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Impact of Convergence on the Competitiveness of the European Consumer Electronics Industry.

An ESTO Project Report

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Preface

This report is based on the findings of an ESTO study ‘*Convergence in the European Consumer Industry: impact on competitiveness*’, finalised in May 2000.

The scope of the study was formulated at the request of the European Commission’s Directorate General for Enterprise (DG ENTR). It aims to respond to growing concerns about the impact of convergence on the competitiveness of European consumer electronics industries, industries which have been perceived as traditionally strong and which have been the source of significant employment and jobs within the EU.

The project’s activities focused on two research clusters: one on products, services and usage, and another on industrial structures and employment. Proposals for research for policy support were developed in a third cluster. Work was completed in April 2000 and resulted in 13 research papers. They are reproduced in annex and were the basis for an initial report for internal ESTO distribution.

The present report is based on the introduction and synthesis of the latter and benefited from discussion at an IPTS workshop held after the project was completed (see annex for a list of participants).

The project was managed by Dr. Nico Hazewindus (MERIT, Netherlands) in collaboration with Dr. Jean-Claude Burgelman (IPTS). The ESTO team led by Dr. Hazewindus consisted of Wendy K. Hansen (also of MERIT), Gerard J. Nauwelaerts, IPC (Ireland), Dr. Puay Tang and Tim Venables, SPRU (United Kingdom), Prof. Dr. Ulrik Jørgensen and Finn Hansen, ITS/DTU (Denmark), Pieter Ballon, TNO/STB (The Netherlands) and Alain Puissochet, IDATE (France).

Table of Content

Executive summary.....	5
1. Convergence in the European Consumer Industry: impact on competitiveness	9
2. Consumer electronics: a traditional view	12
3. Convergence and products	19
4. Convergence, industry structure and employment.....	30
5. Options for research for policy support: issues and methodologies.....	38
6. Conclusion. Convergence, competitiveness and public policy.	46
 Annex I Overview of research papers.....	 48
 Annex II Convergence in the European Consumer Electronics Industry: Impact and Policy Options for Competitiveness. IPTS Workshop, Seville 25-26 May 2000. List of Participants	 148

Executive summary

Scope of the Study

Consumer Electronics is a global business and the European CE industry consists mainly of global players. CE is an important industrial sector in Europe, in terms of both the quality of its products and the number of jobs it generates. CE, together with services and content it helps deliver, has a strong impact on European society.

The study therefore explores how trends in convergence influence the competitiveness of the European CE industry.

The major research questions considered were:

- How is the CE product spectrum changing; how are related services developing and what trends in usage can be identified?
- How is the global structure of the CE industry changing and what effect could this have on employment in the European Union?
- Which public policies could be important in this context and what underlying research is needed to develop them?

Convergence was described in the Commission's Green Paper on the subject as "the ability of different network platforms to carry essentially similar kinds of services" [COM(1999)108 final].

Convergence now manifests itself in the merging or combination of content (audio-visual, publishing, ...), infrastructure (broadcast, telecommunications, mobile..), storage and processing capabilities of computers, and computer electronics in order to develop a single product, application or service. Since the PC, telephone and TV are the key devices of convergence, it follows that the impact on consumer electronics industry will be strong and enduring.

We take Consumer Electronics to include all electronic hardware and software products and systems, fixed and mobile intended for purchase by large numbers of the public, and which can provide them with access to services, functions and content at their discretion.

As such convergence Consumer Electronics can be viewed as a series of products and services resulting from a consumer-oriented value chain as opposed to one which is business-oriented.

Main conclusions

Convergence affects this activity directly or indirectly, creating both opportunities and threats, in the following ways:

- Consumer Electronics Convergence is changing existing products and accelerating the introduction of new ones; it is observable at the hardware level (platforms) but software is more likely to constitute the effective added value.

- Convergence creates opportunities for small- and medium-sized businesses.
- Convergence in CE introduces new relations between CE producers, content owners and service providers.
- Convergence is characterised by growing functionality in Consumer Electronics products *and* services.
- Convergence creates new type of consumers with new types of individual and collective behaviours.
- Convergence affects the whole value chain of Consumer Electronics, while making the industrial operations and structures more complex. It also offers opportunities for radically renewed business models and the emergence of new players, including smaller ones. This in turn may impact on job creation, skills and de-localisation.
- Convergence is also blurring demand-side boundaries while creating new market segmentations.
- Convergence potentially generates a winning market for a traditionally strong sector in Europe but the expected growth of Consumer Electronics may also become a potential threat for high-margin business-oriented markets.

Convergence thus influences the competitiveness and hence the employment potential of the European CE industry in two ways.

- Firstly, the spectrum of CE products changes, rendering existing industrial knowledge and technologies irrelevant whilst requiring new ones. Technologies are changing rapidly, new products and services are flooding the market, and usage is booming.
- Secondly, and related to the first, the global structure of the CE industry is shifting - the industry is in turmoil with mergers, acquisitions and alliances occurring on a global scale as business parameters shift. This may have significant effects on employment and job creation in the EU.

In order to take full advantage of convergence in the European CE industry, public policies should aim at stimulating

- An innovation-minded, educated consumer base
- Internet usage by enterprises as well as consumers
- Fixed and wireless telecommunication and broadcasting infrastructures
- Standardisation processes in Europe

- Creation and transfer of CE-related knowledge
- Collaborative R&D, targeted at CE applications across Europe
- Start-up and growth of small innovative companies
- High-value added manufacturing
- Collaborations between the service, content and CE sectors
- Industrial collaboration and restructuring.

Finally this report reveals the complexity of the issues arising from the relationship between convergence, industrial competitiveness, technological innovation and high-quality employment. Further studies are needed to understand these issues more thoroughly. They must take on board the interrelations between consumer electronics and the developments in telecommunications, broadcasting, services and content generation. They must be forward looking and take account of the global dimensions of the CE industry as well as rapid technological changes. They must acknowledge the changing role of an increasingly sophisticated consumer environment.

In brief, the convergence of the CE in Europe is an intellectual challenge to be taken up by the best researchers in Europe.

1. Convergence in the European Consumer Industry: impact on competitiveness

1.1 Objectives and scope.

The main objective of this report is to explore how trends in convergence influence the competitiveness of the European Consumer Electronics (CE) industry. In doing so, the study attempts to look a decade ahead, with today's situation as the starting point. The project investigates the likely developments of technologies, standards, products and services.

It also looks into consumer behaviour, probably the most uncertain factor of all. In the final analysis, consumers determine the success or failure of new CE products, in interplay with new products and services. The margin of error of any predictive study in this field is therefore considerable.

The major issues considered in this study are:

- How is the CE product spectrum changing? How is related services developing, and which trends in usage can be identified?
- How is the global structure of the CE industry changing and what effect could this have on employment in the European Union?
- What are the implications for public policy and what underlying research is needed to identify policy options?

These issues were explored in a Workshop and a series of studies, which formed an integral part of the project's activities.

Owing to the breadth of scope of the project, it was not possible to address all issues in detail. However, the work provides a good basis for further, more targeted studies, and these are identified in the final part of the report.

The project was carried out through desk research and interviews and exploited the expertise resident in the different participating ESTO-partner organisations.

1.2 Definitions

In this project, Consumer Electronics (CE) are described as follows:

- CE products are all electronic hardware and software products and systems, fixed and mobile, which are intended for purchase by large numbers of consumers, and which can provide them with access to services, functions and content at their discretion. Entertainment, Information and communication are the main fields of application.
- The global CE industry develops, manufactures and sells these kinds of products world-wide. The industry is currently in great turmoil. Technologies change rapidly, new products and services flood the markets and usage is booming. Mergers, acquisitions and alliances are occurring on a global scale as business parameters are changing.

- The European CE industry is understood to comprise these industries which have a complete industrial presence (R&D, manufacturing and commercial activities) within the European Union. It is, however, strongly influenced by global developments, and will be even more so in the future.

Convergence is described in a recent Commission Green Paper (COM(1999)108 final) as follows:

" The term convergence eludes precise definition, but it is most commonly expressed as:

- the ability of different network platforms to carry essentially similar kinds of services, or
- the coming together of consumer devices such as the telephone, television and personal computer."

In the present study, it is assumed that convergence influences the competitiveness of the European CE industry in two ways:

- The spectrum of CE products changes, rendering existing industrial knowledge and technologies obsolescent whilst requiring new ones.
- The global structure of the CE industry shifts, which may have important employment effects in Europe.

Research efforts therefore concentrated on gaining a better understanding of both issues, analysing their impact on the competitiveness of the European CE industry, and reviewing relevant public policy issues.

1.3 Organisation of the study

The project was structured in three clusters, each centred on specific themes: users, industry and a methodology for futures analysis.

In the user cluster the following questions were addressed:

- What will be the main trends in the use of consumer electronics over the next 10 to 15 years?
- What are relevant data that describe these trends; which data are available and which not?
- What are the main opportunities and threats to the competitiveness of the European industry; which public policies are critical in this context?
- How does Europe compare with its main trading partners in these areas?

In the industry cluster the following questions were addressed:

- How will the industry in Europe change, in light of global industry changes, through mergers and acquisitions?

- What might be the economic impact of these developments, particularly on employment?
- How is competitiveness affected?
- How does Europe compare with its major trading partners?
- Which supporting data are available and which are not?

The methodology cluster addressed mainly the issue of how to conduct an extensive future study at the EU level and for Commission purposes, in particular DG ENTR.

This "methodology question" was discussed in a one-day workshop, followed by a phase of further development in a discussion paper. This resulted in an inventory of public policies that could influence the European CE industry and recommendations for underlying studies, together with notes on the methodologies suggested for such studies.

2. Consumer electronics: a traditional view

2.1. Introduction

CE is a large, global business. It is undergoing rapid change with a paradigm shift induced by the convergence of technologies, products and markets. This is perhaps best exemplified by the excitement surrounding the emergence of the Internet as a consumer service.

In Europe, these changes began some two decades ago. At that time, the home computer began making inroads, and a whole new range of CE products emerged. At the same time, the Single Market was becoming a European reality, signalling an end to the national orientation of multiple parallel industrial operations, while simultaneously increasing competition. Globalisation began to influence and change manufacturing strategies and the flow of CE products around the world.

Today, the CE industry is in the midst of a new wave of change. Starting only a decade or so ago, the world of CE is rapidly "going digital". The different worlds of television, telephone and data processing began to use similar technologies and are now starting to develop significant overlaps. This technological "convergence" is giving use to an array of further changes in products, markets and businesses.

In order to understand better the context in which the "convergence" drive is developing today, this chapter sketches a "traditional" perspective of CE, as seen by the end of the 1990's.

2.2. Products and Producers

By the end of the last decade, a wide range of products was in offer on the consumer electronics market place. These products were intended to satisfy all consumers' needs for entertainment, communication and information. They can be grouped into a number of distinct "technology platforms":

- *Entertainment*
 - Video: television, video recorders, camcorders, DVD players, CD recordable
 - Audio: radio, hi-fi, CD players, cassette recorders, Mini Disc, CD recordable
 - Game Players: Dreamcast, Playstation.
- *Communication*
 - Fixed Telecom: telephones, including cordless, answering machines, fax equipment.
 - Mobile Personal Telecom: GSM phones, SMS, Internet access, etc., pagers
- *Information*
 - Desktop Computing: PC's, printers, monitors, scanners, DVD players
 - Mobile Computing (shared with professional electronics): laptops, hand-held computers, PDA's, organisers

However, new kinds of products that did not readily fit into one of these platforms were also developed. They can be categorised as:

- Set top boxes: for cable, satellite transmission, terrestrial broadcast
- Car systems: entertainment, communication, navigation
- Home Networks: home

networks, security, tele-control and telemetry, white goods with embedded terminals, distribution of audio, video and data New stand-alone devices: robot pets, musical instruments New Terminals: MP3 players, GPS watches, Web Pads.

These products were designed, produced and marketed by a number of usually large global operating companies. A selection taken from the membership of the European industry organisations EACEM¹ and EICTA², , and a few non-member companies, shows the diversity of the CE industry:

<i>Alcatel</i>	Motorola
<i>Bang & Olufsen</i>	NEC
<i>Blaupunkt - Werke GmbH</i>	<i>Nokia</i>
<i>Bull</i>	<i>Olivetti</i>
Canon	<i>Philips Electronics</i>
Compaq	<i>Psion</i>
	<i>Sagem</i>
Dell	Samsung
<i>Ericsson AB</i>	Sanyo
<i>Grundig AG</i>	Sharp Electronics
Hewlett – Packard	<i>Siemens</i>
Hitachi Home Electronics	Sony
IBM	SUN Microsystems
<i>Italtel</i>	<i>Thomson Multimedia</i>
Kenwood Electronics	Toshiba
<i>Loewe Opta</i>	Victor Company of Japan Ltd.
Matsushita/Panasonic	Xerox

The companies that have their main "knowledge centre" - i.e. research and development laboratories - in the EU are indicated in italic.

Many other companies, not included in the list above, compete on the European market on the basis of mostly imported products, such as personal computer makers from Taiwan or the USA.

Especially important for the industrial structure in Europe are the suppliers of key components that determine the functionality of the product. This includes suppliers of integrated circuits - in particular, Philips, ST Microelectronics, Infineon (formerly Siemens) - and the large US and Japanese IC manufacturers with European production sites, and makers of display systems (Philips, Thomson), In addition to these large companies selling to the consumer, there are many more (usually smaller) companies that supply components and parts, or provide services to industrial players.

Software is becoming an ever more important part of CE products. Most embedded software is developed by the product maker or under his control by smaller companies. Operating systems are in the hands of large (U.S.) companies, in particular Microsoft for desktop PCs, or owned by (consortia of) smaller ones, like the EPOC platform for personal organisers. Applications software comes from many companies, large and small alike.

¹ European Association of Consumer Electronics Manufactures

² European Information and Communication Technology Association

The shift from hardware functions to software on the one hand, and the changing roles between the three kinds of software (embedded software, operating systems, application software) on the other, cause fierce battles between the major competitors. These confrontations have attracted much publicity in the PC world, but similar, less visible struggles take place in mobile telephony and digital television.

"Content" is critical for many CE products. It comes from sources all over the world, and Europe has a good position in certain areas. Content is delivered in various ways (i.e. broadcast, on discs, on-line) by many companies. Likewise, services play an increasingly important role in the CE markets. Especially in this area, many new entrants are operating with considerable success.

2.3 Industrial structure and market.

The industrial structure of the large CE companies varies greatly, although some similarities may be observed. Innovation activities are usually spread over the world, with typically the more basic R&D concentrated in the firm's home country. The more 'applied' work may then be done in important markets (Europe, USA), in centres of technology (Silicon Valley) or advanced markets (Japan), near important factories or component suppliers (Far East).

Manufacturing too, is spread over the world. Commodity production has moved largely to cheap labour areas like the Far East, Eastern Europe or the US-Mexican border zone. In the European Union, the original European producers have concentrated their operations after the Single Market largely removed the internal borders. This has been a costly and slow process for the European CE manufacturers. The CE market size is not easily measured. First, it is not clear how the range of consumer electronics products is to be defined. In the list given in section 2.2. (software) operating systems are not included, although they are usually bundled into the sale of a computer. Second, some products (computers, telephone sets, video recorders and cameras) are sold in the same form in consumer markets as in professional markets.

An "educated guess" puts the total consumer electronics market in Western Europe at about 50 B EURO³. On average, production in Europe is about 35 B EURO. The local added value, however, is not known; it is generally low in assembly operations but quite substantial for the manufacture of key components.

2.4. The technologies

In the past two decades, the development of new CE products has been driven by technological change, the most important elements of which are:

- Digitalisation: information, communication, processing, etc. all became digital, providing the basis of technological "convergence"; in particular digital signal and image processing techniques that allow low-cost transmission and storage of sound and video.

³ This figure is an "estimated guess" based on Reed Electronics Research (2000,) "The Global Electronics Market Information Resource", (CD ROM).

- Digital integrated circuit technologies: integrated circuit technology allowed dramatically increasing complexity and speed of operation at lower cost, resulting in more powerful processors, larger memories, faster interfaces, etc.
- Digital telecommunication technologies: telecommunications networks began to offer digital capabilities at low cost; fixed (optical cable in backbone) as well as mobile (GSM networks).

In addition, more gradual technological change in many other areas has been incorporated into CE products. Some important areas are:

- Integrated circuit design: allowed "translating" advances in semi-conductor technology into integrated circuits.
- Functional integration: ever more functions are packed on an integrated circuit, reducing costly and bulky interconnection on printed circuit boards.
- Data processing: computer architectures were broadly applied.
- Software Technology: allowed very reliable embedded software, large application programs for computers, etc.
- Displays: in particular flat displays for portable applications became important.
- Data Storage: magnetic as well as optical technologies increased storage capacity.
- Printing Technologies: resulted in reliable, low-cost colour printing technologies, etc.
- Interface Techniques: new concepts were developed in hardware (mouse, remote controls) and software (web browsers).
- Miniaturisation: products have been made smaller, lighter, cheaper through an array of new and refined technologies.
- Smart Cards: applied in many functions, often related to personal identification.
- Battery technology: high-capacity rechargeable batteries, easily shaped and lightweight, especially for mobile products.

Overall, the software content of most CE products has dramatically increased. In the product development phase, software development is often substantially more costly than hardware development.

Finally, the increasing popularity of CE, and the conscious efforts of the manufacturers, resulted in ever-larger production series at the level of key components as well as of final products. This resulted in dramatic price reductions when compound by learning curve and scale effects.

2.5. Enabling and inhibiting factors in CE market development

Experience has shown that new CE markets took off successfully only after certain conditions were met. A number of success factors can be identified:

- Standardisation: proved to be essential in most markets before products, services and content were accepted massively.

- Interoperability: different products of different vendors needed to be able to work together: plug-and-play capability, transparency of networks.
- Access to communication networks: consumers at home, in the car, needed the possibility of easy access to (digital) communication networks.
- Portability: for certain products, low weight, small size, etc. was essential for success.
- Content: availability of content in a product-compatible format was a prerequisite for use in many markets.
- Services: availability of services became increasingly important, in particular in Internet-applications.
- Ease of use: products, content and services were easier to use, for instance through greatly improved interfaces.
- New functions: products with new functions allow people to do known things in a radically different way, or even to do things they never did before.
- Perceived usefulness: consumers perceived the product as useful in today's life, satisfying basic needs for information, entertainment, communication.
- Lifestyle, fun & fashion factors: products became attractive and added pleasure to life.
- Quality when used: products were developed with better image and sound, more options, higher speed.
- Cost of acquisition: product prices had to lower quickly to an "acceptable" price range before they were widely purchased.
- Cost of use: costs of content, services, etc. had to be seen as acceptable.
- Increasing consumer purchasing power: discretionary spending for luxury goods increased substantially.

In different products and at different times, these success factors had different weights. Several factors can be seen as inhibiting the adoption of new CE products. To a large extent these can be derived from the preceding section, i.e. if success factors are insufficiently present. Nevertheless, some specific inhibiting factors may be pointed at:

- High cost of improvement perceived in relation to the small customer benefit: although technologically speaking an improvement can be major, justifying a higher price, the consumer may see the improvement as insufficiently significant to pay that price.
- Lack of content or software: new content, software and services are not always available at the time of market introduction of a new product.
- Difficulty of use: some products are notoriously difficult to use, but are broadly purchased anyway (e.g. VCR's). Other products are still too difficult for use by the masses (e.g. PCs are far too complicated to use).
- Insufficient standardisation, or wrong standard chosen: standards are often established after a prolonged battle in the market place. Consumers often wait for

the outcome - and therefore there may be none. Betting on the wrong standard is usually a cause for failure for new product lines.

- Wrong timing: new products may arrive too early to market. Technologies may still not allow the necessary product characteristics (e.g. portable products which are too heavy), are still too expensive, etc.

2.6 Public policies

Public policies have strongly influenced the development of the CE industry in Europe. This is evident even from a cursory view:

- Single Market policies: national markets have changed into European markets, impacting virtually all aspects of CE business (inward investment by non-European companies, concentration of industrial operations, logistics).
- Trade policies: national trade policies have given way to European policies whilst at the same time World Trade Organisation has gained strength, effectively fostering globalisation of the CE business.
- Deregulation of telecommunications: deregulation of the telecommunications market and the elimination of PTT monopolies has increased competition, lowered consumer prices and stimulated emerging markets such as the mobile communications market.
- Media legislation: in many countries media legislation has evolved, resulting in the rise of commercial broadcasters, etc.
- RTD policies: in particular the EUREKA Programme pre-standardisation RTD (HDTV, DVB).
- Standardisation: national approaches to standardisation gradually have given way to European approaches (e.g. ETSI).
- EU product directives: directives at EU level began to set mandatory levels for safety, interference, etc. for CE products.
- EU Competition Law: competition legislation began to influence mergers and acquisitions as well as alleged monopolistic behaviour of companies outside the EU.

It should be noted that many of these policies did not only have positive effects. For instance, the termination of the telecommunications monopoly may have harmed the solid technology base that existed in Europe.

Media policies allowing for commercial TV broadcasters have put pressure on the creation of quality content for TV. There is ample opportunity for studies assessing the net results of policies.

2.7 Conclusion

CE has had a very important impact on many aspects of people's lives. Over the years, a slow domestication process resulted from a sustained interaction between the exploitation of technological advances and user take-up. New forms of entertainment, information and communication have had a profound effect on society as a whole.

Convergence is accelerating this domestication process, certainly where a number of technological advances come together and make new functions available with a particular cost-effectiveness and ease-of-use. The extremely rapid transformation of the rather abstract notion of the Information Highway to a widely used Internet is the most dramatic, though not unique (see the mobile phone) example. Social changes induced by often-unexpected new usage's and related behaviour, such as. Internet chatting, follow more slowly but have a lasting impact.

3. Convergence and products

3.1. Introduction

This section discusses the influence of convergence on CE products and suggests that the future of these products will result from a dynamic interaction between three "poles":

- The development of critical technologies that allow novel products to be made.
- The availability of services and content in relation to the products.
- The changing nature of usage by consumers.

We assume the interaction will intensify and that, as a consequence, success or failure of new products will become even more difficult to predict than in the past, when technology push was still the dominant force.

Four background reports investigate this issue:

- *Convergence of the European CE Industries: Products and Networks*, analyses the future trends in the CE product spectrum. RPT-I-1
- *Technology Platforms*, discusses the future of selected product platforms. RPT-I-2
- *Services in Consumer Electronics*, reviews the rapidly changing world of services. RPT-I-3
- *User configurations and convergence in consumer electronics*, looks at the consumer acceptance and usage of products. RPT-I-4

An investigation of the public policy issues in this field is made in

- *Public Policy Issues related to Product Use*. RPT-1-5

Two additional notes shed additional light on critical issues arising

- *Broadband Access and Consumer Electronics*. RPT-1-6
- *Strategies of the EC industry* from the four studies mentioned. RPT-1-7

The three poles are discussed in the following subsections.

3.2. Technologies

The future development of critical technologies *per se* is not addressed in this report⁴.

It is however assumed that:

- Semiconductor technologies will continue to improve at about the same rate as in the past decade. The resulting computer power will be deployed in many ways, but in particular, in the improvement of man-machine interfaces.

⁴ IPTS Futures project, in particular E. Cahill and F. Scapolo (1999) Technology Map. The Futures Project series #11.

- The capabilities of telecommunications networks to transport more digital information will significantly increase through better optical transmission technologies and more clever use of the radio frequency spectrum.
- Other underlying technologies such as those mentioned in the previous section will continue to improve, promising more performance at lower cost.

Four cautionary remarks should be noted:

- A hitherto uncertain factor is how much (communication) bandwidth can be accessed and afforded by consumers in their homes. The telephone connection can offer a higher bandwidth through ISDN or ADSL. Optical "local loops" to the home require a massive investment and are unlikely to be offered on an appreciable scale in the next decade. The (TV) cable networks are beginning to offer broadband data connections, but they are currently unable to adequately service many users simultaneously. Satellite connections are becoming available in the US and Canada. Other solutions for the connection to the home such as the application of laser technology are still in their infancy.
- Speech technology has been making great strides in last few years. It is expected to find wide application in CE products and related systems. If successful, speech technology will change CE significantly in the next decade, but a solid prediction is not yet possible.
- Short-distance wireless interconnection technologies are promising new options in many products. The cost of such solutions to the interconnection problem is of course a critical factor, but they have not been assessed in this study.
- At the moment, accessing and using the Internet is relatively inexpensive for consumers. Costs are in fact subsidised by firms that advertise on the various portals and web sites, firms which expect to develop consumer business by the selling of products, services or information. It is beyond the scope of this study to predict whether this financing model will remain in the next decade and how possible changes will affect consumer use of the Internet (e.g. the trend towards ubiquitous computing).

3.3. Existing and future products and services

Present, upcoming and future products can be categorised in terms of their functional complexity: whether they are dedicated information appliances, allow command, control and communication and, if intended for mobile use, information.⁵

This leads to the following observations:

- The functionality of available CE products will be gradually improved in the next decade. They will offer more and better performance than today, have improved user interfaces, etc.
- In most CE products, from existing to future ones, convergence is an important driver. Integration of more functions into one product is the trend; internet functions will move to the television set, communications will migrate to the refrigerator, etc.

⁵ see RPT I-1

- Most emerging and future products will be characterised by high functional complexity. They will integrate a number of (existing) information, command, control and communication functions into one device.
- Only some future products will offer new functions which go beyond the improvement or combination of these existing. The *Electronic Book* is one (still potential) example.
- The Internet will have a strong impact across the full spectrum of CE products. Existing products will be connected and new "web-related" devices, such as the current MP3 players will be developed . The Internet now drives the need for broadband home connections, rather than interactive television which was expected to be the driver only a few years ago.
- Mobility is a key factor for many future products. The range of "mobile or wireless products" is expected to have strong growth, based on the current GSM or future third generation mobile standards like UMTS technology, as well as on upcoming radio-based technologies such as Bluetooth.
- The range, availability and reliability of services are a key determinant for the success of a new product. This will be further explored in point 3.4.

Apart from factors such as the consumer's "appetite" for or "aversion" for a new product, some potential inhibitors can be identified:

- Adequate broadband access at an affordable price. It is not possible to predict the future success of broadband networks without a more in-depth study. The example of ISDN, once regarded as the solution of choice but today only marginally successful, shows the pitfalls facing researchers in predicting the take-up of new technologies or products. And, as several of the research papers point out, how much broadband do consumers actually need? Moreover, the telecommunications infrastructure varies so greatly in the EU, not to speak of those in the candidate countries, that general statements on the telecommunications future should be treated with care.⁶
- The introduction of new standards, be it through *de facto* actions of one or more enterprises, or through regular standardisation processes. Only if the issues of standards are concluded successfully and done so in a short timeframe, will a new "GSM craze" be possible;
- The price level of the new products (and related services) in the light of the increasing consumer spending in Europe — both can be extrapolated only at great risk. Product prices depend on the costs of labour and transportation in different parts of the world, and on political and economical stability. Consumer spending is, among other things, influenced by people's affluence as well as awareness of, and confidence in, the reliability of the products and services;
- The education required by consumers to use the products — here, two virtuous developments are taking place: the average level of sophistication needed on the part of the user decreases due to the introduction of better user interfaces and the average level of education of consumers in the EU rises. But, at what speed this occurs is not obvious. Moreover, this may be counteracted by the

⁶ See RPT-I-6 about the differences between Europe and the USA in this field.

greying of society: the growing, relatively affluent older generation may be less inclined to learn new products than the younger generation..

Substantial sectors of the CE platforms have not yet been digitised.⁷ For instance, the video platform is largely based on analogue technology, though it may be noted that digital signal and picture processing is increasingly applied in high-end television sets. The upcoming transformation to fully digital television is a difficult and complex process that will evoke strong competition in many fields, including standardisation, content creation, access control, networking and interactive services.

Another notable point is that convergence offers new opportunities to new entrants in existing markets. In this respect the set-top platform, the entry point with a "portal" character in the home for digital television and other digital services, is important. Set-top boxes are multifunctional, computer-like devices that define a new consumer interface and effectively reduce the TV set to the role of monitor. New competitors have secured an appreciable share of this new market at the cost of the traditional television set makers.

Convergence also "pulls" traditionally non-CE companies into the CE arena. Mobile phones manufacturers like Nokia and Ericsson have secured themselves a very strong position in CE through technological innovation. Similar examples are also found in computers (e.g. IBM). However, the non-CE companies now have to behave as CE companies (i.e. in terms of fast product development) and are forced to compete against companies who want to profit from the next waves of innovation such as mobile Internet connectivity and the upcoming new UMTS transmission standard.

Finally, and to conclude with respect to the products, new technology platforms are being created as well; game players are one example. Intended originally for playing purposes (as the name suggests), this platform is attempting to become the heart of the television function as well as the Internet access function for young people. Along this road, some companies are creating a formidable competitor for the traditional video and desk computing platforms. At the level of services, a large variety of them are offered to consumers through a range of CE products.⁸ In most cases, such services have a content component, which can be accessed either as an integral part of the device, purchased on a separate carrier or accessed through a network.

Today, specific products deliver specific consumer services. It is expected however, that services will be made available on a much wider range of CE products, and, inversely, that CE products will offer a larger variety of services. The main building blocks will be based on functions like communication, control, information, transaction and entertainment. As suggested in the background research paper, future services will be built up from these blocks, resulting in a so-called digital loop of services, a virtual cycle in which the output of each service component provides the input for the next one. This does not imply that any combination of services is feasible, however, given the large variety in "functional demands" associated with basic service functions.

Though this analysis is helpful in understanding their nature, the question of possible migration paths towards these converged services remains. Indeed it remains to be seen if a complete and seamless convergence in CE services is to be expected, and if

⁷ See RPT I-2 which investigates convergence developments in several technology platforms.

⁸ See RPT-I-3.

not a rather gradual expansion and partial overlap of existing services and products will take place.

