR of more than 400% over these five years (http://www.input.com). These forecasts cover a much wider range of products and services than those of Forrester, and specifically include EDI traffic over the Internet.

An intermediate position is taken by ActivMedia, which forecasts growth in Web-generated revenues from 333 million ECU in 1995 to 240 billion ECU in 2001 - a CAGR over these six years of 250% (http://www.activmedia.com). For the period 1995 to 2000, the CAGR is 292% to Input's 400%, while for the period 1996 to 2000 it is 215% to Forrester's 90%. We have chosen this intermediate position as the starting point for the forecasts.

Methodology and assumptions

The US research (from ActivMedia and based on a series of three semi-annual studies of net marketers; "The Real Numbers behind Net Profits") indicates that average monthly site revenues are currently $ 7,100.

The forecasts in this chapter assume that this figure is virtually unchanged over the forecast period. Thus, the predicted growth in the market is accounted for mainly by the influx of sites over the next few years (rather than by a combination of this and an increase in the number of transactions per site) and represents a conservative view of market development.

Revenues in the forecasts are expressed in billion ECUs.

The first step was to derive a distribution of the non-US revenues between Europe, Asia-Pacific and the Rest of the World. This was based on three assumptions:

- that non-US sales revenues in 1995 were roughly proportional to the numbers of commercial Web sites identified;

Table 12
Distribution of Non-US Revenues (%)

	Sales 1995	2001	Advertising 1995	2001
Europe	63	60	75	72
Asia-Pacific	33	35	25	26
Row	4	5	0	2

- that non-US advertising revenues in 1995 were roughly proportional to the numbers of these sites with advertising;
- that Asia-Pacific and RoW will expand slightly faster than Europe over this period.

Table 12 shows the distributions for sales and advertising revenues assumed in 1995 and 2001. For the purposes of the model, the distributions change smoothly over the period.

The second step was to derive a further distribution of the revenues generated by European Web sites over the countries of the region. Eight geographic areas were selected. The distribution is based on two assumptions:

- that European revenues from sales and advertising in 1995 were roughly proportional to the number of active commercial Web sites identified in the study;
- that the distribution of European revenues will tend over time to conform with the relative size of the markets in these countries as measured by the distribution of ICT market revenues.

Table 13 shows the distributions assumed in 1995 and 2001. For the purposes of the model, the distribution changes smoothly over the period.

The final step was to derive a further distribution of the revenues generated by European Web sites over various market segments. Nine segments were selected. The distribution is based on two assumptions:

Table 13
Distribution of Revenues by Country (%)

	1995	2001
Benelux	12.1	9.4
France	1.0	14.7
Germany	2.0	23.4
Italy	8.1	8.0
Nordic countries	23.3	11.9
Spain	1.0	3.6
UK	41.4	18.8
ROE	11.1	10.2

Table 14
Distribution of Revenues by Segment (%)

	1995	2001
Computers and software	35	16
Consumer products	17	14
Finance and insurance	4	3
Manufacturing and industry	3	11
Publications and information	10	10
Travel	6	4
Business and professional	13	24
Advertising	11	13
Other	1	5

- that the distribution of revenues in 1995 was roughly proportional to the number of commercial Web sites active in those segments in Europe as identified in the study;
- that the distribution of revenues in Europe will tend over time to move away from the current concentration on computers and software and will become more like the USA. The main growth areas identified are the manufacturing, business and professional services segments.

Table 14 shows the distributions assumed in 1995 and 2001. For the purposes of the model, the distribution changes smoothly over the period.

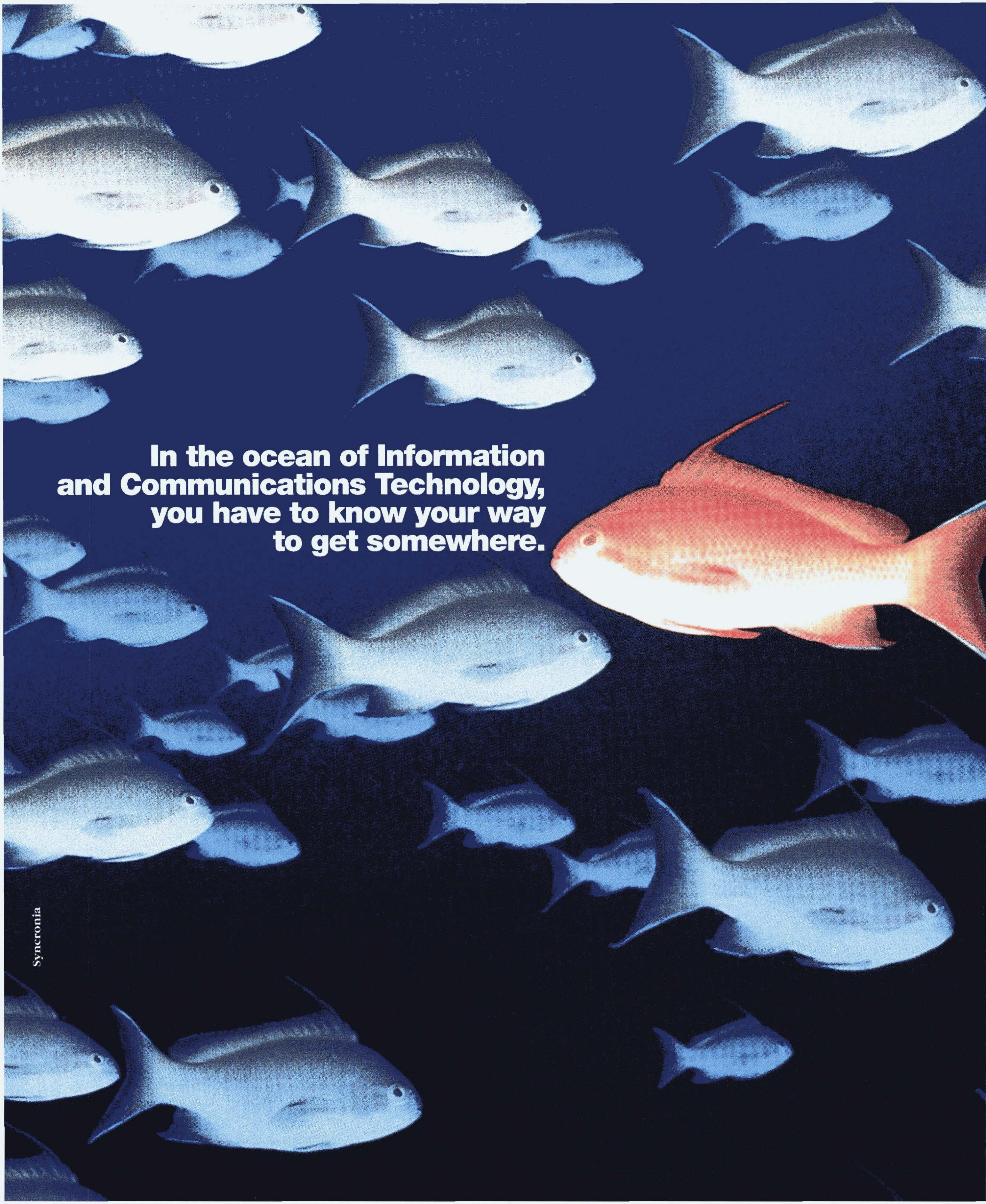
Web site categories

The application categories have been taken from directory listings on Yahoo, one of the best-established Web search engines on the Internet. Yahoo registered 83,000 commercial Web sites worldwide in early June 1996. There may be a slight skewing in favour of English language sites which may underestimate European presence on the Internet.

In order to produce the forecasts in Section 8.4, the mapping shown in *Table 15* of Web site categories to customer groups was used.

Table 15
Mapping of Product Segments to Customer Segments

	Consumers	Education	Government & Defence	Manufacturing and suppliers	Business end-users
Computers and software	✓	✓	✓	✓	✓
Consumer products	✓				
Finance and insurance	✓				
Manufacturing and suppliers			✓	✓	
Publications and information	✓	✓	✓	✓	✓
Travel	✓	✓			
Other	✓	✓	✓	✓	✓


In the ocean of Information
and Communications Technology,
you have to know your way
to get somewhere.
Syncronia

Part Three

Statistical Outlook

The data and forecasts presented in this section have been jointly prepared by IDC and the EITO Task Force on the basis of the information available at the end of November 1996.

ICT market size and growth trends by country and technology reflect the opinion of both the EITO Task Force and IDC. In particular, figures for Germany have been based on the statistics provided by the German Information Technology Manufacturers Association within VDMA and ZVEI. Figures for Italy have been based on the statistics provided by the EITO Task Force.

1. Introduction

This section presents statistics which illustrate the shape and structures behind the information and communications technology markets in Europe. The material is presented in three main sub-sections:

- the shape of the various national ICT markets, within an international context, and the patterns of trade between them;
- the individual market structures with an eye on the competitive aspects, as well as comparative measures of ICT penetration;
- the role of technological advancement in altering the underlying economics of ICT.

Terms are defined at the end of the section.

2. Methodology

Government statistical bodies tend to model the world starting with the system of national accounts. Agreed classifications for industrial activity and trade thus become the measures against which markets are assessed. In many areas the restrictions imposed by such classifications and by the rigorous methods used to collect and process information are too great to make the resulting information useful to the business community. The ICT market is a case in point, and the failure of the standard classifications to get to grips with the subject of software is a specific limitation.

This study is an attempt to shed light on some of the more important aspects of the European markets for telecommunications and information technology products (and services), including substantial elements of the associated market for office automation products.

The basis for the study is the marketplace. Thus, instead of defining the marketplace in terms of what is produced plus the balance of trade, the research is aimed at measuring the market. Valuation is largely based upon the revenues paid to primary vendors, with research results cross-checked against a continuous programme of end-user interviews and distribution channel monitoring. Data on trade flows has also been collected, and matched as closely as possible to market-oriented segmentation, since these data can provide information relating to the position of Europe with respect to the world. What is presented, then, is a comprehensive body of data which aims to illuminate the European ICT Market, to cast light on the situation of the market's major players and the underlying competitive structures.

Given the extraordinary scope of this study in terms of subject matter and data sources, a degree of compromise is necessary in designing an appropriate methodology. The same principles apply to IDC's standard research into the

ICT industry. Because markets differ widely in structure and nature, and because consumers of market research attach different values to various levels of data, a variety of methods are used to research different aspects of the ICT landscape.

Thus, the overall methodology should be viewed not as a single simple entity, but rather as a complex product of an optimisation process which reflects the value placed upon information by its consumers. To illustrate the composite nature of the methodology, consider the contrasting markets for mainframe computers and PCs. Mainframes are generally sold by a direct sales force to the end-user organization without the intervention of channel intermediaries. As a result, the marketplace is sized by monitoring the revenues accruing to primary suppliers of mainframes and checked for consistency with end-user survey results. In the PC market, the heavy reliance on channel intermediaries means that to focus purely on primary suppliers' revenues understates the market size. As a result, measurements of the PC market are by reference to street prices rather than factory revenues. Similarly, the activities of value-added-resellers is monitored via software and services and distribution channels programmes, allowing for a complete picture of the market.

3. European ICT Markets and Patterns of Trade

For the purpose of this study, with an emphasis on the industry supplying goods and services in return for payment, we deal largely with the value of revenues paid to primary vendors for information technology goods and services. For an expanded discussion of the principles implicit within this study, readers are referred to the section on definitions which appears later in this volume.

All forecast data are prepared in local currencies and subsequently converted into constant 1996 ECU using the exchange rates listed at the end of the definitions section. Growth rates therefore correspond to local currency growth rates. No adjustment is made for the effects of inflation. Trade data are reported in current ECU, according to the standard reporting conventions.

In terms of classes of product, again a full account appears later. Here we note that the definition of the hardware marketplace has been expanded beyond the traditional IT systems arena, to include a broad category of office hardware technologies such as photocopiers, typewriters and calculating machines, and tele- and data communications equipment and services.

In terms of geography, the presentation used here is based firmly upon market realities. As the rate of growth in information technology markets has reduced substantially, vendors have been encouraged to pursue opportunities in markets remote from their traditional operations. This is reflected in increased interest in the smaller EU markets, such as Greece, Ireland and Portugal, and further afield in Eastern Europe. As research continues into these markets and as the markets themselves develop, the level of detail at which information is meaningful will change. Until then, the basis of segmentation for some of these countries falls short of that used in the established markets.

Throughout the statistical section, Eastern Europe is considered to refer to Czech Republic, Slovakia, Hungary, Poland and Russia. Bulgaria and Romania are not covered by the analysis. The heading EU refers to Austria, Belgium and Luxembourg, Denmark, Finland, France, Germany, Greece, Italy, the Republic of Ireland, the Netherlands, Spain, Sweden, Portugal, and the UK. The sole exception to this definition of EU is Part 8 ICT Trade Flows where definitions of EU are governed by the methodology of Eurostat. Non-EU is represented by data on Norway and Switzerland. Western Europe figures are the sum of EU countries plus Norway and Switzerland.

4. List of Tables

5. List of Figures

6. Economic Background

Table 1
Real GDP Growth in %, 1990–1998

	1990	1991	1992	1993	1994	1995	1996*	1997*	1998*
Austria	4.2	2.9	1.8	0.4	3.0	1.8	1.1	1.4	2.3
Belgium	3.2	2.2	1.8	- 1.4	2.3	1.9	1.3	2.2	2.6
Denmark	3.0	1.3	0.8	1.5	4.4	2.8	1.9	2.9	3.1
Finland	0.0	- 7.1	- 3.6	- 1.2	4.4	4.2	2.5	3.5	3.6
France	2.5	0.8	1.3	- 1.3	2.8	2.2	1.3	2.5	2.6
Germany	5.7	5.0	2.2	- 1.1	2.9	1.9	1.1	2.2	2.6
Greece	- 1.0	3.2	0.8	- 1.0	1.5	2.0	2.2	2.5	2.8
Ireland	8.6	2.2	3.9	3.1	6.5	10.3	7.0	6.2	6.8
Italy	2.1	1.2	0.7	- 1.2	2.1	3.0	0.8	1.2	2.1
The Netherlands	4.1	2.3	2.0	0.8	3.4	2.1	2.7	2.7	3.0
Norway	1.7	2.9	3.4	2.1	5.0	3.3	5.1	3.0	2.3
Portugal	4.3	2.1	1.1	- 1.2	0.8	2.4	2.6	2.9	3.2
Spain	3.7	2.2	0.7	- 1.2	2.1	2.8	2.1	2.7	3.0
Sweden	1.4	- 1.1	- 1.4	- 2.2	3.3	3.6	1.7	2.2	2.1
Switzerland	2.3	0.0	- 0.3	- 0.8	1.0	0.1	- 0.3	0.8	2.0
United Kingdom	0.4	- 2.0	- 0.5	2.1	3.8	2.4	2.4	3.3	3.0
Western Europe	3.2	1.5	1.2	- 0.5	2.9	2.5	1.6	2.4	2.7
USA	1.2	- 0.6	2.3	2.3	3.5	2.0	2.4	2.2	2.0
Japan	4.8	4.3	1.1	0.1	0.5	0.9	3.6	1.6	3.7

Source: OECD, December 1996 * Estimates and projections

Table 2
Nominal GDP Growth in %, 1990–1998

	1990	1991	1992	1993	1994	1995	1996*	1997*	1998*
Austria	7.7	7.1	6.1	3.8	6.5	10.3	2.7	2.9	3.8
Belgium	6.5	4.9	5.4	2.3	4.9	3.3	2.9	4.2	4.3
Denmark	4.1	3.6	2.8	2.2	6.2	4.5	4.1	5.5	6.3
Finland	5.8	- 4.8	- 2.9	1.2	5.7	7.0	3.8	5.4	6.3
France	5.7	4.1	3.5	1.2	4.3	3.9	3.0	3.8	4.0
Germany	9.1	9.1	7.8	2.7	5.2	4.1	2.4	3.4	3.9
Greece	19.8	22.6	15.0	13.0	12.6	11.5	11.5	9.9	9.3
Ireland	6.7	3.9	6.0	7.4	7.8	10.9	7.7	7.0	7.9
Italy	9.9	8.9	5.2	3.1	5.7	8.2	4.9	4.0	4.7
The Netherlands	6.5	5.0	4.3	2.6	5.3	3.5	4.2	5.1	5.5
Norway	6.3	5.7	3.0	4.8	7.0	6.2	8.7	4.6	4.8
Portugal	17.8	16.7	14.5	6.0	6.0	7.5	7.0	6.4	6.3
Spain	11.3	9.5	7.5	3.0	6.2	7.8	6.1	5.7	5.9
Sweden	10.3	6.4	- 0.4	0.3	5.9	7.4	3.3	4.8	4.8
Switzerland	8.1	5.4	2.3	1.2	2.4	1.5	0.0	1.5	3.0
UK	6.8	4.4	3.8	5.5	6.1	4.9	3.8	5.6	5.3
Western Europe	11.2	7.1	5.4	3.2	5.6	5.5	4.0	4.4	4.8
USA	5.6	3.2	5.2	5.0	5.9	4.5	4.4	4.3	4.1
Japan	7.2	6.3	2.6	0.7	0.8	0.4	3.5	2.1	3.7

Source: OECD, December 1996 * Estimates and projections

Table 3
Real Gross Private Non-residential Fixed Capital Formation (Growth in %), 1990–1998

	1990	1991	1992	1993	1994	1995	1996*	1997*	1998*
Austria	8.3	5.1	– 2.6	6.4	– 4.1	2.9	1.3	2.5	4.2
Belgium	11.8	– 2.7	– 4.5	– 9.7	– 3.2	5.1	4.2	5.3	6.0
Denmark	2.6	-4.5	–11.2	– 5.0	1.4	12.9	6.0	7.0	8.3
Finland	– 6.4	–24.3	–21.3	–22.6	2.3	18.5	14.7	9.7	6.9
France	4.7	0.4	– 4.6	– 8.2	1.5	3.8	1.1	3.4	4.5
Germany	10.1	7.5	0.0	–10.3	0.5	1.9	– 1.2	2.2	6.3
Greece	11.3	– 6.8	3.2	– 1.5	4.3	9.0	11.3	10.5	10.2
Ireland	14.9	–11.9	– 8.3	– 4.0	3.6	10.8	9.1	7.1	11.7
Italy	5.4	– 0.3	– 1.1	–18.6	4.4	11.0	1.2	4.0	5.1
Netherlands	2.4	2.0	– 3.0	– 4.2	– 0.7	10.8	4.5	2.6	6.0
Norway	-32.4	2.9	– 3.4	5.2	6.0	2.6	6.9	3.6	1.8
Portugal	6.8	2.4	5.4	– 4.8	3.5	7.5	8.0	7.5	n.a.
Spain	3.9	2.0	– 1.4	–15.0	3.2	11.9	7.0	7.5	6.0
Sweden	– 1.1	–15.2	–15.5	–13.0	18.6	25.1	12.5	5.0	6.0
Switzerland	3.3	– 3.6	– 8.5	– 7.8	4.1	6.9	3.0	1.2	2.3
UK	– 3.1	– 9.5	– 6.2	– 1.4	3.2	1.9	9.7	8.1	7.3
Western Europe	4.3	-0.6	– 3.4	– 9.6	2.3	6.3	3.5	4.6	6.0
USA	1.2	-5.7	2.0	6.4	9.8	9.5	7.2	6.0	2.6
Japan	11.4	6.6	-4.7	-10.2	-6.0	3.1	6.4	7.7	8.7

Source: OECD, December 1996 — * Estimates and projections

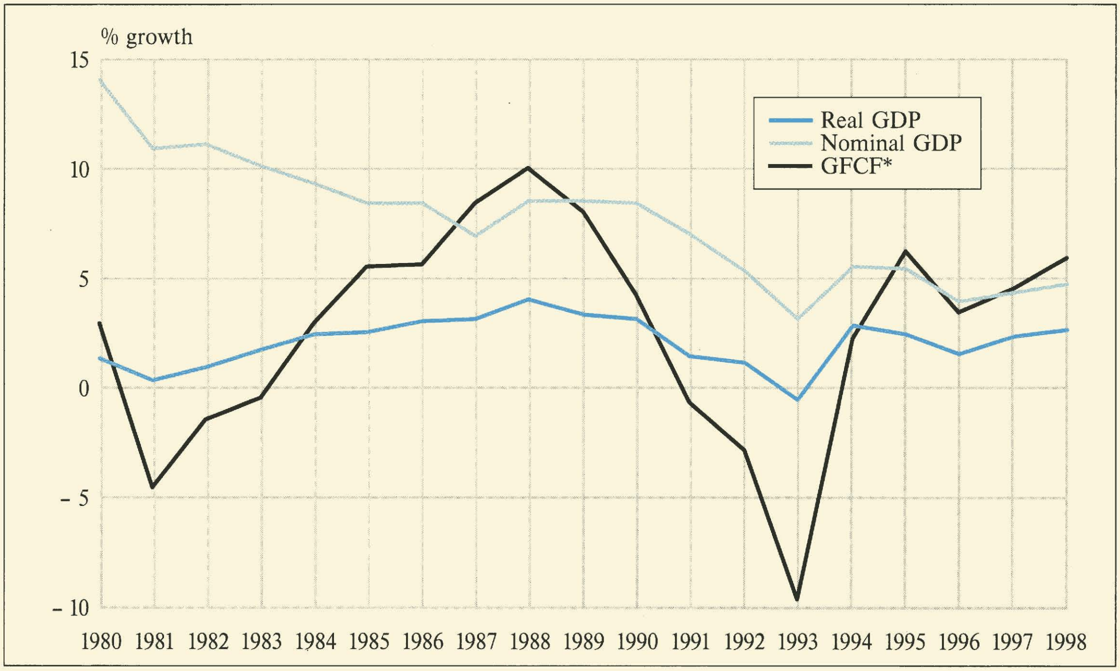
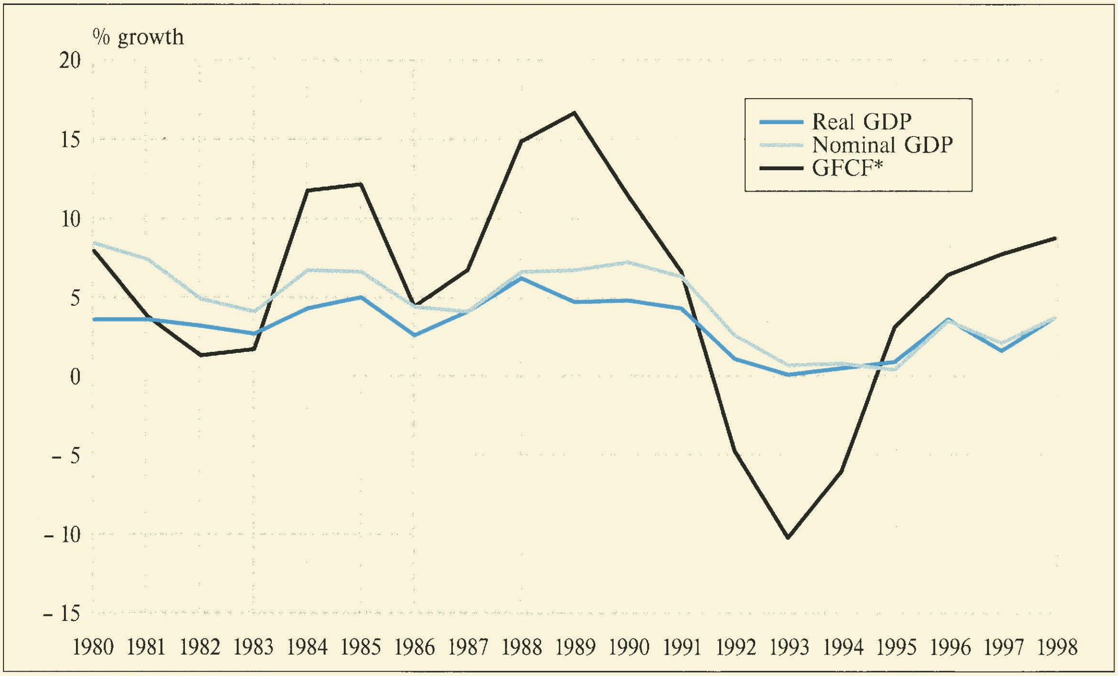


Figure 1
Economic Developments in OECD Europe, 1980–1998

Source: OECD, December 1996 — * GFCF – Gross Fixed Capital Formation

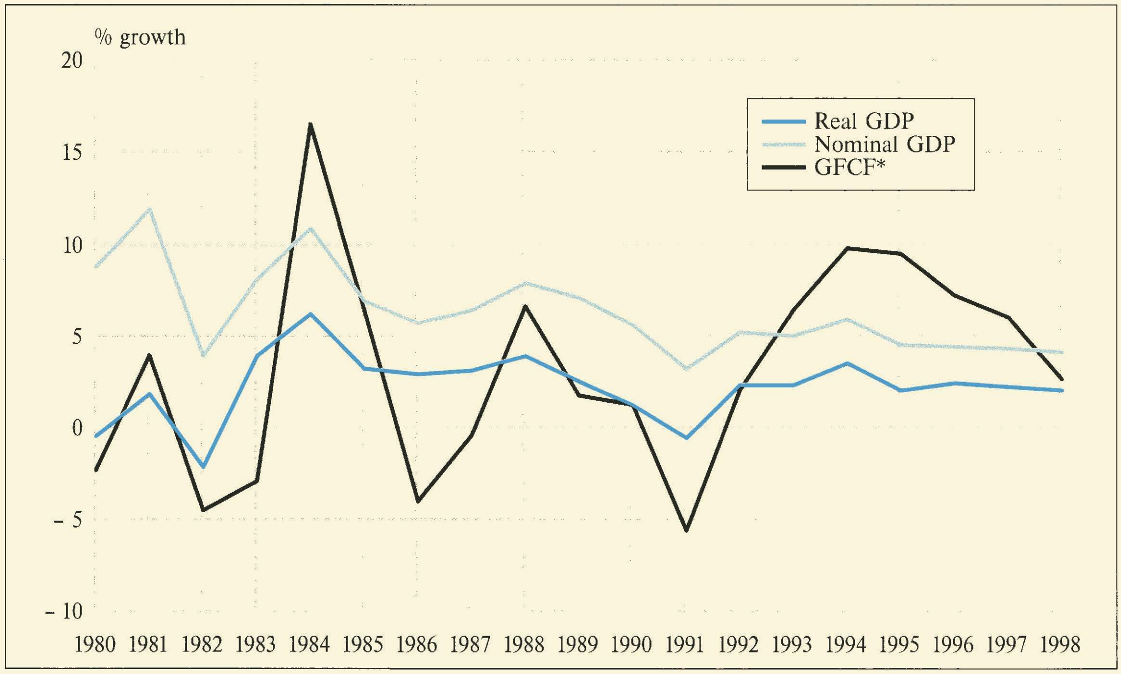
Figure 2
Economic Developments in Japan, 1980–1998



Source: OECD, December 1996

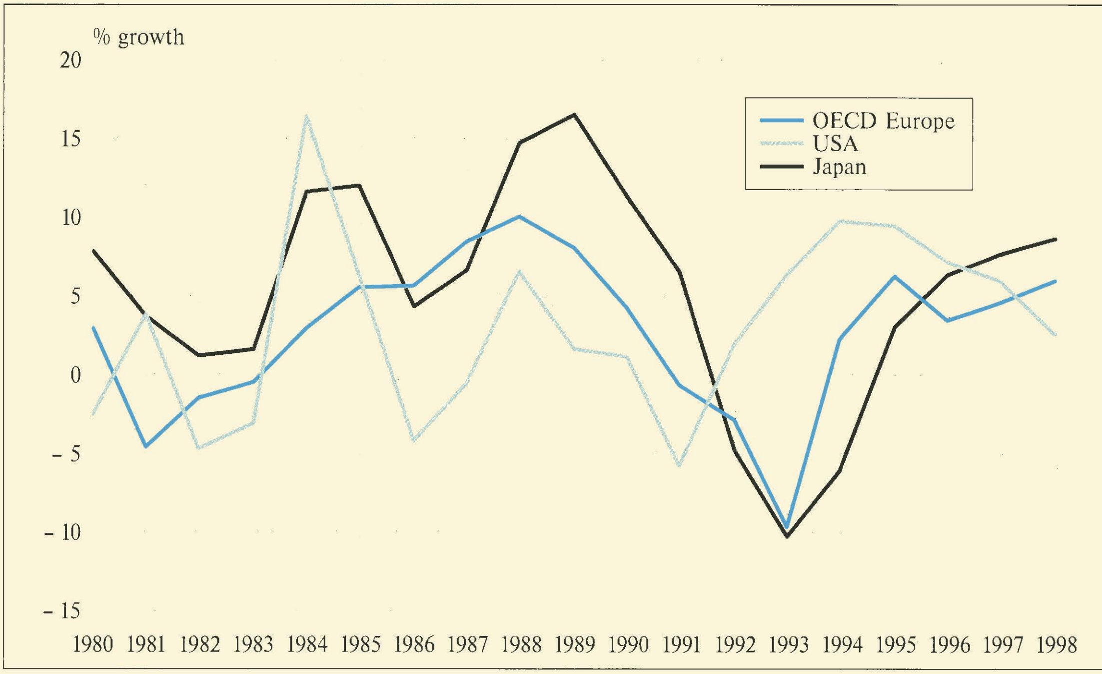
* GFCF – Gross Fixed Capital Formation

Figure 3
Economic Developments in the USA, 1980–1998



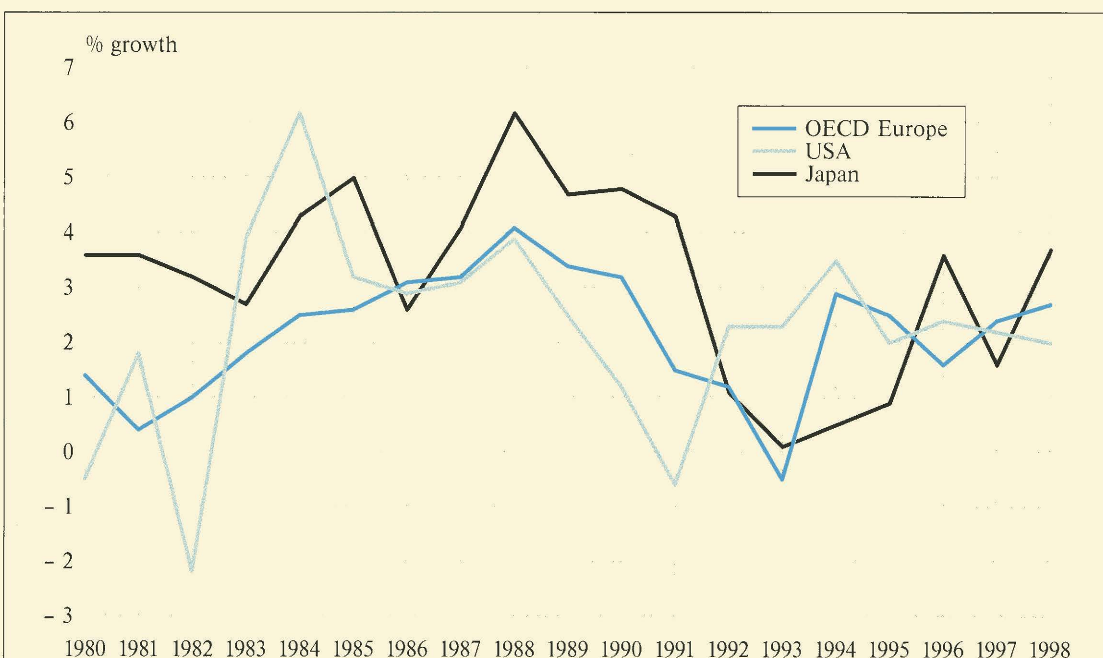
Source: OECD, December 1996

* GFCF – Gross Fixed Capital Formation



Source: OECD, December 1996

Figure 4
Growth of Gross Private Non-residential Fixed Capital Formation in OECD Europe, the USA and Japan, 1980–1998