The "contexts of use" of the services are in that respect important too and in this respect the concept of "service platforms" is put forward. By that is meant central devices and network platforms in a certain context of use, that communicate with a variety of related products, providing specific sets of services. Most probably a push towards a bottom-up model of service consumption can be expected in which users select and combine the services they want (see also 3.4).

From the building blocks mentioned, content, communication and (Internet) connectivity are identified as the more immediate key aspects for CE services and hence that service requirements must be incorporated into new products. Sometimes-conflicting characteristics must be married: the traditional aspects of good, planned CE product design and the often wildly changing service environment.

Finally, the emergence of new business models must be taken into account too, in a market place where different combinations of application service providers, web-based services and software distributors are involved. New value chains and value networks are being developed and activities higher in value (e.g. content provision) are becoming more important.

3.4 User acceptance

To understand the acceptance and accommodation (domestication) of new products by consumers, the notion of "social contexts of use" is developed⁹. This frames the "socio-technical user configuration" in which electronic media must be understood and analysed. Moreover it gives a new dimension in the study of successes and failures of new products, because it points to the fact that cost and usability are only parts of the conditions for a successful penetration of CE products. The conditioning of social norms, the establishment of an imaginary space of social capability of the product, and the creation of fashion are as important.

In this view, penetration of new products is therefore not only a matter of thoughtful marketing to a group of (new) users, but it also entails domestication; the creation of a new user-configuration where consumers invest in making the product or service useful to themselves. Ideally, the scripts of new products or new services, made by the designers, entice consumers to develop practices and values that eventually turn these products into a commercial success.

In the longer run, an intensive three-pole interaction between new product design, new service provision and the creation of user configurations ultimately determines the viability and success of new products. However, in practice, the short-term outcomes of such an interaction are often open-ended and unpredictable.

Convergence then does not only take place between different technologies or products, but it also entails the combination and even integration of different contexts of use as well as the creation of new ones.

In CE, this extra dimension of the convergence issue is dramatically illustrated by considering two archetypes:

⁹ See RPT-I-4

- the television broadcasting system, with the connotation of a centralised, top-down, strongly regulated monopoly, and
- the Internet configuration, which is viewed as decentralised, bottom-up, competition-based structure.

Around these archetypes, complete technological systems have been formed, including industries, content makers, service providers, regulatory frameworks, etc. At the same time, users have organised themselves in different interest and pressure groups that voice their views on the two archetypes.

The overall result is the existence of two "CE cultures", locked-in by past experience, guiding future product and service developments. These cultures may also account for regionally different views and expectations of consumers as well as those of industries. For instance, the role of television or personal computers for home shopping or Internet access may be viewed quite differently by consumers in the USA and Europe, with resulting differences in acceptance of new products and services. In similar ways, the diffusion of mobile communication gives different starting points for new entries and combinations of both communication and services.

What are the important elements with regard to these contexts of use and user configurations? Looking at the contemporary user configurations based on both recent developments in markets and emerging new social contexts of use, the following are identified:

- Networked privacy and entertainment, which can be subdivided in three contexts of use. 'TV and home cinema' as centres of social gathering and/or individual activity, 'Children's and others' entertainment centre' as single machine but multi-user environments often decentralising the media technologies away from the family unit, 'Private communications' and the conditions of both privacy and distance, and 'Omnipotent computing' as an interactive but also specialised and separate social activity.
- Working, over-working and net-working: extends the 'Omnipotent computing' context into professional work relations (including home work) as well as 'Mobile computing' as a professional and student user context.
- Mobilising efficiency and privacy: mobile phones are seen as 'Integrators of daily routines and activities' both also as a child's thing and in relation to the changes to be observed in the use of personal digital assistants and other integration processes. Here also the 'Car as user context' as a technically integrating but socially disintegrating frame, and the role of 'Smart homes' and 'Surveillance and remote control' as new contexts of use is important to bear in mind

Technology is, in this understanding, setting the stage for the actors to perform on. Industries', service providers', and content producers' success on the stage is based on their ability to recruit users and include user configurations in their actions. Here notions like 'ubiquitous' and 'pervasive' computing do not help in understanding the specific market penetration of products and the transformations being the result of domestication and learning processes, not least because the notion itself assumes the computer as the technical entity to be able to perform the translations. One could argue that the only 'pervasive' action taken is through the mental representations of

technological fixes among specialists taking both their colleagues and both politicians and journalists as victims, as they (we) all are afraid of being called conservative and backwards looking. The same holds for the role of the Internet as an icon of the IT revolution and often used as a metaphor for rapid change and time-space compression. There is no doubt that the Internet has opened new avenues of information gathering and communication, but it does not explain by technical means only its user contexts.

3.5 Public policy

Recent shifts in the EU's industrial policies and practices can be observed¹⁰:

- away from interventionism and detailed legislation;
- towards developing good framework conditions for interplay between market players and public, reducing direct financial support volumes, stimulating investment, supporting self-regulation and codes of conduct and acting as enforcer for public protection and essential interests;
- an abandonment of the 1990-1992 paradigm in industrial policy based on the Michael Porter's perspective¹¹;
- a need for a global approach and transatlantic initiative leadership.

The first priority of public policy here should be to achieve an open, transparent and interoperable services environment in which the consumer will have a free choice to buy the terminal products and to access the public and private service options which suit him/her best.

This would stimulate the use of, and hence the market for, convergent CE products. Audio-visual ("media") policies, which have a strong impact on the higher levels of the value-added chain (content creation, distribution, etc.) are not considered in this report but should be included and expanded upon in any future research programme with regard to CE.

3.6 Competitiveness and company strategies

The studies in the user cluster demonstrate that convergence influences the competitiveness of the European CE industry in many ways.

There are certainly threats to traditional products and established market positions. More important are the new opportunities offered by convergence, where European firms can show their ingenuity and creativity.

The most important product-related issues are:

- Convergence trends in traditional technology platforms point at the integration of several basic functions into one product. However, in many new functions, standards are not yet properly defined, nor have standard technology implementations been developed. This obviously threatens the continuity of planned new product generations of the existing manufacturers. Companies must

¹⁰ See RPT I-5.

¹¹ Porter M.E. (1990) *The competitive advantage of nations*. London: Macmillan

acquire new skills and deploy them along the full industrial chain, from design to after-sales service. Of course these convergence trends also offer excellent opportunities to escape the price erosion in the market by offering upscale, higher value-added products. Therefore, they present an opportunity rather than a threat to the European CE industry.

- Serious threats to the European producers arise when the traditional platform becomes more software-based and hence open for influences of de facto software standards, e.g. PC-based operating systems such as Windows-CE migrate into digital television. The same threats do pose themselves when the platform is split up into separate functions, as in the case of set top boxes for digital television or replaced by another platform like game players. In the first cases, European manufacturers are confronted with competitors who have excellent skills in communication, data processing or software systems, though relatively little in terms of traditional television skills. However, the option of competing in this field exists for European suppliers. In the last case, however, there is little to be done. The option of entering the games market seems non-existent for hardware makers although Europe has important content developers in this field.
- Where emerging new products with integrated functions are concerned, European manufacturers are likely to tap into the Silicon Valley environment, certainly where Internet-related skills are required. It is important to note that many of these products will have to operate in a specific European service and user context, which may require substantial translations. This may compensate some of the weaknesses in the somewhat less advanced position of the European CE industry in this field.
- In the mobile telephony market, where the European industry is very strong, a number of uncertainties exist regarding the continuation of that position. These concern the way the GSM-phone is best connected to the Internet, the operating system that will control this access and the implementation of a next-generation system. Regarding the latter issue, it is important to note the challenge the European mobile telephony service provider's face in terms of ability and willingness to invest in the necessary new infrastructure?
- Many new products will support a variety of services. This poses a challenge to the traditional CE manufacturers, who often feel uneasy in the somewhat undisciplined world of content and service providers. Nevertheless, it is essential for them to familiarise themselves with the necessary knowledge and skills and integrate these properly into their businesses.
- With the increasing importance of content and services, players in this area will determine, more and more, the developments in the CE market. Businesses tend to integrate along the value chain (see also section 4), but the traditional CE industry is usually not involved. This entails the risk of becoming a low value-added supplier of boxes that are specified by others. However, in Europe a significant content industry for television has developed, and the possibility for co-operation is an important option for the European CE producers.
- A key factor in the future of "ubiquitous computing" is the availability of highly advanced telecommunication networks in Europe. For the consumer, "bandwidth at home" is the critical factor. The competitiveness of the European CE industry could be favourably affected by a strong European position with respect to

consumer access to communication bandwidth. Though the USA is somewhat more advanced in ADSL and cable deployment, Europe is leading in wireless connections (UMTS). A detailed investigation of European scenarios in the different countries versus those in the USA and Japan is needed to assess this balance with more confidence;

- European industry might better exploit European strengths to improve competitiveness. For instance, existing skills in design and in human interface techniques (and in particular speech applications) could be harnessed to increase the attractiveness and ease of use of new convergent products.

Convergence has a very important - and perhaps often neglected - impact on the consumer. This is most notably illustrated by the new types of consumer behaviour that emerged around the Internet. On the one hand, the Internet (WWW) was developed very much in a bottom-up fashion. An unwritten code of conduct was recognised by users, a culture of debate and openness nurtured. On the other hand, the Internet was used in new and unexpected ways. New forms of social contacts (chat boxes, games) and communication (e-mail) developed quickly.

This has resulted in a youthful, dynamic "subculture" of Internet adepts, consumers with a very different set of attitudes than the "traditional" television watcher. This "subculture" is invading the "regular" culture, as Internet-derived concepts, icons, and languages are broadly used and understood. But also the "regular" culture tries to impose itself on the Internet as commercial interests grow massively, and surveillance by police or security services is expanded. Though it is unclear what the end result will be, it is evident that consumers play a very central role in the development of the Internet. This poses major problems for the "traditional" CE industry, which was much more at ease with top-down organised innovation, based on its own development of new products or services. A fundamental change in customer relations seems necessary. Even if culture change induced by Internet proves to be a transient phenomenon, there are more indications (e.g. in mobile telephony) that consumers - rather than industry - drive innovations into unexpected directions.

Various strategies are being adopted by the CE industry to cope with these issues¹². This is illustrated by the following observations of three companies:

- Philips exploits its brand name world-wide and seeks competitive advantages in the combination of, and innovation in, its traditional and consumer products and underlying key components, such as integrated circuits and picture tubes or LCD displays. It has terminated its involvement in content (sale of Polygram, its media company) and services (i.e. cable networks). Philips seems to concentrate on a broad range of "terminals" that include set-top boxes.
- Thomson Multimedia concentrates on digital television, including set-top boxes, in particular in the USA under the RCA brand. In this context the company develops a series of strategic alliances and collaborations with other players that complements its technology base. Two value-added sectors: components and services are part of this strategy.
- Sony is developing a strategy of integration along the (digital) value chain, ranging from content, such as movies and music to terminals. The latter including

¹² See RPT-I-7,

its highly successful game players. Along with this, the company builds a range of Internet-based service operations such as banking and e-commerce.

It is remarkable that these three major companies apparently adopt such different strategies to deal with the convergence issue. Philips has a horizontal approach, focused on the boxes, Sony has a more vertical approach, concentrating on the services, whereas Thomson situates itself more or less in between these extremes.

3.7 Research needs

What policy research needs at the level of products and services were identified by the contributing researchers?

Related to knowledge and competencies:

- Identification and mapping of the consumer electronics knowledge-, design- and production-chain in Europe, irrespective of size or nature of the actors.
- Identification and mapping of critical dependencies on hardware, software and skills.
- Studies into the necessary knowledge and competence base for service innovation.
- Studies of new challenges in this field, in the light of the present activities and know-how of the CE industry.

Related to users and usage:

- User scenarios: scenarios evoking possible developments in user identities, preferences, behaviour, and in patterns and contexts of use.
- Identification and drawing out of key findings of recent studies on consumer use and behaviour patterns to project general trends.
- Further studies of user contexts and user configurations to get a better understanding of contemporary developments, e.g. usage of mobile equipment and the transformation of PC and Internet usage.

Related to technologies and products:

- Evolution scenarios: scenarios not only giving a view of possible future platforms and networks, but also sketching possible migration paths and different time frames towards convergence.
- Analysis of bandwidth “at home” comparing the EU, USA and Japan;
- Identification of Internet threats and opportunities.
- Identification and mapping of public R&TD programs and academic centres of excellence active into the European CE value-added chain.
- Focus research on those identified CE products, which are the principal and growth expected carriers of the CE industry established in Europe.

Related to other issues:

- New value chains and values networks: Analyses of possible effects of convergence and new business models on industry structure.

- Identification and mapping of existing globally competitive knowledge and production strengths in Europe within industry.
- Identification of the economic value of intra and extra European alliances.

A special research need is clearly related to the availability of data describing trends in the use of consumer electronics. Although data exist on take-up and usage of several products - however not in any systematic form in the public domain - the detailed collection, analysis and integration of such data is highly problematic.

3.8 Conclusion

A comparison of the situation of the European CE industry with its American and Japanese counterparts does not seem very meaningful at the product and product-use level considered in this cluster. The industry is global and most products are global. Philips, Thomson Multimedia and Sony are all considered "European" in the context of this report, but could indeed equally well be viewed as "American".

Accessing specialised knowledge, in Europe or elsewhere, is equally feasible for such global companies and is therefore not a structural factor. However, different companies have built up specific strengths in their original home markets. American companies did so in PCs, Japanese in game players, Europeans in mobile telephones. As discussed, changes brought about by convergence may well favour companies with such a "home advantage".

In this context, the most important difference between the three trading blocks is probably the structure and innovativeness of the market. Factors such as advanced telecommunication infrastructures, regulation of e-commerce, and the present homogeneity of services will determine how new, content and service-oriented CE markets develop. The eagerness of consumers to adopt innovations is another very important point. A company's early intimacy with new, developing markets - usually the result of a long presence and involvement - is critical to its future competitive strength. The strengths and weaknesses of Europe as an innovative market place, compared to the US and Japan, need to be analysed carefully in a future study.

4 Convergence, industry structure and employment

4.1. Introduction

In the second cluster of studies, CE is analysed as an industry rather than as a collection of products and services. It is based on the following background reports:

- *Global Trends in Business Activity & Industrial Organisations*, which investigates the global trends in the CE industry. RPT-II-1
- *Employment - More Than Counting The Numbers*, reports on employment in the European CE industry. RPT-II-2
- *Major Public Policy Issues*, investigates the main policies in the industrial domain. RPT-II-3
- *The Nordic Telecommunication Cluster*, describes the history of GSM. RPT-II-4
- *On digital television broadcasting, and mergers and acquisitions in the CE industry*. RPT-II-5 and RPT-II-6

4.2. Global trends in the CE industry

The CE industry is likely to change in the next decade due to the following factors:¹³

- Emergence of the internet, in terms of both Internet economy as of consumer-use;
- Globalisation, of industry as well as of products and services;
- De-coupling of knowledge-intensive design and marketing, and production;
- Ubiquitous computing, leading to an expansion of the CE playing ground.

As a result the CE industry will increasingly be divided into two, partially overlapping sectors:

On the one hand, a strongly knowledge-based CE industry will emerge focused on innovation and marketing on a global scale.

First, a few, very large, globally operating CE firms will survive the ongoing shake-out in the industry. These companies have the broad knowledge and innovation resources, design, brand name, marketing and logistics power to keep up with the changing technologies, sales and distribution techniques and usage patterns. They are in a position to recoup the high innovation costs on the very competitive global mass markets, whilst providing sufficient returns to satisfy shareholders. These companies also know their customers and are able to provide user-friendly products to them. Manufacturing may be an important part of their operations, although it is not necessarily an in-house activity anymore. Depending on the value-added of the product, the availability of key components and the presence of cost-effective, high-quality manufacturing-driven outsourcing strategies may be chosen. The traditional

¹³ See RPT-II-1,

CE companies and the new PC makers tend to address the manufacturing issue quite differently.

Second, new entrants will certainly come into the CE market, particularly in new product areas that are being opened by technological convergence and where the innovation rate is high. Still, the fundamental economics of mass markets apply for these companies and they will need size and global presence to survive. Therefore alliances in some form with the large companies will usually be needed. However, since for many computer-related products the technical innovations can be bought-in in the form of key components and (operating) software, there is room for low-added value companies that base their strength on clever combinations of e.g. design, marketing, outsourcing and logistics.

Third, specialist niche-market players may survive, for instance, where a premium price can be demanded for superior design or quality or if they are specialists in peripherals (e.g. dish antennae). But in most other cases "innovative SMEs" will enter into alliances with larger players, either by licensing patents to the latter or having products marketed and sold through their channels.

On the other hand a CE manufacturing industry will emerge partly knowledge-driven and partly cost-driven. Two elements to be taken into account here:

- Skill-intensive production: high-technology, high value-added manufacturing deploying high-cost capital goods, carried out in a few places across the globe for the local or global market.
- Commodity production: mass manufacturing of standard products for the global market in low-cost regions. This kind of manufacturing shifts quickly to the most attractive regions, with the lowest sum of production costs and transportation costs.

In addition, the manufacturing sector includes the producers of key components (high value-added products that determine the functionality of the product, usually in highly automated factories), the makers of parts and components (from moulds and plastic parts to fully mounted printed circuit boards), software developers (in particular "embedded software") and service companies (for instance IC design).

From this, three directions can be suggested for the future of European industry:

- Innovation, based on a strong position in research and design, of highly complex hardware-software products that will be needed on the European CE market, in particular by the large players.
- Knowledge-intensive manufacturing, often related to locally present key component supply, by a variety of companies, also in the new member states.

The emergence of a "European Silicon Valley" for innovative SMEs in the new, ICT-related, products

With regard to joint ventures and alliances a great diversity of objectives can be distinguished¹⁴.

A "traditional" CE company like Thomson tries to get "adjacent" technologies on board through collaboration with Microsoft and Alcatel. A non-traditional CE

¹⁴ See RPT-II-6

company like Microsoft invests heavily in the cable industry, attempting to promote its operation system as a standard in set-top boxes. Sony forms alliances to create (web-based) business completely outside its current expertise: in banking or e-commerce.

In addition, very important mergers and take-overs take place somewhat outside the core CE industry, in particular aimed at integration of activities along the value chain. The most notable has probably been the 150B\$ acquisition of the media company Time Warner by the Internet service provider America Online. A shift in interest from "broadcasting" to "narrow-casting" is underlying this move. The recent European take-over of Endemol, a Dutch TV-content maker, by Telefónica, the Spanish telecommunications operator, may have been similarly motivated. The creation of new "superpowers" of this kind is of great relevance to the future competitive position of the European CE industry.

4.3 Employment issues

In 1999, some 29 M people were employed full-time in the manufacturing sector in the EU.¹⁵ Of these, about 0.8 M were employed in the radio, television and communication equipment and apparatus manufacturing industries, or about 2.8% of the total. There are considerable variations in the figures across the different countries (Finland with 7.1% is highest, Spain with 1.1 % is lowest). Variations in time also occur; a moderate decline in employment in CE is seen in 1995-97, followed by a strong increase in 1998 and again a decline in 1999.

Whilst this is indicative of the importance of the CE industry in the industrial landscape of Europe, some important questions remain:

- Convergence is blurring the borderlines between the traditional manufacturing categories in the employment statistics. The definitions of the employment categories do not fully coincide with those used in this report. In particular, PC manufacturing or assembly is not included, but some other products outside the scope of the report may be in. If "everything gets digital", companies' activities in one sector may quickly move into other sectors.
- Changes in industry structure may do the same: engineering activities in a manufacturing company are attributed to the services sector — if the same activities are outsourced they may be attributed to "services"; employment in CE manufacturing industries may be seen to be going down as that in services continues to rise.

The question therefore arises as to whether the present statistical approaches are still valid in a field characterised by rapid convergence and changing industrial structures. Employment in CE industries should be considered along the entire value-added chain, as well as across other sectors which are directly and indirectly impacted by the activities and products of these industries. It would be more useful to consider issues such as the changing skill base in the CE industry and the availability of skilled workers. There is thus a need to focus on the human capital component; the development of indicators of human capital are critical for the health of CE industries in Europe.

¹⁵ See RPT-II-2 which examines recent European employment statistics in radio, television and communication equipment and apparatus manufacturing industries.

4.4 Public policies

Television has played an important role in on Europe-wide innovation-oriented policies in CE.¹⁶ This may have been rooted in the fact that colour television had been introduced in different European countries using different standards (PAL in several variations, SECAM). This resulted in a fragmented European market. In 1984, a common standard was proposed (MAC), to be used first in satellite broadcasting, and supported by a European directive. A EUREKA project to develop a European system for High-Definition Television (HDTV), extending MAC into a 16:9 HDMAC standard, was supported by a number of European governments. Technically it was successful but in the end the HDMAC standard was not accepted. Commercial TV broadcasters were strongly opposed, the analogue standard was seen by many as old-fashioned in a digital era and a consensus at European level could not be obtained. Nevertheless, the EU put in place a support fund for 16:9 productions, and concurrently new digital standards were worked out in another EUREKA project, named Digital Video Broadcasting (DVB). The resultant new approach to standardisation proved to be successful¹⁷.

Part of the development of chipsets (IC's) for HDTV and DMAC has been carried out in the EUREKA projects JESSI and MEDEA, through collaborative efforts from European IC manufacturers and CE companies supported by national governments. The European R&D Programs in successive Framework Programs, have also devoted resources to a variety of CE related research and supported some work in the television projects mentioned above. Manufacturing methods were also part of the Framework programs. A special programme to stimulate supplier companies was initiated by the EACEM industry association and supported by the EU.

4.5 The Scandinavian telecommunications case

An analysis of how the mobile telecommunications industry in the Nordic countries became so successful on the global scene is particular interesting with regard to understanding the dynamics of successful CE strategies¹⁸. The long involvement of a number of Scandinavian and Danish firms, in some cases dating back to the twentieth century, is the starting point. Whereas the gradual shift from marine and military mobile communications to professional systems for civil use (and later on to car phones) provided these firms with a solid technology base in radio communications. In the early 80's a new Nordic Mobile Telecom (NMT) standard for cellular automatic mobile telephony was defined by the Nordic PTT's (then still State monopolies), and the industry rapidly developed mobile products and fixed infrastructures. The success in the local markets, and later in other markets where the NMT standard was adopted, gave the Nordic firms an early lead.

Later in the eighties, CEPT (the standards body of the national PTT's) took the initiative to develop a pan-European digital standard. The resulting proposals of the

¹⁶See RPT-II-3 for an overview of some of the most important public policies that impacted the European CE industry over the last 15 years.

¹⁷ Further insights on the present thinking about standards, and the role of public policy therein, is offered in some detail by the DVB case. The paper suggests that further analyses of the DVB and GSM cases would yield a better insight into the effectiveness of such policies.

¹⁸ See RPT-II-4

Groupe Speciale Mobile (GSM) were accepted by 15 European countries and in the early nineties the first systems became operational. Ericsson and Nokia, who made mobile telephony the cornerstone of their industrial turn-around efforts, quickly moved into this market to become the global leaders (with Motorola of the US).

The innovation rate in GSM phones is high, spurred by clever miniaturisation and power reduction of key components. This made products smaller, lighter and cheaper. For the high-end products new functions were added, such as message services and voice addressing. Manufacturing could largely be kept locally, near to the innovation centre. With regard to recent trends like WAP, EPOC, Bluetooth or UMTS, it should be noted that the standardisation environment has changed dramatically in the last decade when the PTT monopolies were terminated. This supports the expectation that the first-mover advantage of the nordic companies will weaken, while at the same time opportunities exist for, for example PDA makers to enter the market with products making use of their specific expertise.

4.6 Competitiveness and company strategies

From the above, the following major competitiveness issues can be derived:

- The CE industry in Europe, and in particular the large companies, will become even more knowledge-intensive than is the case today. Therefore, innovation processes in the industry must be of the highest quality. They must have a world-wide outlook and reach. Global trends and designs must be implemented from a European perspective, and, where appropriate, vice versa. Interaction with the rapid developments in the worlds of content and services is essential. Within the firm, these processes must be harmonised world-wide and seamlessly connected with production processes.
- This (traditional) industry model requires relatively high investments in innovation that must be recouped in a very competitive market and a financial environment that stresses shareholder-value. Therefore, alternative innovation models are actively sought. One is a model of alliances with specialist companies when new knowledge is needed. Another is to rely predominantly on innovations by suppliers, a strategy used by the PC industry (in that case: processors, operating systems, and applications software).
- The convergence process puts even more urgency on the choice and execution of such strategies. They determine what technological skills the company needs, what can be outsourced, and so forth. The net effect on European employment is uncertain however. In many cases specialist operations spun off from larger entities appear to be doing very well on the market and tend to add employment as opposed to shedding it.
- Standardisation is key for the development of CE in Europe. Important changes are observed in the field of telecommunications and broadcasting. There, standards used to be designed in a top-down fashion usually by or with the guidance of, PTTs or state-owned broadcasters. Different practices are followed today, as in the GSM and DVB. Here, industry itself takes the lead and the public sector plays a supportive role. It is essential for European companies to continue to devote resources to standardisation processes and to develop, where appropriate new, effective methods.

- Around and in the CE industry major restructuring is taking place through take-overs, joint ventures, and alliances. In particular one can see:
 - moves to create larger entities that focus on one business sector (e.g. mobile telephony), to become a supplier of global services;
 - integrations along the value chain, for instance content owner and distributor, to dominate the delivery of content and services to the consumer;
 - collaborations with non-CE firms to enter new fields outside CE;
 - mega-deals, such as those in the USA which seem to shake the traditional relations between the different service and industrial sectors because new companies are being created that have potentially enormous influence on large parts of the CE business (and can compete in many market segments).
- The CE industry will see itself confronted with completely different business models, in which consumer hardware is but a small part of a total value-added. This is already happening where hardware is being given away free of charge with the purchase of services (mobile telephony), or is fully specified and bought by another party (set top boxes). In such cases, the relationship between the traditional CE supplier and the consumer becomes totally different and new competition paradigms arise.
- The possibility - certainly for mature products - to disconnect manufacturing from the innovation, marketing and logistics functions accelerates the movement of commodity manufacturing to low-cost areas outside the European Union. In principle several countries in Eastern Europe are well placed to attract this kind of activity, also in view of the relatively low transportation costs to the EU markets. Facilitating such transfers of manufacturing to Eastern Europe might be a good long-term policy for the EU; though it would run into short-term opposition because of diminishing local employment.
- High value-added manufacturing must be nurtured in the EU despite the present tendency to consider services as the most important driver for employment. It should be noted that such manufacturing sites usually have a close relation with the firm's research, development and design. They rely on a large network of high-value added suppliers, and act as "engine" for many smaller hi-tech enterprises and therefore stimulate employment broadly. The underlying technical and organisational skills need to be supported and developed in the Union, and the "social status" of manufacturing improved.
- Business-to-Business Internet services will play a very important role in a fast-moving industry like CE. Such services must be available in Europe, and European industry should use them. Everything must be done to stimulate this: failure to meet the American or Far-Eastern level of Internet-based business relations is a direct threat for employment in the Union.
- Internet is also likely to impact sales channels. The success of DELL in selling its PCs over the net is a good example of what may come for other consumer products. At least in some European countries a rapid take-off of Internet sales should be expected. However, it is questionable whether European consumers at large will prefer this way of shopping to the more traditional methods. At any

rate, European CE companies have ample opportunity for early learning in the US, thanks to their strong presence there.

- A large potential exists for highly specialised, innovative small enterprises. They could be either taking over outsourced activities from large enterprises, supply special hardware or software technologies or render (probably often web-based) services. Incentives that stimulate the smaller CE-oriented companies should be identified and promoted.

4.7 Further research needs

A better understand of the dynamics of the CE industry, would need work along the following lines:

- Assessing what has been taking place in the labour force in CE industries, specifically addressing skill shifts (level of skill and field of expertise) and occupation shifts.
- International benchmarking of EU CE industries' employment shifts against other nations such as the USA, Canada and Japan.
- Locating employment in the entire value chain, from idea inception through product development (research and development personnel) to the marketplace. This should also address the employment spill-over effect of CE technologies and products.
- An investigation into the links developed between knowledge workers and economic activity (i.e. industry change).
- Assessing the impact and implications of EU expansion for CE industries and employment.
- An important component for building intelligence on employment in CE industries is the gathering of intelligence and data and the provision of timely and qualitative measures. This would include the establishment of a European level database that can be updated, which includes elements not yet gathered (i.e. field of expertise). A scenario-building tool could be designed to assist in the monitoring of employment in CE industries and serve as a tool to plan effective stimuli for preventative or promotional actions that go beyond the Member-State level and highlight the role of the EU in the field. This will also identify data and information gaps and can be used to recommend survey instruments.
- Accumulation of accurate statistics on the entire consumer electronics related design and manufacturing value added.
- Evaluation of the effectiveness of previous public policies for the CE industry, in order to offer better insights into the potential of new policies, which may need to be differentiated to address the various areas of CE.
-

4.8. Conclusions

It is clear that further rearrangements of the global CE industry must be expected to take place in the next decade. The process of take-overs, alliances and joint ventures will continue to rock the industry globally and it will undoubtedly affect the European CE business. Faced with such turmoil, the European CE industry is certainly in a good position because of its commercial and technological strengths. However, it needs to develop its own strategies, as was already briefly discussed in section 3. Whether these will be successful is of course unpredictable.

Still, in view of the importance of Internet for many aspects of the CE business, the development of an active Internet environment in Europe is of critical importance. Lagging with respect to the US environment, this might require a collaborative effort by the main players, for instance, along the lines of a recent initiative of American car manufacturers. In any case, it is felt that more could be done in this field.

A similar remark should be made with respect to digital television. Digital television broadcasting is making rapid progress. Since this medium opens many new opportunities for new services and products, in particular for fusing certain Internet aspects with the TV environment, it is of great importance for Europe to move forward with determination.