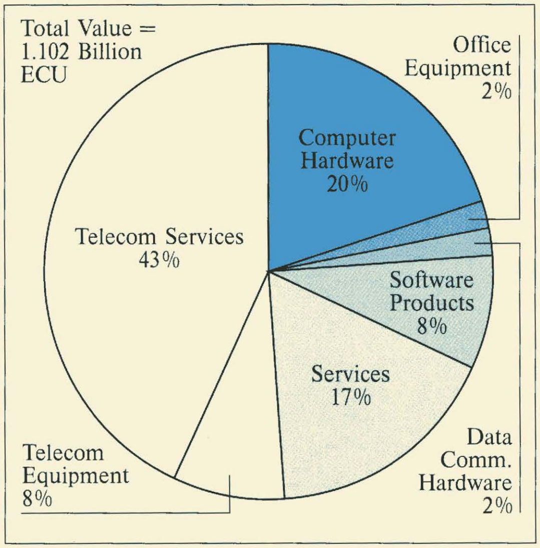


Source: OECD, December 1996

Figure 5
Growth of Real Gross Domestic Product in OECD Europe, the USA and Japan, 1980–1998

7. International ICT Markets

Figure 6
Worldwide ICT Market by Product, 1996



Source: EITO

Million ECU	1994	1995	1996	1997	1998
Europe (incl. Eastern Europe)	133,408	144,232	154,042	164,946	177,053
US	175,456	200,633	225,311	250,546	274,849
Japan	75,459	82,628	91,551	99,333	107,181
Rest of World	52,634	62,266	72,727	84,363	97,017
Total	**436,958**	**489,758**	**543,631**	**599,188**	**656,100**
	% growth				
Europe (incl. Eastern Europe)	5.9	8.1	6.8	7.1	7.3
US	10.0	14.3	12.3	11.2	9.7
Japan	4.7	9.5	10.8	8.5	7.9
Rest of World	14.7	18.3	16.8	16.0	15.0
Total	**8.4**	**12.1**	**11.0**	**10.2**	**9.5**
	% breakdown				
Europe (incl. Eastern Europe)	30.5	29.4	28.3	27.5	27.0
US	40.2	41.0	41.4	41.8	41.9
Japan	17.3	16.9	16.8	16.6	16.3
Rest of World	12.0	12.7	13.4	14.1	14.8
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 4
*Worldwide IT Market Growth Trends. Market Value. Million ECU at Constant 1996 Exchange Rates**

* See Definitions 11.3.6. Exchange Rates

Million ECU	1994	1995	1996	1997	1998
Europe (incl. Eastern Europe)	147,197	160,693	173,559	186,441	199,515
US	139,348	146,175	155,597	165,509	174,985
Japan	66,313	69,631	72,707	75,439	78,042
Rest of World	125,149	139,963	156,697	172,750	187,429
Total	**478,007**	**516,461**	**558,560**	**600,138**	**639,971**
	% growth				
Europe (incl. Eastern Europe)	8.7	9.2	8.0	7.4	7.0
US	3.2	4.9	6.4	6.4	5.7
Japan	6.4	5.0	4.4	3.8	3.5
Rest of World	8.1	11.8	12.0	10.2	8.5
Total	**6.1**	**8.0**	**8.2**	**7.4**	**6.6**
	% breakdown				
Europe (incl. Eastern Europe)	30.8	31.1	31.1	31.1	31.2
US	29.2	28.3	27.9	27.6	27.3
Japan	13.9	13.5	13.0	12.6	12.2
Rest of World	26.2	27.1	28.1	28.8	29.3
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 5
*Worldwide Telecommunications Market Growth Trends. Market Value. Million ECU at Constant 1996 Exchange Rates**

* See Definitions 11.3.6. Exchange Rates

Table 6
*Worldwide ICT Market Growth Trends. Market Value. Million ECU at Constant 1996 Exchange Rates**

Million ECU	1994	1995	1996	1997	1998
Europe (incl. Eastern Europe)	280,605	304,924	327,600	351,387	376,568
US	314,805	346,808	380,908	416,055	449,834
Japan	141,773	152,259	164,258	174,772	185,223
Rest of World	177,783	202,229	229,424	257,112	284,446
Total	**914,965**	**1,006,219**	**1,102,191**	**1,199,326**	**1,296,072**
	% growth				
Europe (incl. Eastern Europe)	7.3	8.7	7.4	7.3	7.2
US	6.2	10.2	9.8	9.2	8.1
Japan	5.5	7.4	7.9	6.4	6.0
Rest of World	10.1	13.8	13.4	12.1	10.6
Total	**7.2**	**10.0**	**9.5**	**8.8**	**8.1**
	% breakdown				
Europe (incl. Eastern Europe)	30.7	30.3	29.7	29.3	29.1
US	34.4	34.5	34.6	34.7	34.7
Japan	15.5	15.1	14.9	14.6	14.3
Rest of World	19.4	20.1	20.8	21.4	21.9
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

* See Definitions 11.3.6. Exchange Rates

Table 7
*Major Regional ICT Markets by Product, 1996 and 1998. Million ECU at Constant 1996 Exchange Rates**

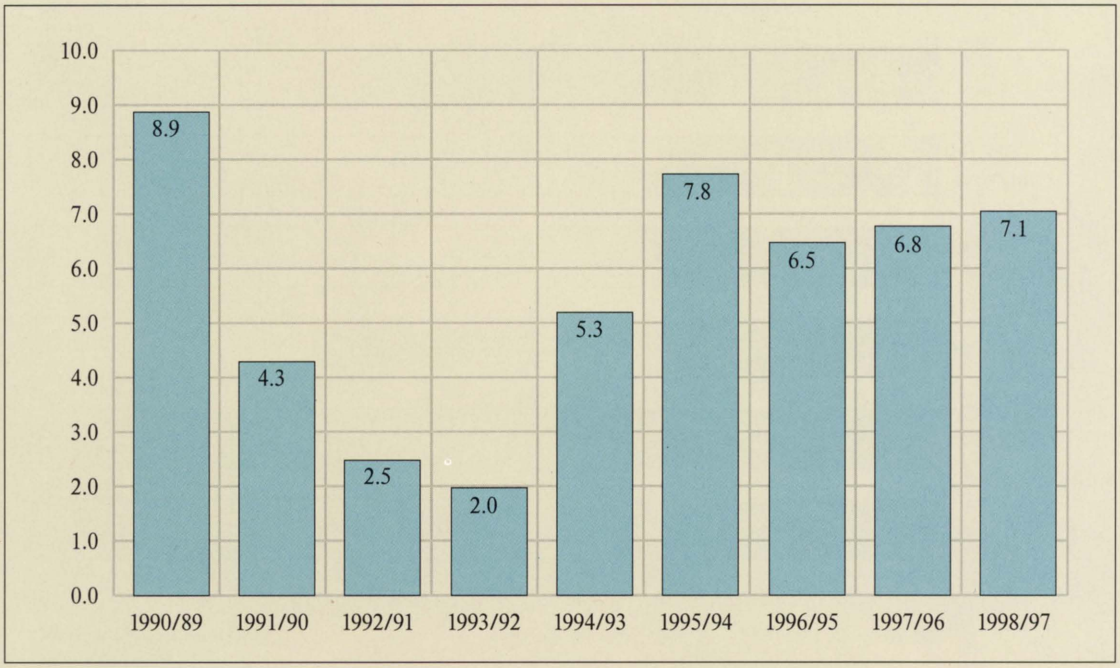
1996	Western Europe	Eastern Europe	US	Japan	Rest of World	World
IT Hardware	65,784	4,025	110,753	50,013	42,869	273,444
Software	31,149	533	38,965	8,752	6,345	85,744
IT Services	51,615	937	75,593	32,786	23,513	184,443
Telecom Equipment	28,688	2,109	19,516	10,163	30,607	91,083
Telecom Services	138,085	4,676	136,081	62,544	126,090	467,476
Total	**315,320**	**12,281**	**380,908**	**164,258**	**229,424**	**1,102,191**
1998	**Western Europe**	**Eastern Europe**	**US**	**Japan**	**Rest of World**	**World**
IT Hardware	74,652	5,113	136,345	58,861	57,418	332,389
Software	37,382	656	48,745	11,460	8,791	107,034
IT Services	57,963	1,287	89,759	36,860	30,808	216,677
Telecom Equipment	31,302	2,525	19,647	10,244	34,878	98,596
Telecom Services	160,004	5,684	155,338	67,798	152,551	541,375
Total	**361,304**	**15,265**	**449,834**	**185,223**	**284,446**	**1,296,072**

* See Definitions 11.3.6. Exchange Rates

Table 8
Major Regional ICT Markets by Product. % Average Annual Growth by Value, 1996–1998

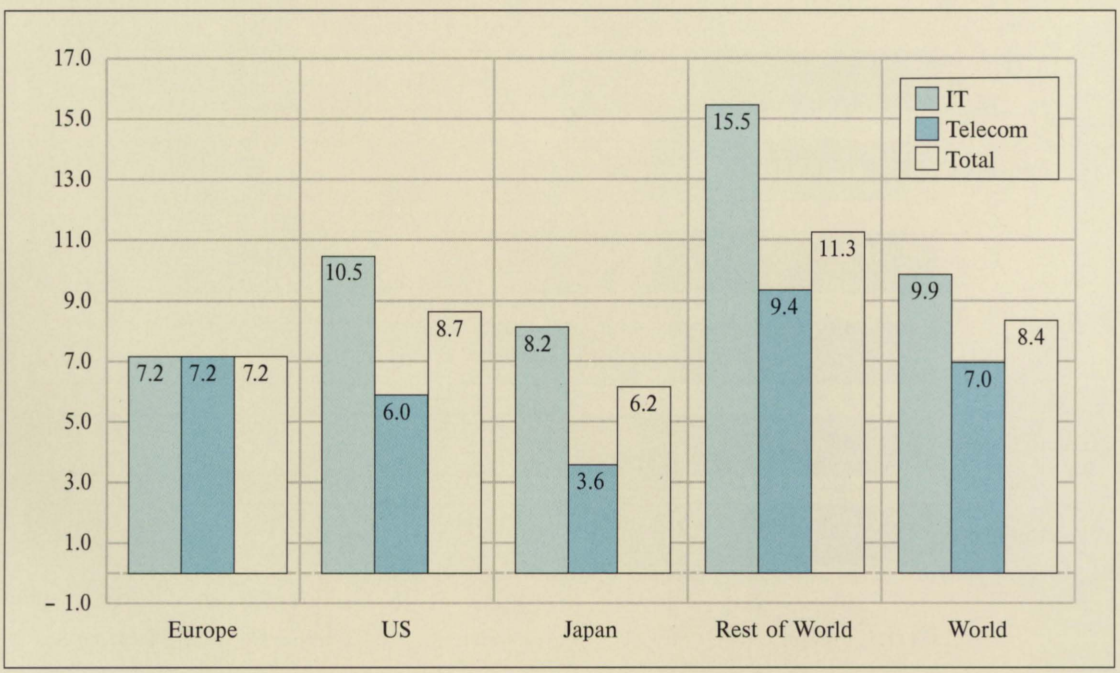
	Western Europe	Eastern Europe	US	Japan	Rest of World	World
IT Hardware	6.5	12.7	11.0	8.5	15.8	10.3
Software	9.5	11.0	11.9	14.4	17.7	11.7
IT Services	6.0	17.2	9.0	6.0	14.5	8.4
IT	7.0	13.3	10.5	8.2	15.5	9.9
Telecom Equipment	4.5	9.4	0.3	0.4	6.7	4.0
Telecom Services	7.6	10.2	6.8	4.1	10.0	7.6
Telecom	7.1	10.0	6.0	3.6	9.4	7.0
Total	**7.0**	**11.5**	**8.7**	**6.2**	**11.3**	**8.4**

Figure 7
Western European IT Market Growth Rates in %, 1989–1998

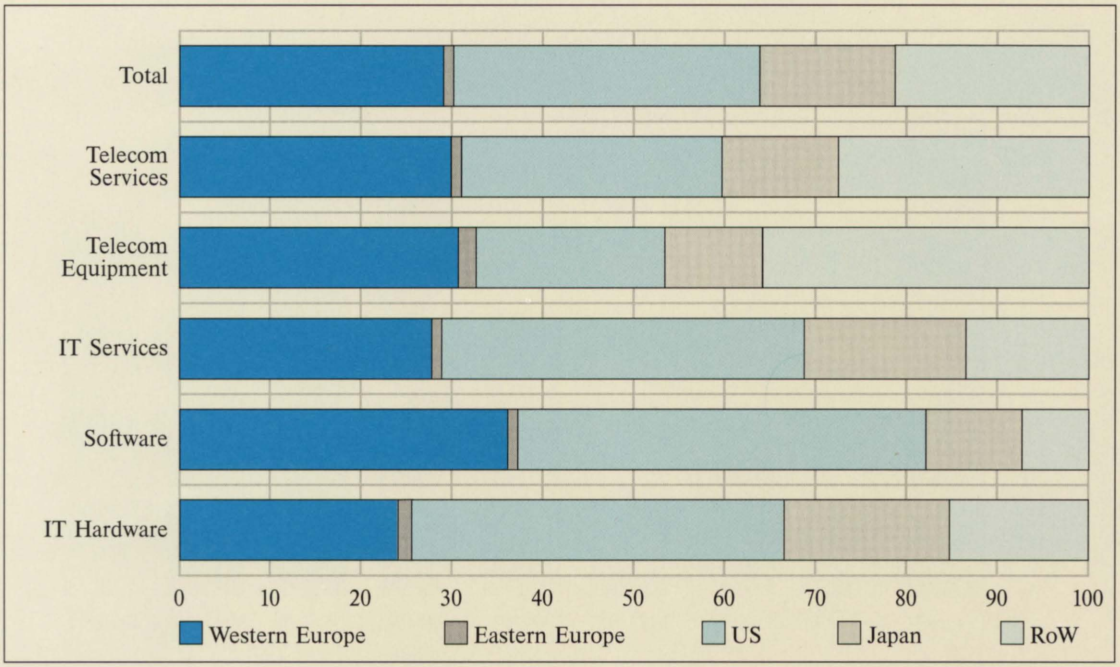


Source: EITO

Figure 8
World Annual ICT Markets Average Annual Growth in %, 1996–1998

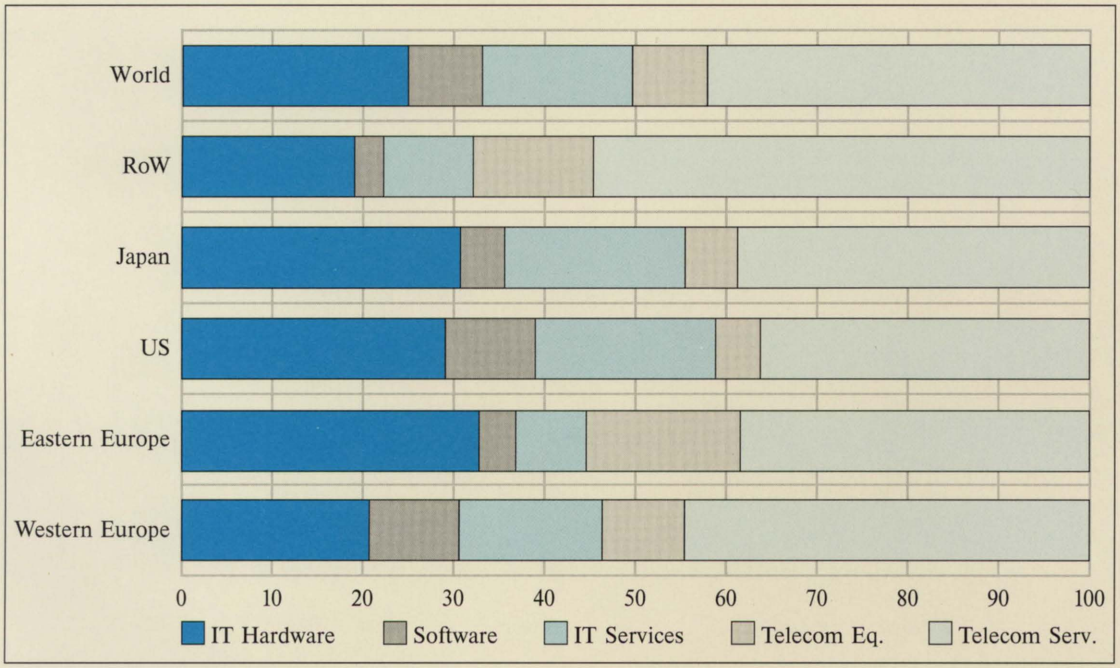


Source: EITO



Source: EITO

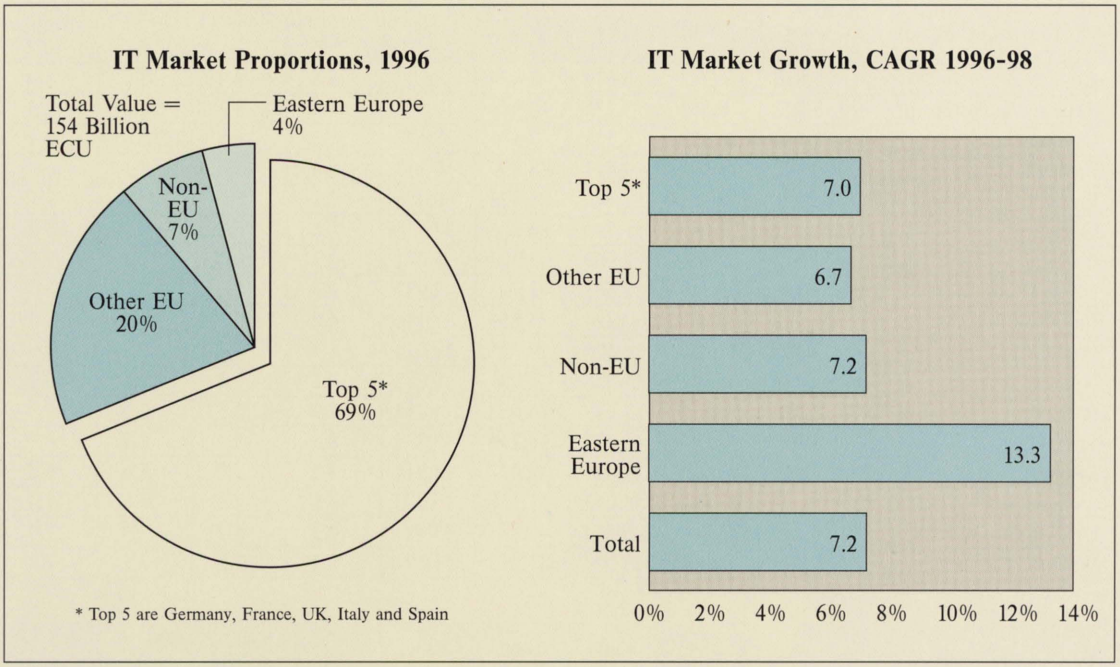
Figure 9
World ICT Market Regional Proportions by Product in %, 1996



Source: EITO

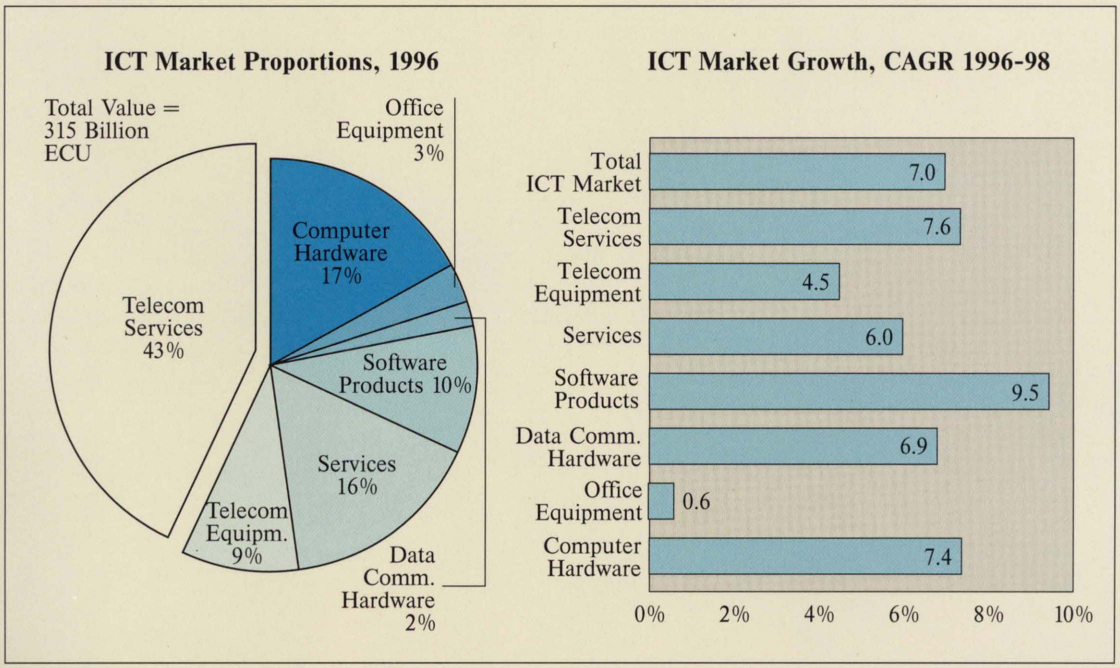
Figure 10
World ICT Market Product Proportions by Region in %, 1996

Figure 11
European IT Market by Region, 1996 and Market Growth, 1996–1998



Source: EITO

Figure 12
Western European ICT Market Proportions by Class of Business, 1996 and Market Growth, 1996–1998



Source: EITO

Table 9
ICT Market
by Country
(Million ECU)

Western Europe	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Austria	5,850	6,347	6,879	7,429	8,027	8.5	8.4	8.0	8.0
Belgium/Luxembourg	8,002	8,563	9,271	10,049	10,888	7.0	8.3	8.4	8.3
Denmark	5,874	6,352	6,785	7,180	7,640	8.1	6.8	5.8	6.4
Finland	3,817	4,199	4,511	4,839	5,173	10.0	7.4	7.3	6.9
France	45,511	48,763	52,449	56,426	60,456	7.1	7.6	7.6	7.1
Germany	71,481	77,608	81,894	86,866	92,535	8.6	5.5	6.1	6.5
Greece	2,394	2,689	2,969	3,300	3,621	12.3	10.4	11.2	9.7
Ireland	2,156	2,359	2,563	2,761	2,982	9.4	8.7	7.7	8.0
Italy	28,982	30,954	33,224	35,619	37,940	6.8	7.3	7.2	6.5
Netherlands	14,188	15,437	16,625	17,795	19,024	8.8	7.7	7.0	6.9
Norway	4,748	5,177	5,556	5,901	6,258	9.1	7.3	6.2	6.1
Portugal	2,930	3,278	3,689	4,052	4,455	11.9	12.5	9.9	9.9
Spain	14,343	15,545	16,873	18,258	19,787	8.4	8.5	8.2	8.4
Sweden	9,618	10,685	11,435	12,077	12,818	11.1	7.0	5.6	6.1
Switzerland	12,099	13,049	14,053	15,156	16,275	7.9	7.7	7.8	7.4
United Kingdom	38,983	43,001	46,544	49,933	53,423	10.3	8.2	7.3	7.0
Western Europe	270,975	294,008	315,320	337,640	361,304	8.5	7.2	7.1	7.0

Table 10
IT Market
by Country
(Million ECU)

Western Europe	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Austria	2,916	3,173	3,429	3,686	3,952	8.8	8.1	7.5	7.2
Belgium/Luxembourg	4,380	4,565	4,847	5,150	5,520	4.2	6.2	6.3	7.2
Denmark	3,342	3,637	3,883	4,069	4,279	8.8	6.8	4.8	5.2
Finland	1,935	2,174	2,359	2,544	2,734	12.3	8.5	7.9	7.4
France	22,963	24,294	25,751	27,418	29,328	5.8	6.0	6.5	7.0
Germany	34,775	37,689	39,824	42,590	45,768	8.4	5.7	6.9	7.5
Greece	467	520	583	663	757	11.5	12.1	13.7	14.2
Ireland	723	771	816	858	907	6.7	5.7	5.2	5.7
Italy	11,480	12,043	12,520	13,227	14,055	4.9	4.0	5.6	6.3
Netherlands	7,479	8,074	8,700	9,328	10,003	8.0	7.7	7.2	7.2
Norway	2,566	2,822	3,029	3,223	3,425	10.0	7.4	6.4	6.3
Portugal	816	869	934	1,001	1,083	6.4	7.5	7.2	8.2
Spain	4,753	5,155	5,579	6,029	6,547	8.5	8.2	8.1	8.6
Sweden	4,957	5,545	5,938	6,253	6,603	11.9	7.1	5.3	5.6
Switzerland	6,197	6,629	7,110	7,640	8,222	7.0	7.3	7.5	7.6
United Kingdom	19,675	21,540	23,246	24,979	26,813	9.5	7.9	7.5	7.3
Western Europe	129,425	139,499	148,547	158,659	169,997	7.8	6.5	6.8	7.1

Table 11
Telecommunications Market by Country (Million ECU)

Western Europe	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Austria	2,934	3,175	3,450	3,743	4,075	8.2	8.7	8.5	8.9
Belgium/Luxembourg	3,621	3,999	4,424	4,899	5,367	10.4	10.6	10.7	9.6
Denmark	2,532	2,715	2,903	3,111	3,360	7.2	6.9	7.2	8.0
Finland	1,882	2,025	2,152	2,294	2,439	7.6	6.3	6.6	6.3
France	22,548	24,469	26,698	29,008	31,128	8.5	9.1	8.7	7.3
Germany	36,706	39,920	42,070	44,275	46,767	8.8	5.4	5.2	5.6
Greece	1,927	2,169	2,386	2,637	2,864	12.5	10.0	10.5	8.6
Ireland	1,433	1,587	1,748	1,903	2,075	10.8	10.1	8.9	9.0
Italy	17,502	18,911	20,704	22,392	23,885	8.1	9.5	8.2	6.7
Netherlands	6,709	7,363	7,925	8,467	9,021	9.7	7.6	6.8	6.5
Norway	2,182	2,356	2,527	2,678	2,833	8.0	7.3	5.9	5.8
Portugal	2,113	2,409	2,754	3,051	3,372	14.0	14.3	10.8	10.5
Spain	9,590	10,390	11,293	12,229	13,241	8.3	8.7	8.3	8.3
Sweden	4,661	5,140	5,496	5,824	6,215	10.3	6.9	6.0	6.7
Switzerland	5,903	6,421	6,944	7,516	8,053	8.8	8.1	8.2	7.2
United Kingdom	19,309	21,462	23,298	24,954	26,611	11.2	8.6	7.1	6.6
Western Europe	141,551	154,510	166,773	178,981	191,306	9.2	7.9	7.3	6.9

Table 12
Austria
ICT Market Value
(Million ECU)

Austria	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	136	123	114	103	96	- 9.9	- 7.5	- 9.4	- 6.5
Servers - medium	125	129	136	162	189	2.7	6.0	18.8	16.8
Servers - small	153	157	172	197	228	2.5	9.5	14.5	15.9
Client-Workstations	43	49	57	62	72	14.4	15.7	10.3	16.1
Client PCs - portable	106	122	141	152	174	15.3	14.8	8.4	14.4
Client PCs - desktop	417	492	538	590	640	18.1	9.3	9.7	8.4
Total Client PCs	523	615	679	743	814	17.5	10.4	9.4	9.6
PC printers	100	113	121	121	117	12.8	6.6	0.5	- 3.4
Computer hardware	**1,081**	**1,185**	**1,278**	**1,388**	**1,517**	**9.7**	**7.8**	**8.6**	**9.3**
Copiers	68	69	70	70	68	1.5	2.2	- 0.1	- 3.3
Other office equipment	71	73	71	71	70	1.8	- 2.1	- 0.4	- 1.1
Office equipment	**139**	**142**	**141**	**141**	**138**	**1.6**	**0.0**	**- 0.2**	**- 2.2**
LAN hardware	41	53	67	75	81	29.0	26.3	11.9	8.0
Other data communications	26	25	26	26	26	- 4.3	3.8	1.7	1.3
Data communications hardware	**67**	**78**	**92**	**101**	**107**	**16.2**	**19.2**	**9.0**	**6.3**
IT hardware	**1,287**	**1,404**	**1,512**	**1,630**	**1,763**	**9.1**	**7.6**	**7.8**	**8.1**
Systems software	298	344	390	435	478	15.4	13.2	11.7	9.8
Application software	280	319	364	407	449	14.2	14.0	11.9	10.2
Software products	**578**	**664**	**754**	**843**	**927**	**14.8**	**13.6**	**11.8**	**10.0**
Professional services	462	499	536	574	614	8.0	7.4	7.1	6.9
Processing services	178	183	187	189	193	2.3	2.2	1.5	1.9
Network services	30	35	39	43	47	15.4	12.0	9.5	9.8
Hardware maintenance & support services	381	388	401	407	409	1.9	3.4	1.5	0.4
Services	**1,051**	**1,105**	**1,163**	**1,213**	**1,262**	**5.1**	**5.3**	**4.3**	**4.0**
Software and services	**1,629**	**1,768**	**1,917**	**2,056**	**2,189**	**8.5**	**8.4**	**7.2**	**6.5**
Total IT market	**2,916**	**3,173**	**3,429**	**3,686**	**3,952**	**8.8**	**8.1**	**7.5**	**7.2**
Switching	127	122	110	99	90	- 3.7	- 9.8	- 9.6	- 9.2
Transmission	100	106	109	114	120	6.2	2.3	4.8	5.3
Mobile communications infrastructure	39	54	63	70	79	37.4	16.7	10.5	12.5
Public network equipment	**266**	**282**	**282**	**283**	**289**	**6.1**	**- 0.2**	**0.5**	**2.0**
PABX & key systems	57	55	54	55	56	- 3.3	- 1.3	1.0	2.9
Telephone sets	76	82	82	83	83	8.1	0.4	1.0	0.5
Mobile terminal equipment	23	27	38	52	66	18.8	39.9	37.2	25.9
Other terminal equipment	65	69	75	81	87	6.3	8.7	7.1	7.5
Private network equipment	**220**	**233**	**250**	**270**	**292**	**5.8**	**7.1**	**8.4**	**8.0**
Telecom equipment	**486**	**515**	**531**	**553**	**581**	**6.0**	**3.1**	**4.2**	**4.9**
Telephone services	1,844	1,923	2,012	2,100	2,189	4.3	4.7	4.4	4.2
Mobile telephone services	124	174	230	304	384	40.0	32.0	32.1	26.3
Switched data and leased line services	375	433	514	572	643	15.5	18.8	11.3	12.4
CaTV services	104	130	163	213	279	25.0	25.2	30.9	30.8
Telecom services	**2,447**	**2,659**	**2,919**	**3,190**	**3,494**	**8.7**	**9.8**	**9.3**	**9.5**
Total telecom	**2,934**	**3,175**	**3,450**	**3,743**	**4,075**	**8.2**	**8.7**	**8.5**	**8.9**
Total ICT	**5,850**	**6,347**	**6,879**	**7,429**	**8,027**	**8.5**	**8.4**	**8.0**	**8.0**