Next to the Internet environment, the available skills base for innovation as well as for manufacturing is critical to the European CE industry's future. However, little insight exists regarding needed expertise, nor are data available. Only a gut feeling suggests that the continued convergence trends will tax the skill base heavily. Consequently, it is important to assess whether any skill problems are looming and the role of public policy. A serious effort by the industry, together with the public sector, is needed to shed more light on this important issue.

Finally, employment in the European CE manufacturing will be concentrated on knowledge-based, high-quality production. Commodity production will inevitably move out of the (present) EU. This entails a change in employment profiles, certainly towards higher quality, though perhaps with fewer people directly involved. Production volume and value will increase with the greater product scope that convergence brings, and the effects of outsourcing etc. must be included to estimate the net effect on numbers of persons employed. At any rate, the question as to how the employment picture will develop in the coming decade will be determined to a large extent by how well Europe can cope with the changes that are imposed.

5. Options for research for policy support: issues and methodologies.

5.1. Introduction

This section is based on the work done under the third cluster “Methodology.”¹⁹ It provides suggestions for research activities in support of a number of public policies that could contribute to the competitiveness of the European CE industry.

The term "policies" is used here in a general sense, and covers a range of intentional actions taken by the public sector. It is therefore neither restricted to policies formalised in laws and regulations or to those of the European Union. Opportunities of enhancing the effectiveness of policies should always be considered, perhaps by creatively using more catalytic models. In particular because policies need private sector support, there must be a degree of consensus amongst the key actors in the CE sector as to the relevance, need and usefulness of such policies. Key actors should therefore be involved at a very early stage.

The sections below focus on policies that influence the CE industry specifically. More generic policies (such as those related to establishing the Single Market) are not mentioned.

The proposed policies and research actions to be taken are clustered in four categories: Knowledge, Consumer, Industrial, and General. In each case a brief description is provided, a methodology is suggested, and some issues regarding this methodology are identified.

5.2 Knowledge policies

Mapping knowledge and competencies in the CE Industry

Description

Mapping the required knowledge and competencies in the CE industry in the EU in the coming decade, in order to provide critical information for a range of policy areas.²⁰

Methodology

A good definition of the CE industry field is needed first. The relevant value chains must be identified. Then the knowledge and competencies need to be catalogued and mapped.

¹⁹ It is based on a one-day workshop by the partners of this project and subsequent (email) discussions between them.

²⁰ Section 2 of this report provides insights regarding the industry definition. Knowledge and competencies will be much more generic than before. Mapping may be too ambitious, but drawing outlines and directions is possible. Studies of value-added chains carried out in the USA may be helpful to define this work.

Stimulating longer-range research

Description

The consumer electronics industry is highly knowledge intensive, in particular in the activities on which the European industry is likely to concentrate. Longer range scientific knowledge is needed for the industry to be successful in the future. Universities and research institutes are key players - they are developers and suppliers of knowledge - but need guidance and incentivitation to do the right things. User needs must be much more of a guideline than in traditional basic research. RTD policies to support this on a European scale need to be renewed and strengthened.

The gap between typical longer-range research outlooks (5-8 years) and the shortening horizons for enterprise R&D (3-4 years) needs to be addressed.

Methodology

Areas for scientific research should be based on the outcomes of the Map just mentioned. European strengths and weaknesses must be identified and measures to stimulate relevant research must be designed. An international survey of CE-related research should identify new concepts for research projects, involving public/private collaboration and funding, and new ways of transferring knowledge from longer-range research to industry.

Improving Education and Training

Description

The CE industry in Europe is critically dependent on human resources of high scientific and technical calibre. In some areas, there is a scarcity of highly skilled personnel and more shortages are expected. This is not a problem of the educational system alone. The industrial community must demonstrate that the CE industry provides attractive and challenging career opportunities for young people. In addition, curricula at vocational schools and (technical) universities have to be made more relevant to the technical skills needed, where required. Continuing education and training, focusing on the necessary industrial competencies in this fast-moving field, must be strengthened for the workforce to remain up-to-date and flexible.

Methodology

Based on skill maps, the needs for (and availability of) training and education can be studied to identify discrepancies between supply and the expected demand by industry. Methods of closing these gaps should be identified. Continuing education issues should be studied in close collaboration with the industry, and suitable approaches to life-long learning suggested.

5.3 Consumer policies.

Training European Consumers

Description

The "comfort level" of consumers needs to be raised before "convergent" CE products find widespread use. Therefore, consumers need to acquire new skills to work with new consumer electronics products and to use newly offered services - in particular in

relation to the Internet. While this must be embedded in the educational system, it also requires a willingness and a massive training effort on the part of the adult population in the EU. In a wider sense, a "culture of technology" must be created across the EU. Cohesion strategies may have an important role as a motivator to develop and carry out initiatives in this field.

Methodology

A view must be developed on the skills that consumers might need to enable and enhance their active participation in the Information Society. Gaps between what exists and what is needed should be analysed for the Member States as well as the pre-accession candidate countries. Options for sensible educational initiatives could be designed and analysed for resource implications and practicality of implementation. A study of best practices across the Union may be useful, as well the programmes in place in other countries such as the United States and Canada.

Widening Consumers' Access to Internet

Description

Consumers in Europe need access to Internet. First, basic Internet services must become available to all residents through the telephone network. Public policies aimed at spreading Internet usage across the Union should be the first priority.

However, many Internet applications for consumers are critically dependent on the bandwidth to which he or she has direct access (e.g. at home or in the car). The European consumer must have access to the maximum bandwidths that are technologically and economically feasible. Public policies - such as the Commission's e-Europe initiative - should stimulate private sector initiatives to improve the quality of Internet access for consumers.²¹

Methodology

The first issue - spreading Internet usage across Europe - would be best studied by a group with broad expertise in European telecommunication networks as well as experience in the consumer markets. They would identify the capabilities and obstacles for widespread usage of networks in the EU and candidate countries to support the desired expansion of Internet usage, the possibilities of increasing network capacity, the scenarios for adoption by the public, and the role of public policies.

The second issue - improving the quality of access - would require a more forward-looking and technical study of present and future broadband options, in particular in the local loop of the fixed telephone network, the use of the (video) cable network and the wireless technologies. Thereafter introduction scenarios for the next decade could be constructed and the positive and negative roles of public policies assessed.

Protecting Consumers and Ensuring their Privacy of Data

Description

The issue of consumer data privacy and confidentiality is of great importance in Internet-type of applications as well as in wireless telephony. Public awareness of these issues grows quickly with the exploding use of these services. Public trust and confidence are essential for a broad acceptance. An EU certification of suppliers

²¹ Such studies might be carried out as a co-operative effort by EICTA and EACEM.

providing e.g. label showing the web site is operated by a "reliable" enterprise, could be envisioned.

Methodology

This field is potentially broad and the policy issues could change rapidly due to new technical developments, diversification of uses and growing societal awareness. It is therefore not useful to make methodological recommendations before specifying the policy issues that need addressing.

Improving the availability, quality and integrity of content

Description

Content is a critical factor in many applications of consumer electronics. The public sector owns a substantial amount of information that might be made available in the form of content to interested consumers. Also, public policies might help to improve quality of content, either by banning unacceptable or by certifying acceptable content. However, with respect to quality, it is difficult to establish a criterion for quality as it can be subjective.²² Regulating content this way could also be construed as a form of discreet censorship. A possible way to go might be bundling the issue of quality with integrity (authenticity) of content.

Methodology

A straightforward methodology to study this difficult issue cannot be formulated at this stage. Rather, it is suggested to start the investigation by conducting a large survey of public and private providers of content, and asking them how they perceive the issue of quality/integrity and how they ensure that they are delivering such content. Based on the findings a further approach could be defined.

5.4 Industrial policies

Industrial restructuring

Description

Although the necessary restructuring of the European industry as a result of convergence is first and foremost the responsibility of the industrial actors themselves, the public sector might be involved as well. For instance, organisational issues related to the shift towards a global knowledge economy could well be on the European research agenda. How to manage a diverse and world-wide technology base? How to ("e-") integrate business processes on a global scale?

Methodology

Based on the outcomes of this project regarding the industry structure a workshop could be convened to discuss the relation between restructuring and public policy, to identify relevant issues for public policy and to draft a research agenda.

²² A quality paradox exists that could be formulated as more information channels (e.g. digital TV) does not mean more (quality) content. On the contrary, to fill the new channels more of the same type of content is used. Stimulating the creation of quality content would be another policy objective. This entails selectively supporting small, innovative media enterprises to avoid dominance of the market by the large commercial content producers.

Improving Standardisation and Interoperability

Description

Standardisation and/or interoperability are essential for the success of many consumer electronics products, systems and applications. A wide variety of standardisation processes currently exist, ranging from those in the formal international standardisation bodies, single-company de-facto standard setting in the market, voluntary agreements between important market players to novel open-source approaches. Whereas these processes are often global in nature, in several cases a European solution is needed (DVB, DAB) or a European initiative desirable (with regard to areas comparable to GSM).

Methodology

The study should analyse the different approaches that have been (or are being) adopted and compare them with the present and future challenges in the consumer electronics markets. Specific opportunities for and threats to the European industry must be outlined and the role of the public authorities (at EU and national level) assessed.

IPR Management, Including Copyright Protection

Description

Convergence in the CE arena leads to convergence of different approaches to, and forms of Intellectual and Industrial Property Rights (IPR), such as copyright, patents and trademarks. Traditionally the CE industry saw its IPR portfolio in the first place as a guarantee to operate without being constrained by patents from other parties. It made its IPR's available to competitors against a (relatively low) per-product fee, sometimes on a cross-license basis, thus effectively stimulating markets for new products on which profits could be made. Examples of this behaviour are the exploitation of Telefunken's PAL package and Philips' CD patents. Today, new entrants have sometimes radically different interests: they are only interested in exploiting IPR's through licensing instead of own production, or have products where IPR's are not easily identified and enforced (e.g. software).

The CE industry has also become deeply involved in a different set of problems related to content. CE digital products allow easy, high-quality copying of content, and content is more and more intertwined with (multimedia) CE products. Protection of artist's rights and company's copyrights restricts consumer use of copying products, and could have a negative impact on the market of CE products. In the new field of multimedia there is also a serious question whether protection of rights hampers innovation, a question that may have a different answer than in the traditional (technical) patents case.

Methodology

It is evident that the problems encountered here are of great importance to the European CE industry, certainly if it grows further into a knowledge industry. However, this issue needs to be investigated so as to make an inventory of existing and future problems, and how reforms to current IP law and industry are dealing with

the threat of digital piracy. Then a view on the role of public policy should be developed.

Priming New Markets

Description

In many cases new consumer electronic markets develop when the public and private sectors join forces. The role of the public sector may be that of an advanced adopter of technology, e.g. by offering public services on the Internet or providing highway traffic data for mobile use. But the public sector may also act as a regulator or deregulator of services or a stimulator of new infrastructures.

Methodology

Many examples of the past may be analysed systematically and compared with current and future concepts of government roles in order to arrive at a view on successful intervention mechanisms and attractive public policy options.

5.5 General policies

Integrating Environmental Policies

Description

Post Kyoto environmental policies have become increasingly important for the European consumer electronics industry. Many initiatives are in place or are to be adopted, such as directives for the collection of components, banning lead in solder joints or requiring lower power consumption.

Methodology

It is necessary to see "the big picture" in the range of environmental measures. This can only be obtained by going through present and planned measures with a clear view of the consequences for the consumer electronics industry. Then an analysis of the effects on competitiveness must be prepared, presenting the positive as well as in the negative impacts.

Stimulating Employment

Description

In the fast changing environment of the consumer electronics industry a large number of jobs may be lost in Europe, but an equally large number of new jobs may be created. It is important to understand these mechanisms to minimise job loss and maximise employment opportunities for EU citizens. Immigration policies, mobility issues and policies regarding the accession of new member states are of particular relevance. Issues with regard to "employability" policies are important to take into account too.

Methodology

First, global shifts in employment in the CE industry must be thoroughly understood. This should be followed by an analysis of the shifts taking place in the European CE industry skill base. The change in the EU skill base should be compared with change taking place in the sector of major competitor regions/countries (i.e. the United

States). The results of this work would provide information on drivers of employment/unemployment and link (contribute to) education and training issues.

Strengthening Industrial Innovation

Description

Industrial innovation requires a flow of ideas from universities to consumers - and back. Financial investments are required to turn ideas into products, markets - and, ultimately, into profits. Research is needed for a better underpinning of existing and new innovation policies.

Methodology

"Realising the full potential of R&D" is an issue that is not yet well understood. A study of dynamics of human capital is needed, focusing on the flow of people and ideas through the innovation chain in the consumer electronics industry.

Stimulating Entrepreneurship

Description

As in other areas, entrepreneurs are essential players in the renewal of the CE industry. More than in the past, today they have opportunities for successful growth in a widening playing field that the "big players" are not able to cover with any degree of completeness.

Methodology

The consumer electronics industry, with its strong line-up of global companies on the one hand and the seemingly endless opportunities for small companies associated with the Internet on the other, is an interesting field of study of the dynamics of entrepreneurship and industrial growth. Studies of the relations between large and small companies need to be revisited and assessed, studies of government stimulation policies reviewed, with an eye on the specific features of the CE environment. This will provide a better insight in the effectiveness of existing practices, and suggest options for new stimulation policies in this field.

Revisiting Competition Policy

Description

Innovation in the CE industry is indeed, and will continue to be, very dynamic due to the effects of convergence. Competition patterns change very unexpectedly; the very diverse examples of DELL selling PC's on the Internet, or Ericsson becoming a consumer-products company, show this convincingly. Are present Competition Policy instruments still adequate? Enterprises also integrate along the value chain to command all aspects from information ownership to content delivery to the consumer, others monopolise interfaces through their power in the market and again others join forces in related businesses to accommodate global markets. It is at least questionable whether current competition law is still adequate to ensure a healthy competitive environment for the European consumer electronics industry.

Methodology

A careful analysis of the present body of relevant legislation and its practical application in the EU, the US and Japan should be made. This should then be compared with current and future trends in the CE industry, with an eye on the competitiveness of the European industry.

6. Conclusion. Convergence, competitiveness and public policy.

CE is a global business, and the European CE industry mainly consists of global players. CE in Europe is an important industrial sector, in terms of quality as well as quantity of employment. CE, together with services and content, has a strong impact on society in Europe.

The competitiveness of the European CE industry is very strongly influenced by convergence.

- Convergence impacts existing products and accelerates the introduction of new products. A different technology base will often be required, new customers must be understood, other market approaches are needed. Companies must acquire new knowledge and skills, they have to become more agile and responsive.
- Convergence creates new competitors. Companies easily cross diffusing borderlines between products and markets. New entrants often introduce new products. Sales methods and channels may change fast. For existing companies there is no guaranteed future, new entrants face enormous risks.
- Convergence introduces new relations between CE producers, content owners and service providers. Collaborations or alliances must be revisited. Mergers and acquisitions take place, changing the rules of the game. CE companies' proven strategies may not be adequate tomorrow, or even today.
- Convergence creates new consumers. Especially around the Internet, a new "community" is coming into being, whilst other, unexpected usage and related behaviour are being developed. Similar trends are seen around GSM. "Traditional" CE makers may have a difficult time understanding and satisfying such consumer groups.
- Convergence thrives on the existence of high-quality networks, with lively markets for content and services, and used by informed and interested consumers. Competitiveness of the European CE industry is critically dependent on the health of these environments, of which Internet is the most influential.
- Convergence affects industrial operations and structures. Different branches of the CE industry use different innovation models and have different approaches to manufacturing, use different approaches to sales, et cetera. Each company must assess its strengths and weaknesses, not only with respect to its existing competitors but in particular with a view on the new ones.
- Convergence creates a wealth of opportunities for small and medium-sized companies. Markets are created for new products and new services — independently offered or in an alliance with larger companies, directly to the consumer market or as supplier - have a very large potential. Fast growth in case of success is essential, taking advantage of Europe's high-quality labour market becoming more flexible.
- Convergence increases the pressure on EU enterprises to attract and maintain highly skilled personnel who are increasingly mobile and in demand in a global marketplace.

It is in the first place the task of industry to identify the threats and opportunities and to chart its course towards the future. However, in view of the importance of the CE industry for the science and technology base and the quality of employment in Europe, a wider circle of stakeholders must understand the issues.

Public policy in Europe should therefore be focused on an aggressive strategy to make the Union an attractive place for industry to be - not only for sales, but also for innovation and production. The following key areas are suggested.

Policies should stimulate

- an innovation-minded, educated European consumer base
- Internet usage, by enterprises as well by consumers;
- fixed and wireless telecommunication and broadcasting infrastructures
- standardisation processes in Europe;
- creation and transfer of CE-related knowledge;
- collaborative R&D, targeted on CE applications, across Europe;
- start-up and growth of small innovative companies;
- high value added manufacturing;
- collaborations between the service, content and CE sectors;
- industrial collaboration and restructuring.

Proper policy measures in each of these areas will help to draw the CE industry to Europe and create an innovative environment and new employment.

Annex I Overview of research papers.

- RPT-I-1: Convergence of the European CE Industries: Products and Networks.
P. Tang & T. Venables.
- RPT-I-2: *Technology Platforms*.
A. Puissochet.
- RPT-I-3: *Services in Consumer Electronics*.
Pieter Ballon.
- RPT-I-4: *User configurations and convergence in consumer electronics*.
Ulrik Jørgensen.
- RPT-1-5: *Public Policy Issues related to Product Use*.
G. J. Nauwelaerts.
- RPT-1-6: *Broadband Access and Consumer Electronics*.
A. Puissochet.
- RPT-1-7: *Strategies of the EC industry*.
A. Puissochet.
- RPT-II-1: *Global Trends in Business Activity & Industrial Organisations*.
G. Nauwelaerts.
- RPT-II-2: *Employment - More Than Counting Numbers*.
W.K. Hansen.
- RPT-II-3: *Major Public Policy Issues*.
A. Puissochet.
- RPT-II-4: *The Nordic Mobile Telecommunication Cluster*.
Ulrik Jørgensen.
- RPT-II-5: *Digital Broadcasting: situation and evolution by geographic area*.
A. Puissochet.
- RPT-II-6: *Mergers and Alliances*,
A. Puissochet.

RPT-I-1 Convergence of the European CE Industries: Products and Networks

Dr P. Tang & T. Venables. SPRU, University of Sussex.

1 Introduction

Pundits watching the development of IT and their applications in a wide spectrum of industries and sectors claim that advanced electronic controls and Internet-linked entertainment and information services will eventually be available to consumers in the household. The convergence of broadcasting, communication, computing and audio-visual technologies that have evolved rapidly since the early 1990s has, in large degree, engendered the blurring of what is traditionally regarded as consumer electronics (CE), which were largely based on mechanical and analogue technologies, and simple embedded electronics. Today, these products are increasingly digitised and involve a wider array of “intelligent” functions that can “speak” to each other (inter-operate) and perform several functions (multi-functionality). Certainly, the apogee of this evolution of CE is expected to be in the convergence of Internet and mobile technologies into these products to create, for instance, a pervasive home computer network control system for remotely operated applications, such as lighting, heating, banking, shopping, controlling household appliances, providing security, information and entertainment.

Underlying the convergence of technologies is their use in the quest for increasing miniaturisation, such as multiple layer printed circuitry boards, high density semiconductor technology which allows more components to be packed on to a microchip and the use of thinner and lighter materials, for example, magnesium. Some MP3 audio players, which allows music to be downloaded from the Internet when plugged into a computer, are no more bigger than a matchbox. Many of these advances have also resulted in lower power consumption, an important consideration for portable consumer products. Common examples of miniaturisation are the Sony Walkman™, which in the early 1980s weighed 390 grams, but is just over 140 grams today, and the MiniDisc audio format of which its manufacturers are racing to develop smaller and smaller players. For instance, JVC has launched a MiniDisc player that weighs 63 grams, a tenth as heavy as the first portable MiniDisc player.

Similar miniaturisation trends can also be seen in the consumer video market. The first video camera recorder (camcorder) weighed around 2.5 kilograms; today the latest home digital camcorder weighs less than 450 grams and can be plugged into a television for viewing. These new generation camcorders are also capable of holding immense amounts of data, such as 2.5 times that held on a floppy disc, and also allows manipulation and combination of live and still pictures. Observers of the CE industry are already talking about a small home computer network control server (unit) that will sit obscurely in a corner of a home to control the myriad applications, as noted above, to make life more convenient and time saving.

This section of the study provides an overview of the progression of CE in a relentlessly convergent and miniaturised environment. For the purposes of this study, we define CE as personal and household electronic equipment and devices not intended for use in a commercial environment. The section is organised in the following way. Section 2 explains why we have divided CE products into categories.

Here, we present two matrices. The first is a representation of products against a time frame. The second shows the underlying technologies and protocols for “convergent” CE. Both will be followed by descriptions of selected CE to illustrate the state of convergence obtained in these products and their underlying technologies. Section 3 concludes with a note on future trends through a brief discussion of convergent technology trajectories, for instance, cross and multi-functional capability enabling technologies, and the factors that impact upon their development. It will also argue why it is not useful to study convergence in the CE as a discrete topic.

2. Scanning the convergent panorama

The Introduction referred to common CE, such as the Sony Walkman™. These are still popular CE products. Yet, yet more sophisticated and versatile CE have already made inroads into the homes of advanced economies. For instance, the Sony Playstation™ or Sega’s Dreamcast™ is either becoming a ubiquitous CE product or one which both adults and children want to acquire. Dreamcast™, for instance, contains sophisticated games technologies and is played on a 128-bit console, compared to the 32-bit console of the first version of Playstation™. The enhanced capability of game players has occurred in less than 2 years, and speaks to the rapid development in this line of CE. Yet, the story does not end here. Sega is already retailing in Japan the Dreamcast™ as an Internet-enabled machine. Equipped with a 56k modem and a web browser, the machine can conduct online activities, such as accessing websites and communicating via email. Not to be outdone by Sega, Sony recently launched its Playstation II which is expected to exceed the versatility of the features of the Dreamcast™, the developments of which are illustrative of the continuing evolution of CE using an array of technologies.

An even more pervasive CE in the home is the television. Here too, there is a bigger vision for the humble television: it is being converted into an interactive and Internet-enabled unit, commonly referred to as iTV (interactive TV). Broadcasters, computing and telecommunication companies are either forming strategic alliances or joint ventures to give people access to shopping, banking and e-mail on television. For instance, in the UK, Open, which is partly owned by British Sky Broadcasting and British Telecommunications, is using conventional satellite technology to broadcast images on the television. Viewers can then order goods or carry out transactions using their television remote controls. The orders are transmitted over telephone lines by modems in special set-up boxes. At the same time, digital television broadcasters have started offering email services over the television, via a special set-top kit.

Broadcasters are also envisaging broadening this service to one providing “enhanced TV” which basically involves services offering information in addition to shopping. For instance, consumers can buy tennis rackets endorsed by Andre Agassi or review his career track record, while simultaneously watching him play. In the US, Microsoft, AOL, Sony and a number of satellite television companies are investing in iTV. Cable operators are upgrading their networks to carry large amounts of data that these kinds of services require, such as by installing asynchronous digital subscriber line (ADSL) technology which allows high speed two-way communication and more data to be carried than conventional copper lines.

The above are merely two examples of the imaginative ways that CE products are utilising technologies. Below, we present a matrix depicting the evolution of CE products. They are divided into categories, which are shown against their status.

Status refers to the state of availability in the current marketplace.

We created 4 levels of status:

- Extant (widely available today, for instance, the television);
- Existing (newly available since the last year or so with limited take-up, for instance, the digital terrestrial decoder for digital television);
- Emergent (newly or being developed, prototyped or speculated, for instance, home networks and appliances);
- Eventual (a speculation of future CE in the next 10 years).

The categories are:

- Information (I) are devices that are “dumb” creators and/or providers of data/information in a basically unalterable form. Information/data can be in visual and/or audio formats.
- Command and control (C^2) are devices that can be used to deliver instructions or control applications and are not dependent on mobile technology.
- Command, control and communication (C^3) are devices that contain C^2 features and a communication capability. They too, are not dependent on mobile technology.
- Command, control, communication and information (C^3I) are devices that contain C^3 features and provide information, in image and audio formats, but are not dependent on mobile technology.
- Mobile command, control, communication and information (MC^3I) are devices that contain C^3 features but are based on mobile technology, which allows remotely operated applications and services.

It is worth noting that the evolution of CE using convergent technologies also begins to blur the boundary between “pure” CE goods and CE services. As the goods in themselves become more versatile and multi-functional, it becomes increasingly less useful to delineate between CE goods and services. (See chapter on Services.) This, in turn, emphasises the convergent nature of current and future CE. The following two sections of this study will further illustrate this observation.

The following matrix illustrates leading examples of CE categories against their status.

Status	Categories				
	<i>I</i>	<i>C</i> ²	<i>C</i> ³	<i>C</i> ³ <i>I</i>	<i>MC</i> ³ <i>I</i>
Extant	Television	Remote Control units	Basic Telephony Devices	Personal Computers	Notebook Computers
	Video Recorders	Basic Game Players		Digital Satellite and Cable Decoders	
	Record Player				
	Cassette Deck				
	CD Player				
	Radio				
	Analogue Satellite and Cable Decoders				
	Answerphones				
	Fax Machines				
	Pagers				
	Camcorders				
	Film Cameras				
	Early PDA's				
	Baby Monitors				
Existing	Digital Terrestrial Decoders			Lifestyle Computers (iMac, Equium 2000)	Later PDA's
	DVD Players			Videophone	WAP Phones
	Mini Disc Player			Advanced Gameplayers (Dreamcast™, Sony Playstation II™)	Email Phones
	Digital Cameras				Web Pads
	GPS Systems				
	Image Intensifiers				
	MP3 Players				
Emergent	DVD Recorders		Home Networks	Network Integrated Domestic Appliances	Bluetooth Headsets
	DVD Audio Players		Robotic Pets (Aibo)	Car control systems	TV Integrated Phones
	Digital VHS				Electronic books
	Streaming Video Devices				
Eventual				Seamless, integrated, multi-functional, interoperable home control system	Multi-functional devices integrated and interoperable with static networks

Fig. 1: Matrix representing the convergence of consumer electronic products

Figure 2 indicates possible technological trajectories for the emergent and eventual CE products and devices. They exclude transmission technologies that are discussed below. However, as with transmission technologies, these are the underlying technologies required to achieve the intended utility and features of the progressively convergent CE, such as remote multi-functionality operating in an interoperable environment. Figure 2, however, does not take into account operating systems that have been and are being developed for CE devices such as EPOC Symbian and the Palm platform, as these operating systems can be considered as enablers of the technologies described in the above Figure.

Fig. 2 Matrix representing the underlying technologies and protocols for convergent consumer electronics devices

Status	Categories	C^2	C^3	C^3I	MC^3I
Extant	Analogue magnetic storage			Digital Magnetic Storage	
	Digital Optical Storage				
Existing	MP3			IP	
	Communication Bus Systems				
Emergent	Narrowcasting			Bluetooth	WAP
				Solid state memory cards (solid state technology)	
Eventual				IP+Bluetooth	IP+ Bluetooth + WAP

Figure 3 below represents a matrix for transmission technologies for CE networks. The progression of these technologies from status I to C^3 suggests an increasing trend to greater complexity and versatility. As will be noted below, these technologies underpin a wide array of convergent CE products through networks that allows both static and mobile applications in the home, in an interoperable and seamless fashion. In particular, Figure 3 mirrors both the trend and development of products and applications represented in Figures 1 and 2.

Figure 3: Underlying transmission technologies for CE networks.

Status	Categories				
	I	C^2	C^3	C^3I	MC^3I
Extant	Analogue broadcasting	Infra-red (low bandwidth)	Basic telephony	ISDN	GSM
Existing	Digital broadcasting (terrestrial and satellite)	Power line (low bandwidth)	Dedicated bus (higher bandwidth)	Digital Subscriber Line (DSL)	
			Home radio frequency		
Emergent				ADSL	UMTS
					General Radio Packet Signaling
Eventual					???

In sum, in reviewing the three Figures, one quickly notes that the emergent and eventual developments of CE lie in the bottom right hand columns, namely products that belong to the C^3I and MC^3I categories. This may not be surprising as the trend toward more storage and functionality, bundled in a miniaturised remotely operated interoperable system, seems to be a major pursuit of CE manufacturers, as evidenced by the CeBIT exhibition of new telecommunications and IT products held in Hanover in February 2000. (See below for examples of these products.) The emphasis on mobile technologies further reinforces the trend toward miniaturisation.

The following section describes examples of the existing and emergent status. It will also include a brief speculation of the CE that the market will offer in the next 5 to 10 years --eventual CE. The section, however, will not review examples from the extant status on the grounds that these products are already well familiar to the public at large. Such examples can be obtained from Figure 1 above.

3. Selected samples of the “new toys”

The selected samples will be divided into existing, emergent and future levels of status.

Existing

DVD Players

Digital Versatile Discs (DVD's) emerged as a new media for both computer data and video in the late 90's. Capable of holding much more information than previous optical disc formats (4.7Gb compared to 650Mb on a conventional CD, or over 2 hours of video per side as opposed to one hour per side on 12" laserdiscs). DVD has the advantage of being a cross platform technology with a certain amount of backwards compatibility with Compact Discs (CD). This means that DVD players can be used to play music CDs and the discs can be used in both stand-alone devices and in computers. Another impressive feature of DVD's is their ability to produce movie-like quality of videos. An audio format for DVD was released in April 1999 but has not made much impact in Europe to date possibly because of the lack of availability of players.

Non traditional computers

Apple revolutionised the home computing market with the release of its iMac computer in 1999. The iMac took a step away from conventional computer design not only because of its vivid translucent colours but more importantly by its ease of set-up. PC manufacturers initially dismissed the iMac as a gimmick but soon began producing models that moved away from beige boxes. This has extended to a range of machines that no longer use the PCI architecture but rely on alternative expansion techniques such as USB. Traditionally in order to add functionality to a computer (e.g. additional storage mediums) it was necessary to either physically install them inside the machine or to use one of a limited number of external ports. Both techniques relied on a good level of technical understanding and would only give the added functionality after the computer had been restarted. Alternative architectures that use different expansion techniques, such as USB, allow external devices to be added when needed. These can be recognised by the computer without the need to restart the machine (plug and play), and allow many more devices to be connected than the PCI architecture does (up to 127 devices on a single USB bus).

Videophones

Video telephony has failed to make any significant impact on the market to date. Part of the reason for this is likely to be a matter of critical mass, needing both sender and receiver to be using compatible equipment. The use of basic video conferencing facilities over the Internet coupled with an increase in multifunction telephone devices could help to achieve this critical mass. The increasing need of governments to develop a supplementary means for delivering health and support services to the home also could stimulate a renewed interest in this device which somehow “died” in the mid 1980s, after much fanfare.

The falling price of videophones, from about £50,000 in the mid 1990s to about £1000 today, and the improving quality of the picture, could also help to boost the take-up of videophones. Siemens, for instance, is devoting large resources to promote

the use of videophones. UK company, Motion Media, is acknowledged to be a leader in this technology.

Later PDAs

Early Personal Data Assistants (PDA's) were little more than an electronic version of a paper diary. As these products have developed in popularity they have also become far more sophisticated. PDA's now link seamlessly with personal computers and share information between applications, for instance, one can download either from the computer or the PDA one's work schedule and address book. Additionally PDA's are now starting to communicate independently with wider networks. Products such as the Palm VII™ now feature wireless access to the Internet. Similarly, the Motorola/Psion (Symbian) device, which is being launched, allows users to make telephone calls, access the Internet and view Web pages.

This product will be using Bluetooth, (see Figure 2) which is a radio technology for linking Internet-connected mobile computers, mobile phones, and handheld devices. Users can beam data between mobiles and computers without the need for clumsy cables. Analysts are expecting increased announcements about the use of this technology in new consumer products. About 1,300 companies are involved in developing Bluetooth specifications, including IBM, Ericsson, 3Com, Intel, Lucent, Microsoft, and Motorola.

Advanced Gameplayers

Early generation of gameplayers offered visually basic games displayed through your television. As processing power increased these games became far more complex and graphically improved, but remained restricted to use within the home. The advent of a range of advanced gameplayers, heralded by Sega's Dreamcast, as described above, but closely followed by Sony's Playstation 2 and Nintendo's Dolphin, extend the capability of these machines by allowing access to online services. "Perhaps the most important device of 2000 will be Sony's PlayStation 2. Although the PlayStation 2 will debut as a game machine, "it is really the start of an entertainment-focused computer that will take on more functions, such as delivering movies loaded via a broadband Internet connection" according Michael Slater on ZDNet.

Web Pads



Similar in some ways to lifestyle computers and advanced gameplayers, web pads take access to online services away from traditional computers and into more user-friendly devices. A web pad is a hand-held device that uses a radio frequency connection to a data port (telephone, ISDN, or cable point) and can be used to browse the Internet and send e-mail. A web pad can be described as an exemplar of a

miniaturised "converged" CE.

MP3 Players



The increasing digitisation of domestic media started with the music industry (Digital AudioTape, which uses matchbox sized cassettes, and CD). It is not surprising that music is one of the first forms of media to be distributed virtually over the Internet. MP3 is

a compression protocol that allows music to be stored in relatively small files. The innovative feature of an MP3 player is its first ever ability to record music from the Internet, when plugged into a computer that is connected to the Internet. Whilst the recording quality is nowhere near that of other digital media, it is eminently suitable for mobile devices particularly as the players need have no moving parts and therefore and not prone to distortion as a result of vibration.

Car control systems

Consumer electronics devices such as stereo equipment have been fitted in vehicles for many years. More recently, however, car systems have evolved beyond the passive information provision of music and news. GPS (Geographical Positioning Systems) receivers have been linked into navigation devices to provide electronic roadmaps and display screens have been fitted for passengers allowing television and game-play access. This trend towards MC³I continues with the development of interactive navigation systems that can check prevailing traffic conditions along the route and suggest alternative routing to avoid congestion. Screens providing entertainment for passengers also allow mobile Internet access

Emergent

Streaming Video Devices

A number of devices have recently been released in the US that take the recording and playback of television signals away from tape media onto disk storage similar to a computers hard drive. Philips' TIVO and Replay Tv's 2020 both can record and playback simultaneously allowing the viewer to 'catch up' if they missed the start of the programme. They can also be programmed to record genres or specific programs by default whenever they appear on programming schedules.

Home Networks

Home Networks can broadly be split into two categories: those specifically aimed at computers, and those aimed at a wider range of communication purposes (home automation, distributed entertainment...). Home computer networks are more of a peripheral than a consumer electronics device, but the wider network would act as a major linkage between CE devices. There has been a strong trend towards convergence in protocols for operating these networks over the last 3 years. The European Installation Bus has amalgamated EHS and BatiBUS into a single European communication protocol but there still remain a number of competing protocols specific to individual European manufacturers as well as protocols from outside the EU such as the American LonWorks. While the market for home networking equipment has not taken off in Europe to the same extent as it has in the US, there is increasing marketing effort from computer and CE manufacturers. They have been frustrated by the approaches of electrical equipment manufacturers to create a market for these networks. Examples can be seen in the Cisco/Laing Internet home in Watford, National Panasonic's Home Information Infrastructure (HII) house in Tokyo, and Intel's CyberHome 2000 in San Francisco.

Network Integrated Appliances

As the use of ICT becomes pervasive their application in what would be traditionally considered white goods brings some of these products within the description of CE. Electrolux, a British company has unveiled what it is calling the first

Internet-connected fridge. This ultimate information appliance can be used to order groceries over the Web, read email, play games, or watch TV.



Due on the market in early 2000, the Electrolux Screenfridge is a standard Electrolux Blueprint fridge with a 13-inch LCD touch-screen and bar-code scanner built into one of its doors. The device allows appliance owners to scan near-empty jars and milk cartons that are running low, and add them to a digital shopping list. The list would then be beamed over the Internet to a grocer selected by the consumer. Depending on the shopper's preferences, the groceries can then be delivered, or picked up. The list could also be held at the store with pointers to appropriate aisles for those who still want to experience real-life aisle surfing. Electrolux previewed the prototype of Screenfridge at the ICL Future Focus Centre in Reading, in the UK. ICL, a software and services firm, will provide software and network support for the fridge. Pricing has yet to be set and the company will launch a large-scale trial in late 2000.

The device will be launched initially in the UK, although European retailers have also shown interest. ICL also has a prototype Internet fridge based on a standard US model. Initially the fridge will feature a standard modem, although future models may have built-in Ethernet or wireless data capabilities.



Ovens that can download cycle times and cooking instructions from the Internet or e-mail a service centre when a fault becomes apparent are also being prototyped. An exemplar of these new “super intelligent” domestic appliances is the new Microwave Bank, being developed by NCR Knowledge Lab in the UK. It is reputed to be easier to use than the average PC. This new fanged device is a standard microwave that can also be

linked over the Internet to your bank account to pay bills, transfer money, and go grocery shopping on the Web. A bar-code reader can scan products, which will then be placed on a shopping list. If desired, the user can arrange for the items to be delivered. An intelligent agent in the microwave is also able to store and process all of your requests, so it learns about your lifestyle and habits. For instance, if you are a frequent purchaser of low calorie meals, the agent can suggest that you buy skim milk, or when Christmas is approaching, it can remind you to buy whatever you traditionally serve for the occasion.

The microwave works with touch-screen technology on the door of the microwave, as well as voice recognition software. The use of voice recognition, iris scanning, fingerprint identification, and password protection could protect bank accounts. NCR expects the Microwave Bank to be available within the next two years. The cost has yet to be disclosed. The UK banking group, Barclays is exploring the use of this gadget for its banking services.

Engineers at the Fraunhofer Institute for Microelectronic Circuits have developed an Internet-capable washing machine with a home page that reports its status from the rinse to the spin cycle. The machine can be controlled with a personal computer and

an Internet connection. A self-voicing Kit, developed by IBM, provides the “voice” of the appliance. When the washing machine’s “home page” is accessed, a user can control its switches and dials and the wash cycle begins once the necessary settings have been established. The technology is also envisaged to help the blind and visually handicapped to operate household appliances, most of which are not equipped with markings Braille.

Bluetooth Headsets



The Bluetooth protocol as noted above, was developed to provide wireless interconnectivity between ICT based devices. While products using the protocol are only now starting to emerge one of the first is Ericsson’s planned release of a headset for its T28 range of phones which will allow hands free voice operation of the phone at distances of up to 20 Metres.

WAP Phones

Wireless Application Protocol (WAP) is software that enables small-screen devices, such as mobile phones, to view web pages. Although companies such as Nokia and Motorola currently producing WAP phones, their limited success has begun to generate disillusionment with the efficiency of these phones, and cynics are already saying that WAP stands for “Where are the Phones?” Nonetheless, there is continuing development on the use of WAP for all kinds of consumer gadgets, such as banking over the Internet, permanent connection to the Internet and mobile telephones with built-in TV aerial. These products are envisaged to be widely available in the next 5-10 years

E-Books

The introduction of a single, universal format has been hailed by its developers as a milestone in the e-book revolution. Called the Open E-book Publication Structure, it defines the format for content converted from print to electronic form. With the spec, publishers will be able to offer content in one standard format. Consumers will be able to download digital content from different publishers on any device. If this standard is widely accepted, this could represent a good, co-operative effort between large and small companies across different sectors to come together.

The major players in the e-book industry support the common standard. They see it as a way to drive the market and forestall divisive competition reminiscent of the VHS vs. Betamax wars (standards for the videocassette recorder; the current one is the VHS). The Open E-book Authoring Group is working on formalising its role in promoting the new electronic book specification. This standard will enable enhanced interoperability, which in turn, could stimulate greater consumer acceptance with respect to portable readers and content.

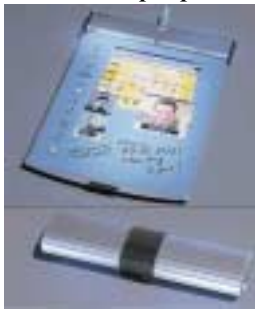
The ongoing development of electronic paper by Lucent and E Ink could further drive the take-up of electronic books. Electronic paper is a lightweight flexible electronic display that would perform as well as traditional paper. Electronic paper involves the harnessing of the plastic transistor, a flexible printable version of the silicon chip. The transistors would be printed onto a flexible plastic coated with E Ink’s electronic ink, which is made up of millions of tiny microcapsules filled with a dark dye and a light

pigment. When charged by the electric field created by the plastic transistors, the capsules change colour and create images. Electronic paper is highly suitable for e-books and e-newspapers, and its commercial availability could contribute to the development of e-books. Currently, the idea of reading a whole book off a laptop, light as some may be, has not captured the interest of consumers, despite the availability (albeit limited) of e-books. Furthermore, electronic paper could also be used to make ultra-thin displays for other consumer electronics, such as cellular phones and PDA's.

Eventual

Future Pervasive Computing

Flexible Laptops?



The move away from traditional computer styling and architecture is set to go even further with Toshiba having recently demonstrated a prototype portable computer called the Dynasheet. This computer features a flexible, touch sensitive screen that allows it to be rolled up when not in use. In a move away from keyboards the computer can be either voice operated or controlled using the screen and a handwriting recognition programme. External connections are managed using the Bluetooth wireless communications protocol.

Advanced Home Networks

Several of the emergent CE, such as the Internet-enabled refrigerator, microwave and washing machine, controlled by a home control system will likely be only widely available in the next 5-10 years. Developments in the US are already aiming to make available a local area network, in the comfort of your own home. To technophobes, this may sound highly intimidating because of cables snaking around carpets and down hallways. But these developments aim for a future in which the household intranet is invisible and painless.

A new industry coalition, the Home Phonenumber Networking Alliance (HomePNA) is working on a specification for building a home computer network out of the copper phone lines already installed through millions of houses. In theory, once plugged into this new household data-path, computers and other digital devices could share servers, printers, and modems, swap video and email, and do all the other things that local area networks ordinarily do in office environments. Compaq is one of the founding members of the new coalition, which also includes 3Com, AMD, AT&T Wireless, Epigram, Hewlett-Packard, IBM, Intel, Lucent Technologies, Rockwell Semiconductor Systems, and Tut Systems. Using the still-unnamed home networking specification, member companies hope to prototype products by the end of 2000 or shortly thereafter. Delivering this whole range of services through copper phone lines does not exactly sound like state of the art technology, given the "push" for wireless and mobile technologies, such as Bluetooth. Yet, the performance of home control computer networks is indeed ambitious and untested.

In a similar effort, many of the same companies belong to another coalition formed in March to push a standard for wireless in-home networks: the Shared Wireless Access Protocol. The membership of the Home Radio Frequency Working Group includes

Microsoft, Compaq, Ericsson, Hewlett-Packard, IBM, Intel, Motorola, and Rockwell Semiconductor and some CE manufacturers. The objective of this protocol is to enable more connectivity between devices in the home, so that one inter-operating network of home electronics will encompass communications between home-based PCs, printers and other peripherals, telephones, and consumer-electronic devices that will communicate with each other in a common language.

Such futuristic products and applications sound like something out of a Star Trek/Star Wars series. Given the pace of technological progress, their development is more than likely assured. Yet, their take-up is less certain and contingent on several factors, which the following section, will briefly address. Importantly, for a seamless, integrated multi-functional and interoperable wireless home control CE system to be realised, it is worth noting that, among other factors, such products need to address the crucial questions of widespread availability and infrastructure robustness to support such products and services.

1. Trends and trajectories

Attempts at extrapolating the *future successes* of products, services and technologies are often fraught with difficulties. One may recall the hype over the promise of ISDN (Integrated Services Digital Networks) in which analysts presented a rosy picture of its take-up in both residential and commercial environments. Yet, 20 years later, the take-up of ISDN has barely made a dent in the consumer market. A main prohibiting factor was the price of their installation and connection. Residential use of the Internet, on the other hand, has witnessed impressive growth over the last 5 years, and its continuing use has not disappointed its advocates. Yet, there is concern in the EU that the region lags behind that of the US, despite the argument that different levels of personal computer penetration, consumer spending, cultural fragmentation and infrastructure, for instance, makes such a comparison of limited value.

There is already increasing take-up of electronic information services, as witnessed by the growth of e-commerce and the Internet, as noted above by European consumers. This could augur a positive trend toward increased network capacity to the home, which could be provided either by cable, fibre to the door, satellite or radio, or any combination of these.

Furthermore, what is important for the EU is its rapidly increasing take-up of mobile phones by the region's consumers, and its leadership in mobile technology. This could enhance the potential deployment of broadband mobile data infrastructures such as Universal Mobile Telephone Services, or broadband fixed wireless systems such as Local Multipoint Distribution System will also build on Europe's lead in mobile phone technology. These trends arguably hold some assurance that products using wireless technologies, such as WAP and Bluetooth, will be widely promoted and attractive to consumers. As Figure 3 shows, there is an identifiable increasing trend, over time (that is, from existing to emergent), toward greater utilisation of bandwidth (from I to C³I), both static and mobile..

With respect to mobile devices, the challenge faced by manufacturers is two-fold. The first is what WAP-and Bluetooth-enabled handheld devices and home computer network systems at affordable prices will be offered. The second is, whether the battle

for a dominant operating system that will allow the multi-functionality and interoperability of the wide range of such CE products and services will be settled to allow their wide-scale production in the next 5-10 years. At the moment, the contestants for the dominant operating system are Microsoft, on one side, and Symbian venture, an alliance of mobile phone companies that uses the Epos operating system from Psion, the UK company that manufactures PDA's.

The continuing increase in the levels of affluence and education of European countries could be a major stimulus for the mass production of these products and supply of networks. There are however, some more immediate factors that could affect the realisation of sophisticated convergent CE products, despite increasing prosperity and a more educated workforce. Prudent policy actions could help to grapple with these obstacles.

The main inhibitors can be summarised as:

- Infrastructure (current lack of broadband);
- Standards (to allow interoperability and seamless connection);
- Consumer awareness and confidence in these products (how secure are the network systems, and how private is personal information);
- Consumer segmentation (intra-national and regional diversity)
- Pricing (telecommunication tariff for Internet traffic, and affordability of products and services)

Subsequent chapters in this report will address some of these impediments in greater detail.

In sum, static and mobile broadband technologies will underpin CE products and networks in a combination of ways. These new products also underscore the inappropriateness of studying the CE industry as a discrete activity. They also reveal the increasing indifference between CE products and services. For them to be yet another mass CE product/service, judicious and strategic policy actions need to be considered.

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RPT-I-2 Technology platforms

Alain Puissechet, Idate.

1. Context

Consumer electronics is a mass-market industry, very often aimed at high volume and low price products. Products should usually be price competitive; brand is an important issue; having a wide offer from top tier expensive products to cheap is often needed. For a large number of products, content availability is of major importance.

Both Internet and convergence due to digitalisation have an important impact: new digital products are appearing or traditional ones are evolving. Networking through telephone line and cable allows for new combination of functions. Moreover, price of the basic components: semiconductors, displays, mass storage, optical components will continue their price decrease, allowing to produce for less price very sophisticated tools. All this lead to the appearance of new products, which are somewhere between telecommunication terminals, personal computer and TV set : the name set-top box covers now very different platforms, with very different functions : hard disk drive, game station, DVD reader, interface between the home and networks,.... It is not expected to have a convergence between computer and TV, but diversified terminals, possibly offering some common services and applications, but mostly offering differentiated services (such as lazy interactivity versus strong interactivity).

These new developments will be accelerated by the development of high-speed connections, as well as the multiplication of new multimedia content.

For the industry, there is a need to control much more diverse technologies in order to stay competitive. Find effective ways to obtain the necessary knowledge is a major issue, which has been already addressed through different strategies: alliance, R&D, buy &merge,...

Relation to content and services is also another issue. Marketing and selling these new products is also undergoing changes: new way of selling products are appearing and may impact the industry: most notably, for products incorporating a high level of content, there is a tendency to subsidise the hardware in order to sell the software (content): this implies major pressures on hardware prices. This is currently seen in computers, mobile phone as well as set-top boxes.

The frontier of the domain is also moving: Set-top box have almost all properties of computers and are capable of being as versatile as computer. Moreover, it is now possible to download new software (i.e. new applications or functions).

The Internet effect will probably lead to a strong growth of people having an usual access to networks, whether Internet or interactive TV. Broadcast and point to point transmission may converge in new applications: between one to many and one to one, is appearing the model "one to few". This in turn will have an impact on new products delivered. Since the economic model for interactive services is still unclear, there is a large domain of uncertainties. The current success of digital pay-TV in UK, and the

current failure in the US and in Sweden of free on the air digital TV should be considered.

In a few pages, it is not possible to go through all consumer electronic platforms. We will concentrate on the digital ones, and on the most important in terms of market. Three main platforms exist currently: cellular phone, personal computers and set-top boxes+TV set. We will consider them, and end with a short analysis of the possible characteristics of the new platforms, which are appearing. For each platform, we will mention the European strengths, and some manufacturing issues

2. Telephone sets and other communication products

European industry has a considerable strength as far as telecommunication and especially voice telecommunication is concerned. We will consider fixed telephone sets, mobile telephone sets and discuss other equipment such as faxes.

Fixed and cordless telephone sets

A large European industry manufacturing telephone sets exists. Industry members include the common joint-venture between Thomson Multimedia and Alcatel, Philips, Matra/Nortel, Siemens, Ascom and Bang&Olufssen. Manufacturing takes place in several countries, both inside Europe and outside Europe (Mexico, China, and Singapore). The simplest terminals are often manufactured abroad. But for top range products with specific design, manufacturing may be done in Europe. They include cordless phones using DECT technology for home use. What should be addressed in this domain is to find out if an industrial policy may facilitate European located manufacturing, and what would be its characteristics.

Cellular phone

This is a domain where European industry is the world leading industry. This industry clearly belongs to consumer industry: in 1999, near 260 millions of phones have been sold, much more than TV sets and personal computers.

In the next three to five years, this strong growth trend should continue, with over 320 million units being sold in 2000 and more than 400 million by 2002. This strongly sustained growth will be based on a rise in the number of new subscribers around the world, on the switch from a still large installed base of analogue to digital terminals (especially in North America and Latin America) and on the replacement of first-generation digital terminals in the most progressive markets. In addition, the proliferation of possibilities for operators to use a second frequency band will boost the development of multi-band terminals (GSM 900-1800, 900-1900).

Due to the weight of the market involved, it has seemed interesting to consider almost all the world players.

Looking at the players involved, although the bulk of the market is in the hands of fewer than 10 manufacturers, the terminals market is becoming increasingly competitive with the arrival of a growing number of protagonists. Nevertheless, the market can still be split into two major supplier groups:

- The top trio comprising Nokia, Motorola and Ericsson, the only ones with two-digit market shares. Nokia succeeded in taking the *lead* in 1998, which it managed to retain in 1999. Ericsson lost ground at the same time and saw its market share (in terms of units sold) fall to between 12 and 13%. Motorola,

in turn, which dominated the market up to 1997, seems to be rallying now that CDMA has really taken off in the USA and thanks to a renewed GSM offering.

- Then follows a group of manufacturers with market shares of between 1 and 5%. They include in Europe Alcatel, endeavouring to strengthen its position in the market for GSM by raising production capacity considerably, Philips Consumer Communications (2.2%): described as one of the most serious challengers to the market leaders, Siemens which bought Bosch telecom activities. Outside Europe one can name Panasonic (Matsushita), Samsung and Qualcomm.

In terms of manufacturing, mobile phones are very often manufactured in the country (or near the country) where they are sold. As an example, Nokia owns plants in Finland, Germany, UK, USA, Hong Kong and Korea. If in some cases, Nokia imported telephone from its plant in the USA to sell them in Europe, it was mostly due to the fact that Nokia's European factories were not able to manufacture enough handsets.

We should distinguish here between the existing second generation (GSM and others) and the third generation to come (UMTS).

Competitiveness for second-generation products is now not related to R&D. Technological issues are already solved and software well defined. The main competitiveness advantage comes from the ability to evolve with a fast changing market and to be able to design, manufacture and deliver in time and in volume. These are typical issues of consumer electronics industry. Some problems encountered by Ericsson stemmed from this lack of consumer electronics culture. Speed to market is a main competitiveness factor.

Third generation is quite another issue, where large standards issues have taken place, with international confrontation and where no established market exists.

3. Television sets and set-top boxes

Consumer electronics players

With over a billion receivers spread around the world, television constitutes an issue of vital strategic importance. The definition of the MPEG-2 standard for digital video image compression marked the start of the technological convergence of television, informatics and telecommunications. The advent of digital TV provides a major opportunity for renewing a vast installed base of TV receivers and for replacing low-margin products (analogue sets) with items offering higher added value, i.e. digital receivers.

This huge market means increased competition, since the new terminals call for multi-skills: those of consumer electronics manufacturers, of IT specialists and of communication equipment suppliers. This, in turn, gives rise to a subtle game of rivalry and alliances.

Sony and Matsushita followed by Thomson Multimedia and Philips led the analogue market. Cost for transportation of analogue TV sets is important, and discourages large volume of import or export from far abroad. So the Japanese leaders do own manufacturing plants in Europe, mostly located in places where labour is cheap and

public subventions available. Among the major strong points of manufacturers in this area are their command of retail distribution techniques, their know-how in low-cost mass production and their mastery of the cathode-ray tube that is a vital part of the TV receiver.

Digital TV represents a major challenge for all producers and they constitute its most energetic promoters, never hesitating to subsidise broadcasters in order to speed up the deployment of digital programs. Associations of manufacturers of consumer electronics equipment (in the United States, CEMA, in Europe EACEM) provide an extremely active lobby for promoting digital TV

Their handicaps are bound up with the new technologies that are now called for and that they do not necessarily master — software, highly complex integrated circuits and telecommunications. To acquire these skills, they either go in for alliances or invest in internal development, or even combine the two options. It is of interest to note Sony's spectacular swing towards software development, resulting in its offer of AperiOS software for set-top boxes.

Apparition of digital television is a complex and difficult process, where national factors are important, whether cultural or legal, where various technologies are competing (terrestrial, cable, and satellite). Content, i.e. TV programs, but also in the near future interactive services and programs, will be key to the market development. The impact of national realities in terms of laws and culture, but also in terms of existing infrastructure implies the need for industry to have a local presence.

Standardisation divergences exist between the European DVB, US ATSC, and industry sponsored ATVEF (where Microsoft plays a major role). Standards has several impacts: establishment of a standard allows for mass production and rapid cost decrease, thus making cheaper the development of content for a mass audience.

Standards are also part of the competition between manufacturers, and specially software developers. To have its own development selected as standard gives a double advantage: allowing to speed up the time to market, and allowing to recoup the R&D expenses.

Thomson Multimedia and Philips are European and even world leaders in the domain of digital TV, and compete efficiently with Japanese competitors, helped by their strong presence on the US market.

New players

Specialised set-top boxes manufacturers

These are of different origins but all engaged in the production of electronic equipment in general and set-top boxes in particular. They are not in the habit of selling to the general public: up to now, they have sold their boxes directly to broadcasters, especially cable operators. Neither do these companies possess any special skills in the field of integrated TV receivers nor they apparently have no ambitions in this direction. This is probably an indication of their confidence in the preponderance of set-top boxes in relation to integrated TV sets. One of their

strengths lies in being able to supply end-to-end systems, particularly where cable operators are concerned.

General Instrument and Scientific Atlanta are dominating a well-protected US market. In Europe, Pace Micro Technology is among European industry leaders, with manufacturing capabilities in United Kingdom, and on a partnership basis in Thailand, Mexico, Brazil and Poland.

IT specialists

This group is facing a probable slowdown in the market for desktop computers and laptops, which could become a renewal and replacement market. The arrival of inexpensive computers — which only help to reduce profit margins — is not sufficient to offset the decline in the market for top-end models. So they are very motivated by the new consumer electronics market. Microsoft, Intel, Sun and Compaq are among the most active in digital TV developments.

Component manufacturers

Producers of components (tuners, demodulators, integrated circuits, screens, hard drives, and local networks) cannot fail to benefit from the development of digital TV. In supplying sophisticated components at ever-decreasing prices (bound up with the fall in the cost of integrated circuits), they will contribute largely to a decrease in costs and an increase in functions. Consumer electronics manufacturers often make components themselves, especially those they consider strategic; this applies to a great many Japanese firms and also to Philips, which claims to have full control of the entire production chain for digital TV receivers. Other Japanese companies, having withdrawn from the market for TV sets, will maintain their presence in the components sector.

It should be noted that Thomson Multimedia aims to concentrate on strategic components and services.

4. Personal computers

It is a domain largely dominated by large US companies. But the standardisation of components and the move to consumer electronics imply changes in manufacturing structure. What was a professional product, with accepted high price and low aesthetic standard has become partly a consumer product, with new accentuation given to design and to price. Some European companies have developed what is mostly assembly and testing work, but which could become very successful.

Up to now, it was difficult in this domain to distinguish between professional and consumer products. It seems to us that a detailed analysis of what is and could be really "personal" and not professional consumer. One could think that notebooks are mainly professional, but organisers are probably not. That is still to be debated.

5. Game players

This is a domain largely dominated by Japanese players Sony, Sega and Nintendo. It seems difficult for European industry to enter the domain, since the entry price is high : it is related to the number of games available on the player (and in that sense, the same problem exist as in operating system market, where Windows dominate through the huge existing number of applications developed on it). But one should evaluate

the impact of game station on DVD readers as exemplified by the Sony recent moves: Sony will subsidise the PlayStation 2, which includes a DVD reader, through the sale of software, thus being able to compete with manufacturers producing only DVD's.

2. New terminals

The diminishing costs and increasing availability of broadband access and components (software and hardware) allows for apparition of new services, contents and also new terminals. A large number of prototypes or "concept equipment" have been developed. More will be. They will be related to communication, Internet, new contents and services. They include information appliances. How to facilitate the development of these new devices is an important domain for thought. The answer will probably differ if they are content driven (in that case, supporting the development of services may help), or network driven. Existence of standards may be effective in order to facilitate new terminals. Identify the competencies needed may also be very effective, in order to sponsor co-operation between industries. This is also a domain where start-ups with new ideas may appear.

Among the new terminals, we may name a few, for illustration's sake :

- webphone, combining telephone, e-mail and Internet access,
- e-commerce terminals dedicated to consumer e-commerce,
- webPad some kind of simplified PC,
- Internet appliances : they could be specialised as kitchen appliances, accounting appliances,... as advocated a few years ago by the company Diba,
- Personal access devices with instant Internet access and wireless connectivity,
- New car equipment
- Digital imaging equipment will probably have to be included in consumer electronics

7. Comment: electronics consumer industry

If we want to identify the real impact of consumer electronics industry in Europe, we could not limit ourselves to the 20 or 30 large and well known players, but have to take into account the huge number of subcontractors, which possess often very sophisticated skills.

Another set of players that should be considered is the component suppliers : the existence of world level suppliers for strategic components in Europe is clearly a strong advantage, and should be taken into account.

RPT-I-3 Services in Consumer Electronics

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1. Introduction

A large variety of services are offered by today's consumer electronics (CE), ranging from games over receiving radio broadcasts to mobile telephony. These services are delivered to users by products (devices or terminals) as diverse as PCs, TV's, game consoles, digital cameras or answering phones. In most cases, consumer electronics services have a content component, which can either be accessed by users as an integral part of the device, purchased on a separate carrier, or accessed in digital or analogue form by means of a network.