*Table 13
Belgium/Luxembourg
ICT Market Value
(Million ECU)*

Belgium/Luxembourg	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	238	217	174	161	156	- 8.6	-20.1	- 7.3	- 2.9
Servers - medium	145	152	154	157	165	4.8	1.4	1.7	5.3
Servers - small	184	187	195	216	241	1.5	4.1	11.0	11.3
Client-Workstations	73	75	81	88	95	3.1	8.4	7.9	7.9
Client PCs - portable	125	133	175	210	253	6.3	31.6	20.5	20.4
Client PCs - desktop	448	505	601	687	778	12.6	19.0	14.4	13.3
Total Client PCs	573	638	775	897	1,031	11.2	21.6	15.7	14.9
PC printers	117	130	134	138	142	10.9	3.5	2.5	2.9
Computer hardware	**1,330**	**1,399**	**1,513**	**1,657**	**1,829**	**5.2**	**8.2**	**9.5**	**10.4**
Copiers	122	126	127	129	132	2.8	1.5	1.2	2.0
Other office equipment	118	118	117	116	116	0.1	- 1.1	- 1.0	0.1
Office equipment	**240**	**244**	**245**	**245**	**248**	**1.5**	**0.3**	**0.2**	**1.1**
LAN hardware	84	99	124	132	140	17.1	25.6	6.0	6.1
Other data communications	35	35	37	38	39	0.4	5.0	2.7	2.8
Data communications hardware	**120**	**134**	**161**	**170**	**179**	**12.2**	**20.2**	**5.3**	**5.4**
IT hardware	**1,690**	**1,777**	**1,919**	**2,071**	**2,256**	**5.1**	**8.0**	**7.9**	**8.9**
Systems software	647	672	717	766	829	3.9	6.6	6.8	8.3
Application software	548	565	595	640	696	3.0	5.3	7.7	8.7
Software products	**1,195**	**1,237**	**1,312**	**1,406**	**1,525**	**3.5**	**6.0**	**7.2**	**8.5**
Professional services	547	579	607	633	658	5.9	4.8	4.4	3.9
Processing services	321	328	335	341	348	2.3	2.0	1.9	2.0
Network services	50	54	59	64	71	7.7	9.0	9.5	9.6
Hardware maintenance & support services	578	590	616	634	663	2.1	4.4	3.0	4.6
Services	**1,495**	**1,551**	**1,616**	**1,673**	**1,739**	**3.7**	**4.2**	**3.5**	**4.0**
Software and services	**2,690**	**2,788**	**2,927**	**3,079**	**3,264**	**3.6**	**5.0**	**5.2**	**6.0**
Total IT market	**4,380**	**4,565**	**4,847**	**5,150**	**5,520**	**4.2**	**6.2**	**6.3**	**7.2**
Switching	138	128	118	109	104	- 7.1	- 7.5	- 8.1	- 4.0
Transmission	120	124	127	130	136	3.4	2.5	2.7	4.7
Mobile communications infrastructure	23	36	59	67	81	56.6	62.1	14.1	20.5
Public network equipment	**281**	**288**	**304**	**306**	**322**	**2.6**	**5.6**	**0.7**	**5.1**
PABX & key systems	66	64	63	64	64	- 2.9	- 0.6	0.5	1.2
Telephone sets	87	94	102	108	113	7.9	7.8	6.1	4.9
Mobile terminal equipment	23	39	56	77	92	69.7	41.5	37.3	19.7
Other terminal equipment	36	39	44	53	64	6.2	12.7	22.6	19.8
Private network equipment	**213**	**236**	**264**	**301**	**333**	**11.0**	**11.9**	**14.1**	**10.5**
Telecom equipment	**493**	**524**	**568**	**608**	**655**	**6.3**	**8.5**	**6.9**	**7.8**
Telephone services	2,249	2,375	2,501	2,625	2,757	5.6	5.3	5.0	5.0
Mobile telephone services	172	267	386	510	585	55.3	44.6	32.2	14.8
Switched data and leased line services	340	411	508	663	843	20.8	23.7	30.6	27.2
CaTV services	367	422	461	493	527	15.0	9.2	6.9	6.9
Telecom services	**3,128**	**3,475**	**3,856**	**4,291**	**4,713**	**11.1**	**11.0**	**11.3**	**9.8**
Total telecom	**3,621**	**3,999**	**4,424**	**4,899**	**5,367**	**10.4**	**10.6**	**10.7**	**9.6**
Total ICT	**8,002**	**8,563**	**9,271**	**10,049**	**10,888**	**7.0**	**8.3**	**8.4**	**8.3**

Table 14
Denmark
ICT Market Value
(Million ECU)

Denmark	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	151	126	103	91	76	-16.6	-18.4	-11.5	-16.6
Servers - medium	88	91	92	108	126	2.3	1.2	18.4	16.2
Servers - small	108	107	127	152	178	- 0.4	18.2	20.3	17.0
Client-Workstations	35	35	38	40	46	0.0	10.0	5.8	13.7
Client PCs - portable	112	132	149	165	183	18.2	12.6	10.8	10.8
Client PCs - desktop	471	633	734	727	720	34.6	15.8	- 0.9	- 1.0
Total Client PCs	582	766	883	892	903	31.4	15.3	1.1	1.2
PC printers	107	121	134	144	150	14.0	10.7	7.1	4.1
Computer hardware	**1,071**	**1,245**	**1,376**	**1,428**	**1,479**	**16.3**	**10.5**	**3.8**	**3.5**
Copiers	81	83	86	88	90	2.8	2.6	2.6	2.4
Other office equipment	75	75	73	73	73	- 0.4	- 2.0	- 0.1	- 0.2
Office equipment	**156**	**158**	**159**	**161**	**163**	**1.3**	**0.4**	**1.4**	**1.2**
LAN hardware	89	107	120	134	143	20.4	12.0	11.8	6.3
Other data communications	40	42	43	44	45	5.3	3.4	2.5	2.7
Data communications hardware	**129**	**149**	**163**	**179**	**188**	**15.8**	**9.6**	**9.3**	**5.4**
IT hardware	**1,356**	**1,553**	**1,698**	**1,768**	**1,830**	**14.5**	**9.4**	**4.1**	**3.5**
Systems software	278	290	305	332	364	4.3	5.1	8.9	9.6
Application software	240	257	270	293	320	7.2	5.0	8.7	9.4
Software products	**518**	**547**	**574**	**625**	**684**	**5.7**	**5.0**	**8.8**	**9.5**
Professional services	599	646	695	741	800	7.9	7.5	6.7	7.9
Processing services	516	536	554	570	586	4.0	3.3	3.0	2.7
Network services	74	82	93	105	118	11.1	12.5	13.3	12.7
Hardware maintenance & support services	280	272	269	259	261	- 2.8	- 1.3	- 3.5	0.7
Services	**1,469**	**1,537**	**1,610**	**1,676**	**1,765**	**4.6**	**4.7**	**4.1**	**5.3**
Software and services	**1,986**	**2,084**	**2,184**	**2,301**	**2,449**	**4.9**	**4.8**	**5.3**	**6.4**
Total IT market	**3,342**	**3,637**	**3,883**	**4,069**	**4,279**	**8.8**	**6.8**	**4.8**	**5.2**
Switching	105	101	98	96	96	- 3.8	- 2.7	- 2.0	0.2
Transmission	91	94	95	97	99	3.4	0.7	1.9	2.5
Mobile communications infrastructure	47	60	68	71	79	28.0	14.0	4.5	10.7
Public network equipment	**243**	**255**	**261**	**264**	**274**	**5.0**	**2.5**	**1.1**	**3.9**
PABX & key systems	42	41	40	40	40	- 2.2	- 2.2	- 0.3	1.9
Telephone sets	57	62	67	72	77	8.0	7.9	8.1	7.4
Mobile terminal equipment	71	70	65	62	60	- 1.6	- 6.3	- 5.3	- 2.5
Other terminal equipment	34	36	40	48	57	6.3	10.8	19.7	19.2
Private network equipment	**203**	**208**	**211**	**221**	**235**	**2.3**	**1.7**	**4.6**	**6.2**
Telecom equipment	**446**	**463**	**473**	**485**	**509**	**3.8**	**2.1**	**2.7**	**5.0**
Telephone services	1,466	1,502	1,544	1,593	1,646	2.4	2.8	3.2	3.4
Mobile telephone services	311	370	420	457	487	19.2	13.4	8.9	6.5
Switched data and leased line services	183	229	284	350	432	25.0	24.0	23.4	23.3
CaTV services	127	152	183	225	286	20.0	20.0	23.4	27.1
Telecom services	**2,086**	**2,253**	**2,430**	**2,625**	**2,851**	**8.0**	**7.9**	**8.0**	**8.6**
Total telecom	**2,532**	**2,715**	**2,903**	**3,111**	**3,360**	**7.2**	**6.9**	**7.2**	**8.0**
Total ICT	**5,874**	**6,352**	**6,785**	**7,180**	**7,640**	**8.1**	**6.8**	**5.8**	**6.4**

Table 15
Finland
ICT Market Value
(Million ECU)

Finland	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	30	30	39	45	52	1.5	27.3	16.9	14.0
Servers - medium	53	53	52	63	73	- 0.3	- 1.4	20.8	16.4
Servers - small	77	74	93	112	130	- 3.7	25.2	20.3	16.3
Client-Workstations	41	46	52	56	63	12.6	12.0	7.6	13.9
Client PCs - portable	66	81	95	93	98	22.8	16.8	- 1.7	5.2
Client PCs - desktop	325	433	464	503	529	33.4	7.2	8.3	5.3
Total Client PCs	391	514	559	596	627	31.6	8.7	6.6	5.3
PC printers	56	74	86	98	102	33.1	16.5	12.9	4.3
Computer hardware	**647**	**791**	**880**	**969**	**1,047**	**22.3**	**11.2**	**10.0**	**8.1**
Copiers	49	50	50	51	53	2.2	0.8	2.5	2.5
Other office equipment	47	47	46	46	46	- 0.4	- 1.3	- 0.3	0.3
Office equipment	**95**	**96**	**96**	**97**	**99**	**0.9**	**- 0.2**	**1.2**	**1.4**
LAN hardware	57	80	94	109	119	41.0	18.1	15.7	9.1
Other data communications	44	47	49	50	51	7.1	3.3	2.5	2.4
Data communications hardware	**101**	**127**	**143**	**159**	**170**	**26.2**	**12.6**	**11.2**	**7.0**
IT hardware	**843**	**1,015**	**1,120**	**1,225**	**1,316**	**20.4**	**10.3**	**9.4**	**7.4**
Systems software	161	174	191	213	239	8.3	9.4	11.7	12.4
Application software	145	154	164	180	200	6.5	6.6	9.4	11.1
Software products	**305**	**328**	**355**	**392**	**439**	**7.4**	**8.1**	**10.6**	**11.8**
Professional services	363	398	440	476	516	9.4	10.6	8.3	8.4
Processing services	231	236	241	246	253	2.0	2.5	2.1	2.8
Network services	20	23	25	27	30	11.1	10.0	9.1	10.2
Hardware maintenance & support services	172	175	178	177	179	1.8	1.7	- 0.8	1.4
Services	**787**	**831**	**884**	**927**	**979**	**5.6**	**6.4**	**4.8**	**5.6**
Software and services	**1,092**	**1,159**	**1,239**	**1,319**	**1,418**	**6.1**	**6.9**	**6.5**	**7.5**
Total IT market	**1,935**	**2,174**	**2,359**	**2,544**	**2,734**	**12.3**	**8.5**	**7.9**	**7.4**
Switching	91	88	83	83	84	- 3.8	- 5.9	0.6	1.6
Transmission	79	82	83	82	83	3.4	1.7	- 1.1	0.8
Mobile communications infrastructure	51	62	64	65	68	22.2	2.4	2.3	4.6
Public network equipment	**221**	**232**	**230**	**231**	**236**	**4.7**	**- 1.0**	**0.5**	**2.2**
PABX & key systems	49	48	46	46	47	- 2.9	- 3.0	- 1.4	1.6
Telephone sets	53	57	62	66	71	8.0	8.5	7.0	6.7
Mobile terminal equipment	98	95	98	102	106	- 3.1	2.9	4.0	4.0
Other terminal equipment	39	42	47	55	62	6.3	11.6	17.2	13.7
Private network equipment	**240**	**242**	**253**	**269**	**286**	**0.9**	**4.6**	**6.2**	**6.2**
Telecom equipment	**461**	**474**	**483**	**499**	**521**	**2.7**	**1.8**	**3.5**	**4.3**
Telephone services	944	958	980	1,007	1,034	1.5	2.3	2.7	2.7
Mobile telephone services	281	359	406	442	477	27.9	12.9	8.8	8.0
Switched data and leased line services	118	136	162	198	234	15.2	19.2	22.1	18.1
CaTV services	78	97	121	148	173	25.0	25.0	21.9	17.2
Telecom services	**1,420**	**1,550**	**1,670**	**1,795**	**1,918**	**9.2**	**7.7**	**7.5**	**6.9**
Total telecom	**1,882**	**2,025**	**2,152**	**2,294**	**2,439**	**7.6**	**6.3**	**6.6**	**6.3**
Total ICT	**3,817**	**4,199**	**4,511**	**4,839**	**5,173**	**10.0**	**7.4**	**7.3**	**6.9**

Table 16
France
ICT Market Value
(Million ECU)

France	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	877	845	789	694	655	- 3.6	- 6.7	-12.0	- 5.6
Servers - medium	939	947	967	1,143	1,316	0.9	2.1	18.2	15.1
Servers - small	921	954	985	1,108	1,259	3.5	3.3	12.5	13.6
Client-Workstations	378	385	421	457	499	1.9	9.3	8.5	9.3
Client PCs - portable	642	669	794	999	1,096	4.1	18.7	25.8	9.8
Client PCs - desktop	2,458	2,773	3,056	3,273	3,467	12.8	10.2	7.1	5.9
Total Client PCs	3,101	3,441	3,850	4,271	4,563	11.0	11.9	11.0	6.8
PC printers	599	722	742	759	778	20.5	2.7	2.4	2.5
Computer hardware	**6,815**	**7,295**	**7,753**	**8,433**	**9,071**	**7.0**	**6.3**	**8.8**	**7.6**
Copiers	737	739	740	747	758	0.2	0.2	0.9	1.5
Other office equipment	643	641	628	626	626	- 0.3	- 2.0	- 0.3	0.1
Office equipment	**1,380**	**1,379**	**1,368**	**1,372**	**1,384**	**0.0**	**-0.8**	**0.3**	**0.9**
LAN hardware	371	454	561	633	709	22.2	23.7	12.7	12.0
Other data communications	316	326	340	353	354	3.2	4.1	3.9	0.3
Data communications hardware	**687**	**780**	**901**	**985**	**1,062**	**13.5**	**15.5**	**9.4**	**7.8**
IT hardware	**8,882**	**9,454**	**10,022**	**10,791**	**11,517**	**6.4**	**6.0**	**7.7**	**6.7**
Systems software	2,042	2,262	2,503	2,790	3,095	10.8	10.6	11.5	10.9
Application software	1,663	1,832	2,022	2,193	2,384	10.2	10.3	8.5	8.7
Software products	**3,704**	**4,095**	**4,524**	**4,983**	**5,478**	**10.5**	**10.5**	**10.1**	**10.0**
Professional services	5,309	5,723	6,130	6,498	7,046	7.8	7.1	6.0	8.4
Processing services	1,636	1,662	1,685	1,721	1,764	1.6	1.3	2.2	2.5
Network services	274	300	331	361	401	9.4	10.3	9.1	11.1
Hardware maintenance & support services	3,157	3,059	3,059	3,065	3,120	-3.1	0.0	0.2	1.8
Services	**10,377**	**10,745**	**11,205**	**11,645**	**12,332**	**3.5**	**4.3**	**3.9**	**5.9**
Software and services	**14,081**	**14,839**	**15,729**	**16,627**	**17,811**	**5.4**	**6.0**	**5.7**	**7.1**
Total IT market	**22,963**	**24,294**	**25,751**	**27,418**	**29,328**	**5.8**	**6.0**	**6.5**	**7.0**
Switching	855	792	800	712	670	- 7.4	1.0	-10.9	- 5.9
Transmission	436	472	502	539	579	8.3	6.2	7.4	7.6
Mobile communications infrastructure	295	359	453	534	612	21.8	26.1	17.9	14.6
Public network equipment	**1,586**	**1,623**	**1,754**	**1,785**	**1,862**	**2.4**	**8.1**	**1.7**	**4.3**
PABX & key systems	610	598	585	575	577	- 2.0	- 2.1	- 1.8	0.4
Telephone sets	781	826	853	870	890	5.7	3.3	2.0	2.3
Mobile terminal equipment	286	412	532	643	720	44.0	28.9	20.9	12.0
Other terminal equipment	720	785	895	1,043	1,197	9.0	14.0	16.6	14.8
Private network equipment	**2,398**	**2,621**	**2,865**	**3,131**	**3,384**	**9.3**	**9.3**	**9.3**	**8.1**
Telecom equipment	**3,984**	**4,244**	**4,619**	**4,916**	**5,246**	**6.5**	**8.8**	**6.4**	**6.7**
Telephone services	15,074	15,691	16,285	16,955	17,457	4.1	3.8	4.1	3.0
Mobile telephone services	836	1,234	1,687	2,036	2,222	47.5	36.7	20.7	9.1
Switched data and leased line services	2,407	2,869	3,526	4,360	5,169	19.2	22.9	23.6	18.6
CaTV services	246	431	580	741	1,034	75.0	34.5	27.8	39.5
Telecom services	**18,564**	**20,225**	**22,078**	**24,093**	**25,882**	**8.9**	**9.2**	**9.1**	**7.4**
Total telecom	**22,548**	**24,469**	**26,698**	**29,008**	**31,128**	**8.5**	**9.1**	**8.7**	**7.3**
Total ICT	**45,511**	**48,763**	**52,449**	**56,426**	**60,456**	**7.1**	**7.6**	**7.6**	**7.1**

Table 17
Germany
ICT Market Value
(Million ECU)

Germany	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	2,771	2,577	2,197	1,985	1,872	- 7.0	-14.7	- 9.6	- 5.7
Servers - medium	1,722	1,840	1,940	1,995	2,039	6.9	5.4	2.8	2.2
Servers - small	2,251	2,528	2,879	3,133	3,361	12.3	13.9	8.8	7.3
Client-Workstations	764	917	963	992	1,022	20.0	5.0	3.0	3.0
Client PCs - portable	1,241	1,551	1,737	2,049	2,377	25.0	12.0	18.0	16.0
Client PCs - desktop	3,876	4,458	4,681	5,243	5,819	15.0	5.0	12.0	11.0
Total Client PCs	5,117	6,008	6,418	7,292	8,197	17.4	6.8	13.6	12.4
PC printers	1,484	1,736	1,858	1,987	2,130	17.0	7.0	7.0	7.2
Computer hardware	**14,108**	**15,607**	**16,256**	**17,385**	**18,621**	**10.6**	**4.2**	**6.9**	**7.1**
Copiers	1,355	1,355	1,355	1,369	1,383	0.0	0.0	1.0	1.0
Other office equipment	623	661	701	734	762	6.1	6.0	4.8	3.7
Office equipment	**1,978**	**2,016**	**2,056**	**2,103**	**2,144**	**1.9**	**2.0**	**2.3**	**2.0**
LAN hardware	601	668	760	830	936	11.1	13.8	9.1	12.9
Other data communications	215	214	210	238	259	- 0.6	- 1.9	13.2	9.0
Data communications hardware	**817**	**882**	**971**	**1,067**	**1,196**	**8.0**	**10.0**	**10.0**	**12.0**
IT hardware	**16,904**	**18,505**	**19,282**	**20,555**	**21,961**	**9.5**	**4.2**	**6.6**	**6.8**
Systems software	3,884	4,123	4,361	4,614	4,885	6.2	5.8	5.8	5.9
Application software	4,317	4,869	5,307	5,785	6,363	12.8	9.0	9.0	10.0
Software products	**8,201**	**8,992**	**9,668**	**10,398**	**11,248**	**9.6**	**7.5**	**7.6**	**8.2**
Professional services	4,660	4,937	5,271	5,671	6,162	6.0	6.8	7.6	8.7
Processing services	942	996	1,053	1,091	1,138	5.7	5.8	3.5	4.4
Network services	897	1,112	1,337	1,602	1,921	24.0	20.2	19.8	19.9
Hardware maintenance & support services	3,171	3,146	3,213	3,274	3,338	- 0.8	2.1	1.9	2.0
Services	**9,670**	**10,192**	**10,874**	**11,637**	**12,559**	**5.4**	**6.7**	**7.0**	**7.9**
Software and services	**17,871**	**19,184**	**20,541**	**22,035**	**23,807**	**7.3**	**7.1**	**7.3**	**8.0**
Total IT market	**34,775**	**37,689**	**39,824**	**42,590**	**45,768**	**8.4**	**5.7**	**6.9**	**7.5**
Switching	1,821	1,623	1,485	1,453	1,491	-10.9	- 8.5	- 2.1	2.6
Transmission	1,465	1,348	1,272	1,261	1,296	- 8.0	- 5.6	- 0.8	2.7
Mobile communications infrastructure	444	471	506	537	557	6.1	7.4	6.2	3.6
Public network equipment	**3,729**	**3,442**	**3,263**	**3,252**	**3,343**	**- 7.7**	**- 5.2**	**- 0.3**	**2.8**
PABX & key systems	845	913	944	965	984	8.1	3.4	2.2	2.0
Telephone sets	1,388	1,485	1,565	1,642	1,718	7.0	5.3	4.9	4.7
Mobile terminal equipment	404	445	463	466	470	10.0	4.0	0.8	0.8
Other terminal equipment	1,038	1,154	1,291	1,449	1,592	11.2	11.9	12.2	9.9
Private network equipment	**3,675**	**3,998**	**4,263**	**4,522**	**4,764**	**8.8**	**6.6**	**6.1**	**5.4**
Telecom equipment	**7,405**	**7,439**	**7,526**	**7,773**	**8,107**	**0.5**	**1.2**	**3.3**	**4.3**
Telephone services	23,305	24,129	25,065	25,974	26,966	3.5	3.9	3.6	3.8
Mobile telephone services	1,904	2,837	3,347	3,798	4,198	49.0	18.0	13.5	10.5
Switched data and leased line services	2,898	4,037	4,556	4,985	5,414	39.3	12.9	9.4	8.6
CaTV services	1,195	1,478	1,575	1,745	2,082	23.6	6.6	10.8	19.3
Telecom services	**29,302**	**32,480**	**34,544**	**36,502**	**38,660**	**10.8**	**6.4**	**5.7**	**5.9**
Total telecom	**36,706**	**39,920**	**42,070**	**44,275**	**46,767**	**8.8**	**5.4**	**5.2**	**5.6**
Total ICT	**71,481**	**77,608**	**81,894**	**86,866**	**92,535**	**8.6**	**5.5**	**6.1**	**6.5**

Table 18
Greece
ICT Market Value
(Million ECU)

Greece	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	11	10	11	11	10	- 3.0	4.0	- 1.3	- 2.0
Servers - medium	20	21	23	26	29	8.8	6.4	15.8	9.8
Servers - small	27	28	34	39	44	3.5	22.6	14.5	12.7
Client-Workstations	10	11	13	16	19	17.0	19.5	21.0	19.3
Client PCs - portable	10	12	15	17	21	15.6	22.0	19.6	19.6
Client PCs - desktop	74	78	85	94	104	5.3	8.8	10.6	10.6
Total Client PCs	85	90	100	112	125	6.5	10.5	11.9	12.0
PC printers	40	49	56	62	71	22.3	14.0	11.7	14.3
Computer hardware	**191**	**210**	**236**	**266**	**299**	**9.6**	**12.7**	**12.5**	**12.3**
Copiers	40	41	42	43	44	3.5	2.5	2.5	2.9
Other office equipment	43	44	44	45	46	1.6	1.3	1.1	2.1
Office equipment	**83**	**85**	**86**	**88**	**90**	**2.5**	**1.9**	**1.8**	**2.5**
LAN hardware	9	11	12	14	15	18.1	16.6	11.6	9.1
Other data communications	9	10	12	14	15	16.7	17.1	12.2	10.9
Data communications hardware	**18**	**21**	**25**	**28**	**30**	**17.4**	**16.8**	**11.9**	**10.0**
IT hardware	**292**	**316**	**347**	**381**	**419**	**8.1**	**10.1**	**9.8**	**9.9**
Systems software	20	24	29	36	44	18.7	19.6	26.9	20.6
Application software	49	61	70	86	105	23.8	15.3	23.0	22.2
Software products	**69**	**85**	**99**	**123**	**149**	**22.3**	**16.5**	**24.1**	**21.7**
Professional services	58	68	80	96	119	17.9	16.8	20.3	23.6
Processing services	14	16	18	20	22	17.1	12.1	11.5	13.3
Network services	1	1	2	2	3	30.0	61.5	33.3	25.0
Hardware maintenance & support services	33·	35	38	41	45	5.2	9.1	8.8	10.3
Services	**105**	**120**	**137**	**159**	**189**	**13.9**	**14.3**	**16.1**	**18.9**
Software and services	**174**	**205**	**236**	**282**	**338**	**17.2**	**15.2**	**19.5**	**20.1**
Total IT market	**467**	**520**	**583**	**663**	**757**	**11.5**	**12.1**	**13.7**	**14.2**
Switching	93	90	86	86	88	- 3.8	- 3.8	- 0.3	2.6
Transmission	81	84	84	86	88	3.4	0.5	2.0	2.3
Mobile communications infrastructure	46	50	59	68	79	9.5	18.1	14.1	16.8
Public network equipment	**220**	**223**	**230**	**239**	**255**	**1.6**	**2.7**	**4.3**	**6.5**
PABX & key systems	22	22	22	23	23	0.0	1.0	1.4	3.4
Telephone sets	51	55	59	65	70	8.0	7.8	9.6	8.2
Mobile terminal equipment	16	20	23	25	25	28.0	14.4	6.0	3.4
Other terminal equipment	30	32	35	43	50	6.3	10.8	21.6	15.8
Private network equipment	**119**	**129**	**140**	**155**	**169**	**8.7**	**8.4**	**10.7**	**8.9**
Telecom equipment	**339**	**352**	**369**	**394**	**424**	**4.1**	**4.8**	**6.7**	**7.4**
Telephone services	1,468	1,567	1,669	1,777	1,889	6.8	6.5	6.5	6.3
Mobile telephone services	93	217	310	424	501	132.5	43.4	36.6	18.0
Switched data and leased line services	28	33	37	42	47	16.2	14.0	12.2	12.7
CaTV services	0	0	0	0	5	–	–	–	–
Telecom services	**1,589**	**1,817**	**2,017**	**2,243**	**2,441**	**14.3**	**11.0**	**11.2**	**8.8**
Total telecom	**1,927**	**2,169**	**2,386**	**2,637**	**2,864**	**12.5**	**10.0**	**10.5**	**8.6**
Total ICT	**2,394**	**2,689**	**2,969**	**3,300**	**3,621**	**12.3**	**10.4**	**11.2**	**9.7**

Table 19
Ireland
ICT Market Value
(Million ECU)

Ireland	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	20	19	21	23	22	- 6.2	11.7	8.0	- 2.6
Servers - medium	27	28	30	32	35	3.4	6.4	7.6	10.3
Servers - small	41	45	46	49	52	8.9	2.9	5.4	6.7
Client-Workstations	7	7	8	9	10	1.0	12.4	11.1	8.0
Client PCs - portable	24	29	32	36	40	19.5	10.7	11.7	11.7
Client PCs - desktop	122	131	140	144	149	7.1	6.6	3.3	3.0
Total Client PCs	147	160	172	180	189	9.1	7.3	4.9	4.7
PC printers	28	31	31	33	36	8.9	2.0	6.8	6.3
Computer hardware	**271**	**290**	**308**	**326**	**344**	**7.2**	**6.4**	**5.8**	**5.3**
Copiers	63	64	64	62	63	1.4	0.2	- 2.9	2.1
Other office equipment	63	63	62	61	61	- 0.5	- 2.0	- 1.0	- 0.5
Office equipment	**126**	**127**	**126**	**123**	**124**	**0.4**	**- 0.9**	**- 2.0**	**0.8**
LAN hardware	11	12	14	16	18	12.0	16.8	14.6	14.4
Other data communications	9	10	11	12	14	14.3	5.5	12.2	14.7
Data communications hardware	**20**	**22**	**25**	**28**	**32**	**13.1**	**11.5**	**13.6**	**14.5**
IT hardware	**416**	**439**	**459**	**478**	**500**	**5.4**	**4.6**	**4.1**	**4.7**
Systems software	65	73	80	87	93	11.8	9.4	8.8	7.2
Application software	53	59	64	69	73	12.0	8.6	7.7	6.6
Software products	**118**	**132**	**143**	**155**	**166**	**11.9**	**9.0**	**8.3**	**7.0**
Professional services	79	86	95	103	112	8.6	9.8	8.5	8.6
Processing services	31	32	32	33	33	2.8	1.8	2.0	2.0
Network services	9	11	14	17	20	26.0	26.7	21.1	17.4
Hardware maintenance & support services	70	72	72	72	76	3.0	0.5	0.0	4.9
Services	**189**	**201**	**213**	**225**	**241**	**6.4**	**6.2**	**5.5**	**7.1**
Software and services	**306**	**333**	**357**	**380**	**407**	**8.5**	**7.3**	**6.6**	**7.1**
Total IT market	**723**	**771**	**816**	**858**	**907**	**6.7**	**5.7**	**5.2**	**5.7**
Switching	78	75	75	77	79	- 3.8	0.5	2.2	3.0
Transmission	67	70	69	72	76	3.4	- 0.4	3.6	5.8
Mobile communications infrastructure	23	24	30	34	37	7.7	25.6	12.8	9.0
Public network equipment	**167**	**168**	**175**	**183**	**192**	**0.6**	**3.7**	**4.6**	**5.2**
PABX & key systems	26	25	25	25	25	- 1.8	- 1.5	- 0.3	0.3
Telephone sets	42	46	49	53	58	8.0	7.3	8.2	8.8
Mobile terminal equipment	13	15	20	22	24	20.0	28.5	12.3	10.6
Other terminal equipment	25	27	30	35	40	6.3	11.4	18.4	13.3
Private network equipment	**106**	**113**	**123**	**135**	**147**	**6.6**	**9.2**	**9.6**	**8.7**
Telecom equipment	**273**	**281**	**298**	**318**	**339**	**2.9**	**5.9**	**6.7**	**6.7**
Telephone services	1,008	1,088	1,153	1,216	1,289	7.9	6.0	5.5	5.9
Mobile telephone services	64	113	164	201	242	76.8	45.5	22.7	20.1
Switched data and leased line services	58	68	84	107	133	16.7	23.0	27.4	24.7
CaTV services	30	38	49	61	73	25.0	30.0	25.0	19.1
Telecom services	**1,160**	**1,306**	**1,450**	**1,585**	**1,736**	**12.6**	**11.0**	**9.3**	**9.5**
Total telecom	**1,433**	**1,587**	**1,748**	**1,903**	**2,075**	**10.8**	**10.1**	**8.9**	**9.0**
Total ICT	**2,156**	**2,359**	**2,563**	**2,761**	**2,982**	**9.4**	**8.7**	**7.7**	**8.0**

Table 20
Italy
ICT Market Value
(Million ECU)