One important preliminary remark to be made is that in today's consumer electronics, there is a distinct 'segmentation of use'. Specific services are most often delivered by specific products, as consumers do not tend to buy all-encompassing solutions for their homes. This is amongst others due to varieties in product characteristics, manufacturers, demand, product life cycles, and costs. As technical possibilities increase, there is no reason to expect that diversification in products and services will decrease. However, the main assumption behind this section of the study is that, as consumer electronics products become more digitised, software-based and miniaturised on the one hand and more networked and interoperable on the other, services will be made available on a much wider range of consumer electronics products, and, inversely, consumer electronics products will offer an increasing variety of services. This 'convergence' of services provides opportunities for traditional consumer electronics manufacturers as well as for ICT providers and other players to enter each other's, as well as new, markets.

In this section of the study, we outline a number of possible developments in the field of consumer electronics services. We start by providing a categorisation of these services, in order to conceptualise the nature and components of existing and emergent CE services. Secondly, a number of trends that will most probably influence (the setting of) CE services are described. To conclude, we make some recommendations for future research.

2. Categorisation of CE Services

This paragraph considers CE services on two levels. First, a framework is presented for imagining new converged services as combinations of functions, characterised by specific forms of interaction and interactivity and presenting specific functional demands. Secondly, we will briefly point towards the concrete environments in which CE services are used and which are expected to lead to the creation of home networks built around specific service platforms.

A first level of analysis refers to the basic functions that services fulfil: information, communication, control, transaction and entertainment. Each of these functions implies different general characteristics in terms of interaction and interactivity, that shape user behaviour, service offerings, product characteristics etc. The following matrix provides a general overview of these characteristics.

Function	Interaction	Interactivity
Communication	Typically one-to-one	Active. Close interaction with interface
Control	Telemetry. Man-machine, machine-man or machine-machine interaction	Limited action required
Information	Consultation model	Active. Rather close interaction with interface. Regular commands
	Broadcast model	Passive. Limited commands.
Transaction	Information and/ or communication type of interaction with added transaction function	The added transaction function requires limited interactivity
Entertainment	Consultation model / Game playing	Active. Rather close interaction with interface. Regular commands
	Broadcast model	Passive. Limited commands.

Fig 1. General functions of CE services and types of interaction and interactivity

As a consequence of convergence, different services and functions are being combined into new service offerings. The functions described above thus become building blocks for new types of services that are increasingly turning into hybrid combinations of different functions.

For instance, in the electronic information industry, services are being developed that are combinations of information (e.g. access to databases, push services), communication (e.g. e-mail, ICQ, newsgroups) and transaction (e.g. digital transaction systems, debit and credit services) components. This is resulting in a so-called digital loop of services, a virtual cycle in which the output of each service component provides necessary input for the next service component. The continuing rise of Internet penetration and Internet use is usually seen as the main driver behind this development. The combination of content, communication and commerce into a digital service loop is illustrated in the figure below.

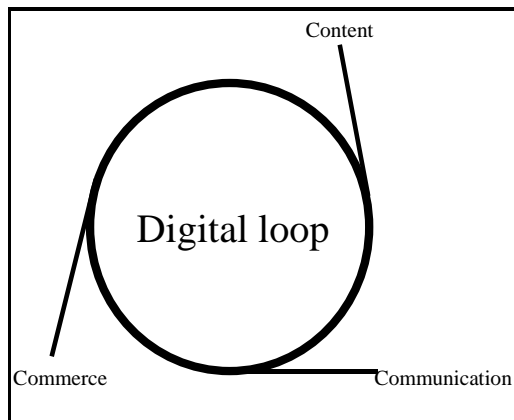


Fig 2. Digital loop in services

Keeping in mind the table presented in figure 1, combinations of services such as these are, nevertheless, limited to a certain extent by the forms of interaction and interactivity typical to the different functions. Such characteristics in part shape existing, emergent and eventual service offerings, interfaces and devices in CE and thus point to possible drivers and bottlenecks for convergence.

Also, these characteristics lead to a number of subsequent functional demands to be fulfilled by the increasing technical possibilities. For instance, the close interaction between user and user interface typical of communication services, leads to functional demands such as flexibility (e.g. through speech and text input and output), customisation and mobility. Control services most of all require connectivity, robustness and alert functions in case of emergencies. Important requirements for information and entertainment services are flexibility, connectivity, quality of interface (e.g. through quality of display, customisation, search tools) for consultation type services, and quality of display and availability of a wide range of content for broadcast type services. Functional demands for transaction services are a.o. quality of information (e.g. through customisation, alert functions) and security.

An estimate of the importance of a number of functional demands and features for different services is given in the table below. Connectivity is estimated to be a very important feature for all kinds of functions. Again, overlapping or diverging functional demands point to possibilities and bottlenecks in terms of convergence.

	Communi- cation	Control	Information	Transaction	Entertain- ment
Mobility	+++	+	++	+	++
Flexibility/ Customisation	+++	+	++	+++	++
Robustness/ Security	++	++	+	+++	+
Connectivity	++	+++	+++	+++	++
Multimedia content	+	+	+++	++	+++
Quality of display	+	+	+++	++	+++

Fig 3. Functional demands associated with CE services

The matrices in figures 1 and 3 provide a framework for the conceptualisation of converging CE services. However, the question of possible migration paths towards these converged services remains. Given the characteristics of CE services which we already discussed (e.g. ‘segmentation of use’, innovation through added functions), a complete and seamless convergence in CE services is not to be expected, but rather a gradual expansion and partial overlap of existing services and products.

As a consequence, on a second level of analysis, one has to deal with contexts of use, i.e. concrete environments in which consumers use CE services. Such environments are reflected in the vision of so-called service platforms, i.e. central devices and network platforms in a certain context of use, that communicate with a variety of related products providing specific sets of services. If indeed convergence in services will lead to the creation of such service platforms, the question of interoperability is to become a crucial issue. In the table below, we have put forward six possible environments for this kind of service platforms, together with a number of related services. Domestic networks and service platforms are in fact already developing in these environments, i.e. in the SOHO (Small Office-Home Office) and home automation context.

<i>Environments/ 'Contexts of Use'</i>	<i>Examples of Services</i>
<i>Personal Communication</i>	<i>E-mail, Fax, Paging, Fixed & Mobile Telephony, Answerphone Services, Chat, Webcam Broadcasting</i>
<i>SOHO</i>	<i>Shared Access, Data Transfer, PDA, Printing, Scanning</i>
<i>Home Automation</i>	<i>Climate Control, Lighting, Appliances, Security</i>
<i>E-commerce (b-t-c)</i>	<i>Shopping via TV, Internet or Telephone</i>
<i>Household / Personal Infotainment</i>	<i>TV, Video, Audio, Cameras, WWW, Games</i>
<i>Car</i>	<i>Audio, Information Services, Tracking & Tracing</i>

Fig 4. 'Contexts of use' and examples of services

Naturally, scenarios for converging services based on such 'contexts of use' need to be complemented further by taking into account more specific data on use and user characteristics. For instance, the 'contexts of use' of services of elderly people will differ significantly from those of other households. Additional research on user groups and characteristics is therefore required to complement this analysis.

3. Trends in CE services

In the previous paragraphs, we already pointed to a number of basic developments, caused by technical progress and market players' strategies, that are driving convergence. The effect of convergence was described as the development and integration of a number of CE products and services around 'service platforms', which will be partly overlapping and competing with other services, products and platforms. In the following, we will briefly highlight some consequences of this evolution, both for service design and innovation, and the CE and I&C industry structure at large.

4. Trends in service design and innovation

As we indicated earlier, CE services are becoming more software-based and increasingly (Internet) connected. Given these developments and the high uptake of mobile technologies and internet penetration (not only via PCs but increasingly via non-PC devices), it is likely that the key aspects of new CE services will be *content, communication and (internet) connectivity*. The acquisition of expertise in these fields presents a clear challenge to traditional CE manufacturers.

Convergence in terms of services also implies that CE manufacturers will have to deal with the influence of IT, telecommunications, media and internet models of service design and innovation. New CE services and products will marry a number of *conflicting characteristics* from these different models. Traditional aspects of consumer electronics, such as ease of use, ease of deployment and ease of maintenance, "calmness" of technology, and robustness and security will remain very important CE features. However, these will have to be combined with characteristics

such as flexibility and customisation, high speed of innovation (shorter product life cycles and time-to-market), and connectivity.

In a more long-term view, trends such as digitalisation and miniaturisation may lead to so-called *ubiquitous or pervasive computing*. This can be seen as the ultimate convergence point of IT, telecom and consumer electronics sectors.

5. Trends in Value Chains

The impact of convergence in CE on business models and industry structure is still an open question. The following paragraphs present a number of brief observations on some of the main developments in this field.

A first remark can be made about the so-called “end of scarcity”, a vision of the future which is still cast in some doubt, despite a number of very optimistic predictions. As broadband internet connectivity to the home is seen as a precondition for the breakthrough of a new generation of CE services, one crucial issue will be if, how and when this “*end of scarcity*” (both in capacity and information) will take place, in relation to the almost unlimited personal needs of users for mobility, communication and information.

As far as the different players and industries are concerned, *new business models* are being developed throughout the different I&C sectors. Examples include application service providers, web-based services and software-distribution models. How these new business models will influence industry structure is still quite uncertain. This uncertainty is e.g. reflected in current speculations about possible industry leaders in a new converged CE environment. Potential industry leaders cited in professional media are as diverse as Palm, Cisco, Nokia, Sun, AOL/Time Warner, Microsoft, Sony etc. In any case, the fact that very few of these companies are traditional CE manufacturers, clearly demonstrates the new setting in which these manufacturers are expected to operate. It also raises the question of what kind of knowledge and competencies will be required for successful service innovation in the future.

The already noted trend towards customisation and internet based services is pushing towards a more bottom-up model of service consumption, in which users are able to select and download services a la carte, using consumer and corporate portals, speech recognition, streaming media, communication services, web-based services and so on. In view of this trend, *customer ownership* becomes a critical issue, as CE services move from a controlled environment (in which terminal vendors or distribution companies own the customer) towards an internet model (in which customer ownership is much more open, moving perhaps towards content producing and packaging businesses).

To conclude, we already noted the increasing importance for CE of activities that are “higher” in the value chain, and therefore of content and service providers. This fits in with a clear trend in the whole field of information and communication industries to vertically integrate a number of activities in the value chain. For instance, consumer electronics manufacturers not only concentrate on producing and vending terminals, but are also expanding into other forms of access to the consumer, as is shown by the current struggle for access systems to internet in set-top boxes, digital TV’s and mobile equipment. *New value chains and value networks* are developing, causing previously separate sectors to compete for functions in the total information and

communication value chain. As is shown in the figure below, one can witness the move by practically all players towards offering intermediary activities such as packaging, distribution and gatekeeping.

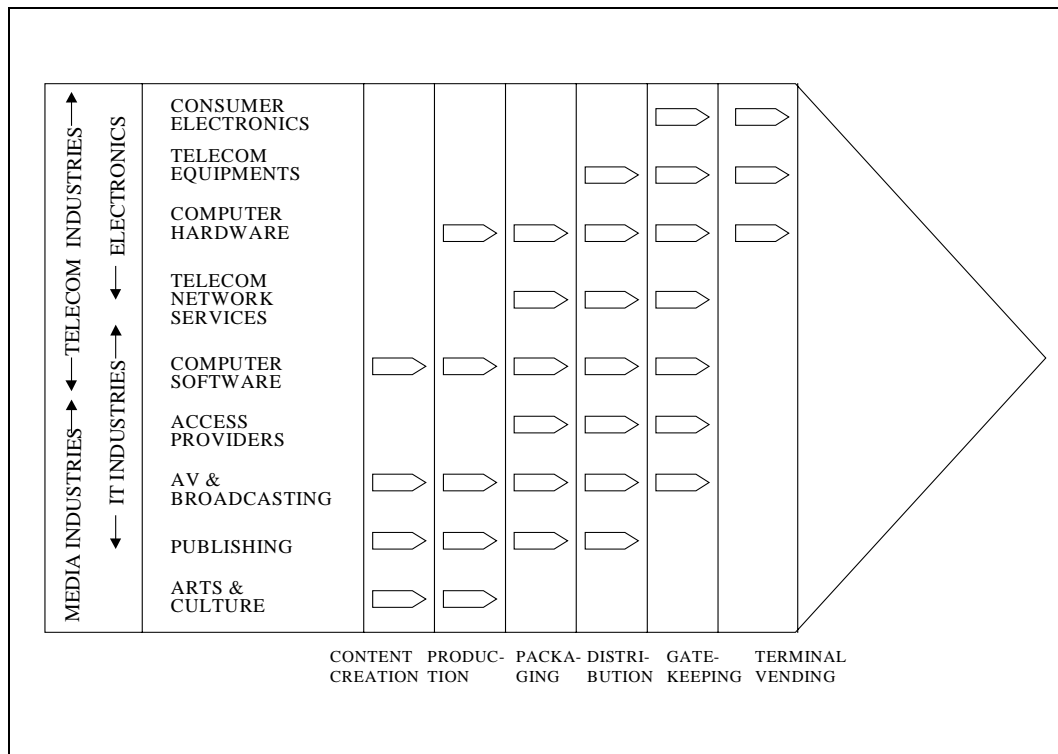


Fig 5. Grand Value Chain of the I&C Sector. (Dialogic, TNO-STB)

6. Suggestions for future research

The intention of this section of the study has been to provide a first glance at current and potential developments in CE services. Further exploration of the ideas and issues put forward in this section is recommended. Important topics of research related to this section are:

- User scenarios: scenarios evoking possible developments in user characteristics, acceptance, behaviour, and in patterns and contexts of use.
- Evolution scenarios sketching the development of service platforms and home networks: scenarios that are not only providing a view of possible future integrated services and systems, but that are also sketching different migration paths towards converging services and products and that are looking at different time frames of this evolution.
- Studies into the necessary knowledge and competence base for service innovation: studies of new challenges in this field, in the light of the present activities and know-how of the CE industry.
- New value chains and value networks: scenarios of possible effects of convergence and new business models on industry structure etc.

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RPT-I-4 User configurations and convergence in consumer electronics

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0. Introduction

This paper intends to answer the questions: What are the main trends in the areas of use of consumer electronics over the next 10 to 15 years? The special focus will be on the acceptance and accommodation (domestication) of new products by consumers. It includes a discussion of the problems both of identifying the user configurations and how they are socially embedded. These configurations develop over time and may develop both based on changes in social structure and culture and follow the access to new products and services. The intention is to be able to assess the speed of change in the adoption or rejection of new product concepts and uses, but this will be rather speculative taking into account the involved learning processes and the complexity of interactions at play.

A number of new technologies will be mentioned and new buzzwords will be used, but not all the new concepts and ideas will enter the text. The selection is - although not completely systematic - based on the view that not all new business concepts and technology visions have proven their right of existence. The ones selected point to the concepts of integration and development that seem to relate to existing and new user contexts and not only to technical concepts.

1. User contexts and configurations

The use of a communication device or the use of a media product is embedded in a set of interrelated needs, symbols, and preferences. The forms of use develop into social practices that are specific both for certain groups and certain (consumer/regional/lifestyle based) cultural settings. But also the symbolic meaning linked to the high-tech and/or the toy character of new gadgets and gismos is an element in the user configuration. The social settings or more precise social contexts of use frame the socio-technical configuration, in which electronic media and services must be understood and analysed. If the successes and failures are to be understood and the specifics of the product-use relation has to be distinguished from each other. For example is the mobile phone in the hand of a business man not the same as youngsters mobile phones, even if the model for certain reasons may be the same.

It is although difficult to do such assessments as the experiences and preferences of the observer will influence both the direction and sensitivity of the observations. This becomes obvious both when commercial interests are involved and producers shape the world ahead in their picture and when outsiders try to understand the developments and stumble through the jungle of advertising and information.

A new electronic device does not become successful based on its functional capability or its practical existence, but by its ability to penetrate certain user situations and become an integral part of social practice in that setting. Cost and usability are only parts of the conditions for a successful penetration, the conditioning of social norms, the establishment of an imaginary space of social accommodation of the product, and the creation of fashion are as important. Therefore the visions and user guidance of

marketing plays an important part of getting access to the buyers and users, which even in cases of failure may lead to a certain volume of sale and short term penetration, not to be mistaken by the 'must' of the social contextualization to be constructed by the user groups (user communities) themselves. The other side of this phenomena is that use of technology does not just take place in contexts already existing and ready to be applied, they very often are active elements in the creation of new contexts.

A number of products have been astonishing fast in to penetrate new user settings, others never made it. As examples of the first could be mentioned the mobile phones and game-consoles amongst youngsters, and the multimedia-PC in many homes. As examples of the other could be mentioned the video-telephone and the integrated home-media-station (the combined TV and PC all-round machine). What does make the difference between success and failure? And when can new technical options be considered a breakthrough for new uses, and not just another step of technical achievements and change?

The process of penetration is an integrated process of introducing and marketing new technologies and products based on their pre-given (inscribed) potentials to a new group of users and into a new area of use, and a process of creating a new user-configuration where the users have to investigate in making the device or service a useful thing for them. This process of domestication is a re-configuration not only of the user context but also a shaping of the specific usability of the product. It includes a number of steps where the first ones: appropriation and objectification more or less has to take the new product or service for granted, the next steps: incorporation and conversion do translate the product or services and their designer script into the users context and intentions. So although the idea for certain types of use have been sketched by the designers in scripts for the products, it is the users who have to develop the practices and values that makes the penetration a reality and the product a commercial success.

Many design situations work with certain user representations as the playground on which developments are measured and tested, but they do often not include all the different types of uses, that develop during domestication. The history of technology is filled with such cases, where the transformation takes place after market introduction. This is the case for the telephone designed for professional use, but transformed into a media of chat and social contact. For the mobile phone produced for professionals but taken by the youngsters as the social networking and co-ordination device. For the PC produced as a workstation, but changed into a game console, that has reshaped the role of 3D-animation dramatically.

In the common discussion of the new amazing products coming out the laboratories the professional and popular technology magazines very often tend to focus on the included scripts and the usability seen from a designers point of view, while the user context is seen as the dependent variable, the new reality that will be shaped by the entrance of the new technology. Indeed a technical fix, that makes most advertisements and many articles about new products less useful for an analysis of user configurations. Although many developments and supply driven (as the economists would say) or driven by the new technologies and the growing capabilities coming out of miniaturisation and growing capacities of chips and networks this does

not mean that these driving forces besides setting the stage for the new world of use also create and shape the new configuration of use. They form an important element in the three-pole dynamic interaction between (new) technologies and products, (new) services and (new) user configurations. The radical lowering of prices of PC's and the open access to new service providers are drivers of the actual penetration of PC's and Internet usage, but it is still shaping a quite open ended space for use and may not determine the outcome in the very detail.

But there are still limitations also in the user constructions and user representations taken into account by designers of new media and equipment. The PC is still perceived as a single user machines, but kids use them in a different way. Networks as group ware may be designed differently and for collective use, but still with the idea of one man, one screen, and one machine. But what about families or groups of professionals who need to work together on one screen and one machine, this has facility has only been included in game-pads for fun uses. So the seemingly technology driven character of the consumer electronics sector does not only include driving forces determined by technical or economies of scale based logic's, it also includes a number of user concepts as they appear in the minds of engineers and designers - often as sci-fi like projections (technological fixes) more than based on experimentation's with users and based on need expressions. This has led to the many time repeated advice that producers should try to learn more from failed systems and include the idea of learning as an active element in design and innovation management.

One example of this type of projection is the very misleading concepts of the Internet often met in post-modern argument for radical shifts of identities in cyberspace. But although there is a strong element of transformation at play in this new technology it does not suddenly produce new social realities with new selves, it assists the experimentation and playing with social reality by establishing new relations. But this radical vision has been part of creating the myth of the Internet from the mid 90ies and has helped shaping the very fast penetration of this new cultural icon into many homes still experimenting with its usability and outreach.

The following identified user contexts and user configurations can from this point of view only be seen as a sketch of scenarios based on the limited knowledge and visions, that are available now. A great part of the developments will necessarily be based on the outcomes of real life, large scale experiments set up by producers of equipment and services. It may at best function as a set of guiding ideas and warnings about the existence of certain boundaries to be aware of when entering the world of fantastic ideas, uses, and devices.

2. Fields of technological convergence

The introduction of digital technologies and the increasing abilities to handle large amounts of data has made the boundaries of distinct spheres of consumer electronics applications and systems float. A number of new technical possibilities are rising from this de-stabilisation of existing technological systems of products, services, and regulations. These changes are often seen as potentials not only for convergence between different technologies, product areas, and services, but also for convergence combining and even integrating different contexts of use. From an industrial point of view and seen in the light of service providers these convergence's offer new

opportunities to cross boundaries between existing systems and thereby extend market potentials. But they as much create turbulence in the market place and threats to the existing market experience based knowledge and products, as the number of potential products and services grow. Leading in the end to new entries and mergers and acquisitions among the existing players.

Convergence has originally been used to characterise a common digital mode at the technical level of information processing and distribution that would establish common base technologies and network facilities for telecommunication, mass media, and computing. But in a line of a linear model based on the fact that technical developments at a certain has been driving a lot of developments in the consumer electronics area it is easy to create an implicit model of determinism going from technology over industry to services, markets and users. In this type of reasoning the meaning of notions like 'digitalisation', 'networking', 'information', 'interaction', and 'multimedia' have a boundary crossing capacity covering both the technical and the social aspects of change. The only 'traitor' in the nest is idea of 'content' which does not cater for a double meaning.

But without doubt, convergence of technologies leads to a restructuring of industries and drives new developments, which again leads to an expansion and rearrangement of user configurations and markets. These new markets are feeding back into the restructuring process, partly in the same circle of commercial, industrial restructuring, partly driven by other mechanisms based on a socio-political restructuring which at a broader level is going on in society, including the creation of new patterns of mobility, new user segments amongst youngsters etc.

The growth in transmission technologies has opened for a technology based competition and bypassing of traditional proprietary networks and systems this has also undermined traditional efforts to regulate mass media and telecommunication both very often criticised for being centralised and monopolies. This does cover some characteristics of the former systems of regulation, but it also opens for a kind of competition, that leaves aside the content creation problem and as the primary target has the opening of the so called 'battle for the living room' - a battle for access and not least for putting up payment systems for services. Whether this creates better content that supports future developments or the opposite has to be studied in specific for the different types of services.

Two archetypes in consumer electronics

Many of the technology visions builds on the two archetypes of communication and information systems that has been developed. These archetypes are not just specific technologies and services but they form complete technological systems including specialised industries, content providers, and regulatory frameworks.

The two basic competing technological systems is the television broadcasting system created as a typically national mass communication system and the PC-terminated Internet building on the extension of the telecommunications network with data-connections through telephone lines and a backbone network for high capacity digital data-transmissions. Both include a lot of both regulatory history and established institutions but also a lot of assigned qualities and limitations.

The television system has been dependent on the supply of TV programs from a limited number of broadcasters and only a limited number of new broadcasters have been able to provide complete TV programs to satisfy regulations and to get access to the limited number of channels. This has also centralised decisions on changes in technologies, as both broadcasters and private households would be forced to renew their installations and apparatus after such a change. This has left this system with the not always flattering characteristic of being a centralised monopoly (or eventually oligopoly).

Telecommunications networks are born as point-to-point communication networks, and are therefore more flexible already from the outset, but with much more limited bandwidth to be assigned to the single communication line. On top of this the Internet has developed, originally created as a military and university data-transfer and communication network. Despite its very centralised and monopoly shaped origins the Internet has become the icon for a decentralised and competition based structure, where almost everything is possible. Besides the irony of its origin it is dangerous to have the Internet as the single correct 'role model' and primary reference point in today's IT development.

In most areas of equipment manufacturing there is an expectations of economies of scale. When coming to the networks the economies of scale become even more obvious, but what about the content production. Does the same benefits come from being a big player with a potential big market for new products. But in this area the economic rationale becomes more questionable. The extension and usefulness of networks and equipment is dependent on not only the few big suppliers of content but of the differentiation of content suppliers. This leads to the content paradox that lies behind many national strategies to support a differentiated content production. But as the legal frameworks for copyright also supports economies of scale, it is not a trivial problem to develop e.g. new multimedia product of some quality and new high quality television programs.

Even the fact that certain media industries like film companies and computer programme developers have been through a period of fast mergers and centralisation does not make it obvious that the new media content providers and innovators are to be found in those born-big types of media corporations. Especially in film production in Europe a number of relative small players produce a larger part of the movies that keeps the media industry alive and innovative the same holds for producers of educational multimedia materials etc. Although it is obvious that a traditional economic argument would identify relative high costs for first copy and low costs of reproduction and consequently large economies of scale and relative importance to market access and widespread distribution this does not result in these arguments to be turned around: that these media conglomerates are the best to pick and choose - often the opposite holds. The mass market and scale advantage on the other hand holds for the commercialisation of those media in their efforts of distributing the old and well known and in marketing and advertising.

Past performance and the lock-in of development caused by past dependency is an important element and consequence of the presence of technological systems. It makes industries look for developments that continues to build on certain product and user concepts as developed in the technological system and continues to let them be

the dominant and guiding principles as it forces companies to build on their established market strength and to extend their potential dominance. This is very easily identified in the different strategies of US, European, and Japanese industries e.g. about Internet access by mobile devices, where this is seen as much closer and more important than in the US, where mobile communication is still less common. It also shows in the different expectations for use of TV versus the PC in home shopping and for Internet access. But interesting is that this also guides visions and projections of those companies and of the market assumptions made by analysts being embedded in the same user contexts - having difficulties in envisaging other possibilities and other sets of priorities.

Points of convergence

A number of areas of change can be highlighted as having special relevance for the understanding of convergence. From having a distinct number of separate products or services with the telephone, the television, the computer, the music centre, the game console, and the video and camera as standard configurations both of products and user conditions, the process of digitalisation and integration - as we have seen - potentially blurs or even breaks down these distinctions.

- The integration of data and information handling in the computer has been combined with the networked communication over the telephone system as a first step of convergence. This has been taken a step further with digital telephone technology and the use of the computer as a communication device eventually also partly taking over the role of the telephone or at least extending the networking services and changing the focus from analogue transmissions to data-transmissions. This is the most conventional and also most used concept of convergence: the common use of networks for both IT (e.g. the Internet based on standardised protocols like the TCP/IP), data and telephony. Especially in companies this integration may lead to radical changes in networks and functions, while private consumers still may have separate terminal systems working but using combined network facilities both in the home (Ethernet, Bluetooth) and over the net (ISDN).
- With the re-construction of the television set into being the screen part of a game and entertainment console the television has been opened for other uses than just a receiver of mass communication and mass entertainment. But the role as mass communication device was already changed when the video tape machines entered the home and the film as home entertainment had its breakthrough. These changes have opened the use of the television but also trivialised its role in the typical household by individualising and differentiating its use.
- The creation of the multi purpose, multimedia PC has shown to be one of the most successful strategies of integration and penetration. The promise that one (work)station could satisfy all these purposes has at least been able to penetrate the first wave of creating the PC as a home workstation and not just a machine for professional, specialised use. Despite the futuristic visions of the display as having a multitude of purposes the function of the PC in the home has still potentials and can be seen as one of the most open-ended technologies.
- The second change that can be headed as convergence is a consequence of the growth in networked television systems and the integration of information

services into these systems, that from a technical point of view reshapes the television into another terminal screen and communication device to be used interactively but at the same time for more restricted goal defined purposes. This is happening in parallel to a change in the Internet facilities to be opened for the distribution of services and eventually both audio and video streaming also to be accessible from the television set.

- Another very important but often hidden element is the establishment of common standards or at least compatible or co-ordinated standards. One important area is the creation of digital picture and video compression standards (MPEG-2) to make possible the storage and transmission of digital video. DVD's are using this standard, as is digital television expected to do so. Similar to this can be mentioned the standardisation of audio and video for streaming over the Internet.
- The growing access for mobile communication (GSM) has radically changed the conditions for mobility both in business and in families. Besides the gismo effects of having the new device it makes a new type of social networking and flexible adjustment of daily routines possible. This makes communication for especially the private users into a co-ordination more than just a facility for contact. And it creates a new sphere for integration of planning, communication, and mobile work and entertainment.
- The flexibility of radio-linking instead of wiring machines and facilities is giving ways to new networking facilities and bridging between specialised communication devices and making integration of mobile equipment with stationary systems accessible (Bluetooth). A limitation is the still too low bandwidth in wire-less networks. But their use is based on their flexibility in temporarily connecting a growing number of different pieces of equipment, where the wire-less connection functions as a 'forced' interfacing communication standard. These features will support the penetration despite the bandwidth problems.
- The automation of home activities and the use of networked surveillance systems makes it possible remotely to control activities that otherwise needed presence. This change is both a change in the view of the role of the household devices, and a change in attitudes in relation to the needed presence. In many contexts this is presented and the smart, intelligent, or networked home and appliances, but the remote control and the surveillance aspect is the challenging part of the change.
- Digitising the photography and the video film is primarily seen as a substitution of traditional technologies with new ones, but it opens for new integrations not only with the computerised possibilities for storing, editing, manipulating, and distribution of images, but also in the reshaping of the media for presentation of family and other documentaries.

The bottom line of this overview of technical spheres of integration could be the digitalisation of electronics technologies, the software capabilities as the new boundaries, the rearrangement of devices into networked linkages and terminals, and the potential multiple use of distribution systems and parallel access to services. But as it is already argued there is a distinct difference in the problem seen from an electronics industry and service providers perspective and the seen as consumers realities. This conflict becomes obvious with another characteristic of actual

developments in products and services: they become mundane, low priced, and more and more specialised in their appearance.

Critical technical issues

Besides the mentioned areas of change that put sets the stage for convergence there are a number of other technical developments that may become important for future developments of consumer products. One of those is the breaking up of the sequential logic and operations of microprocessor controlled equipment's and both the hard wired connection and bus systems and the software systems. Instead of using microprocessors as the building blocks programmable arrays of logical circuits can happen to be an important new development using programmable multifunction chips as the hard ware and so called code morphing as the fast adoption to new types of operations. This opens for more programming capacity, more efficient data handling, and more open structures of programs and use. This new type of data processing does not leave aside the problem of interfacing but opens for new strategies for miniaturisation's and integrated applications and appliances.

There is in general a critical relationship between capacity and pricing enabling new functions and new platforms to emerge. One of the visions that almost every magazine would subscribe to is the Next Generation Internet which should include the capacity to distribute audio and video parallel to the information distribution of today. But there is no obvious way of providing and financing the needed leap of capacity. Already today there may be a growing backbone capacity problem on the Internet and the problems of selling the need for more bandwidth to the consumers are not solved. The idea of information distribution and communication as a free resource is still an active element in the futuristic visions of the Internet, but limitations to capacity may turn out to be a limitation for the idea of free data flow and accessibility in the future.

The last critical, technical issue are the limitations to most interfacing technologies like keyboards, handwriting and speech recognition systems, and screens and presentation systems. They form the real bottlenecks in most systems and limit their usefulness. Most often the size of the screen or the keyboard is a physical limitation to the use of systems which lead the Palm computers to use some simple recognition system detect users hand-written letters, while others have tried to construct miniature keyboards. Here the potential of speech recognition is an obvious area for development. But often the need for size and picture quality is misinterpreted in a serious ways as for example when the full detailed representation of the partners in videophone conversations or in video conferences are seen as the ultimate goal although it should be obvious from e.g. telephone usage that high quality is not the most important feature. There is simply a need for understanding what is the important qualities in the specific user context.

3. Networked privacy and entertainment

In this and the following two chapters some of the most important user setting and their transformation will be presented. The presentation will build on a chosen structure, that does highlight certain aspects and may present change more linear and structured than can be argued from the knowledge about existing user configurations. Some normative structuring is needed for the presentation, but it is intended to show also the dynamics of these changes that could lead to unexpected new developments.

Three different user configurations seem to have developed into quite stable situations in many households. This is partly due to differences in the social conditions and expectations to these uses, partly due to the growing number of devices reserved for specific uses in the home. The former being a result of the negotiated spaces for distinct activities in the home preferred by different groups in the family or household. The latter being a consequence of mass production and the continued lowering of prices on television sets.

A fourth user configuration may constitute the case where integration or convergence may have some impact also for the user configurations.

A. TV and home cinema - centre of social gathering or individual activity

TV is often seen as a quite conservative mass media system that has not undergone change since the black-and-white television was substituted by the colour television. But the media system has already undergone a number of changes and new functions have been added both in its use as entertainment and information provider. Besides its role as terminal for video-cassette players and as screen for game consoles, the new urban wired networks distributing many different channels and text-television has also changed its role. But in most households it still holds the position of being in the centre of the home and an integral part of collective family activity. TV has as already mentioned served as an ideal-typical technology representing the mass media for good and for bad.

But there are differences to be recognised e.g. between different income and cultural layers in society. Both for reasons of available space but also as a result of access to different types of equipment the multiple uses of the television may be more common among less wealthy families than in richer families. But still also different lifestyles play a part as does gender based interests. In certain cultures the TV is running as some kind of background noise just as radio are in others. The latter being much more the case in European countries while TV has more entered the stage of just being around in the US. Such changes in the role of TV does have some significance for both the producers of television sets and for content producers, as they may devalue television into a less important system. Such a trend towards a more Americanised way of living to be taken over in Europe is already under way and especially in the UK it seems to be part of the explanation for differences in TV consumption already. Such a process of change can be observed in other countries too, but it is very difficult to project the end result. In a number of countries including Denmark the reaction against commercials in television are growing.

As a part of arguing for a modernisation of mass media especially service providers and television producers have been asking for more interactive television programs. This concern has not been taken up very much by user, but still a number of experiments with so called interactive TV has been carried out. In most cases the notion 'interactive' seem to be just one more feature to be added and therefore not such a big change - although it in fact it has been cried out as the revolution changing television giving the consumer (viewer) a much greater control over the programs: but the many new kinds of use and new concepts boil down to facilities not that much different from the kind of interactivity that has been around for years with the use of phone voting and supplying program information on teletext.

Also home shopping has been introduced as a very new and big thing. There are although a number of specific problems involved as this service is not new but has been tested in a number of experiments of which none really seem to have survived the user contact. Systems like Prestel in UK, Time Teletext in the US, Videoway in Montreal and Full Service Network in Orlando, Florida have all tried out the home shopping activity but without catching more than limited numbers of interested users. Also different kinds of Videotex systems have been tested out in most countries and they all have disappeared again. One argument for the failures have been the lack of services and the barrier of establishing both a technology and the supply of services at the same time for one system, as opposed to the later developments on the Internet where the common backbone of the communication network was established for other reasons and therefore could be extended by a number of suppliers along with the expansion of the system. There are a few examples of new systems gaining some momentum but often then based on services and types of interaction that was not intended as in the case with the French Minitel where consumer interaction and 'pink services' soon took over and heavily subsidised. Instead of revolutionising television there is a growing number of television programs that use the Internet as an extension to both information and discussions.

The idea of home shopping and e-commerce on television is still active in the UK where the penetration of television set is wider than private PC's. So here some example of national differences can be seen, but it can be questioned whether this difference will not disappear when PC's become more common. The more general idea is the use of the TV as a web and services terminal, and again we see a development mostly driven by the service providers themselves.

Only few people will have access to only one single system in the future and also the number of different terminals in typical households may grow so that eventually 3 or 4 televisions may be installed giving opportunity to individual choice and watching. This will tend to set the idea of integration aside as long as new technologies and new systems emerge continuously and outdates the time specific constructions of interactivity and integration. The multiplicity of uses and functions to be found on the Internet makes the use of television networks into a different media, and even the pointing to the TV-screen as just another terminal does not make the use of TV in its environment into an ideal place for interaction in the communicative sense, that it has developed around the PC as communication machine.

One important differentiation although is the role of narratives and narration for games and films which again supports a certain logic of linearity and an acceptance of leaving the control over the flow of information to an authored medium including beginnings and endings and a certain storyline. Hyper text is on the other hand an intrinsic feature of all information structuring and search, but is not wanted at all times and for all purposes. This shows to a certain extent why accusing the television for being a centralised and monopolistic medium is somehow missing the point, as this is only one aspect of its character. And it does not account for the simple observation that most kids already report, that more channels does not provide a broader variation and more choice. Which again is the basis for what could be named the

content paradox of modern television: there has been so many channels before, but a growing part of the programs are of lower quality.

This may very well lead to a process where the TV is moving away from the centre of the home and will lose its potential as a collective medium for social cohesion and discussion. This is very often seen in part in the shift between generations where video watching amongst youngsters still is a collective phenomena, while TV has become more an individual medium, besides in the group of older people who still see TV watching as a collective activity. This "decentring" of the television and eventually also the entertainment functions, as we have seen in the US, has had the consequence that the US television producers ended up being dominated by low cost, low quality equipment and almost entirely owned by European and Japanese companies.

Today the limiting factors concerning convergence in use is the secondary role of technology compared to the importance of the social place and sphere where the equipment is placed and which elements are given priority like computing and remote management power versus vision quality for example, and like the distinction between a working space with access also to other working tools and a leisure space placed in relaxing surroundings.

A number of multipurpose and integrated television and computer devices have been marketed like Olivetti's Envision with the traditional TV as monitor, or the more advanced Philips Home Theatre. But both of these ran into the problem of content on the one side, at the fast growth in sophisticated new computer equipment on the other.

As we have now seen, the idea of a 'home cinema' and the role of television as a high quality and high end device that may legitimate high cost and a central position in the home is not simply a question of the status of the device but as much a result of the valuation of the content of use, that it can provide. Both the digital surround sound, the digital television (digital picture), and the wide screen format on TV (16:9-format) represent trends in one segment of television production, but as these changes may affect the quality it is maybe overstating the fact to explain this overview as a far reaching evolution of the media. This change is underway and it shows the growing role that both old and new films play for the television media and its high end legitimisation, but it is neither in technical terms nor in user configuration a major change. Eventually it will turn out to be the saviour of the traditional TV and help it to keep a central position in many homes, instead of leaving this to become an individual entertainment instrument. Many arguments can be analysed but the basic reason for this shift is not to be found in consumer pressure for higher quality - they accepted the lower quality standards for videotapes. No the change is induced by industry and content providers to avoid a detour for television usage and a stronger competition between a growing number of broadcasters. An organised plan for a next generation television technology and usage. And a plan to cater for future developments in bigger screen and high definition TV based on more detailed pictures and better image quality. But to establish co-operation around these plans also the pay-TV elements had to be integrated into the technologies. And this is then again supported by the newer better quality images of large Video-disks and DVD's.

One actual example of the convergence between television networks and the telecommunication networks used for data-transmission are the cable networks installed in many urbanised areas where a combination of fibre optical cables and high capacity coax cables supply households with many parallel television programs and easily converted into hybrid networks that can extend the capacity to transmit video-streams and combine this with two-way connections of data like the internet. These networks can even be used as an extension to the low capacity part of the end-user telecommunication network for high capacity Internet transmissions. The future of such network integration was e.g. foreseen in the Danish so called hybrid network which combined the backbone telecommunications networks with the local high capacity transmission of television through dedicated coax cables. This is the most obvious way to establish video-on-demand, that has a bandwidth problem when not connected to television networks.

The other example is the digital set top box that has created a final frontier and shapes maybe a last attempt to integrate the television broadcasting system with the Internet facilities. It makes possible the use of the television set for viewing the Internet. But without any other changes this seem to be the less important part of the set top box' role, where the primary role is to control access to the international.

B. Kids' (and others') entertainment centre - the single-machine multi-user configuration.

The game console has been one of the most penetrating consumer equipment besides the PC in the later years. From being the gismo for computer freaks and boys playing with all the new stuff the game console soon entered the kids world in a number of different versions. From the small handheld game machines to the dedicated a more and more advanced game consoles using the television screen as terminal. Very soon a parallel development started in games to be played on the PC and a competition between the two platforms has been going on since showing both their parallel features and their difference. As television sets have started entering the kids space this competition is still continued. Part of this competition is the role of proprietary systems, which only leaves the market with few competitors on the console hardware side, while games are produced by a number of different suppliers - and here the console platform with most suppliers of games has the better market. Along the line of competition the international part of game producers even supply both the PC and selected console platforms with similar games.

In the use of consoles and PC's both for game playing and for other purposes there is a gender differentiation in the patterns of use. While kids have their own priorities in choosing favourite programs and first when they grow older develop the same user patterns as adults there are also strong differences between boys and girls use. Where girls seem to be much more open to experimentation with productive usage in putting together radio programs or to construct user situations, boys are more acting with and around computer games. Boys collective use of both game consoles and PC's show both competitive elements and co-operation, while girls use typically are much more productive and observant towards their common activity. These patterns reproduce patterns also seen in conversation and other interactions between kids, which may lead to the conclusion that the computer with or without games are used as a device to extend existing interactions in the often gender specific interactions among kids.

Here the problem of the single user PC becomes obvious as the single machine multi-parallel-user problem seem to be challenged both in boys and girls use of the computer. Game consoles have often better gears for multi-user (or at least two-user) activities showing that play-console manufacturers have been more focused, while there is a potential need for change in the multipurpose PC (but single user representation) interfacing equipment.

Partly due to this (but also based on technical complexity) the virtual reality type of interfacing equipment has not really taken off. This gear is typically single user equipment isolating the individual user, and if it is established as multi-user equipment it does create a very technical (artificial) environment for communication.

Private communications

It has been shown from the history of the telephone that its use was expected to be primarily for business and for efficient messaging, but as users came on board a major transformation happened as they soon extended the definition of use also into a medium for private conversations. This kind of use included a gendered element as communications also were used to sustain and extend social networks and maintain social control e.g. over kids. Instead of being a device that was expected to lead to further isolation it eventually was used to extend social contacts and networks.

This multiple purpose use is still the fundamental rationale that makes the telephone one of the most widely spread communication technologies and with a lot of specific uses. But it also shows why the telephone even more today than earlier is seen as a communication device that secures privacy. Even with extended functionality's like conferences with more than two partners and the use of the number keys for banking and other formal activities it has become a taken for granted technology that kids learn to use. That this is a very specific type of cultural learning is shown when the small child picks up the phone (as it has seen the parents do so often) and then starts crying: 'it says it's grandma .. ' - a confusing and obviously very misleading statement.

But the telephone is also one of the most intrusive technologies in modern life, which may explain that for some purposes the e-mailing even has taken over parts of social conversation, as expected from written letters but also from telephone conversations. So in private communication now a variety of media are available, but none of those seem to perish.

The privacy part of telephone communication is the main reason that one of the greater technical fixes in communication: the video-telephone never took off. Presented as the future of telephony in 1964 by AT&T at the World Fair in New York it has been introduced and re-introduced several times, but still not getting any hold of consumers. Some experiments with video-telephones hinted at the simple problem: people in the test started creating virtual environments in front of the video-camera on the phone - nice pictures and none of the common mess to be seen at the other end of the connection. And they started maintaining their looks before taken a call. The self-staged privacy of the conversation (the spell of the telephone) was taken away.

Although video-telephoning will become part of internet connectivity like the transfer of digital pictures and small videos, this will only hold for certain types of personal

interaction, and again staged and performed as an extension of social networking and interaction. Not as a technical means of being more realistic and complete.

D. Omnipotent computing - the interactive but specialised activity.

During the years from the mid 90ies and until today PC's have entered a still growing number of households. In the Nordic countries almost every second household will have a PC and also access to the Internet. Especially in the beginning of the 90ies the reasons for investing in PC's were motivated with the interest in learning about the new device and especially the importance of giving kids an early experience with computers. Later access to the Internet has become a primary motivator for investing in this new cultural icon eventually taking over this role from the television. This diffusion is also heavily promoted by the exposition of adults at work and children at school to the PC and taking these experiences home.

The multiple visions and purposes assigned to the PC can be seen in the understanding of the PC's core functionality starting with its capacity as a calculator, then developing into an advanced substitute for the typewriter, for later to grow into a work station and a communication terminal, and at last to be reborn as a multimedia machine.

One very obvious - but often not mentioned fact, especially not in the advertisements of the computer and software industry - is that the continuous change in size and speed of the computers and the growing complexity in software has made the use of computers into an endless field of experimentation, fascination and frustrations. This process keeps the multipurpose vision alive and it keeps the users busy with the next generation of promises. In this context the purchase of a home PC is still a newer ending story, with a continuous process of testing out new facilities and extensions to its functions.

While HiFi interests and the inventions in television and radio were characterised by a quite co-ordinated set of slow and tested developments, the PC cannot be defined in such a final and limited sense. Even though the PC is entering into a stage of being ordinary supplied with special furniture to support the creations of a work-space around the PC, it does not promise an ending. The open-endedness of the PC technology makes leaves it in most peoples minds as a non-settled and non-standardised piece of equipment. While producers have been able to produce products with a life time less than 5 years and is profiting from the combination of an expanding market and a continuous need for renewal, customers have learned to expect and some times to wait for the next generation and not to trust final product concepts. Every year new elements are introduced: CD-rom's, faster bus'es and larger hard disks, Internet access, 3D video-accelerators etc.

Visions of computer usage and co-ordination are often building on rational models of behaviour and ideas of rational planning, and overlooks the fact that already the existence of the machine monopolise communication and establish a single situation for working and acting - in front of that specific screen and using mouse and keyboard, therefore the limitations of the machine partly also is its tendency to request an implicit disciplining of activities and a work situation like user environment.

A special field has been the development of E-business where there is no doubt that professional business to business trade will develop and take over a lot of the trading, but what about the private households distance shopping? A number of goods will be easy to handle through e-commerce like computer programs, books and other low weight, catalogued goods. But a number of shopping activities will still have a lot of other elements to it, as for example to check out the products quality. It is also interesting to observe that telephone banking systems are still more efficient for certain purposes than the internet based, and the use of menus in combination with spoken messages do account for a number of new services established after the Internet started really to develop.

A rather typical question can be found in magazines concerning the future of the PC is that the PC will become more and more ambiguous and blurred. What frame of understanding should be employed when one can see a DVD movie on the fridge-door and pay the bills via the mobile phone.' Interesting futuristic visions crossing boundaries, but all assuming that information will be provided in a growing number of new and parallel products. But none of these seem to have the same modularity and is expandable in the same way as the PC, which will hold its role as family work station and communication integrator.

As a new field of development is seen the role of digital photo- and video-equipment making the parallel use of the television and the PC possible and even necessary. This opens for a new integration around family entertainment and documentation using the digitised cameras and videos both individually and as social devices to produce materials for social gatherings and bringing the photos and videos to the (television) screen after having edited them (on the PC). Although opening for some integration or better parallel use, the new area does still leave the technology platforms with some distinct features and a different user configurations.

To conclude. In today's setting TV serves a multitude of purposes, it is still relative cheap as used as a single user mass media or game console terminal, while it serves a very different purpose as 'home theatre' where it becomes an expensive and often also collective media for entertainment. Also the PC can serve a multiple set of uses both as passive entertainment machine and as an interactive communication media and where both individual and collective activities can be played out. At certain levels these two media platforms still are significant different media where the user configuration favours the leisure and relaxed use of the one and the efficient work situation of the other. The significance is less defined by the technology than it is by the social configuration of the user context and the user expectations. Even though surfing the web can be similar to zapping television and searching for knowledge can be the result of watching a program as well as seeking information on certain web-pages, these two activities are carried out in different context in most households.

Both technical and narrational preferences are build into those systems seen as integrated technical systems that limit their potentials and use, but these limitation go more in hand with the construction of domesticated user configuration and spaces for social interaction than technical limitations of importance for the character of the electronic elements to be found and the components and standards employed in the constructions. Even networks may end up in delivering in parallel a number of

services and make multiple uses possible but social spaces of intentions prevail and will only change slowly with the change in both lifestyles, cultures, and content.

4. Working, over-working, and net-working

The computer as integrator between spheres of life, breaking down the boundaries of work and privacy. This basically only points to one distinct user configuration, but the consequences for the traditional compartmentalisation of spheres in peoples daily lives may have an important impact of the role of other consumer electronics products and change both standards and availability's for these in segments of society.

In the same role does a number of mobile services also show up, but they are taken up and dealt with in the following chapter.

E. Omnipotent computing revisited - the home as distance work space

The distinction between private use, and the extension of the work space and place by taking certain tasks home to the private computer, is difficult. For teachers and other professionals like consultants, company staff, engineers, doctor's etc. there is nothing special about taking work home in critical situations. The new situation created by the computer is the discipline and alignment of the tools used in the work place and at home. In combination with the communication capabilities of the computer in transferring information and establishing fast communication this alignment makes the distance working at home much easier to organise. So it is the combination of computerised 'discipline' with the telecommunication capabilities that has been the technical drivers of this change.

Telework as it also has been phrased has been presented with very different images of the teleworker and her motivation for teleworking. Also very different rationales have been employed in explaining the growth in teleworking and projecting this into the future. Teleworking practices are obviously very different in home based cells being part of a call centre versus the use of distance working by staff personnel, consultants, professionals, and salesmen using the multiple work places to extend and at the same time rationalise working conditions. This shows the very big divide between the clerical work and the professional's work when introducing the home as an extended or remote work space. As boundaries become blurred this is one of the areas where a distinction between consumer and professional electronics does not have any significance when looking on the products and often even the customers.

F. The professional and student use of mobile computing

Also on the boundary of private use we find the mobile workstation, the laptop or eventually the specialised type of registration, scanning, data-collection, or interfacing equipment. Of most interest here is the alternative to the stationary home based work station PC, the portable computer to be used in different places and making the computer based work with text, data, pictures, communication possible.

While the idea of an integrated personal digital assistant or a palmtop may serve certain functions which will be analysed in the following chapter, the mobile computer and the miniaturisation of those based on the assumption that the current PC-accessed internet has set the standard for networked information distribution will dominate a number uses. This view has particularly been promoted in the US partly

based on the fact that PC's are quite common and therefore may serve as the multipurpose machine. No doubt that there will exist an expanding market of professional users of such services which will include a growing number of students besides the other business professionals, but the user configuration is driven by the need for computing capacity and the use of the computer as a workstation for data acquisition and analysis and for text and visual products and presentations. These need makes the machine a tool and intermediary device for producing products for use in other contexts, which again makes this user context distinct different from the greater number of persons that eventually would need some more features in addition to e.g. a mobile phone, but do not have any reason to carry around a mobile computer.

5. Mobilising efficiency and privacy

Three user configurations seem to be dominant and persistent for the development of the mobile use of electronics devices. The two of those refer to the different contexts of integration of social activities and personal planning and prioritisation. A distinct different but also disintegrating setting for use is the extended home and work place role of the car, especially as long as the car more often forms an extension of the private space for peoples activities.

A fourth configuration could be linked to the omnipotent computing activity building on visions of 'smart homes' and 'smart machines', but it is instead of seeing it as an element in the stationary 'home automation' perspective it is here linked to the mobility perspective as its purpose may more often be relevant for distant control and surveillance than as a distinct technology to automate functions in the home.

G. The mobile integrator of daily routines and activities

There has been a very interesting pattern of penetration of miniature notebook like an palm computers based on the need for co-ordination among certain groups of businessmen, consultants, and others needing to be updated and flexible in their planning and often heavily dependent on others ability to access their calendars. In the first introduced versions they - besides the always existing gismo effect - followed the introduction of group ware and common organisers and software calendar systems but extending these facilities to the mobile sphere not included earlier. Sold as a an electronic notebook or as an electronic calendar and address book these new devices has been one of the fastest growing markets the later years. In itself this could look like a closed market, but there are some reasons to assume that the limited user context, sketched as the first area for penetration is not limited, when these palm computers develop and become more common. For people not really depending on calendars this kind of equipment may not be obvious, but the felt time constrains for at least some greater part of the population working in jobs needing co-ordination makes the market open ended for a number of years.

But the boundaries between palmtops, planners, communicators, and mobile phones (with or without WAP), even laptops with network access establish both a great variety of choice just now, but also a potential for rethinking the user context and the need for integration. This opens for an area of intelligent additions and integration's, but it also opens for some considerations about what could be serving the personal priorities and strategies of control of stress and daily living and working.

The number of mobile phone users are expected to double in two years. This does make this group a potential that even goes beyond the number of potential palmtop users. Therefore a next step in providing extended services to mobile phone users is an obvious extension of the SMS-messaging system, that has been included for some time. As such an extension the already mentioned WAP was initiated by mobile phone producers seeing the potential for a next generation of more differentiated product. By establishing a system similar to the WWW of the internet based on IP and using a simplified HTML-structure called WML for use on small mobile units with limited bandwidth and screen size. WAP is primarily suited for special types of communication and guidance although linked as a parallel to the Internet and in the first generations extending the reach of mobile phones. New type of specialised net-services for the mobile use will develop partly based on new service providers partly based on the duplication of services by existing service providers and portals both to be found on the internet and for the new mobile net services. Although computer and IT magazines already see WAP as a new area for the Internet this vision is misleading and may guide developers in a wrong direction, but a testing of the boundaries of the Internet is important in a period where trends and hype is difficult to distinguish.

Besides taking advantage of the numbers of services already offered on the Internet, the user context for mobile phone users will be quite different from the typical Internet surfer and user. More obvious is an even further kind of product differentiation where both the function of the mobile phone and the WAP system becomes an integral part of the personal planner and communicator. Supporting this perspective is that WAP is planned to work on multiple platforms with operating systems like PalmOS, EPOC and Windows CE. The WAP based service providers will prepare the ground for a number of new intelligent devices ranging from mobile phones, handheld miniature PC's and hybrid products including PDA-functionality to test out the trends in this new service driven field. These new devices will eventually be combined with encryption and personal identity check to be used for accepts of payment via an account and for access control. But the common user configuration of this new test field is the integration of communication, notebook, calendar, information systems in lightweight handheld devices that can support the from day to day co-ordination and integration of activities.

Also the idea of video-telephones has lead to the production of a mobile video-telephone, but according to the earlier mentioned problems of controlling privacy in such situations this does not sound more than one among many gizmos to be found in this field. Of more realistic interest could be the camera and video-extension to the handheld organiser, the inclusion of GPS based localisation and routing equipment, and other facilities that could form the PDA (personal digital assistant) as the new extended type of palmtops.

How these developments are identified is crucial, not as much for the users as for the developers. When for example it is stated in a magazine that the PDA will be squeezed between mobile phones and the portable PC's it is more the result of taking certain devices and industries for granted, and assuming their strength on the market is stable, than to see the potential trends in user configurations. Again the devices are seen as the defining entities, not the user context, they are supposed to work in. The outset is taken from certain lines of path's of development of devices. Certain laptop uses could easily be moved from the PC to an integrated PDA-mobile-phone as the

checking of e-mails and over viewing planned schedules where the online co-ordination with a stationary PC or a head office even could be the most important type of continuous communication. This would also hold for a broad range of data collections and documentation even notes and small picture documentation, while other uses like complex data collection and analysis could not be moved to smaller devices like a palm-top due to its more limited interfacing capabilities.

Intelligent software, that somehow decodes the users preference or has included some assumptions about user contexts, can in combination with selected interface technologies eventually reduce the need for complex detailed functions and can be a way of extending the functional use of palm-top equipment and make possible the combination of different uses into one personal digital assistant.

H. Kids use of mobile phones and pagers as co-ordination devices

One of the very fast growing user configurations for the mobile phone use has been youngsters either equipped with the mobile phone as part of the families ways of keeping control with kids movements simply as a security precaution and a demonstration of parenthood. But this development has been an important driver in the development of a youth culture of its own, where youngsters also themselves invest in mobile phone equipment. This development has been supported by the low prices of mobile phones as part of the competition following the liberalisation of the telecommunication business. The phone is in this context used as a device for co-ordination and social networking to keep in touch and arrange a floating environment of action and entertainment.

In this context the small message systems of the GSM-nets (SMS) has been taken up as a cheap alternative in communication. This use is rapidly growing (7 times last year in the Nordic area) and supports the idea of extending services to the mobile phone systems.

In Japan this has lead to the introduction of a new system of extended services called the i-mode web-phone, which among others has been taken by youngsters. The developments were made by Nippon T&T and have paved the way for new mobile services based on the relative success of this new standard. This system has opened for downloads of music and games, and for searching for information about entertainment programs etc. The Japanese system is technically radical as it is based on package distribution of information to in principle on-line terminals - the mobile phones, but is has many of the same features now being introduced in Europe under the name of WAP.

The European system is based on a simplified HTML page layout, than can be read by a slightly modified mobile phone with an extended display and can both transmit web-based services, work with e-mails and be used as ordinary mobile phones. Like the Japanese system WAP may turn out to be useful for searching all kind of location information like cinema programs, traffic time tables, telephone and address information, and eventually also for making reservations etc. It may also support the integration of new functions into the mobile phone, expanding its use to become also a music player based on e.g. MP3 and a small game player. Such differentiated and combined gismos are introduced by Samsung and others in the market and may enter the youngsters user community with some ease, at least as motives for renewing the device and to play out status.

In the introduction of WAP there is an interesting set of rival views on mobility and how the Internet can be taken as the 'role model' for future developments. One position sees the Internet as the ideal an open network that has to be ported to other new networks and facilities like e.g. the WAP-phone, while others would focus on the special requirements for services for a WAP-based network and user community, but still with services running parallel in the two different sub-nets. This is partly a consequence of the mythical status that the Internet has been assigned, which makes new developments based on more closed or limited use to look as a return to proprietary standards and nets. Such myth can be misleading judgements about the future use of WAP-based services.

I. The car as user context and its disintegration

From being equipped for entertainment purposes and eventually for traffic information the car radio has been the primary electronic media component in most cars. This is going to change according to magazine writers and professionals in both the car industry and in leading companies, because the car is going to be equipped with much more integrated electronic system for work, communication, traffic navigation, and entertainment. This integration will need specialised systems not least driven by space limitations, and is argued by the fact, that the car somehow serves as both an extension of work space and home spaces. But the car has also played its own role as an individual space of privacy. So the idea of the car as just a rational extension of workspace may be a very limited vision.

There is not much doubt that cars will be more equipped with electronics both as part of their technical systems of control and maintenance and as a way of rationalising cabling. This includes control systems for brake control, engine optimisation, and even speed and traffic management. In some regions of the world with large and complicated traffic systems also GPS based electronic navigation systems may eventually enter the more luxury cars as standard equipment. Also regulations on traffic safety will force professionals to install mobile phone systems in their cars somehow co-ordinated with the cars entertainment systems of radio and tape or CD players.

But the vision of the extended workspace is typical a vision of the work edited rational manager or a very pragmatic reaction to the professional already having the car as the primary workspace. For the latter connection to fax, Internet, and the need for a better equipped workspace is already a fact and is often satisfied with a combination of mobile equipment both to be used in the car and at distant work places. Whether this can be established as a car-integrated system or will stay just another mobile workplace is an open question, but for a number of jobs this will develop into more specialised installations for package control and registration purposes. For the rational manager vision is can be questioned whether this is a field of broader interest. It may well be established as a specialised market, but without the price limitations that normally would be a restriction for consumer electronics mass market. But it can be questioned if these developments do further the idea of technical integration of systems in the car, or if they rather will lead to differentiated car electronic systems specialised to serve different user definitions of the car space.

The car serves as a private sphere for many drivers who have to use some time on the road driving to and from work and to access other activities. This has supported the

penetration of radio and audio systems. For special groups it may even support some distribution of high-end entertainment system with television or DVD-based equipment. But it serves as a different user space than the idea of an extended workspace. It may for other co-ordination reasons be combined with mobile phone and traffic management systems, but still it has a very different perspective, than is embedded in the computer-and-network based ideal of the mobile office.

J. Surveillance and remote control

In professional markets the use of computers and electronic devices in surveillance and remote control has a long history, and in the later years the number of different mobile devices to control cargo, to overlook remote installations, and to monitor nature and systems is growing fast. These devices are in growing numbers using the GSM system as transmission system. Even for monitoring photocopiers and soft-drink automates the professional usage is entering and will be found in all types of equipment for measurement, monitoring, surveillance and even disaster monitoring in the future. Using wordings like 'pervasive' and 'ubiquitous' in combination with computing these development visions are somehow considered also to enter into the consumers sphere often headed under the broader vision of 'home automation'.