Italy	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	670	572	505	454	410	-14.7	-11.7	-10.0	- 9.6
Servers - medium	341	351	356	378	409	2.9	1.5	6.0	8.4
Servers - small	630	679	723	760	818	7.8	6.5	5.0	7.6
Client-Workstations	259	272	299	328	350	5.0	9.8	9.8	6.8
Client PCs - portable	225	287	330	372	429	27.7	15.0	12.6	15.3
Client PCs - desktop	1,110	1,290	1,355	1,478	1,597	16.2	5.1	9.0	8.1
Total Client PCs	1,335	1,577	1,685	1,849	2,026	18.1	6.9	9.7	9.5
PC printers	406	438	439	443	451	8.0	0.0	0.9	2.0
Computer hardware	**3,641**	**3,889**	**4,007**	**4,211**	**4,465**	**6.8**	**3.0**	**5.1**	**6.0**
Copiers	367	404	420	428	443	10.0	4.0	1.9	3.5
Other office equipment	326	310	291	283	273	- 5.0	- 6.0	- 2.8	- 3.5
Office equipment	**693**	**713**	**711**	**710**	**715**	**2.9**	**- 0.3**	**0.0**	**0.7**
LAN hardware	122	149	179	197	208	22.0	20.0	10.5	5.6
Other data communications	78	80	84	88	89	2.0	5.3	4.5	1.2
Data communications hardware	**200**	**228**	**262**	**285**	**297**	**14.2**	**14.9**	**8.5**	**4.3**
IT hardware	**4,534**	**4,830**	**4,980**	**5,207**	**5,477**	**6.5**	**3.1**	**4.6**	**5.2**
Systems software	1,220	1,265	1,341	1,475	1,626	3.7	6.0	10.0	10.2
Application software	975	1,022	1,078	1,157	1,254	4.8	5.5	7.4	8.4
Software products	**2,195**	**2,286**	**2,419**	**2,631**	**2,880**	**4.2**	**5.8**	**8.8**	**9.4**
Professional services	2,344	2,484	2,638	2,843	3,075	6.0	6.2	7.8	8.2
Processing services	626	634	641	650	660	1.3	1.1	1.4	1.5
Network services	336	371	405	449	498	10.5	9.0	10.9	11.0
Hardware maintenance & support services	1,445	1,437	1,437	1,447	1,465	- 0.5	0.0	0.7	1.3
Services	**4,751**	**4,926**	**5,121**	**5,389**	**5,698**	**3.7**	**4.0**	**5.2**	**5.8**
Software and services	**6,946**	**7,213**	**7,540**	**8,020**	**8,578**	**3.8**	**4.5**	**6.4**	**7.0**
Total IT market	**11,480**	**12,043**	**12,520**	**13,227**	**14,055**	**4.9**	**4.0**	**5.6**	**6.3**
Switching	837	803	793	766	776	- 4.1	- 1.3	- 3.4	1.3
Transmission	502	489	491	507	526	- 2.8	0.6	3.2	3.8
Mobile communications infrastructure	218	398	480	520	548	82.6	20.6	8.4	5.3
Public network equipment	**1,558**	**1,690**	**1,765**	**1,794**	**1,851**	**8.5**	**4.4**	**1.6**	**3.2**
PABX & key systems	233	222	216	212	212	- 4.7	- 2.7	- 1.6	0.0
Telephone sets	427	452	473	499	524	5.8	4.6	5.5	5.0
Mobile terminal equipment	409	474	503	526	550	16.0	6.1	4.4	4.7
Other terminal equipment	386	411	441	477	515	6.4	7.4	8.2	8.0
Private network equipment	**1,455**	**1,559**	**1,633**	**1,714**	**1,802**	**7.2**	**4.8**	**4.9**	**5.1**
Telecom equipment	**3,013**	**3,249**	**3,398**	**3,508**	**3,652**	**7.8**	**4.6**	**3.2**	**4.1**
Telephone services	12,398	12,512	12,998	13,356	13,740	0.9	3.9	2.8	2.9
Mobile telephone services	1,254	2,132	3,032	3,811	4,332	70.0	42.2	25.7	13.7
Switched data and leased line services	832	1,007	1,240	1,533	1,833	21.0	23.2	23.6	19.6
CaTV services	5	12	36	185	328	150.0	200.0	416.5	77.1
Telecom services	**14,489**	**15,663**	**17,306**	**18,884**	**20,232**	**8.1**	**10.5**	**9.1**	**7.1**
Total telecom	**17,502**	**18,911**	**20,704**	**22,392**	**23,885**	**8.1**	**9.5**	**8.2**	**6.7**
Total ICT	**28,982**	**30,954**	**33,224**	**35,619**	**37,940**	**6.8**	**7.3**	**7.2**	**6.5**

Table 21
Netherlands
ICT Market Value
(Million ECU)

Netherlands	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	246	214	163	135	115	-12.9	-23.9	-16.9	-15.1
Servers - medium	265	264	266	298	330	- 0.6	0.9	12.1	10.5
Servers - small	292	288	315	346	392	- 1.6	9.6	9.8	13.3
Client-Workstations	98	106	119	137	151	7.4	13.0	15.0	9.9
Client PCs - portable	207	261	336	410	466	26.1	28.6	22.2	13.6
Client PCs - desktop	950	1,166	1,309	1,375	1,433	22.8	12.3	5.1	4.2
Total Client PCs	1,157	1,427	1,645	1,786	1,900	23.4	15.3	8.6	6.4
PC printers	231	258	279	292	302	11.7	8.0	4.7	3.3
Computer hardware	**2,289**	**2,556**	**2,787**	**2,995**	**3,189**	**11.7**	**9.0**	**7.4**	**6.5**
Copiers	309	314	313	311	319	1.7	- 0.5	- 0.5	2.4
Other office equipment	271	270	266	262	263	- 0.1	- 1.7	- 1.3	0.4
Office equipment	**580**	**585**	**579**	**573**	**582**	**0.8**	**- 1.0**	**- 0.9**	**1.5**
LAN hardware	180	228	269	297	315	26.6	18.1	10.4	5.9
Other data communications	73	76	80	85	89	3.7	6.2	5.2	4.9
Data communications hardware	**253**	**304**	**350**	**382**	**403**	**20.0**	**15.2**	**9.2**	**5.6**
IT hardware	**3,122**	**3,445**	**3,715**	**3,950**	**4,174**	**10.3**	**7.9**	**6.3**	**5.7**
Systems software	807	885	994	1,105	1,235	9.6	12.3	11.1	11.7
Application software	864	956	1,071	1,184	1,307	10.6	12.1	10.6	10.4
Software products	**1,672**	**1,841**	**2,065**	**2,289**	**2,541**	**10.1**	**12.2**	**10.8**	**11.0**
Professional services	1,193	1,310	1,420	1,568	1,731	9.8	8.4	10.5	10.4
Processing services	556	559	566	575	584	0.4	1.3	1.6	1.6
Network services	67	73	79	85	91	9.1	8.3	7.7	7.1
Hardware maintenance & support services	869	847	854	860	881	- 2.5	0.9	0.7	2.4
Services	**2,685**	**2,789**	**2,919**	**3,089**	**3,287**	**3.8**	**4.7**	**5.8**	**6.4**
Software and services	**4,357**	**4,630**	**4,984**	**5,378**	**5,829**	**6.2**	**7.7**	**7.9**	**8.4**
Total IT market	**7,479**	**8,074**	**8,700**	**9,328**	**10,003**	**8.0**	**7.7**	**7.2**	**7.2**
Switching	238	236	235	230	227	- 0.7	- 0.6	- 2.2	- 1.0
Transmission	146	158	162	167	179	7.9	2.6	3.2	6.9
Mobile communications infrastructure	43	74	76	78	84	74.3	2.3	3.0	7.1
Public network equipment	**427**	**469**	**473**	**475**	**490**	**9.7**	**0.9**	**0.5**	**3.1**
PABX & key systems	206	208	210	213	216	0.9	0.9	1.5	1.4
Telephone sets	163	178	194	209	224	9.3	9.1	7.7	7.2
Mobile terminal equipment	142	193	229	236	244	36.0	18.1	3.3	3.2
Other terminal equipment	140	163	201	245	283	16.8	23.2	21.7	15.4
Private network equipment	**651**	**743**	**834**	**903**	**967**	**14.1**	**12.3**	**8.3**	**7.0**
Telecom equipment	**1,078**	**1,212**	**1,307**	**1,379**	**1,457**	**12.4**	**7.9**	**5.5**	**5.7**
Telephone services	4,172	4,338	4,485	4,624	4,758	4.0	3.4	3.1	2.9
Mobile telephone services	417	636	792	886	960	52.3	24.5	11.9	8.3
Switched data and leased line services	520	578	701	897	1,121	11.2	21.4	27.9	24.9
CaTV services	522	600	640	681	726	15.0	6.7	6.4	6.6
Telecom services	**5,631**	**6,151**	**6,618**	**7,089**	**7,564**	**9.2**	**7.6**	**7.1**	**6.7**
Total telecom	**6,709**	**7,363**	**7,925**	**8,467**	**9,021**	**9.7**	**7.6**	**6.8**	**6.5**
Total ICT	**14,188**	**15,437**	**16,625**	**17,795**	**19,024**	**8.8**	**7.7**	**7.0**	**6.9**

Norway	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	32	31	37	40	41	- 2.2	17.6	9.6	2.8
Servers - medium	56	55	54	58	66	- 0.8	- 2.7	9.0	12.4
Servers - small	104	97	109	119	132	- 6.7	12.6	9.4	10.9
Client-Workstations	51	51	53	57	62	0.3	5.1	5.9	9.1
Client PCs - portable	101	117	141	165	197	16.2	20.4	16.5	19.4
Client PCs - desktop	385	509	554	570	570	32.1	8.9	2.9	0.1
Total Client PCs	486	627	696	735	767	28.8	11.0	5.6	4.4
PC printers	71	88	102	107	110	24.5	15.5	4.9	2.7
Computer hardware	**799**	**948**	**1,050**	**1,115**	**1,177**	**18.7**	**10.7**	**6.3**	**5.5**
Copiers	55	51	51	53	54	- 6.8	0.3	2.6	3.0
Other office equipment	58	56	55	56	57	- 2.8	- 1.6	0.3	2.6
Office equipment	**113**	**107**	**107**	**108**	**111**	**- 4.7**	**- 0.7**	**1.4**	**2.8**
LAN hardware	65	98	110	127	138	49.2	12.9	15.3	8.5
Other data communications	38	41	42	44	45	5.7	4.7	2.5	2.7
Data communications hardware	**104**	**138**	**153**	**171**	**183**	**33.1**	**10.5**	**11.7**	**7.0**
IT hardware	**1,015**	**1,194**	**1,309**	**1,394**	**1,471**	**17.6**	**9.7**	**6.5**	**5.5**
Systems software	210	223	239	258	281	6.3	6.9	7.9	9.3
Application software	192	201	214	230	248	4.5	6.2	7.9	7.7
Software products	**403**	**425**	**452**	**488**	**529**	**5.4**	**6.6**	**7.9**	**8.5**
Professional services	470	505	538	579	631	7.3	6.6	7.8	8.9
Processing services	381	389	395	404	413	2.1	1.7	2.1	2.3
Network services	56	70	84	99	114	23.8	21.2	17.5	14.9
Hardware maintenance & support services	240	240	250	259	266	- 0.1	4.2	3.3	3.0
Services	**1,148**	**1,203**	**1,268**	**1,341**	**1,425**	**4.8**	**5.4**	**5.8**	**6.2**
Software and services	**1,551**	**1,628**	**1,720**	**1,829**	**1,954**	**5.0**	**5.7**	**6.3**	**6.8**
Total IT market	**2,566**	**2,822**	**3,029**	**3,223**	**3,425**	**10.0**	**7.4**	**6.4**	**6.3**
Switching	112	107	102	97	93	- 3.8	- 5.3	- 5.1	- 3.5
Transmission	97	100	100	105	113	3.4	- 0.4	5.2	7.6
Mobile communications infrastructure	44	47	49	51	58	8.5	3.3	4.7	14.2
Public network equipment	**252**	**255**	**250**	**253**	**265**	**1.1**	**- 1.8**	**0.9**	**4.7**
PABX & key systems	32	31	30	30	30	- 2.0	- 2.0	- 1.3	0.2
Telephone sets	61	66	71	77	81	8.0	8.8	7.5	6.0
Mobile terminal equipment	117	105	91	79	75	-10.4	-13.0	-13.1	-5.8
Other terminal equipment	45	48	55	68	83	6.3	14.1	23.9	22.8
Private network equipment	**255**	**250**	**248**	**254**	**269**	**- 2.0**	**- 0.7**	**2.4**	**6.1**
Telecom equipment	**507**	**505**	**498**	**507**	**534**	**- 0.5**	**- 1.2**	**1.7**	**5.4**
Telephone services	1,291	1,312	1,347	1,381	1,419	1.6	2.6	2.6	2.7
Mobile telephone services	264	382	472	519	554	44.6	23.4	10.1	6.7
Switched data and leased line services	78	112	157	203	243	43.1	40.7	28.9	19.8
CaTV services	41	45	54	67	83	10.0	18.3	26.1	22.8
Telecom services	**1,675**	**1,851**	**2,029**	**2,171**	**2,299**	**10.5**	**9.6**	**7.0**	**5.9**
Total telecom	**2,182**	**2,356**	**2,527**	**2,678**	**2,833**	**8.0**	**7.3**	**5.9**	**5.8**
Total ICT	**4,748**	**5,177**	**5,556**	**5,901**	**6,258**	**9.1**	**7.3**	**6.2**	**6.1**

Table 22
Norway
ICT Market Value
(Million ECU)

Table 23
Portugal
ICT Market Value
(Million ECU)

Portugal	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	44	46	42	40	44	3.8	- 7.8	- 4.8	9.0
Servers - medium	57	58	61	67	72	3.0	4.6	9.0	8.3
Servers - small	91	97	113	121	131	6.5	15.5	7.9	8.0
Client-Workstations	14	15	18	20	23	8.3	18.9	12.4	12.8
Client PCs - portable	10	13	15	18	21	22.0	18.6	17.7	17.0
Client PCs - desktop	151	167	183	198	214	10.9	9.3	8.6	8.0
Total Client PCs	161	180	198	216	235	11.6	10.0	9.3	8.7
PC printers	20	22	23	24	25	10.6	5.2	3.6	3.1
Computer hardware	**387**	**418**	**454**	**488**	**529**	**8.1**	**8.6**	**7.4**	**8.4**
Copiers	49	51	52	53	54	2.8	2.3	2.0	2.0
Other office equipment	51	52	53	53	54	2.6	1.0	1.0	1.0
Office equipment	**100**	**103**	**104**	**106**	**107**	**2.7**	**1.6**	**1.5**	**1.5**
LAN hardware	11	12	12	13	13	4.3	3.2	3.1	3.3
Other data communications	15	16	16	17	17	3.3	3.2	3.2	3.0
Data communications hardware	**27**	**28**	**29**	**29**	**30**	**3.7**	**3.2**	**3.1**	**3.1**
IT hardware	**514**	**549**	**587**	**623**	**667**	**6.8**	**7.0**	**6.2**	**7.0**
Systems software	68	72	77	84	93	6.0	6.6	9.2	11.6
Application software	56	60	66	75	85	7.0	10.2	13.7	12.6
Software products	**124**	**132**	**143**	**159**	**178**	**6.5**	**8.2**	**11.3**	**12.0**
Professional services	71	76	87	97	111	7.8	14.5	11.5	14.2
Processing services	30	32	33	34	35	4.2	3.7	3.6	3.5
Network services	2	3	3	4	5	14.8	19.4	18.9	22.7
Hardware maintenance & support services	76	78	81	84	87	3.1	4.2	3.4	4.0
Services	**179**	**188**	**204**	**219**	**238**	**5.3**	**8.5**	**7.2**	**8.8**
Software and services	**303**	**320**	**347**	**378**	**416**	**5.8**	**8.4**	**8.8**	**10.1**
Total IT market	**816**	**869**	**934**	**1,001**	**1,083**	**6.4**	**7.5**	**7.2**	**8.2**
Switching	111	107	133	108	111	- 3.8	24.4	-19.0	2.6
Transmission	97	98	101	106	115	1.5	3.3	4.5	9.0
Mobile communications infrastructure	71	73	75	77	81	3.2	2.1	3.1	5.6
Public network equipment	**279**	**278**	**309**	**291**	**307**	**- 0.2**	**11.1**	**- 6.0**	**5.7**
PABX & key systems	46	47	48	49	51	1.9	1.9	2.0	3.3
Telephone sets	64	69	76	82	89	8.0	9.0	8.1	8.4
Mobile terminal equipment	6	9	13	15	16	44.0	42.7	11.6	6.2
Other terminal equipment	45	48	53	64	76	6.3	11.3	21.1	17.8
Private network equipment	**162**	**174**	**190**	**210**	**231**	**7.2**	**9.5**	**10.4**	**9.9**
Telecom equipment	**441**	**452**	**499**	**501**	**538**	**2.5**	**10.5**	**0.3**	**7.5**
Telephone services	1,406	1,528	1,666	1,804	1,955	8.7	9.1	8.3	8.4
Mobile telephone services	115	256	383	490	577	123.3	49.6	27.7	17.8
Switched data and leased line services	152	173	206	255	298	14.2	18.7	23.8	16.8
CaTV services	0	0	0	2	4	0	0	0	66.7
Telecom services	**1,672**	**1,957**	**2,255**	**2,550**	**2,833**	**17.0**	**15.2**	**13.1**	**11.1**
Total telecom	**2,113**	**2,409**	**2,754**	**3,051**	**3,372**	**14.0**	**14.3**	**10.8**	**10.5**
Total ICT	**2,930**	**3,278**	**3,689**	**4,052**	**4,455**	**11.9**	**12.5**	**9.9**	**9.9**

Spain	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	264	242	186	160	154	- 8.5	-23.0	-13.8	- 3.9
Servers - medium	212	233	254	280	304	9.9	8.7	10.2	8.8
Servers - small	337	345	389	430	488	2.6	12.5	10.6	13.6
Client-Workstations	103	111	124	139	158	7.6	12.1	12.1	13.5
Client PCs - portable	100	134	165	184	193	33.9	23.2	11.3	4.8
Client PCs - desktop	663	716	832	964	1,113	8.0	16.2	15.8	15.5
Total Client PCs	763	850	997	1,147	1,305	11.4	17.3	15.0	13.8
PC printers	211	256	266	262	258	21.4	4.0	- 1.7	- 1.3
Computer hardware	**1,890**	**2,038**	**2,216**	**2,418**	**2,668**	**7.8**	**8.8**	**9.1**	**10.4**
Copiers	235	240	238	237	234	1.9	- 0.6	- 0.8	- 0.9
Other office equipment	225	225	219	215	211	0.0	- 2.4	- 2.1	- 1.8
Office equipment	**460**	**465**	**458**	**451**	**445**	**1.0**	**- 1.5**	**- 1.4**	**- 1.3**
LAN hardware	89	123	159	170	174	37.1	29.5	7.0	2.2
Other data communications	60	61	66	67	69	2.4	8.1	2.0	2.1
Data communications hardware	**149**	**184**	**225**	**237**	**242**	**23.2**	**22.4**	**5.5**	**2.2**
IT hardware	**2,500**	**2,686**	**2,899**	**3,106**	**3,356**	**7.5**	**7.9**	**7.2**	**8.0**
Systems software	340	403	455	511	578	18.3	13.0	12.2	13.3
Application software	488	585	668	753	845	19.9	14.2	12.7	12.2
Software products	**829**	**988**	**1,123**	**1,264**	**1,423**	**19.2**	**13.7**	**12.5**	**12.6**
Professional services	601	642	688	747	815	6.9	7.1	8.6	9.1
Processing services	141	136	134	139	144	- 3.8	- 1.1	3.4	3.7
Network services	31	36	41	47	53	15.8	13.6	14.4	12.6
Hardware maintenance & support services	651	667	694	727	756	2.4	4.1	4.7	4.1
Services	**1,424**	**1,481**	**1,557**	**1,659**	**1,768**	**4.0**	**5.1**	**6.6**	**6.5**
Software and services	**2,253**	**2,469**	**2,681**	**2,923**	**3,191**	**9.6**	**8.6**	**9.0**	**9.2**
Total IT market	**4,753**	**5,155**	**5,579**	**6,029**	**6,547**	**8.5**	**8.2**	**8.1**	**8.6**
Switching	507	403	341	328	327	-20.6	-15.4	- 3.8	- 0.5
Transmission	265	275	278	286	298	3.7	1.3	2.9	4.1
Mobile communications infrastructure	88	248	281	297	313	182.7	13.5	5.7	5.2
Public network equipment	**860**	**926**	**901**	**912**	**938**	**7.7**	**- 2.7**	**1.2**	**2.8**
PABX & key systems	190	187	231	184	184	- 1.7	23.5	-20.5	0.1
Telephone sets	208	215	226	241	256	3.3	5.3	6.2	6.5
Mobile terminal equipment	62	80	112	142	173	28.0	40.3	26.3	22.0
Other terminal equipment	107	118	140	166	197	10.2	18.6	18.4	18.8
Private network equipment	**568**	**600**	**710**	**732**	**810**	**5.7**	**18.3**	**3.1**	**10.7**
Telecom equipment	**1,428**	**1,526**	**1,611**	**1,644**	**1,748**	**6.9**	**5.6**	**2.1**	**6.3**
Telephone services	7,316	7,678	8,060	8,452	8,864	4.9	5.0	4.9	4.9
Mobile telephone services	251	502	817	1,129	1,389	100.3	62.7	38.2	23.0
Switched data and leased line services	581	660	761	917	1,084	13.6	15.2	20.6	18.2
CaTV services	14	24	45	87	157	75.0	86.0	91.5	80.9
Telecom services	**8,162**	**8,864**	**9,682**	**10,585**	**11,493**	**8.6**	**9.2**	**9.3**	**8.6**
Total telecom	**9,590**	**10,390**	**11,293**	**12,229**	**13,241**	**8.3**	**8.7**	**8.3**	**8.3**
Total ICT	**14,343**	**15,545**	**16,873**	**18,258**	**19,787**	**8.4**	**8.5**	**8.2**	**8.4**

Table 24
Spain
ICT Market Value
(Million ECU)

Table 25
Sweden
ICT Market Value
(Million ECU)

Sweden	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	99	89	78	77	75	- 9.6	-11.9	- 1.9	- 3.2
Servers - medium	121	128	141	163	184	5.6	10.0	15.8	12.9
Servers - small	171	166	183	212	239	- 2.6	10.3	15.6	12.7
Client-Workstations	138	150	160	168	182	8.9	6.5	5.0	8.9
Client PCs - portable	200	272	317	333	362	36.2	16.6	4.8	8.9
Client PCs - desktop	626	856	913	896	894	36.9	6.6	- 1.8	- 0.3
Total Client PCs	825	1,129	1,230	1,229	1,256	36.7	9.0	- 0.1	2.2
PC printers	144	176	204	219	225	22.2	16.2	7.1	3.0
Computer hardware	**1,497**	**1,837**	**1,996**	**2,067**	**2,161**	**22.7**	**8.7**	**3.5**	**4.5**
Copiers	103	105	104	103	101	1.4	- 1.0	- 0.4	- 1.8
Other office equipment	105	104	100	99	99	- 1.4	- 3.2	- 1.2	0.3
Office equipment	**208**	**208**	**204**	**202**	**201**	**0.0**	**- 2.1**	**- 0.8**	**- 0.8**
LAN hardware	144	177	206	226	232	23.1	16.4	9.3	2.9
Other data communications	64	67	71	74	76	4.9	6.4	4.4	1.7
Data communications hardware	**208**	**244**	**277**	**300**	**308**	**17.5**	**13.7**	**8.0**	**2.6**
IT hardware	**1,913**	**2,290**	**2,478**	**2,569**	**2,669**	**19.7**	**8.2**	**3.7**	**3.9**
Systems software	359	389	414	450	488	8.5	6.4	8.7	8.5
Application software	359	392	426	465	505	9.1	8.7	9.2	8.6
Software products	**718**	**781**	**839**	**915**	**992**	**8.8**	**7.5**	**8.9**	**8.5**
Professional services	1,317	1,458	1,588	1,736	1,899	10.7	8.9	9.3	9.4
Processing services	480	482	485	488	492	0.2	0.7	0.7	0.8
Network services	62	67	72	77	82	7.1	8.0	6.2	7.0
Hardware maintenance & support services	467	468	476	468	468	0.4	1.6	- 1.7	0.0
Services	**2,327**	**2,475**	**2,621**	**2,769**	**2,941**	**6.4**	**5.9**	**5.7**	**6.2**
Software and services	**3,044**	**3,256**	**3,461**	**3,684**	**3,934**	**6.9**	**6.3**	**6.5**	**6.8**
Total IT market	**4,957**	**5,545**	**5,938**	**6,253**	**6,603**	**11.9**	**7.1**	**5.3**	**5.6**
Switching	192	177	175	177	179	- 8.1	- 1.1	1.2	1.4
Transmission	159	162	164	171	183	1.9	1.1	4.3	6.6
Mobile communications infrastructure	81	82	83	84	85	2.1	1.0	1.0	1.5
Public network equipment	**432**	**422**	**422**	**432**	**447**	**- 2.5**	**0.1**	**2.4**	**3.5**
PABX & key systems	135	129	123	120	119	- 4.2	- 4.4	- 2.7	- 0.7
Telephone sets	157	165	193	182	191	5.5	16.8	- 5.8	5.1
Mobile terminal equipment	181	242	242	234	231	33.6	0.0	- 3.2	- 1.4
Other terminal equipment	134	149	170	189	214	11.6	13.8	11.1	13.3
Private network equipment	**606**	**686**	**728**	**725**	**755**	**13.1**	**6.2**	**- 0.5**	**4.1**
Telecom equipment	**1,038**	**1,107**	**1,150**	**1,157**	**1,202**	**6.6**	**3.9**	**0.6**	**3.9**
Telephone services	2,381	2,444	2,511	2,567	2,629	2.6	2.7	2.2	2.4
Mobile telephone services	810	1,069	1,164	1,233	1,296	32.0	8.8	6.0	5.1
Switched data and leased line services	216	269	371	498	619	24.3	37.9	34.2	24.3
CaTV services	214	250	301	370	470	17.0	20.0	23.0	27.1
Telecom services	**3,622**	**4,033**	**4,346**	**4,667**	**5,013**	**11.3**	**7.8**	**7.4**	**7.4**
Total telecom	**4,661**	**5,140**	**5,496**	**5,824**	**6,215**	**10.3**	**6.9**	**6.0**	**6.7**
Total ICT	**9,618**	**10,685**	**11,435**	**12,077**	**12,818**	**11.1**	**7.0**	**5.6**	**6.1**

Table 26
Switzerland
ICT Market Value
(Million ECU)

Switzerland	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	210	188	171	148	134	-10.2	- 9.2	-13.5	- 9.6
Servers - medium	158	169	175	195	217	6.5	3.9	11.4	11.0
Servers - small	262	263	282	313	341	0.2	7.6	10.9	9.0
Client-Workstations	146	162	187	208	225	11.6	14.9	11.4	8.2
Client PCs - portable	253	322	334	369	392	27.2	3.8	10.5	6.1
Client PCs - desktop	857	881	890	909	950	2.7	1.0	2.2	4.6
Total Client PCs	1,111	1,203	1,224	1,278	1,342	8.3	1.8	4.4	5.0
PC printers	164	198	219	233	239	20.5	10.8	6.5	2.4
Computer hardware	**2,050**	**2,182**	**2,258**	**2,375**	**2,497**	**6.4**	**3.5**	**5.2**	**5.1**
Copiers	28	28	28	29	29	1.2	1.6	2.1	1.2
Other office equipment	168	168	168	168	169	- 0.3	0.0	0.0	1.0
Office equipment	**196**	**196**	**196**	**197**	**199**	**- 0.1**	**0.2**	**0.3**	**1.0**
LAN hardware	93	131	171	179	188	40.8	30.6	4.5	5.2
Other data communications	35	36	37	37	38	4.1	2.0	1.7	0.5
Data communications hardware	**128**	**167**	**208**	**216**	**225**	**30.8**	**24.4**	**4.0**	**4.4**
IT hardware	**2,373**	**2,545**	**2,662**	**2,788**	**2,922**	**7.2**	**4.6**	**4.8**	**4.8**
Systems software	687	773	885	1,015	1,147	12.5	14.5	14.6	13.1
Application software	738	828	945	1,078	1,213	12.2	14.2	14.1	12.6
Software products	**1,425**	**1,601**	**1,830**	**2,093**	**2,361**	**12.3**	**14.3**	**14.3**	**12.8**
Professional services	1,084	1,145	1,216	1,293	1,387	5.6	6.2	6.3	7.3
Processing services	337	333	339	345	351	- 1.1	1.7	1.9	1.6
Network services	168	193	218	244	277	14.8	13.3	11.9	13.2
Hardware maintenance & support services	809	813	845	878	926	0.5	3.9	3.8	5.5
Services	**2,398**	**2,484**	**2,618**	**2,760**	**2,940**	**3.6**	**5.4**	**5.4**	**6.5**
Software and services	**3,823**	**4,084**	**4,448**	**4,852**	**5,300**	**6.8**	**8.9**	**9.1**	**9.2**
Total IT market	**6,197**	**6,629**	**7,110**	**7,640**	**8,222**	**7.0**	**7.3**	**7.5**	**7.6**
Switching	333	304	275	254	246	- 8.6	- 9.7	- 7.5	- 3.4
Transmission	289	299	298	305	317	3.4	- 0.4	2.4	4.1
Mobile communications infrastructure	80	82	83	85	85	2.2	2.1	1.8	0.4
Public network equipment	**702**	**685**	**656**	**644**	**648**	**- 2.5**	**- 4.2**	**- 1.8**	**0.7**
PABX & key systems	106	104	102	100	100	- 1.8	- 1.8	- 2.0	0.0
Telephone sets	207	224	235	243	252	8.0	5.0	3.5	3.8
Mobile terminal equipment	82	83	87	96	103	1.6	4.2	10.0	8.0
Other terminal equipment	123	130	145	174	204	6.3	11.4	19.4	17.6
Private network equipment	**517**	**541**	**569**	**612**	**659**	**4.6**	**5.1**	**7.6**	**7.7**
Telecom equipment	**1,219**	**1,226**	**1,225**	**1,256**	**1,307**	**0.5**	**- 0.1**	**2.5**	**4.1**
Telephone services	3,718	3,859	4,002	4,152	4,294	3.8	3.7	3.8	3.4
Mobile telephone services	237	365	452	518	565	54.0	23.8	14.7	9.0
Switched data and leased line services	420	571	725	910	1,056	35.9	27.0	25.6	16.0
CaTV services	308	400	540	679	832	30.0	35.0	25.8	22.4
Telecom services	**4,683**	**5,195**	**5,719**	**6,260**	**6,746**	**10.9**	**10.1**	**9.5**	**7.8**
Total telecom	**5,903**	**6,421**	**6,944**	**7,516**	**8,053**	**8.8**	**8.1**	**8.2**	**7.2**
Total ICT	**12,099**	**13,049**	**14,053**	**15,156**	**16,275**	**7.9**	**7.7**	**7.8**	**7.4**

Table 27
United Kingdom
ICT Market Value
(Million ECU)

United Kingdom	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	839	793	636	560	552	- 5.4	-19.8	-11.9	- 1.4
Servers - medium	723	749	841	949	1,047	3.7	12.3	12.7	10.3
Servers - small	931	956	1,135	1,265	1,481	2.7	18.8	11.4	17.1
Client-Workstations	411	478	527	576	633	16.4	10.3	9.2	9.9
Client PCs - portable	767	864	961	980	1,064	12.6	11.2	2.0	8.5
Client PCs - desktop	2,483	2,905	3,272	3,724	4,054	17.0	12.6	13.8	8.9
Total Client PCs	3,250	3,769	4,232	4,704	5,118	16.0	12.3	11.1	8.8
PC printers	670	767	817	853	853	14.4	6.6	4.4	0.0
Computer hardware	**6,823**	**7,512**	**8,190**	**8,907**	**9,684**	**10.1**	**9.0**	**8.8**	**8.7**
Copiers	660	671	672	666	658	1.7	0.1	- 0.9	- 1.2
Other office equipment	595	592	583	574	573	- 0.4	- 1.5	- 1.6	- 0.2
Office equipment	**1,255**	**1,264**	**1,255**	**1,239**	**1,230**	**0.7**	**- 0.7**	**- 1.3**	**- 0.7**
LAN hardware	635	811	940	1,022	1,077	27.8	15.8	8.8	5.3
Other data communications	431	425	409	385	363	- 1.3	- 3.8	- 5.9	- 5.8
Data communications hardware	**1,066**	**1,237**	**1,349**	**1,407**	**1,439**	**16.1**	**9.1**	**4.3**	**2.3**
IT hardware	**9,144**	**10,013**	**10,794**	**11,553**	**12,353**	**9.5**	**7.8**	**7.0**	**6.9**
Systems software	1,861	2,071	2,280	2,517	2,775	11.3	10.1	10.4	10.2
Application software	2,113	2,329	2,568	2,821	3,085	10.2	10.2	9.9	9.4
Software products	**3,974**	**4,400**	**4,847**	**5,338**	**5,860**	**10.7**	**10.2**	**10.1**	**9.8**
Professional services	2,951	3,453	3,813	4,172	4,557	17.0	10.5	9.4	9.2
Processing services	974	991	1,005	1,015	1,027	1.8	1.4	1.1	1.1
Network services	316	338	361	389	418	6.8	7.0	7.6	7.6
Hardware maintenance & support services	2,316	2,346	2,425	2,511	2,598	1.3	3.4	3.6	3.4
Services	**6,557**	**7,127**	**7,605**	**8,087**	**8,599**	**8.7**	**6.7**	**6.3**	**6.3**
Software and services	**10,531**	**11,527**	**12,452**	**13,426**	**14,459**	**9.5**	**8.0**	**7.8**	**7.7**
Total IT market	**19,675**	**21,540**	**23,246**	**24,979**	**26,813**	**9.5**	**7.9**	**7.5**	**7.3**
Switching	685	682	681	690	696	- 0.5	- 0.1	1.3	0.9
Transmission	457	483	488	499	509	5.7	1.2	2.2	2.1
Mobile communications infrastructure	401	457	471	490	513	14.1	3.1	4.1	4.7
Public network equipment	**1,542**	**1,621**	**1,640**	**1,679**	**1,719**	**5.1**	**1.2**	**2.4**	**2.4**
PABX & key systems	452	434	418	404	395	- 4.0	- 3.7	- 3.3	- 2.3
Telephone sets	474	513	554	588	619	8.3	8.0	6.1	5.2
Mobile terminal equipment	678	705	649	594	548	4.0	- 8.0	- 8.5	- 7.7
Other terminal equipment	614	715	872	1,056	1,202	16.4	21.8	21.2	13.8
Private network equipment	**2,218**	**2,367**	**2,492**	**2,642**	**2,763**	**6.7**	**5.3**	**6.0**	**4.6**
Telecom equipment	**3,760**	**3,988**	**4,132**	**4,321**	**4,482**	**6.1**	**3.6**	**4.6**	**3.7**
Telephone services	11,767	12,026	12,282	12,458	12,680	2.2	2.1	1.4	1.8
Mobile telephone services	1,585	2,722	3,377	3,757	4,038	71.7	24.1	11.3	7.5
Switched data and leased line services	2,012	2,266	2,627	3,016	3,349	12.6	15.9	14.8	11.0
CaTV services	184	459	880	1,402	2,061	150.0	91.6	59.4	47.0
Telecom services	**15,548**	**17,473**	**19,166**	**20,633**	**22,128**	**12.4**	**9.7**	**7.7**	**7.2**
Total telecom	**19,309**	**21,462**	**23,298**	**24,954**	**26,611**	**11.2**	**8.6**	**7.1**	**6.6**
Total ICT	**38,983**	**43,001**	**46,544**	**49,933**	**53,423**	**10.3**	**8.2**	**7.3**	**7.0**

Czech Republic	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	28	1	7	15	13	-94.9	355.6	130.5	-16.4
Servers - medium	37	39	39	40	41	5.7	0.4	3.5	3.0
Servers - small	36	38	37	39	42	5.8	- 4.1	5.7	7.8
Client-Workstations	9	14	14	15	15	52.6	- 4.5	8.8	3.8
Client PCs - portable	44	53	54	58	61	20.3	1.8	7.1	6.7
Client PCs - desktop	242	317	332	346	381	31.3	4.6	4.1	10.2
Total Client PCs	286	370	386	403	442	29.6	4.2	4.5	9.7
PC printers	67	88	96	105	111	32.3	8.0	9.6	6.0
Computer hardware	**463**	**551**	**577**	**617**	**665**	**19.1**	**4.7**	**6.9**	**7.7**
Copiers	43	45	49	53	58	5.8	7.6	9.3	9.5
Other office equipment	20	22	24	26	28	11.7	8.3	8.8	6.5
Office equipment	**63**	**68**	**73**	**79**	**86**	**7.7**	**7.8**	**9.1**	**8.6**
LAN hardware	5	7	7	9	10	22.1	9.6	20.9	10.0
Other data communications	5	7	7	9	10	22.1	9.6	20.9	10.0
Data communications hardware	**11**	**13**	**15**	**18**	**19**	**22.1**	**9.6**	**20.9**	**10.0**
IT hardware	**537**	**632**	**664**	**714**	**770**	**17.8**	**5.1**	**7.4**	**7.9**
Systems software	48	58	63	68	75	19.2	8.9	8.0	10.6
Application software	48	60	68	74	78	23.6	13.6	8.2	6.5
Software products	**97**	**118**	**131**	**141**	**153**	**21.4**	**11.3**	**8.1**	**8.5**
Professional services	178	198	222	252	292	11.3	12.2	13.5	15.5
Other Services	42	60	74	90	101	40.8	23.3	21.7	12.5
Services	**220**	**258**	**296**	**342**	**392**	**17.0**	**14.8**	**15.6**	**14.7**
Software and services	**317**	**375**	**427**	**484**	**546**	**18.3**	**13.7**	**13.3**	**12.9**
Total IT market	**854**	**1,007**	**1,091**	**1,197**	**1,316**	**18.0**	**8.3**	**9.7**	**9.9**

Table 28
Czech Republic
IT Market Value
(Million ECU)

Table 29
Hungary
IT Market Value
(Million ECU)

Hungary	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	19	0	3	11	4	-98.4	–	340.6	-60.3
Servers - medium	28	21	21	24	25	-24.8	1.9	10.7	5.7
Servers - small	27	19	21	23	24	-28.4	6.4	9.3	7.2
Client-Workstations	10	7	8	10	11	-24.2	7.6	28.0	7.8
Client PCs - portable	20	16	18	19	24	-16.6	8.2	6.7	25.0
Client PCs - desktop	174	159	168	180	194	- 8.7	5.6	7.1	7.6
Total Client PCs	194	175	186	199	217	- 9.5	5.9	7.1	9.2
PC printers	55	48	49	53	59	-12.4	2.2	8.0	10.8
Computer hardware	**333**	**272**	**288**	**320**	**341**	**-18.3**	**5.8**	**11.2**	**6.6**
Copiers	38	38	40	43	47	0.3	4.9	7.3	8.7
Other office equipment	12	14	15	16	17	18.3	10.0	6.3	3.6
Office equipment	**50**	**52**	**56**	**59**	**64**	**4.5**	**6.3**	**7.0**	**7.3**
LAN hardware	6	7	7	7	8	13.9	4.3	8.2	7.6
Other data communications	6	7	7	7	8	13.9	4.3	8.2	7.6
Data communications hardware	**12**	**13**	**14**	**15**	**16**	**13.9**	**4.3**	**8.2**	**7.6**
IT hardware	**394**	**337**	**357**	**394**	**421**	**-14.4**	**5.8**	**10.5**	**6.7**
Systems software	38	42	44	47	51	11.5	5.5	6.8	6.7
Application software	46	51	55	58	63	10.0	7.3	5.6	9.2
Software products	**84**	**93**	**99**	**105**	**114**	**10.7**	**6.5**	**6.1**	**8.1**
Professional services	83	91	106	126	145	9.4	16.3	19.5	15.0
Other Services	38	44	49	51	54	17.3	10.9	4.9	6.3
Services	**120**	**135**	**154**	**177**	**200**	**11.9**	**14.5**	**14.9**	**12.5**
Software and services	**204**	**228**	**253**	**282**	**313**	**11.4**	**11.2**	**11.5**	**10.8**
Total IT market	**599**	**565**	**610**	**677**	**734**	**- 5.6**	**8.0**	**10.9**	**8.4**

Poland	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	3	0	5	7	12	-86.3	-	52.5	61.1
Servers - medium	33	27	28	29	31	-16.1	3.8	1.7	6.1
Servers - small	35	35	37	39	41	- 1.9	7.1	6.3	3.7
Client-Workstations	7	11	11	13	15	54.8	2.6	18.5	18.8
Client PCs - portable	22	34	39	47	50	57.6	13.6	20.0	6.7
Client PCs - desktop	268	365	403	450	514	36.3	10.4	11.5	14.2
Total Client PCs	290	399	442	496	564	37.9	10.7	12.3	13.5
PC printers	82	104	107	113	131	26.4	3.6	5.8	15.9
Computer hardware	**449**	**576**	**630**	**698**	**793**	**28.2**	**9.5**	**10.7**	**13.6**
Copiers	45	51	57	64	72	12.7	13.5	11.8	12.2
Other office equipment	23	25	28	31	33	12.1	10.9	9.2	7.4
Office equipment	**67**	**76**	**85**	**95**	**105**	**12.5**	**12.7**	**11.0**	**10.7**
LAN hardware	8	10	11	13	14	23.1	13.5	11.7	12.8
Other data communications	8	10	11	13	14	23.1	13.5	11.7	12.8
Data communications hardware	**16**	**20**	**23**	**25**	**29**	**23.1**	**13.5**	**11.7**	**12.8**
IT hardware	**533**	**672**	**739**	**818**	**927**	**26.0**	**9.9**	**10.8**	**13.3**
Systems software	43	47	54	62	70	8.9	14.6	14.2	13.2
Application software	36	45	61	74	86	24.4	35.7	21.1	17.4
Software products	**79**	**92**	**115**	**135**	**156**	**16.0**	**24.9**	**17.9**	**15.5**
Professional services	63	67	101	114	150	7.5	50.0	12.7	32.4
Other Services	16	31	54	71	78	95.0	74.4	30.9	10.1
Services	**79**	**98**	**155**	**185**	**229**	**25.3**	**57.7**	**19.1**	**23.8**
Software and services	**158**	**190**	**270**	**320**	**385**	**20.6**	**41.9**	**18.6**	**20.3**
Total IT market	**691**	**862**	**1,009**	**1,138**	**1,312**	**24.8**	**17.0**	**12.9**	**15.2**

Table 30
Poland
IT Market Value
(Million ECU)

Table 31
Russia
IT Market Value
(Million ECU)

Russia	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	29	10	10	17	24	-64.2	- 3.8	71.4	39.4
Servers - medium	28	62	74	78	88	119.8	17.9	6.5	12.2
Servers - small	30	61	64	67	84	103.7	4.7	5.0	25.0
Client-Workstations	20	24	27	29	34	19.3	12.9	5.9	16.7
Client PCs - portable	45	77	82	100	110	71.9	7.0	21.7	10.7
Client PCs - desktop	676	902	1,232	1,478	1,642	33.4	36.6	20.0	11.0
Total Client PCs	721	979	1,314	1,578	1,752	35.8	34.3	20.1	11.0
PC printers	171	179	220	269	310	4.8	23.3	22.2	15.0
Computer hardware	**999**	**1,315**	**1,709**	**2,039**	**2,291**	**31.7**	**29.9**	**19.3**	**12.4**
Copiers	198	222	234	269	310	12.5	5.3	15.1	15.2
Other office equipment	78	85	94	110	126	8.9	10.3	17.1	14.7
Office equipment	**276**	**307**	**328**	**379**	**436**	**11.5**	**6.7**	**15.7**	**15.0**
LAN hardware	26	31	35	38	36	20.7	12.0	7.9	- 3.6
Other data communications	17	21	24	25	24	20.7	15.3	6.1	- 3.6
Data communications hardware	**43**	**52**	**59**	**63**	**61**	**20.7**	**13.3**	**7.1**	**- 3.6**
IT hardware	**1,318**	**1,675**	**2,096**	**2,481**	**2,788**	**27.1**	**25.2**	**18.4**	**12.4**
Systems software	49	53	57	62	64	8.2	7.6	9.9	2.6
Application software	72	86	95	106	121	20.0	10.2	10.9	14.4
Software products	**121**	**139**	**152**	**168**	**185**	**15.2**	**9.2**	**10.5**	**10.0**
Professional services	132	148	186	224	256	12.1	25.4	20.7	14.3
Other Services	82	94	101	120	148	14.1	7.7	19.0	23.3
Services	**214**	**242**	**286**	**344**	**404**	**12.9**	**18.5**	**20.1**	**17.4**
Software and services	**335**	**381**	**438**	**512**	**589**	**13.7**	**15.1**	**16.8**	**15.0**
Total IT market	**1,653**	**2,055**	**2,534**	**2,993**	**3,377**	**24.4**	**23.3**	**18.1**	**12.8**

Table 32
Slovakia
IT Market Value
(Million ECU)

Slovakia	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	3	4	5	6	7	17.9	30.4	16.7	21.4
Servers - medium	9	12	13	14	15	40.2	5.4	11.5	6.3
Servers - small	14	24	15	17	20	75.7	-36.8	9.4	18.1
Client-Workstations	2	3	3	4	5	47.9	13.9	30.0	11.5
Client PCs - portable	7	10	11	12	13	53.5	8.4	10.1	10.0
Client PCs - desktop	56	69	71	81	87	23.6	2.7	13.5	7.4
Total Client PCs	63	79	82	93	100	26.8	3.5	13.0	7.8
PC printers	16	22	25	26	29	37.5	10.2	5.9	11.5
Computer hardware	**106**	**145**	**143**	**160**	**176**	**36.0**	**- 1.2**	**11.8**	**9.9**
Copiers	14	15	16	18	19	5.8	7.6	9.3	9.6
Other office equipment	7	7	8	9	9	5.7	14.3	8.9	6.5
Office equipment	**21**	**22**	**24**	**26**	**29**	**5.7**	**9.8**	**9.1**	**8.6**
LAN hardware	1	1	1	1	1	6.7	9.9	9.0	8.7
Other data communications	1	1	1	1	1	6.7	9.9	9.0	8.7
Data communications hardware	**2**	**2**	**2**	**2**	**3**	**6.7**	**9.9**	**9.0**	**8.7**
IT hardware	**129**	**169**	**169**	**188**	**207**	**30.7**	**0.4**	**11.4**	**9.7**
Systems software	13	16	18	21	25	18.4	13.0	19.6	17.9
Application software	13	17	18	20	23	26.6	8.5	8.7	15.2
Software products	**27**	**33**	**36**	**41**	**48**	**22.5**	**10.7**	**14.1**	**16.6**
Professional services	27	34	35	39	49	24.6	4.5	11.4	24.5
Other Services	5	8	10	12	13	53.6	26.0	19.8	12.4
Services	**32**	**41**	**45**	**51**	**62**	**29.1**	**8.5**	**13.2**	**21.7**
Software and services	**59**	**74**	**81**	**92**	**110**	**26.1**	**9.5**	**13.6**	**19.4**
Total IT market	**188**	**243**	**250**	**281**	**317**	**29.2**	**3.1**	**12.1**	**12.9**

Table 33
EU
ICT Market Value
(Million ECU)

EU	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	6,395	5,903	5,057	4,540	4,290	- 7.7	-14.3	-10.2	- 5.5
Servers - medium	4,839	5,045	5,314	5,821	6,319	4.3	5.3	9.5	8.6
Servers - small	6,214	6,610	7,389	8,140	9,042	6.4	11.8	10.2	11.1
Client-Workstations	2,373	2,657	2,880	3,088	3,323	12.0	8.4	7.2	7.6
Client PCs - portable	3,836	4,559	5,260	6,018	6,777	18.9	15.4	14.4	12.6
Client PCs - desktop	14,174	16,604	18,162	19,896	21,512	17.1	9.4	9.5	8.1
Total Client PCs	18,009	21,164	23,422	25,914	28,289	17.5	10.7	10.6	9.2
PC printers	4,213	4,893	5,190	5,434	5,639	16.1	6.1	4.7	3.8
Computer hardware	**42,042**	**46,272**	**49,253**	**52,937**	**56,902**	**10.1**	**6.4**	**7.5**	**7.5**
Copiers	4,239	4,311	4,333	4,357	4,399	1.7	0.5	0.5	1.0
Other office equipment	3,256	3,273	3,254	3,257	3,272	0.5	- 0.6	0.1	0.5
Office equipment	**7,494**	**7,584**	**7,587**	**7,614**	**7,672**	**1.2**	**0.0**	**0.4**	**0.8**
LAN hardware	2,445	2,983	3,519	3,867	4,179	22.0	18.0	9.9	8.1
Other data communications	1,415	1,435	1,455	1,491	1,506	1.4	1.4	2.5	1.0
Data communications hardware	**3,860**	**4,418**	**4,973**	**5,357**	**5,686**	**14.4**	**12.6**	**7.7**	**6.1**
IT hardware	**53,396**	**58,274**	**61,813**	**65,908**	**70,260**	**9.1**	**6.1**	**6.6**	**6.6**
Systems software	12,051	13,047	14,134	15,414	16,821	8.3	8.3	9.1	9.1
Application software	12,149	13,460	14,732	16,108	17,670	10.8	9.5	9.3	9.7
Software products	**24,200**	**26,507**	**28,866**	**31,521**	**34,492**	**9.5**	**8.9**	**9.2**	**9.4**
Professional services	20,555	22,360	24,086	25,955	28,213	8.8	7.7	7.8	8.7
Processing services	6,677	6,821	6,968	7,114	7,281	2.2	2.2	2.1	2.4
Network services	2,170	2,506	2,860	3,272	3,758	15.4	14.2	14.4	14.9
Hardware maintenance & support services	13,664	13,580	13,814	14,025	14,347	- 0.6	1.7	1.5	2.3
Services	**43,066**	**45,267**	**47,729**	**50,366**	**53,599**	**5.1**	**5.4**	**5.5**	**6.4**
Software and services	**67,266**	**71,774**	**76,595**	**81,887**	**88,090**	**6.7**	**6.7**	**6.9**	**7.6**
Total IT market	**120,662**	**130,048**	**138,408**	**147,796**	**158,350**	**7.8**	**6.4**	**6.8**	**7.1**
Switching	5,878	5,425	5,213	5,014	5,020	- 7.7	- 3.9	- 3.8	0.1
Transmission	4,065	4,043	4,026	4,118	4,288	- 0.5	- 0.4	2.3	4.1
Mobile communications infrastructure	1,868	2,450	2,769	2,995	3,217	31.2	13.0	8.1	7.4
Public network equipment	**11,811**	**11,919**	**12,008**	**12,126**	**12,525**	**0.9**	**0.8**	**1.0**	**3.3**
PABX & key systems	2,978	2,993	3,027	2,973	2,994	0.5	1.1	- 1.8	0.7
Telephone sets	4,028	4,299	4,555	4,759	4,983	6.7	5.9	4.5	4.7
Mobile terminal equipment	2,414	2,829	3,042	3,195	3,325	17.2	7.6	5.0	4.1
Other terminal equipment	3,414	3,788	4,333	5,003	5,634	11.0	14.4	15.5	12.6
Private network equipment	**12,834**	**13,908**	**14,957**	**15,930**	**16,936**	**8.4**	**7.5**	**6.5**	**6.3**
Telecom equipment	**24,645**	**25,827**	**26,965**	**28,056**	**29,461**	**4.8**	**4.4**	**4.0**	**5.0**
Telephone services	86,797	89,758	93,212	96,510	99,853	3.4	3.8	3.5	3.5
Mobile telephone services	8,218	12,887	16,513	19,476	21,685	56.8	28.1	17.9	11.3
Switched data and leased line services	10,720	13,167	15,578	18,393	21,217	22.8	18.3	18.1	15.4
CaTV services	3,086	4,094	5,034	6,353	8,204	32.7	22.9	26.2	29.1
Telecom services	**108,821**	**119,906**	**130,337**	**140,732**	**150,959**	**10.2**	**8.7**	**8.0**	**7.3**
Total telecom	**133,466**	**145,733**	**157,302**	**168,788**	**180,420**	**9.2**	**7.9**	**7.3**	**6.9**
Total ICT	**254,128**	**275,782**	**295,710**	**316,584**	**338,770**	**8.5**	**7.2**	**7.1**	**7.0**

Table 34
Western Europe
ICT Market Value
(Million ECU)

Western Europe	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	6,636	6,122	5,265	4,728	4,465	- 7.7	-14.0	-10.2	- 5.6
Servers - medium	5,052	5,269	5,542	6,074	6,602	4.3	5.2	9.6	8.7
Servers - small	6,579	6,970	7,780	8,572	9,515	5.9	11.6	10.2	11.0
Client-Workstations	2,569	2,870	3,120	3,352	3,609	11.7	8.7	7.4	7.7
Client PCs - portable	4,190	4,999	5,736	6,552	7,366	19.3	14.7	14.2	12.4
Client PCs - desktop	15,416	17,994	19,606	21,374	23,033	16.7	9.0	9.0	7.8
Total Client PCs	19,606	22,993	25,342	27,927	30,398	17.3	10.2	10.2	8.9
PC printers	4,448	5,179	5,511	5,774	5,988	16.4	6.4	4.8	3.7
Computer hardware	**44,891**	**49,402**	**52,560**	**56,428**	**60,577**	**10.1**	**6.4**	**7.4**	**7.4**
Copiers	4,321	4,390	4,413	4,438	4,483	1.6	0.5	0.6	1.0
Other office equipment	3,482	3,497	3,477	3,481	3,499	0.4	- 0.6	0.1	0.5
Office equipment	**7,803**	**7,888**	**7,890**	**7,919**	**7,982**	**1.1**	**0.0**	**0.4**	**0.8**
LAN hardware	2,604	3,212	3,800	4,172	4,505	23.4	18.3	9.8	8.0
Other data communications	1,488	1,51 1	1,534	1,572	1,589	1.6	1.5	2.5	1.1
Data communications hardware	**4,091**	**4,723**	**5,334**	**5,744**	**6,094**	**15.4**	**12.9**	**7.7**	**6.1**
IT hardware	**56,785**	**62,013**	**65,784**	**70,091**	**74,652**	**9.2**	**6.1**	**6.5**	**6.5**
Systems software	12,948	14,044	15,258	16,686	18,250	8.5	8.6	9.4	9.4
Application software	13,079	14,488	15,891	17,416	19,132	10.8	9.7	9.6	9.9
Software products	**26,028**	**28,532**	**31,149**	**34,102**	**37,382**	**9.6**	**9.2**	**9.5**	**9.6**
Professional services	22,110	24,010	25,840	27,827	30,231	8.6	7.6	7.7	8.6
Processing services	7,394	7,543	7,703	7,863	8,045	2.0	2.1	2.1	2.3
Network services	2,394	2,768	3,163	3,615	4,148	15.6	14.3	14.3	14.7
Hardware maintenance & support services	14,714	14,633	14,909	15,162	15,4	- 0.5	1.9	1.7	2.5
Services	**46,612**	**48,954**	**51,615**	**54,466**	**57,963**	**5.0**	**5.4**	**5.5**	**6.4**
Software and services	**72,640**	**77,486**	**82,763**	**88,568**	**95,345**	**6.7**	**6.8**	**7.0**	**7.7**
Total IT market	**129,425**	**139,499**	**148,547**	**158,659**	**169,997**	**7.8**	**6.5**	**6.8**	**7.1**
Switching	6,323	5,837	5,589	5,365	5,359	- 7.7	- 4.2	- 4.0	- 0.1
Transmission	4,451	4,442	4,424	4,527	4,718	- 0.2	- 0.4	2.3	4.2
Mobile communications infrastructure	1,991	2,579	2,901	3,130	3,361	29.5	12.5	7.9	7.3
Public network equipment	**12,765**	**12,859**	**12,915**	**13,023**	**13,438**	**0.7**	**0.4**	**0.8**	**3.2**
PABX & key systems	3,115	3,127	3,159	3,103	3,124	0.4	1.0	- 1.8	0.7
Telephone sets	4,297	4,589	4,861	5,079	5,317	6.8	5.9	4.5	4.7
Mobile terminal equipment	2,613	3,017	3,221	3,370	3,503	15.5	6.7	4.6	4.0
Other terminal equipment	3,581	3,966	4,533	5,244	5,921	10.7	14.3	15.7	12.9
Private network equipment	**13,607**	**14,699**	**15,774**	**16,796**	**17,864**	**8.0**	**7.3**	**6.5**	**6.4**
Telecom equipment	**26,372**	**27,558**	**28,688**	**29,818**	**31,302**	**4.5**	**4.1**	**3.9**	**5.0**
Telephone services	91,806	94,928	98,560	102,043	105,565	3.4	3.8	3.5	3.5
Mobile telephone services	8,719	13,634	17,437	20,514	22,804	56.4	27.9	17.6	11.2
Switched data and leased line services	11,218	13,850	16,460	19,506	22,516	23.5	18.8	18.5	15.4
CaTV services	3,435	4,540	5,627	7,100	9,119	32.2	24.0	26.2	28.4
Telecom services	**115,179**	**126,952**	**138,085**	**149,163**	**160,004**	**10.2**	**8.8**	**8.0**	**7.3**
Total telecom	**141,551**	**154,510**	**166,773**	**178,981**	**191,306**	**9.2**	**7.9**	**7.3**	**6.9**
Total ICT	**270,975**	**294,008**	**315,320**	**337,640**	**361,304**	**8.5**	**7.2**	**7.1**	**7.0**

Table 35
Eastern Europe
ICT Market Value
(Million ECU)

Eastern Europe	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	83	16	29	56	60	-80.3	75.9	96.7	5.5
Servers - medium	134	161	175	185	200	20.4	8.3	5.9	8.0
Servers - small	143	178	174	185	211	24.8	- 2.2	6.3	14.0
Client-Workstations	48	59	63	71	80	23.1	6.2	12.7	12.8
Client PCs - portable	136	190	203	235	259	39.4	6.9	15.6	10.0
Client PCs - desktop	1,416	1,813	2,206	2,534	2,816	28.0	21.7	14.9	11.1
Total Client PCs	1,552	2,003	2,410	2,770	3,075	29.0	20.3	14.9	11.0
PC printers	391	442	497	567	641	13.0	12.6	14.0	13.0
Computer hardware	**2,351**	**2,859**	**3,347**	**3,834**	**4,266**	**21.6**	**17.1**	**14.5**	**11.3**
Copiers	338	371	396	447	507	10.0	6.7	12.9	13.2
Other office equipment excl. typewriter & calculator	139	154	170	192	213	10.4	10.3	13.3	11.1
Office equipment	**477**	**525**	**566**	**639**	**720**	**10.1**	**7.8**	**13.0**	**12.6**
LAN hardware	46	56	62	68	70	20.2	11.0	10.2	2.7
Other data communications	37	45	50	55	58	20.0	12.3	9.8	4.1
Data communications hardware	**84**	**100**	**112**	**123**	**127**	**20.1**	**11.6**	**10.0**	**3.3**
IT hardware	**2,911**	**3,485**	**4,025**	**4,597**	**5,113**	**19.7**	**15.5**	**14.2**	**11.2**
Systems software	192	215	236	261	285	12.5	9.5	10.5	9.2
Application software	216	259	297	330	372	19.8	14.7	11.3	12.4
Software products	**408**	**474**	**533**	**591**	**656**	**16.4**	**12.3**	**10.9**	**11.0**
Professional services	483	538	650	756	892	11.5	20.8	16.3	18.1
Other services	183	236	287	344	395	29.1	21.6	19.6	14.9
Services	**665**	**774**	**937**	**1,099**	**1,287**	**16.3**	**21.0**	**17.3**	**17.1**
Software and services	**1,073**	**1,248**	**1,470**	**1,690**	**1,943**	**16.3**	**17.7**	**15.0**	**15.0**
Total IT market	**3,984**	**4,733**	**5,495**	**6,287**	**7,056**	**18.8**	**16.1**	**14.4**	**12.2**
Total telecom	**5,646**	**6,183**	**6,786**	**7,460**	**8,209**	**9.5**	**9.7**	**9.9**	**10.0**
Total ICT	**9,630**	**10,916**	**12,281**	**13,747**	**15,265**	**13.3**	**12.5**	**11.9**	**11.0**

Austria	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	17	24	27	30	32	40.7	12.1	10.4	8.4
Servers - medium	271	316	383	465	547	16.6	21.2	21.5	17.7
Servers - small	6,150	8,317	9,778	11,457	12,284	35.2	17.6	17.2	7.2
Client-Workstations	3,181	3,964	4,753	5,408	6,436	24.6	19.9	13.8	19.0
Client PCs - portable	46,012	50,981	60,081	68,853	83,131	10.8	17.8	14.6	20.7
Client PCs - desktop	244,385	300,594	338,565	372,929	402,888	23.0	12.6	10.1	8.0
Total Client PCs	290,397	351,575	398,646	441,782	486,019	21.1	13.4	10.8	10.0
PC printers	224,077	263,914	285,900	311,703	332,415	17.8	8.3	9.0	6.6
Typewriters	24,745	20,926	17,755	14,417	11,694	-15.4	-15.2	-18.8	-18.9
Calculators	418,666	426,309	434,213	443,221	454,090	1.8	1.9	2.1	2.5
Copiers	25,263	26,023	27,183	27,852	28,256	3.0	4.5	2.5	1.5
LAN cards	108,000	134,000	165,000	207,640	272,117	24.1	23.1	25.8	31.1

Table 36
Austria
IT Hardware Shipments (Units)

Belgium/ Luxembourg	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	30	30	23	24	24	- 1.7	-22.9	6.6	- 2.4
Servers - medium	311	431	473	516	544	38.7	9.7	9.1	5.4
Servers - small	8,523	12,608	15,988	18,294	19,707	47.9	26.8	14.4	7.7
Client-Workstations	5,455	6,289	7,055	7,868	8,581	15.3	12.2	11.5	9.1
Client PCs - portable	54,666	57,465	73,554	90,324	109,858	5.1	28.0	22.8	21.6
Client PCs - desktop	249,466	296,914	356,987	411,825	469,536	19.0	20.2	15.4	14.0
Total Client PCs	304,132	354,379	430,540	502,149	579,395	16.5	21.5	16.6	15.4
PC printers	268,146	305,225	340,260	379,553	430,913	13.8	11.5	11.5	13.5
Typewriters	43,129	40,714	38,159	35,825	33,341	- 5.6	- 6.3	- 6.1	- 6.9
Calculators	569,895	590,228	614,993	641,640	669,955	3.6	4.2	4.3	4.4
Copiers	48,705	50,068	51,400	52,268	54,074	2.8	2.7	1.7	3.5
LAN cards	201,000	253,000	308,000	370,200	423,131	25.9	21.7	20.2	14.3

Table 37
Belgium/Luxembourg
IT Hardware Shipments (Units)

Denmark	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	29	24	20	18	16	-15.9	-18.5	- 8.9	-12.3
Servers - medium	222	228	292	366	420	2.8	28.0	25.2	14.9
Servers - small	4,964	9,236	12,498	15,903	16,836	86.1	35.3	27.2	5.9
Client-Workstations	2,287	2,749	3,223	3,509	3,793	20.2	17.2	8.9	8.1
Client PCs - portable	46,000	50,600	58,410	66,120	75,050	10.0	15.4	13.2	13.5
Client PCs - desktop	277,317	341,655	391,706	402,428	401,942	23.2	14.6	2.7	- 0.1
Total Client PCs	323,317	392,255	450,116	468,548	476,992	21.3	14.8	4.1	1.8
PC printers	250,345	274,520	301,370	319,173	323,047	9.7	9.8	5.9	1.2
Typewriters	24,653	22,255	19,863	17,477	15,097	- 9.7	-10.7	-12.0	-13.6
Calculators	437,233	442,042	455,166	469,132	483,402	1.1	3.0	3.1	3.0
Copiers	31,462	33,726	35,136	36,725	37,796	7.2	4.2	4.5	2.9
LAN cards	203,000	234,700	293,835	330,122	343,092	15.6	25.2	12.3	3.9