Studying this field shows a number of different concepts and ideas, but of which most seem to reflect the 'pervasiveness' of developers minds and user-representations. Home automation is mostly to be considered a technocratic concept, that has not - even after more than 10 years of experimentation - met its user context. The concept of integration and automation contains certain ideas and user representations, but does not fit into the practices in most households, and leaves the more realistic user configuration in this field to the interest of remotely controlling certain features like heating and process starts on one hand and the surveillance of outdoor and indoor facilities on the other. Although ideas has been developed focusing on the need for so-called 'robust' user interfaces, based on simplified and situation dependent user interfaces and communication dialogues selected by intelligent software, there is still no clear reason why this should become a more useful tool in common households. Even if the systems could establish routines reducing choices according to the specifics of actual user situations, this primarily overcomes the computer introduced complexity itself.

When for example Ericsson puts 50 refrigerators out for experimentation with high performance internet access on a screen mounted to the door, it sounds a little like a technical fix of some weird kind focusing on the screen as an icon of modern IT-installations. But the problem rests as the strength of pictures and screen as communication devices is contested, and the user context may be misunderstood. Seen as an element of the so-called 'digital home' one of the arguments is that e.g. the fridge door already functions as the advertisement and notice board in many homes using 'magnet-pins'. In the experiment is includes a wired net system connecting the units because the Bluetooth technology does not allow video-transmissions yet due to bandwidth limitations. The interesting thing is the technology focused type of experimentation which is still the cornerstone of companies way of studying future usage, and it may in fact give much more knowledge about the use of information in the busiest room of most households, where co-ordination of food and production of meals is based on a lot of information and practice. But it still leaves the question

open: does the home situation in any meaning shape a user context that can be likened with automated production or information processing.

Following these reasoning the actual user configuration in households who could afford more sophisticated equipment still more will support the remote control and surveillance type of equipment for the consumer markets for a long period of time. Professional surveillance of installations on the other has a realistic chance of taking of including the remote monitoring and control of installation in homes. This is the user configuration to be looked upon in the coming decade, while both the concepts of 'home automation' and 'ubiquitous computing' are driven by technological potentials in both networks (wired and radio-based) and extensions of equipment control systems and are based on user representations produced as projections of these potentials.

6. When does technology drive use?

The areas of consumer electronics developments analysed in this paper shows the importance of different product concepts and how producers tend to employ user representations in their projection of the future developments supporting extensions of already existing product developments. This leads to different and conflicting ways of predicting future uses, and it leaves out the important role of learning and experimentation from the real life market test of new products.

Convergence in core electronic technologies and in the opening for parallel use of different transmission systems can be seen as a technology driven process. Technology is in this understanding setting the stage for the actors to perform on. Industries, service providers, and content producers success on the stage is based on their ability to recruit users and include user configurations in their actions. Technology opens for a great number of new applications but it does not secure a safe penetration of the products when they meet their users. This is not least due to the importance and also difficulty in recruiting users to enter into new user configurations. Here notions like 'ubiquitous' and 'pervasive' computing do not help in understanding the specific market penetration of products and the transformations being the result of domestication and learning processes. The only 'pervasive' action taken is in the mental representation among specialists. The same holds for the role of the Internet as a war-story and a metaphor rapid change and time-space compression.

RPT-I-5 Convergence. Public Policy Issues related to Competitiveness & Product Use

G.J.Nauwelaerts, IPC

1. Introduction and assumptions

Based on current technology, market and product developments it must be assumed that public policy will have to play an important role in facilitating, promoting and protecting user/consumer needs and interests in the network connected products and systems, whether mobile or fixed.

Today's predictions advance a forthcoming world of ambient networking intelligence, characterised by a wide variety of agents and leading to a migration from the current context of network elements to the new context of service or intelligence elements. Central to this change process will be the question of interworking of and connectivity to all these service elements and how to implement an interoperable, user-friendly consumer-to-network interaction with the level of simplicity matching the new generations' pace of average computing literacy.

Assumed is also that over the next decade, consumer electronics products will all be network connected or network dependent products for the use of infotainment and e-commerce and that there will be a proliferation in tailor-made application specific devices.

Provided technology and applications develop at the current average speed, the main challenge for public policy will be to keep pace with this speed and to prevent information societal chaos.

2. Relationship for Public Policy with CE Definition Issue

What is really the differentiation factor to distinguish the CE Industry from the other converging industries in the ICT field?

Definition Proposal:

“ CE products are all electronic hardware and software products and systems, fixed and mobile, which are being purchased by large numbers of consumers, through channels used or intended for use by them, and which can provide consumers with access to services, functions and content which they want to use “

3. Relationship with public policy for industry competitiveness.

Precisely because of convergence, public policies will have to interrelate for their simultaneous effect on all ICT sectors and their consequences for cross-sectoral competitiveness. The basic features of this approach were summarised in spring 1999 by A. Servantie, Head of the IT International Unit of the European Commission: Simplify-Clarify-Adapt in order to:

The trustworthiness of the services in terms of privacy and investment protection:

- Stimulate Growth & Investment
- Strengthen European competitiveness
- Promote the Information Society

Shift in formerly prevailing EU industrial public policy assumptions & practices:

- Away from interventionism and detailed legislation
- Towards developing good framework conditions for interplay between market players and public, reducing direct financial support volumes, stimulating investment, supporting self-regulation and codes of conduct and acting as enforcer for public protection and essential interests
- Abandonment of the 1990-1992 directive industrial policy papers approach after the milestone publication of Michael Porter “The competitive advantage of nations”.
- Need for global approach and transatlantic initiative leadership

Currently prevailing assumptions & notions on public policy in ICT fields:

- Everything is or will become consumer electronics (convergence causing ubiquity)
- Importance of horizontal and interoperable public policy needs
- Policies should be enabling and supportive rather than supporting
- Global public policy framework needed but not to exclude European origin initiatives
- If regulation, then flexible regulation enabling timely anticipation and adjustments from market actors
- Competition policy enforcement is critical
- In leading technology application areas, interconnectivity and network access standards (Publicly Available Specifications – PAS) will be jointly developed by ad hoc consortia composed of those players who have most to gain from rapid consumer acceptance and market growth potential (UMTS, SYMBIAN, DVB, DVD, WAP,...)
- Policymaking is no longer reserved for civil servants and politicians. Multi-party transparency and interplay will therefore make legislation slow and complex (Examples: copyright, e-commerce and privacy protection)
- Industry has to learn taking real and practical co-responsibility for its part of co-regulation or co-ordination (soft law)
- Product approval to be replaced by internationally regulated self declaration of conformity (SdoC)
- Risk: Shift of policy attention from manufacturing industry needs to services industry needs: In ICT environment, manufacturing is less interesting and less important than services. (frequently heard quote)

3. Relationship with public policy for consumer/user needs and markets.

Central to the consumer acceptability and market development of the pervasive terminals will also be the role which public policy will be able to play in facilitating a trustworthy operating environment for the end user.

Public policy will have to blend global developments with regional consumer and user differentiation in Europe, North-South and East-West, with material differences in cultures, market dynamism, consumer behaviour and adoption of convergence driven network terminal products (Glocal approach).

With a forward view, it will be important not to assimilate public policy with regulation as the former has a much wider role to play than the latter.

Generally and from the consumer terminal product's use point of view, public policy attention should be expected to address:

- The achievement of an open, transparent and interoperable services environment in which the consumer will have a free choice to buy the terminal products and to access the public and private service options which suit him best.

This objective entails activity in the following fields:

- The unrestricted and standardised technical access to broadcast and communication networks, res. distribution systems
- The access to content under free or reasonable payment conditions and the reduction of the cost of communication
- The trustworthiness of the services in terms of privacy and investment protection
- Future application oriented spectrum allocation management
- Support (push) and influence single and open European standards and interoperability for global applications
- Support CE mass market information and education programmes on the use of interactive terminals
- Support consumer trust and confidence building collaborative R&D in those areas where private players tend to under invest

5 Product and systems related priority fields

In terms of specific CE products, it can be assumed with a reasonable degree of certainty that the integrated digital television receiver, the interactive digital set-top box, the consumer PC, the WAP mobile phone and the in-car communication and traffic guidance systems will be the principal cars on the information society's highways. Voice recognition technology development can be expected to play a strategic role in the development of new CE product mass markets before the end of this decade. The distribution of digital services should be expected to further develop DAB products, audio-video and telecom antennas and Internet application devices and recording/replay products. The role of public policy on the impact of convergence on CE products and systems can by necessity only be conceived in the field of network-connected use.

Where less considered for the purpose of this study the non-convergence sensitive products (not connected to networks) such as home or portable audio products and hi-fi products operated by tape-, disk- or chip storage, neither the multimedia home systems as interconnection of several network connected components. This approach should however NOT be understood to qualify these as not important for innovative industrial design and production.

While important with respect to content creation, availability and its distribution in Europe, the influence of audio-visual policy is not taken into account for the purpose of this study. Politically and culturally sensitive, it is however recommended that audio-visual policy implications be included in the scope of a wider and larger research project.

6. Natures of public policy activity and application fields

It is assumed that public policy should not be sector specific but should be horizontally oriented to address those issues, which have a common and interrelated impact on the user. Depending on the ability of the market players to achieve consensus on issues where the public interest requires product use related protection, public policy should be light handed, coercitive supportive and complementary.

The enumeration of product use related policy fields should be understood to use these 4 types of approaches, depending on the objective pursued in each specific case:

- consumer protection: ensure user privacy, financial safety, protection of minors;
- standardisation management & processes: ensure optimal interconnection and interoperability options – ex.: support the HAVI, MMHP, UMTS – 3G platform objectives, Bluetooth;
- competition: enforce compliance to avoid concentration and abuses, monitor codes of conduct, guarantee freedom of consumer service choice;
- support development of new interactive digitally delivered television and internet audio-visual content services;
- ensure access to content/programmes and fair communication cost of service carriage transaction;
- general public education and awareness: ensure independent public information and support skills enhancement at all ages;
- public R&D: support any activity leading to improved consumer trust building;
- optimise trading & cost consequences of international customs classification and component imports;
- protect the right to copy for personal & household retrieval and use
- ensure effective management of scarce resources: spectrum availability, “ubiquitous broadband”, numbers and addresses;
- SME support and knowledge exploitation: find them, map them and organise an effective knowledge and value added feeder system in the European based supply chain;

- Enable and support CE application oriented (embedded) software development.

7. Closing recommendations.

All of the above suggests a very critical responsibility and role for European public policy with respect to the CE industry's future competitiveness in Europe as well as with respect to the acceptability and future use of CE products by the consumer

In the effort to seek manageable definitions of the CE industry and its present and future products for public policy action proposal, it is therefore vital that thorough research be undertaken to:

- identify & map the consumer electronics knowledge-, design- and production chain in Europe irrespective of size or nature of the actors
- identify & map existing globally competitive knowledge and production strengths in Europe within industry and
- identify & map critical dependencies on hardware, software and skills
- identify Internet threats and opportunities
- identify the economic value of intra and extra European alliances
- identify & map the public R&TD programmes and academic centres of excellence active into the European CE value added chain
- identify recent studies on consumer use & behaviour and project general trends
- focus the above research on those identified CE products, which are the principal, and growth expected carriers of the CE industry established in Europe.

Finally and for the purpose of this project it seems imperative to include both on substance and as a research reference the Futures Reports Series collection of the European Joint Research Centre itself.

This Futures collection contains indeed much of the key findings and considerations for public policy, which this project addresses and intends to assemble for a comprehensive compilation towards its objective.

RPT-I-6 Broadband access and consumer electronics

Alain Puissochet, Idate

1. High speed access : a strong growth expected

High-speed access is today the new frontier of the Information Society. The level of dissemination of high-speed access stays low, but many factors seem favourable for a real growth in Europe:

- An increasing number of broadband access technologies and platforms whether terrestrial or wireless, fixed or mobile, and adapted to the different characteristics of the market segments or the geography,
- An increasing number of services which will need or at least greatly benefit from the explosion of Internet applications in the business and residential markets: electronic commerce, Intranet, VPN, financial and banking services, music distribution and video streaming,...
- A more competitive context in the local loop, and the presence of alternative broadband long distance infrastructures (more than 20 pan-European network projects are under way),
- A technical convergence based on digitalisation and new associated standards: MPEG, IP, DVB, ATSC,...

2. A large variety of platforms

Definition of broadband access is not clearly defined. If we take as a definition a faster speed (at least theoretically, although not always practically) than analogue telephone lines, we have to consider as broadband access the technologies able to reach more than 56 Kbit/s. They will include: ISDN, xDSL, cable TV networks , digital TV systems (terrestrial or satellite), wireless technologies (mobile wireless from GPRS to Edge and UMTS and fixed wireless LMDS/MMDS and other radio based technologies), satellite transmission, optical fibre (mostly for corporate customers), the different varieties of fibre to the home/curb/building, which are combined with various technologies to reach the final customer, local wireless, ADSL, VDSL,...., digital power line.

All these technologies are already deployed or could be in the next years.

3 Compared situations in Europe and USA

In terms of broadband access, the situation differs widely in different countries in Europe, as well as in Japan and the USA: access to cable networks, extension of ISDN developments, status of unbundling for the PSTN lines, status of terrestrial DTV, agenda of LMDS licensing, mobile penetration, development of digital TV through satellite, UMTS agenda and so on.

There is clearly an advance in the US as compared to Europe in terms of ADSL and cable deployment. But this advance is limited (one or two years ahead) and does not

seem to imply a handicap for Europe. On the contrary, for UMTS and other radio high speed access, Europe may benefit from its advance in mobile communication.

If we consider ADSL deployment, in the major European countries, operators have announced that 80% of the households will have access to it in 5 years (this does not mean necessarily the end of ISDN, since ISDN may technically coexist with ADSL). The speed of development will then depend on the number of customers willing to pay for broadband access. This will be related to the existence of services at an affordable price.

Situation is different with cable TV. Cable TV programs are the main justification for installation, and Internet access and telephone services are most of the time just a supplementary benefit. So in the countries where digital TV by satellite or terrestrial broadcast will exist before digital cable develops, cable may not become universal, or at least will have to coexist and compete with other competing technologies. In the US, a large proportion of the households has access to cable (coming close or above 75% of households), so cable has and will keep an important place there, more important than in most countries. But this does not give any clear market advantage as compared to ADSL services.

Moreover prices of both ADSL and cable are expected to decrease in the next future, and probably (that is a personal opinion) to converge.

4. Impact on the consumer market

In 1994, it was expected that the consumer market was the leading market for high bandwidth to the home through interactive and digital television. The attempt exemplified by the Orlando experiment failed, and on the contrary Internet accessed using personal computers became the success story, and the main motivation for high-speed access. The recent changes addressed in the whole report made the situation quite different now. High speed access will open new consumer markets: news, games, leisure, e-commerce, As we have seen above, the main issue is to provide new and interesting services pushing people to buy high speed connection (in some cases, the price of the connection will be subsidised by the service provider). As the development of high speed access is clearly related to services, the challenge for CE is to develop and provide terminals and equipment allowing these new services. One of the issues is the relationship between service providers and equipment developers: who will specify the equipment, if they are to diversify?

The CE industry as a whole will largely benefit from a development of broadband access, first stimulated by Internet (mainly text and pictures), but which will be more and more stimulated by audio and video services.

RPT-I-7 Strategies of EC industry

Alain Puissochet, Idate

1. Context

For the industry, there is a need to control much more diverse technologies in order to stay competitive. Finding effective ways to obtain the necessary knowledge is a major issue, which has been already addressed through different strategies: alliance, R&D, buy & merge,...

Relation to content and services is also another issue. Marketing and selling these new products is also undergoing changes: new ways of selling products are appearing and may impact the industry: most notably, for products incorporating a high level of content, there is a tendency to subsidise the hardware in order to sell the software (content): this implies major pressures on hardware prices. This is currently seen in computers, mobile phone as well as set-top boxes.

This chapter addresses briefly the strategies of three world players Sony, Thomson Multimedia and Philips, as well as the strategy of Pioneer, a smaller size CE company.

2. Thomson Multimedia

The company is a major manufacturer of TV receivers, probably the leading producer in the United States, and the world's biggest supplier of digital set-top boxes. In 1998, after a ten-year period of losses, the company came out of the red. The company has strongly emphasised digital TV. In December 1998, Alcatel, DirecTV, Microsoft and NEC each acquire a 7.5% stake in Thomson Multimedia. This has led to co-operation with all partners:

- with Microsoft for software (selection of the ATVEF standard, used in TAK),
- with Alcatel for communication consumer electronics and home networks (partnership in fixed telephone set September 1999),
- with NEC for plasma flat panel displays,
- with DirecTV as a main customer for satellite set-top box.

In the PC sector, Thomson developed co-operation in 1998 with Compaq (mixed PC-TV terminal) and Oracle (Network Computer).

Thomson Multimedia has defined two main value added sectors:

- value added components such as plasma displays,
- services

In the domain of services, several attempts have been made :

- development of fully interactive television TAK in alliance with Microsoft, where Thomson could act as a service provider for content developers,
- development of a MP3 portal in co-operation with Virgin,
- developments in EPG with Gemstar.

3. Philips

Philips is the third largest CE group after Matsushita and Sony. The company is a large supplier of set-top boxes. Through its numerous activities, Philips claims to have total command of digital systems components and a product offering ranging from

integrated TV receivers to set-top boxes, and taking the entire video chain from recording to broadcasting.

The company was one of the first manufacturers of WebTV boxes.

In the domain of components, the company has strong connections with the Taiwanese TSMC and the Korean LG.

Philips manufactures GSM handset, considered as a strategic market and has announced end 1999 to own 6% of the world market.

Philips sold in 1998 its disk company Polygram. The merge of its consumer communication activities with Lucent in 1997 was dissolved in 1998.

4. Sony

CE accounts for 80% of Sony activities, the remaining activity comprising content production. Sony has experienced the same difficulties as other CE manufacturers, but managed to stay profitable thanks to the success of its PlayStation game console. It should be noted that sales of game console are subsidised by the sales of content (games). That allows the PlayStation 2 to include a DVD and to be price competitive with other DVD's. This new game machine is not simply a new weapon for Sony in its competition with rivals Nintendo and Sega in the game station market - it represents a major example of the new consumer terminals now appearing. In fact, it is really a multi-usage multimedia platform.

Sony is investing heavily in new digital techniques for both the professional market and the consumer market. In January 1999, Sony decided to redirect half of its technicians to the software sector, with a view to PC applications and operating systems for domestic appliances. The same month Sony became a major shareholder of General Instrument, the leader of cable set-top boxes in the US. Sony is also a PC manufacturer with a rather successful brand VAIO, which the company combines with digital AV equipment including miniature CCD cameras, allowing to capture still or moving pictures and to store them on a computer. Sony has also decided to use its brand name to develop services : banking on Internet, insurance, creation of joint-ventures for e-commerce including downloading of games, music and movies and sales of a wide range of products : travel, music, gifts, tickets for shows and cars.

5. Pioneer

Pioneer is a smaller manufacturer and has chosen to focus on 4 main spheres: home entertainment, mobile entertainment (mostly in cars), business systems (set-top boxes, satellite receivers) and display components (plasma and organic displays).

Pioneer has made the strategic choice of co-operation to get software knowledge for set-top boxes. A strategic agreement, "The Alliance" has been concluded with Canal+, C-Cube and Divicom. It has allowed Pioneer to compete with General Instruments and Scientific Atlanta in the US. Pioneer has made the choice of standards (the company is member of DVB) and develops R&D in Europe, Japan and the US. Pioneer was the first to launch a DVD-RW recorder. The company is also a content provider developing CDs, videotapes, DVD's and LD's.

RPT-II-1 Global Trends in Business Activity & Industrial Organisations

G.J.Nauwelaerts

1. Support Rationale for Trends Outlook

The following key factors will be driving the business activity of the consumer electronics manufacturing industry *established in Europe*:

The most fundamental and radical influencing factors:

1. consequences of the internet economy developments and of the internet consumer use
2. consequences of the globalisation of supply, of technology ownership & alliances and of new application driven consumer electronics products and services
3. migration from a production industry to a knowledge management and application design industry
4. ubiquitous computing leading to ubiquitous personal and home CE applications

Other factors:

- Explosion of CE definition and CE manufacturing industry to new products/applications and new manufacturing concepts for entertainment, information and communication: the era of “pervasive consumer electronics” and the “era of design- and- distribution manufacturers”. The management of the design, the supply chain and the distribution of products, home systems and related services can be expected to become the core in-house strategic corporate activity.
- Commodity manufacturing (products and components) to keep moving to cheapest producing locations world-wide
- Further fast absorption of and transition to digital technologies in network and broadcast connected products and systems
- Broadcasting, wireless mobile communication and consumer Internet to be the driving waves of product and market development subject to bandwidth availability
- Increasing impact of “shareholders’ value” requirements on corporate strategies and investments – conflict potential with consumer requirements on cost-quality-user friendliness ratio.
- Manufacturing industry to become e-services and e-commerce economy driven

- CE industry to be strategic component-, (embedded-) software- and content-dependent and driven. Full control over key in-house designed components will determine quality of innovation and market leadership.
- Human interface-, screen-microprocessor and memory technologies as well as standardised interoperability should be among the most critical factors to determine product developments.
- Further migration to knowledge- and IPR based companies with minimal in-house manufacturing, yet very capital intensive
- Optimal “outsourcing” of the manufacturing of non-key products, assemblies and components – Concentration in key components supply base (ex.: plasma screens)- Access to strategic components and licences will drive level of competitiveness
- Extreme reduction in number of parts & components use and supply by circuit integration
- Further migration to integration of network connected entertainment, communication and information functions in products and systems
- Further reduction in number of global players active in traditional audio-video products – Concentration, acquisitions in core business – De facto standards increasingly the norm
- Existing powerful players increasing their market influence and share in newly defined consumer electronics market – Acquisitions by computer manufacturing companies of consumer market players (market know-how and distribution acquisitions or mergers)
- Digital Web casting, Interactive Digital Video-Broadcasting and MP3-type NetWare to further develop the on-line video and audio services markets
- Further development of complementary alliances towards integration of total business chain activities from design to content delivery
- Increasing number of venture capital knowledge based SME's to weave into the micro pores of the manufacturing and communication fabric
- CE markets to be dominated by increasing skilled and non-skilled user differentiation as well as generation preferences
- Mobility of high value added assets (knowledge, physical and human capital) to become driver of competitiveness – Mobility on fixed network to increase (smart cards)
- Mass market accepted and platform developed de facto standards to determine market uptake and sales volume speed

- Concentration in computer based game industry and migration to interactive, proprietary internet environments
- Skill intensive production will become a key investment factor as cost of capital will not be very different geographically. Finding these skills is still problematic outside the Union and NAFTA. Combined high skill and capital intensive production can therefore be expected to remain where currently implanted in the EU and, even more so, for R&D dependent production.
- Cost of longer term oriented R&D becomes prohibitive due to short time to market
- Scattered ownership of patents and other IPR's to delay introduction of new products and systems onto the market
- Simplicity of use, consumer confidence, low product and service cost, compatibility and access to content to be the determining factors for market acceptance.
- The success level of the implementation of the Multimedia Home Platform (MHP) as developed in Europe by the MHP consortium
- Migration from analogue TV and Radio to digital receivers market to move undesirably slowly due to uncertainties on cut-off dates and simulcast scenarios.
(national analogue transmission cut-off dates planned between 2006 and 2011)
- Software development being a key competitive driver in CE products and systems development, the importance of low wage software skilled countries will grow significantly in the creation of software (ex. India).
- Finally, increasing availability of bandwidth for internet related mobile and static applications as well as the capability and skill to make use of these bandwidth related opportunities, will become very critical sustaining and development factors.

2.Global Trends Outlook for Business Activity & Industrial Structures

Providing a ten-years-ahead foresight on business activity and changing industrial structures is highly speculative in the given circumstances of never experienced change processes in the information and communication technology field.

The consumer electronics industry, by whichever definition of identity or scope, is going through a Darwinian evolution of the species. Not the strongest or the most intelligent will survive but the one who adjusts best to the changing environment.

In light of the aforementioned key trends and influencing factors, it would be safe to claim that the next ten years will see fundamental changes taking place in the nature, structure and fabric and activities of the consumer electronics industry in Europe. It

would be equally safe to say that this industry, whether of local or foreign parentage, will be significantly and interactively dependent on non-European supply and knowledge partnerships.

With the nature of manufacturing itself changing for technology and market leaders, i.e. increasing design, development and marketing in-house at the expense of in-house production and assembly, future CE manufacturing and assembly activity in Europe will further reduce to very few sites for high technology, high value-added and capital intensive production. As mentioned sub 1) above “skill intensive production” capability will be a strategic factor.

With the large number and volume of consumer electronics products and key components being already imported, it would be safe to assume that from the traditional brown goods industry products list, only a few high technology content television and radio production sites, set top box and reception decoder production, niche manufacturers as well as a small number of high end audio SME-type assemblers and antenna/dish producers will constitute total brown goods production activity in Europe by 2010.

Substantial television receiver set manufacturing should remain established as the principal brown good production activity in Europe well beyond 2010 with Eastern Europe developing due to the need of close-to-market manufacturing for transport cost sensitive TV receivers.

With the expanding variety of new convergence driven consumer electronics products and home systems, local production, assembly or subassembly could be essentially found in mobile telephony, set top boxes and decoders, internet devices, smart card devices, voice recognition and programme delivery interfaces, home system interconnection and network access devices, highly simplified personal computers, consumer home office products and those products which undoubtedly will be introduced before the end of the next decade.

The fundamental question to investigate is whether and to what production of these new products will be outsourced as opposed to production / assembly in the by then extended Union. The availability of cost efficient manufacturing and supply of key parts and components will be a determining factor in answering this question.

Consumer electronics manufacturing activity and industrial value chain supply structures will be fundamentally influenced by:

1. what the terminal-software-content integration will be able to offer and at what cost, and
2. by critical production cost-quality ratios and performance.

Established companies will leave the CE market or disappear completely as an entity.

Newly formed companies and brand names will emerge on new CE product, - systems and -services markets and existing personal computer and telecom terminal equipment manufacturers will keep increasing their presence and impact on the growing and changing

CE applications market. Simply put: not only will one see different players and teams but also the game itself and the playground will be different.

With the analogue-to-digital technology shift continuing, mastering the combination of video and data compression over mobile and home system communication delivery networks becomes relatively cheap and available everywhere. A more determining factor will be the ability to generate and renovate reliably the software for these products.

3. Convergence and the Outlook for the global market oriented companies

At the level of the global market actors, technology convergence should be expected to drive the global players to new business models shaped by mergers, acquisitions, complementary alliances and the further shedding of non-core activities.

The martial law of the consumer electronics mass market will keep dictating high volume-low margin ratios, fast time-to-market cycles, feature differentiation, cost efficiency and distribution effectiveness, including e-commerce and services delivery. Under these global, economic and technological pressures, it is to be expected that akin the car and telecom services industry, there will only be room for a few global competitors in each of the product and system segments which will form the mass consumer electronics market of the future.

During the 1990-2000 period, product innovations, mass market penetration and growth were all driven by digital technology. Examples are: the personal computer, the television receiver, the set-top box decoder, the mobile phone, the DVD, the D to A converter and processor for audio, the camcorder, the digital radio receiver, the personal organiser and palmtop, the digital tape and disk recorder, the game consoles, the home cinema video and audio systems and the in-car traffic guidance systems/

Capabilities in fundamental research, computing and communication technology, key components, utmost simplicity of use and product/system interoperability are most likely to determine the future of the existing, global market oriented manufacturers. For these, stronger or weaker “shareholder value”-pressures may be critical for the development of longer-term strategies and design cycles. Under growing pressure of global financial markets, finding the right balance between shareholder value, corporate longer-term growth needs and consumer expectations will increasingly be vital for sustained future existence.

The high cost of design and development in innovation, of marketing, of distribution and of license fees, combined with the typical low margins in consumer mass markets will drive out those manufacturers whose product market share is too low to sustain their market presence. It can therefore be expected that several manufacturers with currently well known brand names will either have stopped their activity in current product lines, continue production on an OEM base or be taken over by large consumer electronics market entrants, eager to acquire consumer market and distribution know how. This likelihood is particularly present for PC manufacturers who show difficulties in developing consumer friendly plug-and-use products and in mastering fast changing distribution channels and methods.

Convergence drives the migration of the stand-alone product period to the era of the network-connected products and interconnected home systems for information, entertainment and communication. The next decade is therefore likely to witness a

shake-out among those consumer electronics manufacturers (by disappearance, merger, acquisition or OEM transformation), born in the analogue period and too technology and capital dependent or, with too small market shares in the traditional brown goods products to justify continued market presence. Inevitable and strong concentration is therefore to happen among traditional manufacturers of main consumer electronics products such as television, radio, video-recorders, camcorders and portable audio.

Also, a shrinking market in these traditional product lines due to saturation and sustained changes in consumer spending patterns will further precipitate this trend.

Technology convergence has led to the critical importance of complex software development and computing environments as well as to the functioning of complex multi-actor vertical integration processes as is well illustrated by the activity of the European Multimedia Home Platform²³

Based on existing technological and competitive strengths, it would be reasonable to predict that digital television receiver multimedia development, digital set top boxes, mobile telephony, evaluative consumer PCs and Internet appliances should constitute the essential design and assembly activity in Europe during the next decade.

Analogue TV sets can be expected to continue being manufactured in high volumes in Europe with digital set top boxes continuing to dominate and outpace the production of high end integrated digital TV receivers. With the development of infotainment via digital broadcasting, one can expect that the digital TV (integrated or not) will become a key component in the future communications system of the home.

Convergence and Niche market players

The effects of globalisation and convergence may have much less impact on those manufacturers active in specific niche markets, whether in television or in audio.