Table 38
Denmark
IT Hardware Shipments (Units)

Table 39
Finland
IT Hardware Shipments
(Units)

Finland	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	4	4	5	6	7	0.0	27.5	18.0	13.3
Servers - medium	113	116	147	186	225	2.4	27.0	26.3	21.3
Servers - small	4,301	5,171	7,330	9,265	10,890	20.2	41.8	26.4	17.5
Client-Workstations	3,246	3,776	4,242	4,769	5,484	16.3	12.3	12.4	15.0
Client PCs - portable	24,920	34,290	43,146	45,600	48,408	37.6	25.8	5.7	6.2
Client PCs - desktop	177,958	250,565	272,000	302,345	326,654	40.8	8.6	11.2	8.0
Total Client PCs	202,878	284,855	315,146	347,945	375,062	40.4	10.6	10.4	7.8
PC printers	123,198	185,207	221,929	260,589	291,980	50.3	19.8	17.4	12.0
Typewriters	15,869	15,075	14,270	13,450	13,033	- 5.0	- 5.3	- 5.7	- 3.1
Calculators	320,398	323,602	327,520	331,578	335,683	1.0	1.2	1.2	1.2
Copiers	32,608	33,586	34,586	35,391	36,506	3.0	3.0	2.3	3.2
LAN cards	174,000	266,000	354,000	410,000	455,500	52.9	33.1	15.8	11.1

Table 40
France
IT Hardware Shipments
(Units)

France	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	128	122	118	117	117	- 5.0	- 3.2	- 0.9	0.5
Servers - medium	1,287	1,511	1,855	2,190	2,457	17.4	22.8	18.0	12.2
Servers - small	44,278	55,591	71,282	87,110	98,862	25.5	28.2	22.2	13.5
Client-Workstations	27,548	32,693	37,352	41,243	45,752	18.7	14.3	10.4	10.9
Client PCs - portable	272,882	295,804	379,565	503,500	600,000	8.4	28.3	32.7	19.2
Client PCs - desktop	1,436,508	1,718,064	2,023,056	2,268,954	2,524,732	19.6	17.8	12.2	11.3
Total Client PCs	1,709,390	2,013,868	2,402,621	2,772,454	3,124,732	17.8	19.3	15.4	12.7
PC printers	1,328,297	1,648,938	1,820,810	1,991,112	2,159,761	24.1	10.4	9.4	8.5
Typewriters	212,691	192,060	175,564	158,251	142,595	- 9.7	- 8.6	- 9.9	- 9.9
Calculators	3,312,789	3,528,121	3,656,456	3,930,329	4,240,902	6.5	3.6	7.5	7.9
Copiers	265,920	273,897	280,623	296,821	316,474	3.0	2.5	5.8	6.6
LAN cards	914,000	1,188,902	1,469,824	1,859,729	2,517,954	30.1	23.6	26.5	35.4

Table 41
Germany
IT Hardware Shipments
(Units)

Germany	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	224	232	233	248	245	3.6	0.4	6.4	- 1.2
Servers - medium	3,293	3,420	3,867	4,211	4,404	3.9	13.1	8.9	4.6
Servers - small	94,647	119,216	139,761	161,284	187,331	26.0	17.2	15.4	16.1
Client-Workstations	44,761	53,192	60,479	70,131	81,357	18.8	13.7	16.0	16.0
Client PCs - portable	484,896	587,732	683,533	819,737	987,456	21.2	16.3	19.9	20.5
Client PCs - desktop	3,027,585	3,502,916	3,881,230	4,424,603	5,143,604	15.7	10.8	14.0	16.3
Total Client PCs	3,512,481	4,090,648	4,564,763	5,244,340	6,131,060	16.5	11.6	14.9	16.9
PC printers	2,600,933	2,951,592	3,206,543	3,533,460	3,993,304	13.5	8.6	10.2	13.0
Typewriters	666,289	546,222	443,993	357,561	285,043	-18.0	-18.7	-19.5	-20.3
Calculators	8,888,342	8,446,698	8,014,313	7,594,491	7,188,454	- 5.0	- 5.1	- 5.2	- 5.3
Copiers	536,706	538,538	540,675	548,092	557,577	0.3	0.4	1.4	1.7
LAN cards	1,712,000	2,113,297	2,429,742	2,870,969	3,507,853	23.4	15.0	18.2	22.2

Table 42
Greece
IT Hardware Shipments
(Units)

Greece	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	2	2	2	2	2	-12.1	- 3.3	0.6	- 3.5
Servers - medium	71	93	112	132	149	30.7	20.6	18.0	13.0
Servers - small	1,074	1,402	1,945	2,291	2,650	30.5	38.7	17.8	15.7
Client-Workstations	1,004	1,252	1,487	1,811	2,123	24.7	18.8	21.8	17.2
Client PCs - portable	9,404	10,633	13,579	15,915	18,980	13.1	27.7	17.2	19.3
Client PCs - desktop	71,810	82,192	96,000	107,674	117,373	14.5	16.8	12.2	9.0
Total Client PCs	81,214	92,825	109,579	123,589	136,352	14.3	18.0	12.8	10.3
PC printers	23,108	31,297	36,415	41,962	46,145	35.4	16.4	15.2	10.0
Typewriters	153,399	166,160	173,305	177,638	182,079	8.3	4.3	2.5	2.5
Calculators	114,506	125,996	138,292	150,587	163,975	10.0	9.8	8.9	8.9
Copiers	18,603	18,242	17,719	18,012	19,261	- 1.9	- 2.9	1.7	6.9
LAN cards	57,579	58,969	61,210	65,264	71,843	2.4	3.8	6.6	10.1

Table 43
Ireland
IT Hardware Shipments
(Units)

Ireland	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	3	3	3	3	3	-10.0	9.3	6.4	- 7.6
Servers - medium	67	112	130	145	163	66.7	16.3	11.6	12.7
Servers - small	1,890	2,786	3,322	3,530	3,870	47.4	19.2	6.3	9.6
Client-Workstations	2,733	2,764	3,254	3,776	4,245	1.1	17.8	16.0	12.4
Client PCs - portable	7,743	8,828	10,066	11,566	13,345	14.0	14.0	14.9	15.4
Client PCs - desktop	49,541	55,830	62,918	72,347	84,920	12.7	12.7	15.0	17.4
Total Client PCs	57,284	64,659	72,984	83,913	98,265	12.9	12.9	15.0	17.1
PC printers	36,829	43,600	46,672	49,772	50,391	18.4	7.0	6.6	1.2
Typewriters	40,738	32,620	25,896	20,367	15,857	-19.9	-20.6	-21.4	-22.1
Calculators	425,515	450,395	463,462	490,252	462,127	5.8	2.9	5.8	-5.7
Copiers	30,242	30,202	28,939	29,239	29,465	- 0.1	- 4.2	1.0	0.8
LAN cards	23,005	23,931	27,845	31,249	35,817	4.0	16.4	12.2	14.6

Table 44
Italy
IT Hardware Shipments
(Units)

Italy	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	161	123	108	103	97	-23.6	-12.2	- 4.6	- 5.8
Servers - medium	1,152	1,200	1,230	1,280	1,320	4.2	2.5	4.1	3.1
Servers - small	32,335	42,355	48,245	53,475	59,836	31.0	13.9	10.8	11.9
Client-Workstations	14,178	15,984	18,679	21,154	24,208	12.7	16.9	13.3	14.4
Client PCs - portable	148,991	182,513	205,305	240,138	272,258	22.5	12.5	17.0	13.4
Client PCs - desktop	774,786	996,123	1,051,055	1,166,420	1,266,985	28.6	5.5	11.0	8.6
Total Client PCs	923,777	1,178,636	1,256,360	1,406,558	1,539,243	27.6	6.6	12.0	9.4
PC printers	852,146	1,005,483	1,064,952	1,154,893	1,229,274	18.0	5.9	8.4	6.4
Typewriters	142,600	136,585	118,268	107,825	96,645	- 4.2	-13.4	- 8.8	-10.4
Calculators	2,036,000	2,099,132	2,073,704	2,085,102	2,099,091	3.1	- 1.2	0.5	0.7
Copiers	162,626	184,679	192,910	198,822	202,401	13.6	4.5	3.1	1.8
LAN cards	387,000	564,000	658,000	749,000	804,000	45.7	16.7	13.8	7.3

Table 45
Netherlands
IT Hardware Shipments
(Units)

Netherlands	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	46	38	32	27	24	-18.1	-14.5	-14.8	-12.4
Servers - medium	418	432	524	602	657	3.3	21.3	14.9	9.2
Servers - small	16,536	18,279	23,710	28,075	30,941	10.5	29.7	18.4	10.2
Client-Workstations	7,810	9,040	10,022	11,316	12,016	15.7	10.9	12.9	6.2
Client PCs - portable	97,848	121,429	157,255	195,782	226,404	24.1	29.5	24.5	15.6
Client PCs - desktop	639,497	812,801	908,718	952,115	997,435	27.1	11.8	4.8	4.8
Total Client PCs	737,345	934,230	1,065,973	1,147,897	1,223,839	26.7	14.1	7.7	6.6
PC printers	495,113	549,322	640,318	724,600	828,013	10.9	16.6	13.2	14.3
Typewriters	96,950	89,756	69,624	48,321	25,440	- 7.4	-22.4	-30.6	-47.4
Calculators	1,172,700	1,184,427	1,186,688	1,188,859	1,181,531	1.0	0.2	0.2	-0.6
Copiers	115,250	122,555	124,958	127,063	134,339	6.3	2.0	1.7	5.7
LAN cards	476,000	637,660	736,484	809,298	864,304	34.0	15.5	9.9	6.8

Table 46
Norway
IT Hardware Shipments
(Units)

Norway	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	8	7	7	8	8	-14.2	5.7	7.4	3.3
Servers - medium	95	99	121	137	150	3.8	22.2	13.5	9.3
Servers - small	5,518	5,929	8,477	9,792	10,922	7.5	43.0	15.5	11.5
Client-Workstations	3,899	3,964	4,206	4,446	4,822	1.7	6.1	5.7	8.5
Client PCs - portable	46,300	47,411	53,098	61,488	74,593	2.4	12.0	15.8	21.3
Client PCs - desktop	236,620	301,454	339,744	366,622	371,786	27.4	12.7	7.9	1.4
Total Client PCs	282,920	348,865	392,842	428,110	446,379	23.3	12.6	9.0	4.3
PC printers	157,281	201,873	248,312	273,352	287,604	28.4	23.0	10.1	5.2
Typewriters	21,367	19,665	18,708	17,683	16,576	- 8.0	- 4.9	- 5.5	- 6.3
Calculators	354,635	343,287	321,102	298,176	268,049	- 3.2	- 6.5	- 7.1	-10.1
Copiers	23,796	22,844	23,266	24,238	26,039	- 4.0	1.8	4.2	7.4
LAN cards	188,000	241,000	270,000	322,000	381,235	28.2	12.0	19.3	18.4

Table 47
Portugal
IT Hardware Shipments
(Units)

Portugal	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	6	7	6	7	8	8.3	- 2.6	2.6	17.7
Servers - medium	95	115	131	153	171	20.7	14.4	16.3	12.2
Servers - small	2,184	4,084	5,535	6,675	7,316	87.0	35.5	20.6	9.6
Client-Workstations	1,000	1,251	1,564	1,805	2,095	25.1	25.0	15.4	16.1
Client PCs - portable	6,700	7,400	8,200	8,778	9,066	10.4	10.8	7.0	3.3
Client PCs - desktop	132,000	144,300	148,314	158,766	173,552	9.3	2.8	7.0	9.3
Total Client PCs	138,700	151,700	156,514	167,544	182,618	9.4	3.2	7.0	9.0
PC printers	109,100	134,637	146,194	153,804	157,614	23.4	8.6	5.2	2.5
Typewriters	165,685	191,035	200,969	201,572	202,177	15.3	5.2	0.3	0.3
Calculators	121,509	147,998	170,494	189,418	208,360	21.8	15.2	11.1	10.0
Copiers	21,260	22,057	23,182	24,387	25,729	3.8	5.1	5.2	5.5
LAN cards	82,819	86,127	89,435	95,743	105,741	4.0	3.8	7.1	10.4

Table 48
Spain
IT Hardware Shipments (Units)

Spain	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	56	50	36	32	32	-10.0	-28.2	-11.2	- 1.9
Servers - medium	468	539	581	632	664	15.3	7.7	8.8	5.1
Servers - small	13,064	17,596	22,535	26,527	32,153	34.7	28.1	17.7	21.2
Client-Workstations	7,822	7,984	8,990	10,040	11,314	2.1	12.6	11.7	12.7
Client PCs - portable	68,549	85,755	99,476	109,424	116,145	25.1	16.0	10.0	6.1
Client PCs - desktop	533,394	588,867	671,358	786,780	905,652	10.4	14.0	17.2	15.1
Total Client PCs	601,943	674,622	770,834	896,204	1,021,796	12.1	14.3	16.3	14.0
PC printers	580,806	686,019	762,336	813,604	894,946	18.1	11.1	6.7	10.0
Typewriters	115,140	94,415	77,349	62,226	49,995	-18.0	-18.1	-19.6	-19.7
Calculators	1,468,296	1,515,282	1,564,653	1,616,256	1,670,610	3.2	3.3	3.3	3.4
Copiers	110,717	115,622	115,622	115,622	115,622	4.4	0.0	0.0	0.0
LAN cards	273,000	388,760	477,018	565,668	650,845	42.4	22.7	18.6	15.1

Table 49
Sweden
IT Hardware Shipments (Units)

Sweden	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	25	21	14	12	12	-17.8	-31.0	-13.4	0.5
Servers - medium	335	327	450	572	640	-2.5	37.6	27.2	12.0
Servers - small	10,528	11,895	18,315	20,808	22,651	13.0	54.0	13.6	8.9
Client-Workstations	11,025	12,607	13,720	15,096	16,692	14.3	8.8	10.0	10.6
Client PCs - portable	92,910	116,416	135,767	142,554	162,501	25.3	16.6	5.0	14.0
Client PCs - desktop	436,345	578,157	647,330	645,185	636,751	32.5	12.0	-0.3	-1.3
Total Client PCs	529,255	694,573	783,096	787,739	799,252	31.2	12.7	0.6	1.5
PC printers	310,072	392,403	469,127	516,900	546,879	26.6	19.6	10.2	5.8
Typewriters	86,482	70,915	57,997	44,444	34,852	-18.0	-18.2	-23.4	-21.6
Calculators	1,409,564	1,454,670	1,580,803	1,854,634	2,266,806	3.2	8.7	17.3	22.2
Copiers	76,395	77,923	78,310	80,738	83,183	2.0	0.5	3.1	3.0
LAN cards	422,000	506,000	591,000	642,000	645,000	19.9	16.8	8.6	0.5

Table 50
Switzerland
IT Hardware Shipments (Units)

Switzerland	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	33	28	26	29	30	-15.0	- 8.8	13.2	4.0
Servers - medium	350	439	483	613	695	25.4	10.2	26.7	13.5
Servers - small	13,156	15,745	18,435	20,435	24,991	19.7	17.1	10.8	22.3
Client-Workstations	11,338	13,758	16,347	18,824	21,076	21.3	18.8	15.2	12.0
Client PCs - portable	98,936	121,197	142,980	160,138	172,455	22.5	18.0	12.0	7.7
Client PCs - desktop	406,451	434,090	448,993	456,730	483,461	6.8	3.4	1.7	5.9
Total Client PCs	505,387	555,286	591,974	616,868	655,916	9.9	6.6	4.2	6.3
PC printers	309,365	374,610	458,914	537,718	611,321	21.1	22.5	17.2	13.7
Typewriters	62,516	56,414	52,088	46,565	40,072	- 9.8	- 7.7	-10.6	-13.9
Calculators	748,780	766,001	783,793	802,175	832,280	2.3	2.3	2.3	3.8
Copiers	40,923	40,360	40,085	40,517	41,928	- 1.4	- 0.7	1.1	3.5
LAN cards	216,000	272,237	352,586	383,730	428,986	26.0	29.5	8.8	11.8

Table 51
United Kingdom
IT Hardware Shipments
(Units)

United Kingdom	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	155	141	113	110	131	- 9.2	-19.9	- 2.7	19.7
Servers - medium	2,146	2,037	2,809	3,215	3,578	- 5.1	37.9	14.5	11.3
Servers - small	59,355	65,565	87,109	99,907	123,279	10.5	32.9	14.7	23.4
Client-Workstations	33,062	41,470	46,508	51,683	57,741	25.4	12.1	11.1	11.7
Client PCs - portable	430,848	472,640	516,064	556,833	625,524	9.7	9.2	7.9	12.3
Client PCs - desktop	2,023,356	2,365,303	2,671,877	3,020,626	3,259,083	16.9	13.0	13.1	7.9
Total Client PCs	2,454,204	2,837,943	3,187,941	3,577,460	3,884,607	15.6	12.3	12.2	8.6
PC printers	1,573,947	1,838,815	2,049,679	2,222,058	2,354,288	16.8	11.5	8.4	6.0
Typewriters	269,070	238,665	209,226	180,817	151,329	-11.3	-12.3	-13.6	-16.3
Calculators	3,602,037	3,648,863	3,684,065	3,707,424	3,707,708	1.3	1.0	0.6	0.0
Copiers	292,446	307,068	318,747	328,006	339,296	5.0	3.8	2.9	3.4
LAN cards	1,720,000	2,155,012	2,304,291	2,636,085	3,059,198	25.3	6.9	14.4	16.1

Table 52
Czech Republic
IT Hardware Shipments
(Units)

Czech Republic	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	11	3	5	6	6	-72.7	66.7	20.0	0.0
Servers - medium	120	136	135	142	146	13.3	- 0.7	5.2	2.8
Servers - small	1,993	1,048	1,140	1,240	1,420	-47.4	8.8	8.8	14.5
Client-Workstations	1,042	1,191	1,200	1,310	1,410	14.3	0.8	9.2	7.6
Client PCs - portable	25,544	27,495	28,000	30,000	32,000	7.6	1.8	7.1	6.7
Client PCs - desktop	157,096	190,030	210,000	230,000	260,000	21.0	10.5	9.5	13.0
Total Client PCs	182,640	217,525	238,000	260,000	292,000	19.1	9.4	9.2	12.3
PC printers	166,486	200,964	218,052	232,287	244,557	20.7	8.5	6.5	5.3
Copiers	22,610	24,225	26,815	28,000	28,910	7.1	10.7	4.4	3.3
LAN cards	62,838	76,012	84,000	92,000	104,000	21.0	10.5	9.5	13.0

Table 53
Hungary
IT Hardware Shipments
(Units)

Hungary	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	5	0	2	6	3	-100.0	–	200.0	-50.0
Servers - medium	73	58	62	71	86	- 20.5	6.9	14.5	21.1
Servers - small	667	725	750	820	880	8.7	3.4	9.3	7.3
Client-Workstations	690	612	690	870	980	- 11.3	12.7	26.1	12.6
Client PCs - portable	9,052	6,930	7,500	8,000	10,000	- 23.4	8.2	6.7	25.0
Client PCs - desktop	107,808	101,935	112,500	124,000	135,000	- 5.4	10.4	10.2	8.9
Total Client PCs	116,860	108,865	120,000	132,000	145,000	- 6.8	10.2	10.0	9.8
PC printers	90,937	97,334	100,252	109,648	122,157	7.0	3.0	9.4	11.4
Copiers	18,470	17,090	17,925	19,030	20,370	- 7.5	4.9	6.2	7.0
LAN cards	46,357	40,774	45,000	49,600	54,000	- 12.0	10.4	10.2	8.9

Poland	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers – large	1	0	3	4	5	-100.0	–	33.3	25.0
Servers – medium	84	107	110	112	120	27.4	2.8	1.8	7.1
Servers – small	906	1,412	1,550	1,720	1,850	55.8	9.8	11.0	7.6
Client-Workstations	1,165	733	820	1,100	1,350	- 37.1	11.9	34.1	22.7
Client PCs – portable	13,075	22,012	25,000	30,000	32,000	68.4	13.6	20.0	6.7
Client PCs – desktop	232,605	286,878	323,000	355,000	400,000	23.3	12.6	9.9	12.7
Total Client PCs	245,680	308,890	348,000	385,000	432,000	25.7	12.7	10.6	12.2
PC printers	218,682	266,490	283,561	302,454	341,284	21.9	6.4	6.7	12.8
Copiers	18,215	20,410	22,930	25,620	28,550	12.1	12.3	11.7	11.4
LAN cards	81,400	100,407	122,740	134,900	152,000	23.4	22.2	9.9	12.7

Table 54
Poland
IT Hardware Shipments
(Units)

Russia	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers – large	18	6	4	6	8	-66.7	-33.3	50.0	33.3
Servers – medium	85	205	222	242	280	141.2	8.3	9.0	15.7
Servers – small	1,100	2,704	2,800	2,875	3,450	145.8	3.6	2.7	20.0
Client-Workstations	1,850	1,573	1,620	1,920	2,150	-15.0	3.0	18.5	12.0
Client PCs – portable	25,000	43,000	46,000	56,000	62,000	72.0	7.0	21.7	10.7
Client PCs – desktop	625,000	832,000	1,054,000	1,264,000	1,458,000	33.1	26.7	19.9	15.3
Total Client PCs	650,000	875,000	1,100,000	1,320,000	1,520,000	34.6	25.7	20.0	15.2
PC printers	540,000	523,872	687,152	820,620	903,560	- 3.0	31.2	19.4	10.1
Copiers	117,700	133,025	144,000	161,350	178,425	13.0	8.3	12.0	10.6
LAN cards	156,250	249,600	316,200	379,200	437,400	59.7	26.7	19.9	15.3

Table 55
Russia
IT Hardware Shipments
(Units)

Slovakia	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers – large	2	1	3	3	4	-50.0	200.0	0.0	33.3
Servers – medium	23	35	36	42	42	52.2	2.9	16.7	0.0
Servers – small	423	675	460	510	565	59.6	-31.9	10.9	10.8
Client-Workstations	167	231	260	390	420	38.3	12.6	50.0	7.7
Client PCs – portable	4,000	5,405	5,945	6,540	7,200	35.1	10.0	10.0	10.1
Client PCs – desktop	46,540	52,390	59,000	66,800	74,800	12.6	12.6	13.2	12.0
Total Client PCs	50,540	57,795	64,945	73,340	82,000	14.4	12.4	12.9	11.8
PC printers	49,182	53,870	58,242	61,959	68,576	9.5	8.1	6.4	10.7
Copiers	7,537	8,075	8,938	9,333	9,637	7.1	10.7	4.4	3.3
LAN cards	13,900	15,400	17,000	18,533	19,933	10.8	10.4	9.0	7.6

Table 56
Slovakia
IT Hardware Shipments
(Units)

Table 57
EU
IT Hardware Shipments
(Units)

EU	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	886	819	739	738	749	- 7.6	- 9.7	- 0.1	1.4
Servers - medium	10,249	10,876	12,983	14,663	15,941	6.1	19.4	12.9	8.7
Servers - small	299,829	374,101	467,352	544,600	628,605	24.8	24.9	16.5	15.4
Client-Workstations	165,112	195,016	221,329	249,610	281,838	18.1	13.5	12.8	12.9
Client PCs - portable	1,792,369	2,082,487	2,444,000	2,875,124	3,348,125	16.2	17.4	17.6	16.5
Client PCs - desktop	10,073,948	12,034,280	13,521,115	15,092,997	16,711,107	19.5	12.4	11.6	10.7
Total Client PCs	11,866,317	14,116,768	15,965,115	17,968,121	20,059,232	19.0	13.1	12.5	11.6
PC printers	8,776,117	10,310,972	11,392,505	12,473,184	13,638,971	17.5	10.5	9.5	9.3
Typewriters	2,057,440	1,857,404	1,642,238	1,440,190	1,259,176	- 9.7	-11.6	-12.3	-12.6
Calculators	24,297,450	24,383,763	24,364,823	24,692,925	25,132,696	0.4	- 0.1	1.3	1.8
Copiers	1,768,202	1,834,188	1,869,992	1,919,037	1,979,979	3.7	2.0	2.6	3.2
LAN cards	6,753,403	8,610,359	9,965,685	11,642,967	13,756,395	27.5	15.7	16.8	18.2

Table 58
Western Europe
IT Hardware Shipments
(Units)

Western Europe	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	927	854	772	775	787	- 7.9	- 9.5	0.4	1.6
Servers - medium	10,694	11,414	13,587	15,413	16,785	6.7	19.0	13.4	8.9
Servers - small	318,503	395,775	494,264	574,826	664,518	24.3	24.9	16.3	15.6
Client-Workstations	180,349	212,738	241,882	272,880	307,735	18.0	13.7	12.8	12.8
Client PCs - portable	1,937,605	2,251,095	2,640,078	3,096,750	3,595,173	16.2	17.3	17.3	16.1
Client PCs - desktop	10,717,019	12,769,824	14,309,852	15,916,349	17,566,354	19.2	12.1	11.2	10.4
Total Client PCs	12,654,624	15,020,919	16,949,930	19,013,099	21,161,527	18.7	12.8	12.2	11.3
PC printers	9,242,763	10,887,455	12,099,731	13,284,254	14,537,895	17.8	11.1	9.8	9.4
Typewriters	2,141,323	1,933,483	1,713,034	1,504,438	1,315,825	- 9.7	-11.4	-12.2	-12.5
Calculators	25,400,865	25,493,051	25,469,719	25,793,275	26,233,025	0.4	- 0.1	1.3	1.7
Copiers	1,832,922	1,897,392	1,933,342	1,983,792	2,047,945	3.5	1.9	2.6	3.2
LAN cards	7,157,403	9,123,596	10,588,271	12,348,697	14,566,616	27.5	16.1	16.6	18.0

Table 59
Eastern Europe
IT Hardware Shipments
(Units)

Eastern Europe	1994	1995	1996	1997	1998	1995/94 %	1996/95 %	1997/96 %	1998/97 %
Servers - large	37	10	17	25	26	-73.0	70.0	47.1	4.0
Servers - medium	385	541	565	609	674	40.5	4.4	7.8	10.7
Servers - small	5,089	6,564	6,700	7,165	8,165	29.0	2.1	6.9	14.0
Client-Workstations	4,914	4,340	4,590	5,590	6,310	-11.7	5.8	21.8	12.9
Client PCs - portable	76,671	104,842	112,445	130,540	143,200	36.7	7.3	16.1	9.7
Client PCs - desktop	1,169,049	1,463,233	1,758,500	2,039,800	2,327,800	25.2	20.2	16.0	14.1
Total Client PCs	1,245,720	1,568,075	1,870,945	2,170,340	2,471,000	25.9	19.3	16.0	13.9
PC printers	1,065,287	1,142,530	1,347,259	1,526,968	1,680,134	7.3	17.9	13.3	10.0
Copiers	184,532	202,825	220,608	243,333	265,892	9.9	8.8	10.3	9.3
LAN cards	360,746	482,193	584,940	674,233	767,333	33.7	21.3	15.3	13.8

8. ICT Trade Flows

The data presented on trade are based upon the Combined Nomenclature, an international standard for such data. The details concerning the product categories included are given at the end of the statistical section. In general terms, the trade data can be considered to match well but not exactly with the classification used for IT and telecommunications hardware throughout the statistical section. Data processing equipment, electronic office equipment, and components and related spares are all included. Semiconductor devices and other electronic components are not included.

Figures are presented in current ECU, according to standard valuation rules. Imports are generally stated at customs value or by reference to the concept of customs value (cif). Exports are stated at the value of the goods at the place and time that they leave the statistical area of the exporting member state (fob). Data availability for this exercise has been governed by the framework of the European Commission's statistical systems which now includes EU countries only.

The term intra-EU refers to trade between member states. Extra-EU trade is that between a member state and a non-member state. It should be noted that intra-EU import statistics are based upon the country of consignment, and not necessarily on the country of origin.

Table 60
Austria
Trade in ICT Hardware
(Thousand ECU)

Austria	1993	1994	1995
Imports from EU	731,137	844,591	1,370,502
Imports from other countries	914,869	1,062,612	456,486
Imports total	1,646,006	1,907,203	1,826,988
Exports intra-EU	280,327	245,953	299,148
Exports extra-EU	311,218	350,602	355,304
Exports total	591,545	596,555	654,452
Extra-EU/intra-EU exports	111.0%	142.5%	118.8%
Extra-EU/intra-EU imports	125.1%	125.8%	33.3%
Trade balance	-1,054,461	-1,310,648	-1,172,536
EU trade balance	- 450,810	- 598,638	-1,071,354

Table 61
Belgium/Luxembourg
Trade in ICT Hardware
(Thousand ECU)

Belgium/Luxembourg	1993	1994	1995
Imports intra-EU	1,508,064	1,779,553	2,377,669
Imports extra-EU	620,923	754,058	872,183
Imports total	2,128,987	2,533,611	3,249,851
Exports intra-EU	1,066,922	1,203,070	1,734,824
Exports extra-EU	611,782	1,003,193	845,708
Exports total	1,678,704	2,206,263	2,580,532
Extra-EU/intra-EU exports	57.3%	83.4%	48.7%
Extra-EU/intra-EU imports	41.2%	42.4%	36.7%
Trade balance	-450,283	-327,348	-669,320
Extra-EU trade balance	- 9,141	249,135	- 26,475

Table 62
Denmark
Trade in ICT Hardware
(Thousand ECU)

Denmark	1993	1994	1995
Imports intra-EU	996,569	1,034,533	1,542,801
Imports extra-EU	463,542	525,029	425,742
Imports total	1,460,111	1,559,562	1,968,543
Exports intra-EU	160,414	201,857	504,154
Exports extra-EU	344,658	447,047	269,445
Exports total	505,072	648,904	773,599
Extra-EU/intra-EU exports	214.9%	221.5%	53.4%
Extra-EU/intra-EU imports	46.5%	50.8%	27.6%
Trade balance	-955,039	-910,658	-1,194,943
Extra-EU trade balance	-118,884	- 77,982	- 156,297

Finland	1993	1994	1995
Imports from EU	244,334	313,118	835,749
Imports from other countries	564,865	832,954	538,350
Imports total	809,199	1,146,072	1,374,099
Exports intra-EU	455,376	599,216	946,091
Exports extra-EU	458,167	657,178	681,463
Exports total	913,543	1,256,394	1,627,553
Extra-EU/intra-EU exports	100.6%	109.7%	72.0%
Extra-EU/intra-EU imports	231.2%	266.0%	64.4%
Trade balance	104,344	110,322	253,455
EU trade balance	211,042	286,098	110,342

Table 63
Finland
Trade in ICT Hardware
(Thousand ECU)

France	1993	1994	1995
Imports intra-EU	5,268,517	5,923,238	6,533,932
Imports extra-EU	3,382,821	4,014,284	4,585,949
Imports total	8,651,338	9,937,522	11,119,881
Exports intra-EU	4,063,636	4,734,635	6,024,790
Exports extra-EU	2,350,053	2,544,368	2,649,307
Exports total	6,413,689	7,279,003	8,674,096
Extra-EU/intra-EU exports	57.8%	53.7%	44.0%
Extra-EU/intra-EU imports	64.2%	67.8%	70.2%
Trade balance	-2,237,649	-2,658,519	-2,445,785
Extra-EU brade balance	-1,032,768	-1,469,916	-1,936,642

Table 64
France
Trade in ICT Hardware
(Thousand ECU)

Germany	1993	1994	1995
Imports intra-EU	5,733,191	6,815,048	8,307,693
Imports extra-EU	9,467,006	10,063,036	10,245,156
Imports total	15,200,197	16,878,084	18,552,849
Exports intra-EU	5,084,938	5,677,217	7,330,322
Exports extra-EU	4,759,559	5,623,051	5,171,753
Exports total	9,844,497	11,300,268	12,502,074
Extra-EU/intra-EU exports	93.6%	99.0%	70.6%
Extra-EU/intra-EU imports	165.1%	147.7%	123.3%
Trade balance	-5,355,700	-5,577,816	-6,050,775
Extra-EU trade balance	-4,707,447	-4,439,985	-5,073,404

Table 65
Germany
Trade in ICT Hardware
(Thousand ECU)

Table 66
Greece
Trade in ICT Hardware
(Thousand ECU)

Greece	1993	1994	1995
Imports intra-EU	381,898	372,957	374,208
Imports extra-EU	162,238	135,413	105,415
Imports total	544,136	508,370	479,623
Exports intra-EU	51,302	40,055	35,078
Exports extra-EU	13,004	14,571	20,417
Exports total	64,306	54,626	55,495
Extra-EU/intra-EU exports	25.3%	36.4%	58.2%
Extra-EU/intra-EU imports	42.5%	36.3%	28.2%
Trade balance	-479,830	-453,744	-424,128
Extra-EU trade balance	-149,234	-120,842	- 84,998

Table 67
Ireland
Trade in ICT Hardware
(Thousand ECU)

Ireland	1993	1994	1995
Imports intra-EU	745,517	773,728	1,201,035
Imports extra-EU	1,565,713	2,055,872	2,942,843
Imports total	2,311,230	2,829,600	4,143,878
Exports intra-EU	2,873,709	3,518,890	5,667,386
Exports extra-EU	1,856,879	1,782,637	1,797,309
Exports total	4,730,588	5,301,527	7,464,696
Extra-EU/intra-EU exports	64.6%	50.7%	31.7%
Extra-EU/intra-EU imports	210.0%	265.7%	245.0%
Trade balance	2,419,358	2,471,927	3,320,818
Extra-EU trade balance	291,166	- 273,235	-1,145,534

Table 68
Italy
Trade in ICT Hardware
(Thousand ECU)

Italy	1993	1994	1995
Imports intra-EU	3,081,983	3,348,104	4,098,351
Imports extra-EU	1,727,369	1,726,871	1,743,065
Imports total	4,809,352	5,074,975	5,841,416
Exports intra-EU	2,813,318	2,844,340	3,191,337
Exports extra-EU	1,203,399	1,381,542	1,597,102
Exports total	4,016,717	4,225,882	4,788,438
Extra-EU/intra-EU exports	42.8%	48.6%	50.0%
Extra-EU/intra-EU imports	56.0%	51.6%	42.5%
Trade balance	-792,635	-849,093	-1,052,978
Extra-EU trade balance	-523,970	-345,329	- 145,963

Netherlands	1993	1994	1995
Imports intra-EU	3,697,268	4,864,276	5,603,904
Imports extra-EU	4,092,617	5,800,501	6,552,897
Imports total	7,789,885	10,664,777	12,156,801
Exports intra-EU	5,350,143	8,485,912	10,526,760
Exports extra-EU	1,446,909	2,000,159	1,535,309
Exports total	6,797,052	10,486,071	12,062,068
Extra-EU/intra-EU exports	27.0%	23.6%	14.6%
Extra-EU/intra-EU imports	110.7%	119.2%	116.9%
Trade balance	- 992,833	- 178,706	- 94,733
Extra-EU trade balance	-2,645,708	-3,800,342	-5,017,588

Table 69
Netherlands
Trade in ICT Hardware
(Thousand ECU)

Portugal	1993	1994	1995
Imports intra-EU	487,667	508,383	637,632
Imports extra-EU	153,948	142,712	114,153
Imports total	641,615	651,095	751,786
Exports intra-EU	57,599	55,956	61,548
Exports extra-EU	18,488	19,537	13,405
Exports total	76,087	75,493	74,954
Extra-EU/intra-EU exports	32.1%	34.9%	21.8%
Extra-EU/intra-EU imports	31.6%	28.1%	17.9%
Trade balance	-565,528	-575,602	-676,832
Extra-EU trade balance	-135,460	-123,175	-100,748

Table 70
Portugal
Trade in ICT Hardware
(Thousand ECU)

Spain	1993	1994	1995
Imports intra-EU	1,929,631	1,973,748	2,278,626
Imports extra-EU	854,113	1,073,060	1,075,696
Imports total	2,783,744	3,046,808	3,354,322
Exports intra-EU	738,015	823,575	698,973
Exports extra-EU	616,954	753,848	822,873
Exports total	1,354,969	1,577,423	1,521,846
Extra-EU/intra-EU exports	83.6%	91.5%	117.7%
Extra-EU/intra-EU imports	44.3%	54.4%	47.2%
Trade balance	-1,428,775	-1,469,385	-1,832,476
Extra-EU trade balance	- 237,159	- 319,212	- 252,823

Table 71
Spain
Trade in ICT Hardware
(Thousand ECU)

Table 72
Sweden
Trade in ICT Hardware
(Thousand ECU)

Sweden	1993	1994	1995
Imports from EU	719,078	914,057	2,150,316
Imports from other countries	1,507,464	1,718,094	886,904
Imports total	2,226,542	2,632,151	3,037,221
Exports intra-EU	803,368	713,317	809,563
Exports extra-EU	966,228	1,266,051	1,327,672
Exports total	1,769,596	1,979,368	2,137,235
Extra-EU/intra-EU exports	120.3%	177.5%	164.0%
Extra-EU/intra-EU imports	209.6%	188.0%	41.2%
Trade balance	-456,946	-652,783	- 899,986
EU trade balance	84,290	-200,740	-1,340,753

Table 73
UK
Trade in ICT Hardware
(Thousand ECU)

UK	1993	1994	1995
Imports intra-EU	5,752,384	6,818,219	7,758,613
Imports extra-EU	7,832,374	8,575,893	9,069,755
Imports total	13,584,758	15,394,112	16,828,368
Exports intra-EU	6,746,608	7,998,328	10,426,364
Exports extra-EU	4,056,396	5,216,541	5,283,127
Exports total	10,803,004	13,214,869	15,709,491
Extra-EU/intra-EU exports	60.1%	65.2%	50.7%
Extra-EU/intra-EU imports	136.2%	125.8%	116.9%
Trade balance	-2,781,754	-2,179,243	-1,118,877
Extra-EU trade balance	-3,775,978	-3,359,352	-3,786,629

Table 74
EU
Trade in ICT Hardware
(Thousand ECU)

EU	1993	1994	1995
Imports intra-EU	28,586,125	34,211,787	40,714,464
Imports extra-EU	30,322,665	34,866,729	37,732,855
Imports total	58,908,790	69,078,516	78,447,319
Exports intra-EU	28,846,193	35,583,835	46,201,535
Exports extra-EU	17,278,081	20,786,494	20,005,755
Exports total	46,124,274	56,370,329	66,207,290
Extra-EU/intra-EU exports	59.9%	58.4%	43.3%
Extra-EU/intra-EU imports	106.1%	101.9%	92.7%
Trade balance	-12,784,516	-12,708,187	-12,240,029
Extra-EU trade balance	-13,044,584	-14,080,235	-17,727,101

9. Market Structures and Penetration of ICT

The different markets in Europe certainly share certain features with their neighbours, but equally, the degree of variation amongst the countries is also considerable. The tables which follow attempt to illustrate the degree to which Western European countries differ in terms of their competitive fabric, and overall use of IT and telecommunications.

The market share of a leader in a particular market is, for the purposes of this study, a composite measure. This is necessary because of the nature of the IT market in Europe. Thus, it should not be assumed that a figure under this heading gives the total market share of a single national supplier. The composite measure is designed to assess the degree to which the market leaders in various related sectors dominate those markets. A similar principle is used in arriving at a figure for market concentration. These figures refer to the cumulative market share of the top ten vendors in each year, with the composition of the top ten varying from year to year. The software and services markets are here defined in terms which stress the separate products. They are not therefore sensitive to the balance of power between the traditional hardware suppliers and independent specialists. This is justified with reference to the theory of de-integration of the industry, and because of the predominance of hardware suppliers in terms of the systems software that is essential for the operation of the machines but not intimately associated with the solution of user-oriented problems.

Throughout Western European countries, the ratios of the value of the ICT market to gross national product, or of the IT market value to the total population, vary considerably.

Table 75
Austria
Market Structures and Penetration of ICT

Austria		1993	1994	1995
Industry leader's share	Hardware	23.7%	21.1%	15.5%
	Software	2.8%	6.0%	6.9%
	Services	3.0%	2.1%	1.8%
Industry concentration (top 10 vendors)	Hardware	63.4%	61.4%	58.1%
	Software	11.1%	21.0%	25.2%
	Services	15.9%	10.0%	9.0%
Market comparisons	IT market versus GDP	1.69%	1.72%	1.80%
	Per capita IT expenditure (ECU)	340	366	396
	ICT market versus GDP	3.39%	3.46%	3.61%
	Per capita ICT expenditure (ECU)	681	735	793

Table 76
Belgium/Luxembourg
Market Structures and Penetration of ICT

Belgium/Luxembourg		1993	1994	1995
Industry leader's share	Hardware	20.2%	19.5%	16.4%
	Software	3.1%	3.1%	3.6%
	Services	2.9%	3.0%	4.3%
Industry concentration (top 10 vendors)	Hardware	60.5%	60.7%	55.3%
	Software	15.6%	10.1%	11.8%
	Services	19.5%	17.6%	16.7%
Market comparisons	IT market versus GDP	2.28%	2.25%	2.25%
	Per capita IT expenditure (ECU)	423	436	453
	ICT market versus GDP	4.10%	4.11%	4.22%
	Per capita ICT expenditure (ECU)	760	797	850

Table 77
Denmark
Market Structures and Penetration of ICT

Denmark		1993	1994	1995
Industry leader's share	Hardware	27.1%	23.7%	21.7%
	Software	2.9%	7.4%	7.7%
	Services	4.4%	4.2%	4.3%
Industry concentration (top 10 vendors)	Hardware	62.0%	60.1%	61.8%
	Software	13.0%	17.4%	18.2%
	Services	16.8%	14.0%	14.0%
Market comparisons	IT market versus GDP	2.70%	2.63%	2.76%
	Per capita IT expenditure (ECU)	619	643	698
	ICT market versus GDP	4.59%	4.62%	4.82%
	Per capita ICT expenditure (ECU)	1,051	1,130	1,219

Finland		1993	1994	1995
Industry leader's share	Hardware	15.7%	13.9%	15.1%
	Software	5.6%	7.7%	8.3%
	Services	8.4%	9.5%	11.0%
Industry concentration (top 10 vendors)	Hardware	53.9%	57.7%	65.3%
	Software	24.7%	30.0%	33.2%
	Services	26.2%	22.3%	21.9%
Market comparisons	IT market versus GDP	2.20%	2.23%	2.31%
	Per capita IT expenditure (ECU)	358	381	426
	ICT market versus GDP	4.34%	4.39%	4.46%
	Per capita ICT expenditure (ECU)	708	751	822

Table 78
Finland
Market Structures and Penetration of ICT

France		1993	1994	1995
Industry leader's share	Hardware	19.5%	20.4%	19.6%
	Software	7.1%	7.4%	7.4%
	Services	4.4%	4.2%	4.7%
Industry concentration (top 10 vendors)	Hardware	60.3%	61.2%	57.0%
	Software	22.8%	19.7%	20.9%
	Services	22.3%	18.6%	17.9%
Market comparisons	IT market versus GDP	2.09%	2.02%	2.05%
	Per capita IT expenditure (ECU)	397	396	417
	ICT market versus GDP	3.91%	4.00%	4.12%
	Per capita ICT expenditure (ECU)	741	785	837

Table 79
France
Market Structures and Penetration of ICT

Germany		1993	1994	1995
Industry leader's share	Hardware	18.4%	17.1%	10.6%
	Software	5.9%	6.4%	6.5%
	Services	5.7%	3.3%	4.5%
Industry concentration (top 10 vendors)	Hardware	56.6%	56.9%	41.7%
	Software	14.9%	20.0%	22.0%
	Services	19.8%	10.3%	13.0%
Market comparisons	IT market versus GDP	2.08%	1.99%	2.07%
	Per capita IT expenditure (ECU)	426	426	460
	ICT market versus GDP	4.05%	4.10%	4.27%
	Per capita ICT expenditure (ECU)	827	876	946

Table 80
Germany
Market Structures and Penetration of ICT

Table 81
Italy
Market Structures and Penetration of ICT

Italy		1993	1994	1995
Industry leader's share	Hardware	28.5%	33.7%	25.2%
	Software	2.5%	4.6%	5.0%
	Services	8.1%	8.1%	9.1%
Industry concentration (top 10 vendors)	Hardware	62.6%	63.4%	54.8%
	Software	9.3%	15.2%	15.0%
	Services	30.8%	17.8%	20.9%
Market comparisons	IT market versus GDP	1.49%	1.38%	1.34%
	Per capita IT expenditure (ECU)	209	204	214
	ICT market versus GDP	3.48%	3.48%	3.44%
	Per capita ICT expenditure (ECU)	487	516	550

Table 82
Netherlands
Market Structures and Penetration of ICT

Netherlands		1993	1994	1995
Industry leader's share	Hardware	18.5%	19.5%	20.8%
	Software	4.2%	2.9%	3.1%
	Services	12.2%	10.4%	12.5%
Industry concentration (top 10 vendors)	Hardware	57.1%	58.9%	65.3%
	Software	17.8%	14.4%	14.9%
	Services	34.9%	27.9%	30.9%
Market comparisons	IT market versus GDP	2.65%	2.62%	2.71%
	Per capita IT expenditure (ECU)	471	486	521
	ICT market versus GDP	4.94%	4.97%	5.18%
	Per capita ICT expenditure (ECU)	877	922	997

Table 83
Norway
Market Structures and Penetration of ICT

Norway		1993	1994	1995
Industry leader's share	Hardware	14.1%	15.0%	14.5%
	Software	3.1%	11.1%	10.5%
	Services	2.5%	2.2%	3.0%
Industry concentration (top 10 vendors)	Hardware	49.2%	54.7%	61.2%
	Software	19.1%	26.1%	29.4%
	Services	14.2%	13.5%	16.3%
Market comparisons	IT market versus GDP	2.40%	2.42%	2.50%
	Per capita IT expenditure (ECU)	556	592	648
	ICT market versus GDP	4.43%	4.49%	4.58%
	Per capita ICT expenditure (ECU)	1,025	1,096	1,189

Spain		1993	1994	1995
Industry leader's share	Hardware	20.5%	19.1%	14.9%
	Software	6.4%	12.2%	16.9%
	Services	11.6%	9.0%	8.6%
Industry concentration (top 10 vendors)	Hardware	53.9%	54.7%	49.5%
	Software	19.7%	32.3%	37.3%
	Services	37.5%	37.3%	36.4%
Market comparisons	IT market versus GDP	1.32%	1.18%	1.18%
	Per capita IT expenditure (ECU)	128	121	131
	ICT market versus GDP	3.45%	3.55%	3.57%
	Per capita ICT expenditure (ECU)	335	366	396

Table 84
Spain
Market Structures and Penetration of ICT

Sweden		1993	1994	1995
Industry leader's share	Hardware	17.3%	17.3%	20.9%
	Software	2.7%	9.9%	20.7%
	Services	6.3%	5.7%	7.5%
Industry concentration (top 10 vendors)	Hardware	56.4%	56.0%	80.7%
	Software	12.7%	24.0%	34.0%
	Services	26.5%	24.4%	21.0%
Market comparisons	IT market versus GDP	2.70%	2.79%	2.90%
	Per capita IT expenditure (ECU)	522	566	630
	ICT market versus GDP	5.26%	5.41%	5.58%
	Per capita ICT expenditure (ECU)	1,019	1,098	1,214

Table 85
Sweden
Market Structures and Penetration of ICT

Switzerland		1993	1994	1995
Industry leader's share	Hardware	20.7%	21.7%	19.6%
	Software	2.9%	6.7%	6.7%
	Services	1.8%	1.6%	1.4%
Industry concentration (top 10 vendors)	Hardware	56.7%	58.6%	62.7%
	Software	8.3%	19.7%	20.3%
	Services	7.6%	4.8%	4.7%
Market comparisons	IT market versus GDP	2.79%	2.73%	2.86%
	Per capita IT expenditure (ECU)	888	887	942
	ICT market versus GDP	5.04%	5.33%	5.63%
	Per capita ICT expenditure (ECU)	1,606	1,732	1,855

Table 86
Switzerland
Market Structures and Penetration of ICT

Table 87
United Kingdom
Market Structures
and Penetration of ICT

United Kingdom		1993	1994	1995
Industry leader's share	Hardware	13.6%	13.8%	16.9%
	Software	5.4%	5.1%	4.8%
	Services	4.4%	4.4%	4.9%
Industry concentration (top 10 vendors)	Hardware	51.1%	50.3%	60.0%
	Software	16.5%	16.1%	16.0%
	Services	32.7%	27.0%	31.2%
Market comparisons	IT market versus GDP	2.43%	2.45%	2.55%
	Per capita IT expenditure (ECU)	319	339	370
	ICT market versus GDP	4.77%	4.85%	5.09%
	Per capita ICT expenditure (ECU)	626	672	739

Table 88
Per Capita IT
Expenditure ECU
(left)

Table 89
IT % GDP
(right)

	1993	1994	1995	1996
Austria	340	366	396	426
Belgium/Luxemb.	423	436	453	480
Denmark	619	643	698	744
Finland	358	381	426	460
France	397	396	417	440
Germany	426	426	460	483
Greece	41	45	50	55
Ireland	190	203	217	229
Italy	209	204	214	223
Netherlands	471	486	521	558
Norway	556	592	648	692
Portugal	81	83	88	95
Spain	128	121	131	142
Sweden	522	566	630	671
Switzerland	888	887	942	1,004
UK	319	339	370	398
Western Europe	335	340	365	389
US	624	674	763	862
Japan	540	603	672	759

	1993	1994	1995	1996
Austria	1.69	1.72	1.80	1.90
Belgium/Luxemb.	2.28	2.25	2.25	2.32
Denmark	2.70	2.63	2.76	2.84
Finland	2.20	2.23	2.31	2.41
France	2.09	2.02	2.05	2.12
Germany	2.08	1.99	2.07	2.08
Greece	0.63	0.62	0.62	0.63
Ireland	1.67	1.66	1.63	1.60
Italy	1.49	1.38	1.34	1.29
Netherlands	2.65	2.62	2.71	2.84
Norway	2.40	2.42	2.50	2.51
Portugal	1.15	1.11	1.10	1.11
Spain	1.32	1.18	1.18	1.21
Sweden	2.70	2.79	2.90	3.02
Switzerland	2.79	2.73	2.86	3.03
UK	2.43	2.45	2.55	2.63
Western Europe	2.06	1.99	2.04	2.08
US	3.27	3.36	3.67	4.01
Japan	1.94	2.15	2.40	2.67

Table 90
Per Capita Telecommunications Expenditure ECU (left)

Table 91
Telecommunications % GDP (right)

	1993	1994	1995	1996
Austria	341	369	397	428
Belgium/Luxemb.	337	361	397	438
Denmark	432	487	521	556
Finland	349	370	396	420
France	344	389	420	456
Germany	401	450	487	510
Greece	163	185	207	227
Ireland	387	403	446	490
Italy	278	312	336	368
Netherlands	405	436	476	509
Norway	470	503	541	577
Portugal	187	214	244	279
Spain	207	245	265	287
Sweden	497	532	584	621
Switzerland	718	845	913	980
UK	307	333	369	399
Western Europe	333	372	405	437
US	524	535	556	586
Japan	481	530	554	576

	1993	1994	1995	1996
Austria	1.70	1.73	1.80	1.91
Belgium/Luxemb.	1.82	1.86	1.97	2.11
Denmark	1.89	1.99	2.06	2.12
Finland	2.14	2.17	2.15	2.20
France	1.82	1.98	2.07	2.20
Germany	1.96	2.10	2.20	2.20
Greece	2.51	2.55	2.57	2.57
Ireland	3.41	3.30	3.36	3.44
Italy	1.99	2.10	2.10	2.14
Netherlands	2.28	2.35	2.47	2.59
Norway	2.03	2.06	2.08	2.10
Portugal	2.67	2.87	3.04	3.26
Spain	2.13	2.38	2.39	2.45
Sweden	2.56	2.62	2.69	2.79
Switzerland	2.25	2.60	2.77	2.96
UK	2.34	2.40	2.54	2.64
Western Europe	2.05	2.18	2.26	2.33
US	2.74	2.66	2.67	2.73
Japan	1.72	1.89	1.98	2.03

Table 92
Per Capita ICT Expenditure ECU (left)

Table 93
ICT % GDP (right)

	1993	1994	1995	1996
Austria	681	735	793	854
Belgium/Luxemb.	760	797	850	918
Denmark	1,051	1,130	1,219	1,300
Finland	708	751	822	880
France	741	785	837	896
Germany	827	876	946	994
Greece	204	230	257	282
Ireland	577	606	663	719
Italy	487	516	550	591
Netherlands	877	922	997	1,067
Norway	1,025	1,096	1,189	1,269
Portugal	268	297	332	374
Spain	335	366	396	429
Sweden	1,019	1,098	1,214	1,292
Switzerland	1,606	1,732	1,855	1,984
UK	626	672	739	798
Western Europe	668	712	770	826
US	1,148	1,209	1,318	1,448
Japan	1,021	1,133	1,226	1,336

	1993	1994	1995	1996
Austria	3.39	3.46	3.61	3.82
Belgium/Luxemb.	4.10	4.11	4.22	4.43
Denmark	4.59	4.62	4.82	4.96
Finland	4.34	4.39	4.46	4.61
France	3.91	4.00	4.12	4.32
Germany	4.05	4.10	4.27	4.29
Greece	3.14	3.16	3.18	3.20
Ireland	5.08	4.97	4.99	5.04
Italy	3.48	3.48	3.44	3.43
Netherlands	4.94	4.97	5.18	5.42
Norway	4.43	4.49	4.58	4.61
Portugal	3.82	3.98	4.14	4.37
Spain	3.45	3.55	3.57	3.67
Sweden	5.26	5.41	5.58	5.81
Switzerland	5.04	5.33	5.63	5.98
UK	4.77	4.85	5.09	5.28
Western Europe	4.11	4.17	4.31	4.41
US	6.02	6.02	6.34	6.74
Japan	3.66	4.05	4.38	4.70

10. Price Dynamics

Figure 13
Evolution of Average Selling Prices for PCs, US (ECU) 1991–1998

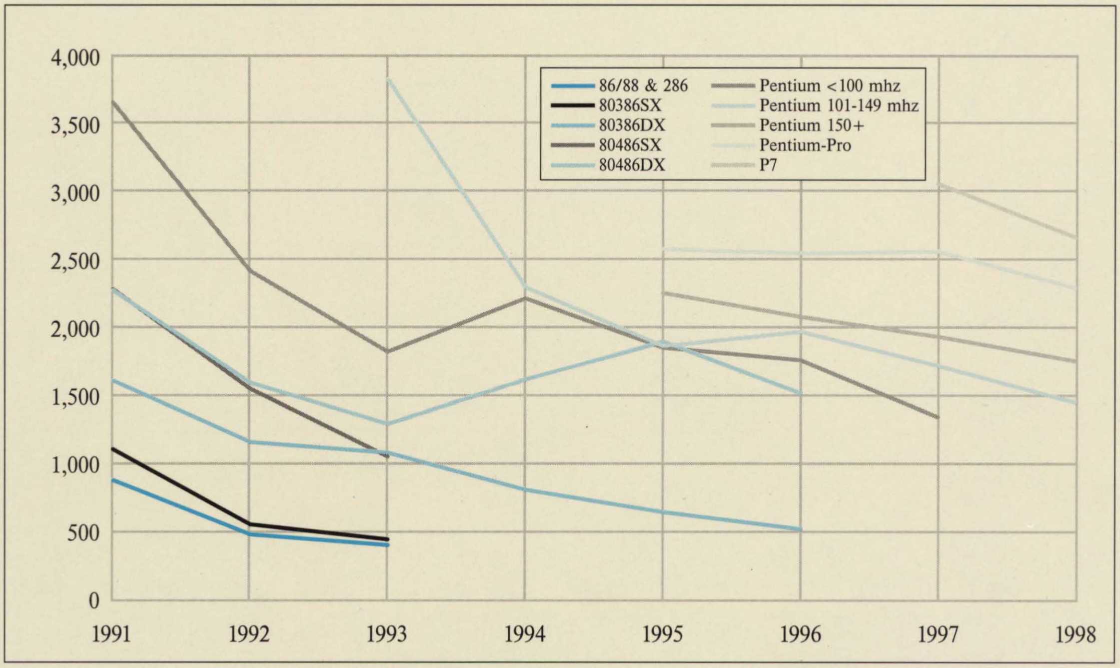


Table 94
Evolution of Average Selling Prices for PCs, US (ECU Exchange Rates 1996) 1991–1998

	1991	1992	1993	1994	1995	1996	1997	1998
86/88 & 286	883	484	406	n/a	n/a	n/a	n/a	n/a
80386SX	1,109	555	445	n/a	n/a	n/a	n/a	n/a
80386DX	1,617	1,164	1,086	812	648	523	n/a	n/a
80486SX	2,289	1,555	1,055	n/a	n/a	n/a	n/a	n/a
80486DX	2,281	1,602	1,297	1,626	1,904	1,525	n/a	n/a
Pentium <100 mhz	3,664	2,422	1,828	2,221	1,858	1,766	1,346	n/a
Pentium 101–149 mhz	n/a	n/a	3,836	2,305	1,871	1,978	1,728	1,458
Pentium 150+	n/a	n/a	n/a	n/a	2,261	2,086	1,940	1,761
Pentium-Pro	n/a	n/a	n/a	n/a	2,586	2,556	2,570	2,302
P7	n/a	n/a	n/a	n/a	n/a	n/a	3,067	2,674

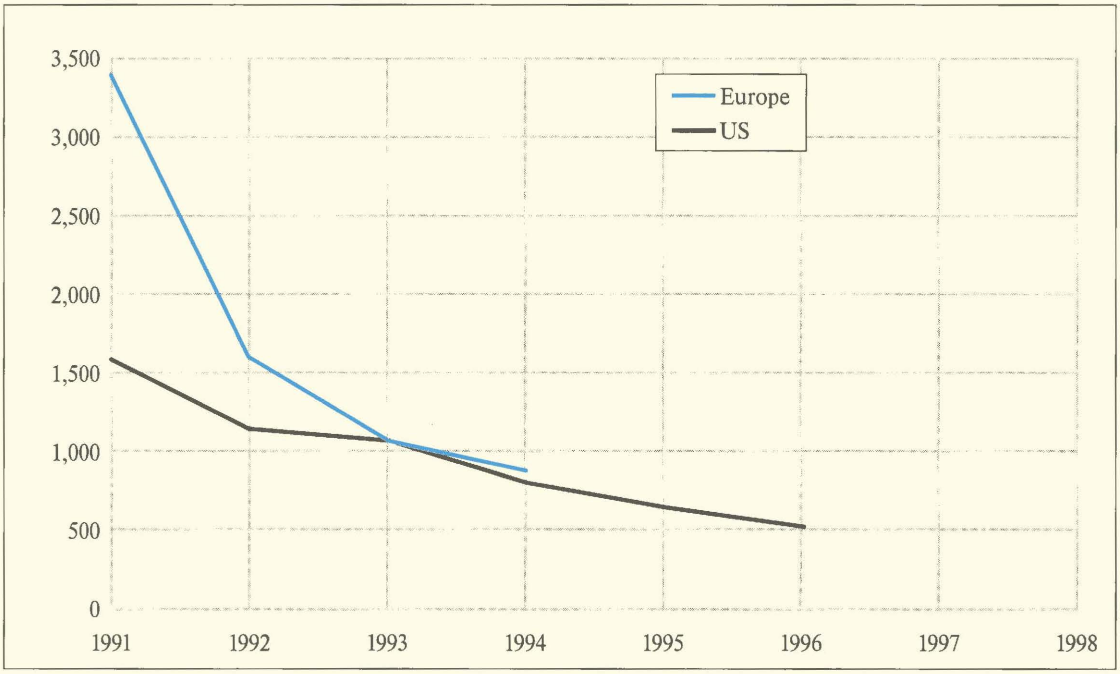


Figure 14
Convergence of Average Selling Prices for 386DX PCs (US versus Europe), ECU, 1991–1998

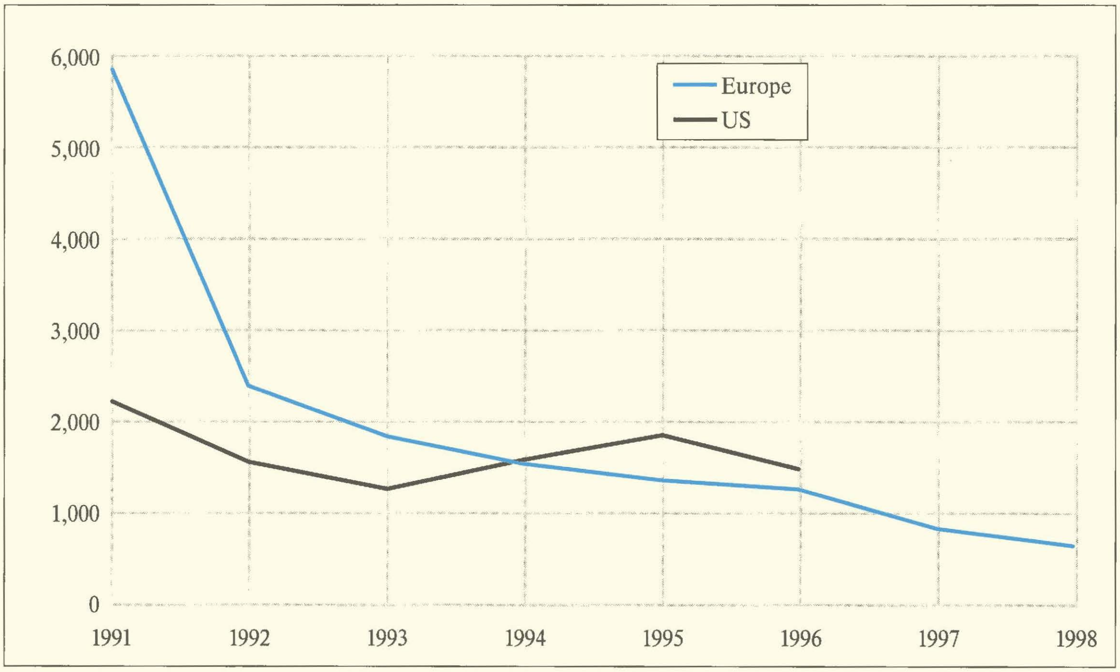


Figure 15
Convergence of Average Selling Prices for 486DX PCs (US versus Europe), ECU, 1991–1998

Figure 16
Evolution of Average Selling Prices for PCs, Europe (ECU), 1991–1998

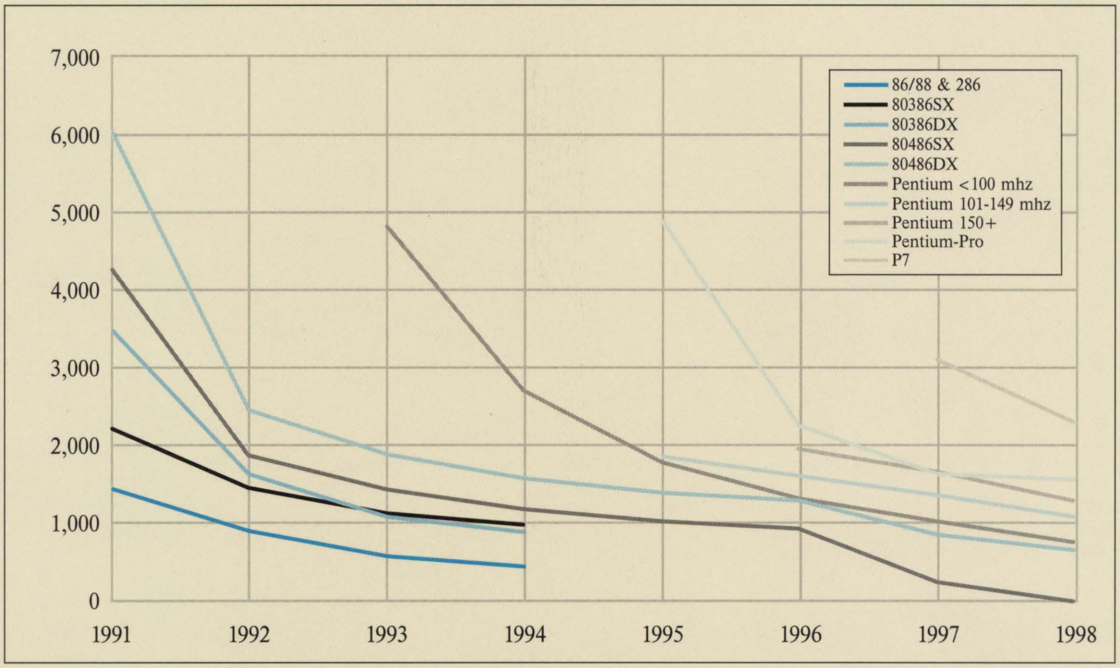


Table 95
Evolution of Average Selling Prices for PCs, Europe (ECU Exchange Rates 1996), 1991–1998

	1991	1992	1993	1994	1995	1996	1997	1998
86/88 & 286	1,441	903	577	445	n/a	n/a	n/a	n/a
80386SX	2,213	1,456	1,127	980	n/a	n/a	n/a	n/a
80386DX	3,468	1,632	1,082	887	n/a	n/a	n/a	n/a
80486SX	4,252	1,873	1,433	1,180	1,023	930	245	n/a
80486DX	6,008	2,454	1,884	1,576	1,391	1,291	852	657
Pentium <100 mhz	n/a	n/a	4,805	2,702	1,779	1,318	1,023	760
Pentium 101-149 mhz	n/a	n/a	n/a	n/a	1,857	1,606	1,360	1,086
Pentium 150+	n/a	n/a	n/a	n/a	n/a	1,951	1,660	1,291
Pentium-Pro	n/a	n/a	n/a	n/a	4,876	2,251	1,632	1,562
P7	n/a	n/a	n/a	n/a	n/a	n/a	3,096	2,302

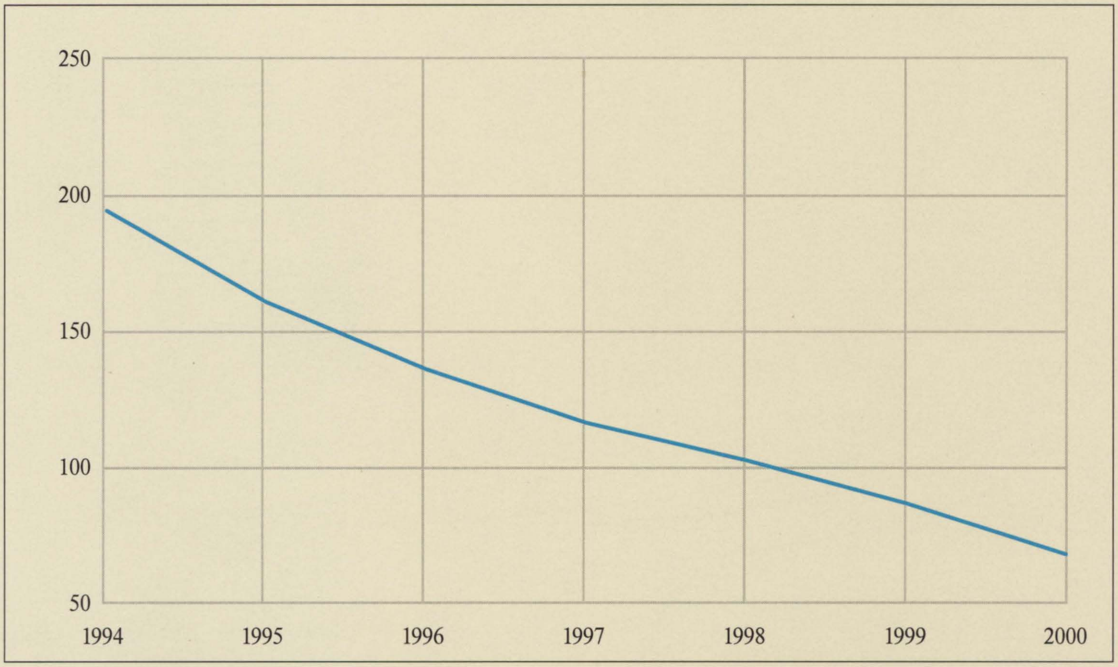


Figure 17
Evolution of Average Selling Price for PC Network Interface Card Worldwide (ECU), 1994–2000

11. Definitions

The Statistical Section of the EITO is based upon a set of definitions and methodologies agreed between the EITO Task Force and IDC, and upon the European Union standards for trade statistics. These definitions are outlined below.

Geographic coverage

The heading European Union (EU) refers to Austria, Belgium & Luxembourg, Denmark, Finland, France, Germany, Greece, Italy, the Republic of Ireland, the Netherlands, Portugal, Spain, Sweden and the UK. Non-EU is represented by data on Norway and Switzerland. Eurostat trade statistics to the end of 1994 refer to the twelve-member EU. Western Europe includes the European Union states plus Norway and Switzerland. Europe includes both, Western and Eastern Europe.

Throughout the statistical section Eastern Europe is considered to refer to the Czech Republic, Slovakia, Hungary, Poland and Russia.

The Four Tigers refers to Hong Kong, Korea, Singapore and Taiwan.

Information technology

For the purposes of this study information technology refers to the combined industries of hardware for office machines, data processing equipment, data communications equipment, of software and services.

Information and communications technologies (ICT)

For the purposes of this study information and communications technologies refer to information technology plus telecommunications equipment and telecommunications services.

All market values are in *constant* 1996 ECU (first 9 months average), therefore growth is expressed in local currencies (without the effects of changes in currency conversions). Trade data are reported in *current* ECU.

Domestic markets

Domestic market value reflects the revenues paid to primary vendors and the value-added across the distribution channels for sale to the final customer for office machines, DP systems, software and/or services. For product-specific definitions, see other terms below.

Unit shipments are the unit measure of hardware product sales by vendors to all distribution channels or to end-users. Units are counted as they leave suppliers and are not double-counted in the case of original equipment manufacturer (OEM) relationships.

IT user budgets are investigated in IT user surveys. As these measure purchase intentions and behaviours that vary according to different geographic and time parameters, growth rates of IT user budgets do not match with growth rates of market values.

11.1. Information Technology

11.1.1. IT Hardware

Computer hardware

Server systems include CPU(s) and basic peripherals (e. g., data storage devices, terminals, memory and peripherals), as well as revenue for new systems added to the installed base. Multiprocessor configurations are counted as single systems.

Server systems is a classification used to group all large-, medium- and small-scale systems (i. e., all computer systems except personal computers and single-user workstations) as well as PC servers. Multi-user computers are typically multi-tasking, multi-user systems which support and are principally marketed to support two or more users.

- *Servers large-scale:* Included in this class of systems are all high-end mainframes computers and supercomputers; typical products include IBM 3090 and ES/9021, Siemens-

Nixdorf H90, H120 and H130, Amdahl 5995, etc. These products are often - but not always - bounded at the bottom end by prices in excess of $ 1,000,000. They are almost exclusively used by large companies in data centres, although some of the most specialised systems are found in specialised smaller scientific and technical environments.

- *Servers medium-scale:* Included in this class of systems are all low-end mainframe computers and high-end midrange systems; typical products include IBM ES/9121, ES/9221 and high-end AS/400, Siemens-Nixdorf low-end BS2000 mainframes and RM600 Unix-based machines, Digital DEC 7000 and 10000, Tandem Cyclone/R and CLX, Groupe Bull's DPS/7000. These products are often, but not always, bounded at the top end by prices less than $ 1 million and at the bottom end by prices greater than $ 100,000. They are used by large and medium-sized companies in data centres, and by large companies in branch and departmental environments; some specialised systems are used in smaller scientific and technical environments.
- *Servers small-scale:* Included in this class of systems are all low-end minicomputers, workstation servers, and dedicated LAN servers; typical products include low-end IBM AS/400 and RS/6000, Digital's VAX 3000 and AlphaServer 1000, Siemens Nixdorf's RM400, low-end MX and 8860, Bull's DPS 6000, and DPX/20, ICL's low-end Teamserver and SuperServer, etc. These products are - but not always - bounded at the top end by prices lower than $ 100,000 and, at the bottom end by the ability to support a minimum of two terminal devices (e. g. the systems must be primarily designed to be sold as a multi-user computer). They are used in a wide variety of environments from departmental computing in large and medium-sized businesses to corporate computing in small businesses. Small-scale servers also include PC servers.

Client - workstations: Workstations include all workstations and personal workstations with the exception of NT/Pentium-based systems which are included in the PC segment. Traditional single-user workstations are defined by processor, operating system and typical price band of $ 4,000-15,000. This includes typical workstation-class processors, such as Sparc, MIPS, PA-RISC, Power, Clipper and MC680x0. Personal workstations represent the movement of PC vendors upward and workstations vendors "downwards". Personal workstations have the functionality, features, graphics and distributed computing together with the PC's buying patterns, price points and ease of use.

Client - personal computers (PCs) - are general purpose, single-user, microprocessor-based machines that are capable of supporting attached peripherals and can be programmed in a high-level language. Board level products are excluded. For microprocessor-based systems that can support more than one user, the distinction between a small-scale system and a personal computer is based on the system's most common configuration. If a system is designed as a server or is multi-microprocessor based, it is classified as a small-scale system.

- *Client PCs - portables:* portable and transportable machines are included in this category, but electronic organizers (such as the Psion Organizer products) are not counted. Sub-categories acknowledged include AC-portables, battery operated laptops, notebooks and sub-notebooks. Small hand-held products such as high-end organizers and palmtops are excluded from the portable definition.

- *Client PCs – desktops:* desktop and tower machines are included in this category, but dedicated games machines (such as Nintendo) are not included.

PC printers include models designed to be attached to PCs, not sold with the systems. These include dot matrix printers, thermal/thermal transfer printers, non-impact page printers, ink-jet printers and colour printers.

Office equipment

Office equipment includes:

Typewriters: mechanical, electric and electronic typewriters;

Calculators: professional desktop, pocket and hand-held models;

Copiers: personal, digital, and colour copiers;

Other office equipment: duplicating equipment (offsets, ink duplicators), cash registers and point of sale systems, document filing (microfilm, WORM optical disks), and other products (franking, addressing, labelling machines, mail handling systems, etc.).

Data communications hardware

Data Communications Hardware includes the LAN hardware and other data communications equipment markets.

LAN hardware is restricted to the equipment for multi-user systems, PCs, or workstations required to implement a local area network; it does not include software (e. g., specialized network operation systems) or servers, which are counted in their respective software and system categories. For this project, LAN connections that come bundled with a system and/or integrated on the mother board (e. g., Ethernet in workstations) are excluded to avoid double counting with the value of systems shipments.

The LAN hardware category includes LAN interfaces, LAN concentrators, terminal servers, internetwork equipment, repeaters.

- *LAN interfaces:* three categories are tracked here: LAN cards, workstation network interfaces and multi-user interfaces. Value is normally assigned on a per-node basis and includes both new networks and nodes shipped into existing LANs.
- *Intelligent LAN concentrators:* for this volume are hardware devices that act as central points for star wiring for the nodes attached to the LAN and additionally provide network management functionality over the physical layer.
- *Terminal servers* provide terminal connectivity to the LAN.
- *Internetwork equipment* includes bridges and routers. Bridges connect two networks, operate at level 2 (data link) of the International Standards Organisation (ISO) Open System Interconnection (OSI) model and are protocol-insensitive. Routers are devices that allow for multiple paths, providing two or more connections. They operate at level 3 (network) of the ISO OSI model and are protocol-sensitive, which allows them to "intelligently" decide how to route data.

Other data communications hardware is for this project expressly limited to hardware and to the following categories, of which it will be the sum: modems, multiplexers, X.25 pocket switching equipment, digital switching equipment, communications processors and channel extenders.

- *Modems* tracked are restricted to analogue and short haul modems, segmented into dial-up and leased line segments and by speed (14.4, 16.8-19.2, 1200, 4800 and 9600 bps); not counted are fibre optic, satellite, pocket, or broad band modems or digital-over-voice (DOV) products.

- *Multiplexers* are devices used to multiplex telecommunications circuits, using time-division and statistical time-division technology. Seven market segments are tracked: time-division multiplexers, point to point T-1 TDMs, networking T-1 TDMs, T-3 multiplexers (aggregates of 28 DS-1 circuits), and statistical TDMs; not addressed are coaxial or frequency division multiplexers or digital access cross-connect systems.
- *Packet switching equipment* includes all packet switch nodes to route data packets via the most efficient available path and PADS (Packet assemblers/disassemblers) to convert asynchronous and/or synchronous data to the relevant protocol format (e. g., X.25).
- *Digital switching equipment* includes matrix switches (designed to provide local and remote patching, switching and diagnostic functions, typically installed in data processing centres with two or more front-end processors) and data PBXs used to connect terminals to computer ports (increasingly obsolescent due to competition from front-end processors and local area networks).
- *Communications processors* are specialised and customised data communication devices that serve as nodal points for communications between IBM compatible hosts and other nodes on a network. The classical communications processor was a front-end processor configured to function solely as the interface between an SNA host and a cluster controller attached to 3270 terminals or PCs emulating terminals. Alternatives include remote processors configured as nodes in an SNA network and gateway processors configured to translate and/or route network protocols between SNA and non-SNA nodes.
- *Cluster controllers* are devices designed to control the I/O operations of a group of 3270-type devices, including displays and printers.
- *Channel extenders* are devices that extend the distance over which an I/O channel on a single IBM mainframe can communicate with an IBM compatible peripheral or another IBM mainframe.

The computer, office, and telecommunications equipment definitions above refer to what the EITO Task Force classifies as general-purpose products. This equipment can be used for a variety of applications in a variety of industries.

In addition to these general-purpose products, information technology is also used in a wide range of application-specific devices. These include, but are not limited to: retail point-of-sale systems, automatic teller machines, credit authorization terminals, smart-card readers, factory data collection systems, numerical controllers for manufacturing equipment, cheque processing equipment, computer assisted publishing systems, and specialized systems for the military, aerospace and other industries. Taken together these markets are significant.

Readers should keep these definition issues in mind when working with this volume and other statistical sources. Figures from IT companies, industry research firms and institutions, trade associations, and governments may well include a mix of general purpose and application-specific equipment, complicating attempts to make direct comparisons with the published EITO figures.

11.1.2. Software Products

Software products are commercially-available packaged programmes for sale or lease from systems vendors and independent software vendors (ISVs), and do not include specially designed application software solutions added by turnkey systems houses to systems acquired from a hardware manufacturer or other third party. The primary categories are 1) systems software and utilities 2) application tools, and 3) application solutions.

Also, for this volume the software products category includes license fees partially earmarked for software maintenance, services, and/or support; other forms of software support would be counted within the support services category.

- *Systems software* includes operating systems and utilities, as well as application tools. Operating systems and utilities are software programmes designed (1) to operate hardware through basic operating systems and programming languages, increase the efficiency of systems personnel through system performance measurement tools, improve the operating capabilities of the hardware system by routing the flow of data among machine units and handle data entry and delivery, or (2) to ensure programme integrity through maintenance and security programmes, convert programmes from one language to another, organize data resources through sort/merge products and monitor machine usage. Major components today include operating systems enhancements (e. g., MVS/ESA) and data centre management software, especially automated operations programmes. However, because bundled software is by definition not a market from which users can choose to buy, and to avoid double-counting with systems categories, bundled operating systems are counted only in the hardware systems categories.
- *Application tools* are programmes that allow users to retrieve, organize, manage and manipulate data and databases. This group is divided into four subcategories: data access/retrieval, data management, data manipulation and programme design development. It includes all database management system (DBMS) software; decision support and executive information system (EIS) programmes; spreadsheet programmes, including Lotus 1-2-3 and Excel; front-end and back-end CASE tools; and emerging areas like co-operative processing and/or object management application development tools.
- *Application solutions* software includes programmes designed to provide packaged software solutions for specific problems inherent in an industry or a business function. Such software can address "cross-industry" functions (e. g., accounting, human resource management, payroll, project management or word processing and other office activities) or specific industry solutions for vertical markets (e. g., banking/financial, manufacturing, health care, oil and gas exploration, etc.).

11.1.3. Services

Professional services

Professional services comprise procurements obtained on a customised or contractual basis for system and/or software development, systems design, integration, installation, related training/education, facilities management and consulting services for information technology purposes only (i. e. management consulting services are not included). The primary professional services activities can be divided into six categories:

- Requirements analysis, planning and strategy, as well as needs assessment for future IT services and equipment. This typically includes audits of hardware, software, personnel, security, work flow etc.
- Systems design represents the detailed deployment plans for the development of coherent information technology systems out of set resources.

- Contract programming and custom software development represents services (not products) offered on a fixed-fee, cost-plus, or per diem basis for application design, development, integration, and documentation.
- Systems and network implementation and integration includes physical systems integration, migration, system installation, "glue-code", cabling, subsystems integration, tuning, testing, and "burn-in".
- Management and administration constitutes charges for managing and administering a large services contract (e. g. project management for systems integration, or systems and/or network operations in facilities management). It includes overhead costs not captured elsewhere (e. g. human resources in a facilities management contract would be counted, but not the cost of system hardware or packaged software, which would be countered in the proper market category).
- Education and training includes course work and training (both on- and off-site) related to 1) systems and/or network installation and/or 2) software and programming, expect as provided for within a vendors service contract counted within software services above. Excluded from education and training are books and other published material and course work offered through public schools, colleges, universities and non-profit private institutions.

These six categories of activity can be variously applied in a number of ways, including business process redesign, systems integration and facilities management contracts. However, professional services do not include data processing that a vendor may resell from the client's site to a number of unrelated users at other sites, not does it include traditional time-sharing services or so-called processing services.

To avoid double-counting with the packaged software category, for this project, support services excludes software support contracted as part of long-term update and support agreements.

Processing services

Processing services comprises bureau-type services which can be classified under two further sub-headings; problem solving and transaction processing. Problem solving covers the provision of charged time on systems providing access to computer software tools, models or applications. Transaction processing covers access to specific applications programmes with charges often based upon the number of transactions processed.

Network services

Network services are defined as chargeable value-added services, and comprise managed network services, network processing services, network messaging services. E-mail, EDI and Value-added transport services are typical examples.

Hardware maintenance and support services

Hardware maintenance and support services comprise the repair or replacement of components of computer systems hardware (including data communications equipment, but not industry-specific terminals like ATMs), other hardware services (namely: disaster recovery, site planning, installation and relocation) and non-license-fee software support activities (telephone support, help desk outsourcing, etc.). Maintenance revenue may be generated by on-site maintenance, time and materials, parts for self-maintenance and/or depot services, in each case on a specific service contract or non-contract basis. To avoid double-counting, for this project, support services excludes software support contracted as part of long-term update and support agreements.

11.2. Telecommunications

11.2.1. Telecommunications Equipment

The market is classified according to the nature of the user:

Public network equipment

This segment includes all equipment used by carriers to provide voice/data network services.

Switching: local and junction switches, trunk switches, telex switches, data switches, cellular radio switches.

Transmission: multiplexers, microwave, cross connects, line terminals.

Mobile communications infrastructure: all types of equipment and systems used by PTO's in the build-up of their mobile telecommunications networks.

Private network equipment

Includes all the equipment installed at telecommunications users premises.

PABXs and key systems, private telecommunications switches used for switching incoming and outgoing calls.

Telephone sets includes domestic and business phones. Mobile terminal devices are not included in this category.

Mobile equipment (domestic and business), this segment includes mobile terminal devices: cordless phones and GSM hand-held devices, car phones, CTx and DECT systems, pagers. Equipment used in the running of a public wireless network is not included.

Other equipment includes domestic and business private equipment not otherwise counted above. This includes fax machines, answering machines, audio conferencing, video conferencing and automatic call distribution equipment.

11.2.2. Telecommunications Services

Telephone services: this segment includes carrier service revenues for residential, business, national and international voice services.

Mobile telephone services: this segment includes service revenues from analogue, digital and telepoint mobile networks (carphones and personal phones).

Switched data and leased-line services: this segment includes service revenues for the following categories:

- *Private line services,* a private line is a fixed connection between two points. Private lines are leased to a single customer, and only the traffic of that customer can travel through the circuit. Tariffs are based on fixed price per distance segment. No time or traffic related charges are made.
- *Switched data services,* this segment includes service revenues from packet switched data networks (e. g. Transpac) circuit switched networks, value added networks (e. g. GEIS), and ISDN services.

CaTV: includes revenues from basic CaTV subscriber service providing transmission improvement and/or added broadcast channels, plus revenues from auxiliary CaTV services (such as pay-TV, security services, or shopping revenues) when provided via a separate CaTV network. This includes revenues from any operator, public or private.

11.3. Performance Measures

11.3.1. Trade Statistics

All trade statistics are presented in current ECU and are based upon official European Union data. All conventions common in the presentation of such statistics have been observed. For a full treatment of this complex area readers are referred to the publications of the Customs Cooperation Council and Eurostat. Data based upon standard sub-headings of the Combined Nomenclature as listed below.

The reported areas (or grouping of countries) are: intra-EU (imports/exports occurring between a reporting country and a trading partner that are both within the EU), extra-EU (imports/exports occurring between one reporting/trading country in the European Union and one reporting/trading partner outside the EU).

Values of imports are generally stated at customs value or by reference to the concept of customs value (cif); exports are stated at the value of the goods at the place and time that they leave the statistical area of the exporting member state (fob). The main concern is in reporting countries of the European Union.

Please note: descriptions have been abbreviated. Product codes have been stated to indicate the level at which data was collected for this exercise. Thus, 84.69 should be considered to include all lower sub-headings below 84.69. Readers interested in the full details of the trade classification are referred to the following publications.

1. Explanatory Notes to the Combined Nomenclature of the European Union, published by the Office for the Official Publications for the European Commission.

2. Explanatory Notes to the Harmonised System Nomenclature, pub. Customs Cooperation Council.

List of import/export codes used to value IT and telecommunications hardware trade

84.69	typewriters and word processing machines
84.70	calculators: calculating machines, accounting machines, cash registers, postage franking machines, ticket-issuing machines and similar machines, incorporating a calculating device
84.43.12	offset printing machinery, sheet fed, office type, sheet size =<22x36 cm
84.71	DP equipment: Automatic data processing machines and units thereof; optical readers, machines for transcribing data onto data media in coded form, and machines for processing data.
84.72	"other" office equipment: printers, hectograph or stencil duplicating machines, addressing machines, automatic banknote dispensers, coin-sorting machines, coin-counting (or wrapping) machines, pencil sharpening machines, perforating or stapling machines
84.73	parts for use with the machines of sub-headings 84.69-84.72
90.09	photocopiers
85.17	equipment used for line telephony/ telegraphy: telephone sets, apparatus for carrier-current line systems, telegraphy apparatus, faxes, weather map plotters.
85.20.20	telephone answering machines incorporating a sound device.

11.3.2. Industry Leader's Market Share

Market share statistics are based upon aggregations of IDC research, to illustrate structural issues within the market while at the same time preserving confidentiality. For example, the figure reported for the leader's share of the hardware market in a particular country is in fact an aggregate of the market shares of the individual leaders of each of the standard IDC hardware market sectors.

11.3.3. Industry Concentration

As for the industry leader's (sic) market share (see above), industry concentration is an aggregate market share statistic. In this case, the market positions of the top 10 vendors in each of IDC's primary categories are used to compute the degree of concentration.

11.3.4. Exchange Rates

All *market* data and forecasts are presented in constant 1996 exchange rates. The exchange rates used for all except the East European markets are based upon the averages of daily rates for the individual currencies on the Paris money markets, as reported by the OECD. Averages are measured over the first 9 months of 1996.

1996 exchange rates have been preferred to 1995 annual averages (as in the past EITO reports) due to the high variations in the exchange rates of some European currencies during 1995. These changes would have affected the conversion of ICT market values leading to differences up to 80% in some countries.

Due to the characteristics of the local markets, Eastern European research has been carried out in a different fashion to that used for an established market. A different treatment is still necessary for Russia. In this case valuations continue to be made relative to a set of initial dollar values for equivalent Western machines. These reference values are then discounted by a variable amount which reflects the age of the systems. Finally, data are converted into ECU using the appropriate $/ECU exchange rate.

ECU Exchange Rates

(Units per ECU)

	1994	1995	1996*
Austria	13.60	13.18	13.37
Belgium	39.83	38.56	39.15
Denmark	7.57	7.32	7.35
Finland	6.21	5.71	5.84
France	6.61	6.52	6.48
Germany	1.93	1.87	1.90
Greece	288.33	302.75	305.85
Ireland	0.80	0.82	0.80
Italy	1,920.24	2,129.41	1,971.17
Netherlands	2.17	2.09	2.13
Norway	8.40	8.29	8.22
Portugal	197.62	195.95	195.97
Spain	159.52	163.01	160.19
Sweden	9.19	9.32	8.54
Switzerland	1.63	1.54	1.55
UK	0.77	0.82	0.83
US	1.19	1.31	1.27
Japan	121.2	123.01	136.71
Source: OECD			
Local commercial rates			
Czech Republic (Crowns)	33.6	33.4	34.4
Hungary (Forints)	126.1	193.7	185.4
Poland (Zloties)	2.7	3.5	3.5
Russia** (Roubles)	2,929.5	6,834.0	6,248.0
Slovak Republic (Crowns)	37.1	39.0	38.6

* Average of the first 9 months of 1996, as published by the OECD.
** Russia: research is carried out using US Dollars rather than Roubles. The Russian currency's steep devaluation makes local currency research impossible (e.g., in December 1995, rouble to ECU exchange rate was 7,146 roubles to the ECU).

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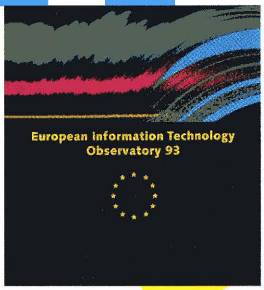

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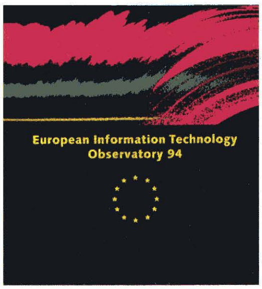

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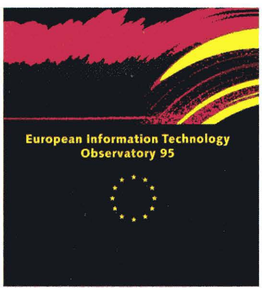

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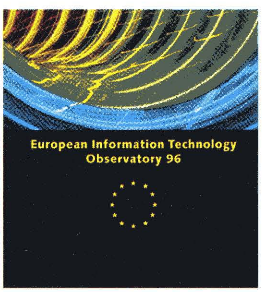

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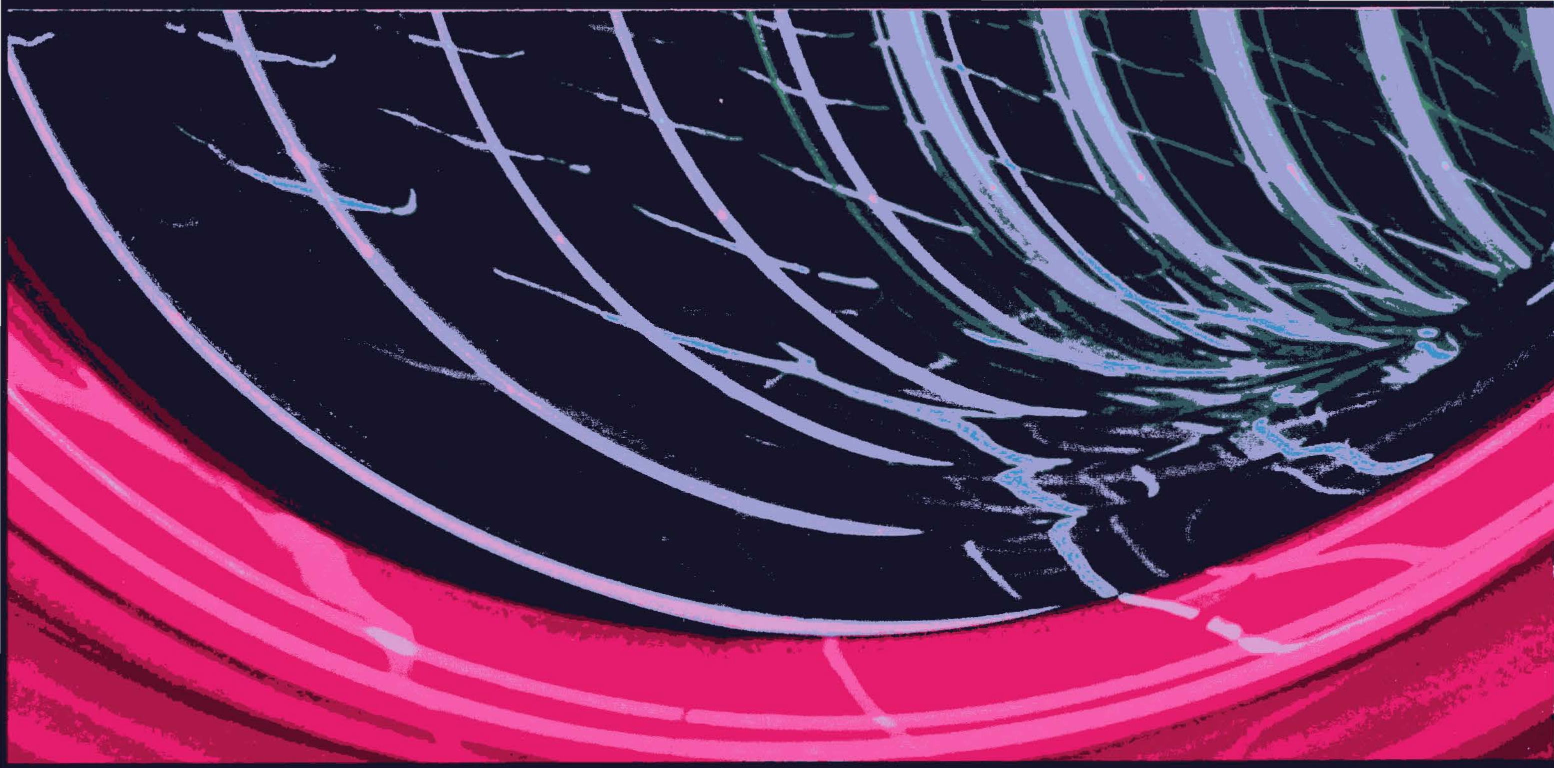

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