High end product style design and research in ergonomics software and processing are their strategic differentiation and competitive advantage factors over the high volume producers. Yet, the cost of critical components and license royalties to keep manufacturing state-of-the-art products and systems will remain an ongoing concern in terms of technological dependency.

Convergence and “The innovative SME’s”

Finally, with the fast development of the European knowledge base in ICT convergence technologies and the great potential for small, innovate enterprises to fill the multiplying micro pores of the information appliances age, it would be reasonable to predict a European Silicon Valley development for innovative SME’s. Current facts, value chain centres of excellence and numbers of companies support this forecast.

See Annex 2: (Report of the European IST Conference in Helsinki, 22-24 November 99)

²³ See Presentation of Prof. Dr. Reimers at the 1999 General Assembly of EACEM (www.EACEM.be)

4. Market development speed

Based on the history of CE products market development and with the exception of the mobile phone as proof of the general rule, the introduction and mass-market growth of products and systems of a radical and innovative novelty are usually a slow moving process. Product diversification in the communication and infotainment markets and the difficulty of reaching standardised platforms for consumer volume acceptance and production can be expected to remain a hurdle to fast market introduction of new products and systems.

Convergence of technologies causing in the very first place a combination of applications and functions through modular hardware assembly, the next decade is unlikely to produce products and systems of a nature or kind which have not been foreseen already.

Digital video and audio broadcasting and reception, , voice recognition, third generation mobile telephony, multimedia home systems and smart card technology, as European strengths, can be expected to be the most progressing technologies to drive CE products and systems manufacturing design and production together with exponential internet use and services growth.

5.Strategic economic research requirement

Accurate statistics being a key pre-condition to quantify and qualify the nature and economic role of the CE industry in Europe, it is an essential requirement for the successful completion of a convergence impact study, to establish factual demonstration of the entire consumer electronics related design and manufacturing value added chain.

In doing this, it should however most probably become clear that the impact of technology convergence on the CE industry in Europe as a whole will be one of concentration, complementary knowledge based alliances, transmission technology and content distribution development, software and production skills shortage, specialisation and component design and of further decreasing and delocalising mass production.

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RPT-II-2 Employment in EU CE industries - More Than Counting The Numbers

Wendy Hansen, MERIT

1. Introduction

At the recent EVORA conference, Ministerial contributions stressed the determination to raise employment levels in the EU, and not just more jobs but better jobs. The Lisbon Summit which took place in March of this year concluded the need for action in ten specific areas. They deal with a range of issues as diverse as the information society, the business environment, economic reform, education and training, employment ('more and better jobs'), modernising social protection and promoting social inclusion. Subsequent Council debates will consider the new and global conditions of government, employment and competitiveness (i.e. business competitiveness and employment in a Europe of innovation and knowledge (May 18 by the Industry Council) and education, information and employment (June 8 by the Education Council).

What strategies must CE industries adopt to remain competitive in a global market place? How can public policy ensure European CE industries have the environment (i.e. regulatory, human capital, research and development) necessary to vie and grow in a highly competitive global information based economy?

The contribution of this paper can be described as having two main aims. Firstly, it presents information on what is known about recent employment trends in CE industries in the EU. CE industries are defined as (limited to) NACE 32: radio, television and communication equipment and apparatus manufacturing industries.

The second aim of the paper is to demonstrate that much work is needed to more fully capture and better understand the contribution of CE industries (and products) for employment, job creation and social inclusion in the EU, and suggests how to advance information and understanding of these issues. The paper concludes with some recommendations for future research directions which lend support to current policy priorities, for both the public and private sector decision makers and planners.

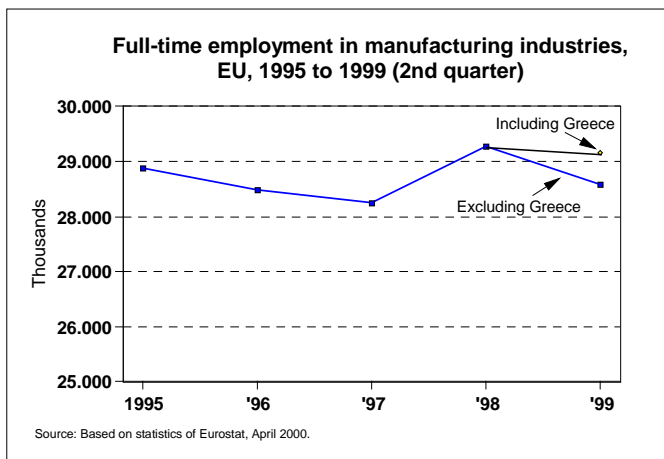
2. Employment

2.1 Recent trends in full-time employment

Given the time frame and scope of the study, it was not possible to acquire data from individual national sources. For this study, Eurostat was asked to provide EU level full-time employment figures²⁴. For the total EU, only the years 1995 to 1998 are available. One might assume however, more extensive time series may be available on an individual Member state basis.

²⁴ The data is drawn from a survey on employment conducted in the 2nd quarter of each year. The figures (for individual countries) have been generated during the period of those three months when the survey was carried out; the survey is distributed along different weeks depending on the country and therefore is not simultaneous in all Member states; in some countries, the survey takes more weeks than in others. Consequently, the data must be considered as 2nd quarter rather than a given

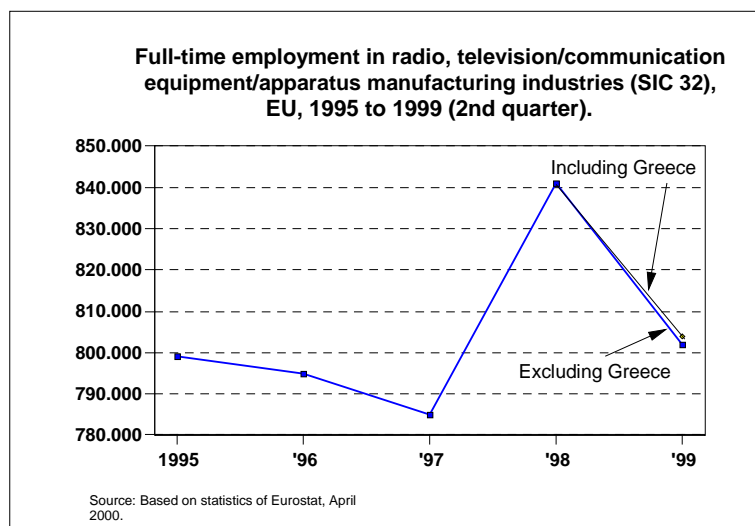
In 1998, there were 29,270,000 people employed full-time²⁵ in manufacturing²⁶ industries in the EU. This was a rise of 1.3% over the number reported in 1995. Figures for Greece for the year 1999 are not available. Using the 1998 figure for Greece, the estimate for 1999 is 29,157,000²⁷, which equates to an increase of close to 1% over the 1995 figure. However, this masks a downturn between 1998 and 1999 when full-time employment in the manufacturing sector fell by 0.4%. In 1999, there were some 114,000 fewer full-time employees in the manufacturing sector compared with just one year earlier. This is the general health of manufacturing industries (sector) as a whole in the EU, in terms of full-time employment. Note: this does not include part-time or other non-payroll forms of employment (i.e. contractors).



Full-time employment increased more rapidly in the radio, television and communication equipment and apparatus²⁸ (CE) manufacturing industries²⁹ although this too ended in 1998. Between 1995 and 1998 the number of full-time employees in these industries rose from 799,000 to 841,000 which was an increase of 5.3%.

Using the 1998 figure for Greece to estimate the 1999 figure for the EU, in 1999 there were 804,000 people employed full-time in CE industries. This meant that between 1998 and 1999 there was a rather staggering decline of 4.4% in full-time employment in CE industries (or a drop in the number of full-time employees of some 37,000 between 1998 and 1999).

This compares with a drop of only 0.4% in full-time employment in total manufacturing industries for the EU between 1998 and 1999. Until the year 2000 data is available it is too early to make assumptions as to whether this is the beginning of a longer term decline or a temporary drop.



Countries like Austria, Denmark, Finland, Netherlands and Portugal saw full-time employment in CE

²⁵ Data provided by Eurostat, April 2000. The figures refer to full-time employment in the 2nd

²⁶ NACE classification D: manufacturing industries, Version 15 December,

²⁷ The 1999 figure for Greece was not available. For discussion purposes, a figure for Greece was estimated using the 1998

²⁸ NACE

²⁹ Figures in CE industries exclude

industries remain stable or increase somewhat between 1998 and 1999. Countries like Belgium, Germany, Spain, France, Ireland, Italy, Sweden and the United Kingdom saw full-time employment in CE industries drop.

Full-time employment in the manufacture of radio, television and communication equipment and apparatus, EU, 1995 to 1999.								
Country	1992Q2	1993Q2	1994Q2	1995Q2	1996Q2	1997Q2	1998Q2	1999Q2
Thousands								
AT	n.a.	n.a.	n.a.	19	17	19	25	26
BE	n.a.	25	19	25	20	22	16	13
DE	n.a.	n.a.	n.a.	215	230	204	223	220
DK	n.a.	7	6	12	13	8	10	12
ES	n.a.	34	36	37	24	30	30	28
FI	n.a.	n.a.	n.a.	21	26	25	29	32
FR	n.a.	110	115	125	124	130	136	119
GR	n.a.	3	2	3	2	3	2	(est.)2
IE	n.a.	2	3	4	5	6	20	19
IT	67	76	97	97	80	80	78	72
LU	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
NL	n.a.	84	81	43	48	48	42	45
PT	n.a.	14	16	19	14	11	14	14
SE	n.a.	n.a.	n.a.	32	41	44	47	41
UK	n.a.	291	117	148	150	153	169	159
EU total	67	646	493	799	795	785	841	804

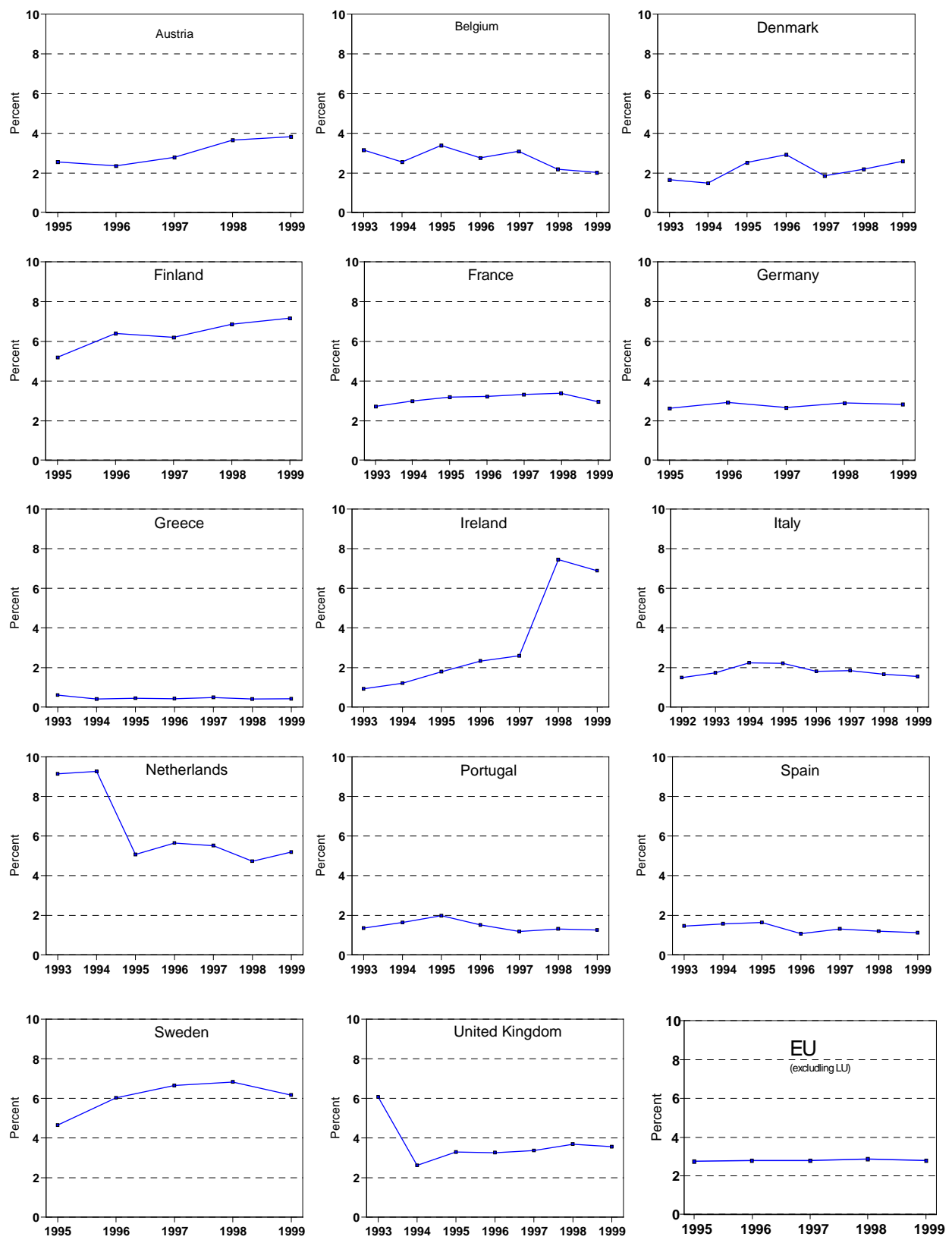
How much of full-time employment in manufacturing industries do CE industries contribute? In 1995, CE industries represented 2.8% of full-time employment in the manufacturing sector in the EU (excluding Luxembourg). This changed little over the five-year period, with CE industries accounting for 2.7% of total full-time employment in manufacturing industries in 1999.

Full-time employment in manufacturing industries (sector), EU, 1995 to 1999.								
Country	1992Q2	1993Q2	1994Q2	1995Q2	1996Q2	1997Q2	1998Q2	1999Q2
Thousands								
AT	n.a.	n.a.	n.a.	750.6	713.0	687.5	682.6	689.9
BE	834.4	778.6	743.8	729.8	722.0	720.2	708.6	650.9
DE	9871.4	9282.2	8740.7	8166.2	7806.2	7652.5	7751.3	7753.5
DK	461.5	440.4	438.1	468.0	448.9	448.8	456.5	463.5
ES	2631.9	2360.5	2254.8	2263.3	2226.3	2316.6	2483.5	2536.8
FI	n.a.	n.a.	n.a.	397.5	403.3	409.0	428.1	447.6
FR	4326.8	4028.0	3844.4	3915.1	3859.9	3895.8	3979.3	4016.8
GR	607.5	565.1	562.8	562.3	560.8	547.0	561.8	(est)562.0
IE	214.1	203.8	215.6	225.8	227.6	251.0	269.4	274.5
IT	4516.0	4417.6	4351.4	4383.6	4411.9	4321.1	4676.0	4650.9
LU	26.36	23.26	23.7	21.83	21.01	21.5	20.29	20.56
NL	919.31	915.23	874.03	853.14	854.26	865.07	897.12	876.44
PT	996.8	1006.7	989.8	967.6	935.0	906.5	1098.1	1082.1
SE	n.a.	n.a.	n.a.	690.8	672.9	669.0	683.6	671.0
UK	4852.5	4784.7	4472.8	4488.4	4617.4	4539.1	4574.0	4460.2
Total	30258.6	28806.2	27511.9	28883.9	28480.5	28250.5	29270.3	29156.9

n.a.: not available.

The extent to which CE industries accounted for total full-time employment in manufacturing industries, however, is quite different when individual member states are examined. For example, in 1999, in Finland CE industries accounted for more than 7% of the full-time employment in manufacturing and it had been on the rise since 1997. In countries like Spain and Portugal, CE industries accounted for only around 1% of full-time employment in manufacturing. Below, charts show how the

role of CE industries, in terms of the share of total full-time employment in manufacturing industries is changing over time and variance by Member state.



Note from the author: The sudden rise between 1997 and 1998 and subsequent drop between 1998 and 1999 raised some concern. This was discussed with the data supplier with the resultant response: "It is true that employment in industry or in NACE 32 increases in 1998 and decreases in 1999 for some countries, but if you calculate the evolution of the percentage of the industry in total employment or the percentage in manufacturing you will see that it follows a normal pattern"³⁰. This is supported by the trends in the charts above.

2.2 Measuring employment in CE industries in a time of economic restructuring and convergence

There will always be a gap between economic restructuring, the statistics gathering instruments and the development of new indicators. It is the task of researchers to suggest new ways of building the information base.

The 'blurring' of the lines

The employment information and charts in section 2.1 are based on a traditional classification system, in this case NACE. However, the convergence of CE industries, the accelerated greying of the lines between sectors and new models of work organisation in an information economy are anything but traditional. It is at this point this paper departs from the traditional approach to employment in CE industries to the challenge of enhancing the measurement of employment and jobs in these industries and more specifically, capturing CE industries' impact on employment as a whole.

As CE products and activities converge and span (or spill over) a number of sectors (i.e. components of computer manufacturing and service sectors), it is necessary to expand the measurement to include the spill-over effects of CE industries' activities and products.

- Statistics in the new economy may be being used to 'rob Peter to feed Paul'. Today, figures tell us it is the services sector driving employment growth whereas employment growth scenarios in manufacturing tends to be somewhat gloomy. How much of this growth/shrinkage is due to real activity or to statistical classifications and their manipulation? Take for example, professional engineers and their activities. Prior to restructuring which resulted in down-sizing and out-sourcing in the mid- to late-1980s, employment of engineers was typically captured in manufacturing industries' employment figures. Then companies reorganised, restructured and considered out-sourcing an important mechanism for acquiring contributions of skilled workers such as engineers. Engineers hired on a contract basis are typically classified under the services sector in industries such as business consulting services. As a result, engineers' employment in manufacturing shows a drop as their employment in services increased. Engineers continued to do the same work and the net employment loss/gain might in fact be zero. We must be careful to 'understand' the figures and consider the wider picture to interpret them.
- Another example of this reclassification of employment is found among the large computer manufacturers such as IBM. For example, IBM was one of the larger firms which, during its years of restructuring, reduced its in-house staff by contracting out a number of activities. This resulted in an employment 'loss' in computer manufacturing industries (manufacturing sector) and a rise in service

³⁰ Eurostat datashop. 4 May 2000

industries such as computer services and business services. In more recent years, IBM has begun recruiting to build its in-house expertise which may bring some interesting trends between the service and manufacturing sector figures.

- Finally, there is the example of CE software— manufacturing or services? Is software development in/for CE products a service or is it a manufacturing activity in an information-based economy?

These examples suggest the difficulty of measuring net employment gain in an economy where the lines between manufacturing and services are blurring. If one considers today's business environment where the onus is on employability and firms and people working in non-traditional relationships (such as contracting, virtual research teams and so on), how valid are employment figures delineated by sector.

In CE industries', activities and products are converging. Research and development are crossing traditional sector lines, as are products. As Puissechet's paper points out, traditional CE industries like Nokia are entering the arena of IT industries (and vice versa). One can also argue that a range of activities (and employment) in other sectors are driven by CE industries yet credited to other sectors of the economy (i.e. computer manufacturing, IT service industries).

- The employment figures in this report are limited to NACE 32 - manufacture of radio, television and communication equipment and apparatus. How does the trend in these industries' full-time employment compare with a related sector of manufacturing activities, that of office machinery and computer manufacturing (NACE 30). For example, this latter group of industries shows an increase in full-time employment from 370,000 in 1995 to 423,000 in 1997 when it peaked; thereafter full-time employment fell until 1999 when it stood at 394,000. Perhaps it is more useful to consider these sectors' employment trends together given the convergence of products and activities. What other sectors might be included to give a more accurate picture of the employment impact of CE industries?

In order to get a more accurate picture of the impact of CE industries on employment, it will be necessary to consider employment in CE industries along the entire value-added chain, as well as across other sectors which are directly (and indirectly) impacted by the activities and products of these industries.

Exploring 'drivers' of employment shifts

Generally speaking, employment figures such as those used in this report can provide a broad picture of employment and its change over time. There is little information on what is taking place in the employment structure of CE industries, what factors might be driving employment growth or employment decline.

- What types of expertise are growing in demand and which are waning? What are the links between the human capital skill base and growth?
- How are demographics affecting the labour force of these industries today and how will they in the future (i.e. typically engineers produce an older age profile compared with other expert age cohorts).
- How dependent are these industries on foreign-born talent?

Predictions of supply and demand for these industries remain limited without additional insights into the characteristics of the labour force. How can these industries attract and keep the talent they need to compete? How can EU policy help ensure that European CE industries have the skilled knowledge workers they need?

Much can be learned from the experience of others. For instance, what are the trends in other IT-based industries? What is the experience of CE industries in competitor countries like the USA and Japan? Who do they recruit and how do they manage scarcity of supply. The USA has instigated fast tracking of S/E professionals — what are the impediments European industries face? A focus on the human capital component and the development of indicators of human capital are critical for the health of CE industries in Europe.

Research and Development

Research and development transforms traditional employment and creates new employment. The new ideas and products revolutionise traditional sectors and create new ones. At the same time there is growing evidence of the catalytic role researchers play in enterprise growth and job creation, directly (start-ups — forming new companies to bring the products to market) or indirectly (positive impacts of introduction of new processes and products).

The patterns of innovation are changing. Collaborative efforts are crossing traditional borders between universities and firms, and between firms themselves. Enhanced use of R&D personnel data can be used to shed light on innovative activities of CE industries. Human resource indicators are a necessary part of understanding the system, whether in terms of the broader S&T system or the more specific national system of innovation. These indicators may also shed light on the knowledge spill-over's and impact on employment.

3. Conclusions and Future Research Directions

In order to gain a better understanding of employment, and in particular, creation of high quality jobs in the EU, researchers need to develop new approaches and methodologies. It is clear that expanding the set of tools used to better understand the drivers of employment shifts (i.e. using field of expertise to see what kinds of people are filling the jobs) is essential.

Recent studies done by MERIT for the Canadian government show that the skill base of the labour force in information and communication technologies is not only changing but it varies by industry focus. For example, in telecommunication carrier industries in Canada, there is growing reliance upon university graduates from commerce and management to fill the management ranks whereas in communication and electrical equipment manufacturing industries, management ranks continue to rely upon people with scientific or technical backgrounds³¹. It is true that the higher the level of education, the lower the unemployment rate — this is not new. However, there now is empirical evidence suggesting which fields of expertise weather poorer economic times than others. Drawing again from the Canadian studies, there was a contraction in the labour force in the communication and electrical equipment manufacturing industries between 1986 and 1991 (a drop of 20% was endured) and a subsequent expansion of 33% in the next five-year period 1991 to 1996. During these rather tumultuous times, at the Bachelor skill level, there was virtually no change in the representation of fields of expertise over the decade, whereas at the graduate degree levels, it was people with engineering and applied science or mathematics and physical science backgrounds who gained ground. What is unclear is are the shifts in the expertise of the workers a result of conscious decisions on the part of the enterprises (demand indicator) or a way of dealing with shortages of qualified personnel?

What is the situation with CE industries in the EU? Who is getting the 'good jobs' and who is not? How are the occupations in CE industries in the EU shifting, in terms of representation and skills requirements?

The studies suggested below are designed to meet a number of objectives in support of policy priorities. They provide direct support for CE industries (i.e. human resource planning and management) and a range of policy areas including immigration (i.e. need for skilled personnel); employment (i.e. earnings; types of skills (level of skill and field of expertise), deployment, job creation, changing nature of work, increased participation of minority groups (i.e. women, disabled, elderly); education and training; science policy (i.e. investment in research and development; and, regulatory affairs (i.e. standards, pricing).

The first group are a set of suggestions for future research which could be carried out in the short- to medium-term.

- A study (assessment) on what has been taking place in the labour force in CE industries, specifically addressing skill shifts (level of skill and field of expertise) and occupation shifts. This study would also contribute to supply/demand building

³¹ From the studies on ICT industries in Canada, MERIT, February and March 2000, available at <http://meritbbs.unimaas.nl/publications/ict.html>.

for skilled knowledge workers, both within the Member states and the EU as a whole;

- International benchmarking of EU CE industries employment shifts against other nations such as the USA, Canada and Japan. This would provide intelligence to EU CE industries and public policy on how ex-EU enterprises are coping with rapid change and competition. This study and the one described above could make good use of case studies of some of the major players in the EU and abroad, as well as capture the employment driven by multinationals;
- A study on employment in the entire 'value-added chain', from idea inception to product development (research and development personnel) to the marketplace. This study would also address the employment spill-over affect of CE technologies and products;
- A study on developing links between knowledge workers and economic activity (i.e. industry change). For example, how does the investment in research and development, including personnel translate to CE market success? How does the organisation of work (i.e. subcontracting of activities versus in-house personnel) impact on enterprise growth?
- A study on the impact and implications of EU expansion for CE industries and employment. This will provide information on the impact and implications of the EU expansion. It will also provide candidate countries with expertise and experience of the EU and favour a harmonic integration of policy (i.e. regulatory, human capital, research and development).
- This last suggestion is a study for the medium-longer term. It represents significant commitment on behalf of senior management as well as significant resources.
- An important component for building intelligence on employment in CE industries, is the gathering of intelligence and data and to provide timely and qualitative measures. This study would include the establishment of a European level data base which can be updated, which includes elements not yet gathered (i.e. field of expertise). A scenario building tool could be designed to assist in the monitoring of employment in CE industries and serve as a tool to plan effective stimuli for preventative or promotional actions that go beyond the Member state level, and highlight the role of the EU in the field. This will also identify data and information gaps and can be used to recommend existing survey instruments, which could be used to collect the 'missing' information to minimise respondent burden and additional resource requirements. It could also identify other activities within the 5th framework program which could provide intelligence and experience (i.e. DG Research, Technology and Development launch of a brain-drain study on research scientists and engineers which includes a sector examination component).

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RPT-II-3 Major public policies issues

Alain Puissochet , Idate.

O. Introduction

We discuss briefly (a mass of documentation exists!) the European policy in the past years (not going back to 80's and to the control of video recorders import by the French government!). Due to the diversity of industries, which are addressed in this report under the name "consumer electronics", it would be more accurate to speak about distinct public policies. Public policy towards television and telecommunication have had up to now little in common. Public policy towards personal computing for consumer is also quite a different domain, where personal computing for consumer was not much differentiated from personal computing for corporate use.

It would be too ambitious to try to synthesise the action of public policies in all these domains. We will concentrate in this paper on digital radio and TV. Still, the work should be done about the impact of the convergence for these policies.

1. Overview of past public policy for TV

In the 1950s and 1960s, industrialised countries selected standards for TV broadcasting. Most European adopted PAL, but with several variants ; France selected SECAM. As a consequence the European market was fragmented. In 1984 the EBU (European Broadcasting Union) developed a family of standards called MAC, which would apply to the next generation of broadcasting based on stationary satellites. In 1986 the MAC directive made the standard mandatory, but only for high power satellites called BSS, and not for what is called telecommunication satellites or FSS . Unfortunately, the FSS satellites succeeded, and not the BSS.

Partly in order to stop a tentative of Japan to propose its own standard of high definition TV, a high definition standard compatible with MAC was proposed: HDMAC. The Eureka programme HDTV was started in 1986 by a large consortium of European companies to develop a full chain of HDMAC-compatible equipment, from studio camera's to television sets. A technical success, the consortium set up full-scale demonstrations on several occasions. In parallel, a research programme on integrated circuits for HDTV was carried out as a part of the Eureka programme named JESSI, partially supported by the Commission. In the radio domain, a large activity over DAB (Digital Audio Broadcasting) took also place in the JESSI programme.

In 1992, the renewal of the European directive was abandoned, related to strong opposition from broadcasters. This give rise to the termination of the HDTV project and the foundation of DVB (see below). At the same time, the part of JESSI dedicated to TV was reoriented towards digital TV. This work was pursued in EUREKA programme named MEDEA, with a strong emphasis put on standards and platform definition. In parallel, discussions led to a common agreement on 16:9 format as a common goal, which would allow for a renewal of the park of installed TV sets (a major motivation for manufacturers). Then the typical problem for content dependant equipment arise : what should start first : equipment or content, or how is it possible to stimulate both. The answer was the 4-year Action Plan launched in July 1993. The

main choice was to fund content development, without any constraint about transmission. Funding was based on payment per hours of broadcasting or production. The results of the Action Plan, which was an interesting attempt to solve the egg and chicken problem, are viewed differently by industry. An evaluation work is currently on going. Its results should be watched carefully while trying to stimulate a market for consumer electronics products relying on content availability.

2. European R&D programs

The European Commission has funded several Framework programmes. The fifth became operational in 1999. More specifically dedicated to communication were the programmes ESPRIT, ACTS and now IST. It is too early to discuss the results of the 5th Framework. The 4th had among its main goals the support for scientific and technical base of Europe, the co-ordination of research policy between Member States and the Community, and utilisation and dissemination of results.

What was the exact effectiveness of these programmes in the consumer electronics domain as a whole is to be established.

3. Establishment of standards

Three component activities contribute to harmonisation of the market:

- the harmonisation of legal frameworks fixing rules that must be observed by every market player and by products put on the market;
- the formal standardisation activity, that lays down standards relying on "an open consensus of all those with a market interest in a product being standardised";
- the market organisation, resulting from market solutions determined by market players ; these solutions are made by private standards or de facto standards ; when made publicly available, they are known as publicly available specifications and already incorporate a level of consensus among the actors (but which may not represent and universal consensus of all the parties with an interest) ; but the market may also organise itself via best practices, codes of conduct, memorandum of understanding, developed through self-regulation approaches.

The DVB (Digital Video Broadcasting) is the main actor for defining de facto standards in Europe. Launched in 1991 by broadcasters and consumer electronics manufacturers (European Launching Group), it has developed a MoU (Memory of Understanding) defining the rules for collective action (September 1993). DVB has taken the engagement to use open existing standards and aim at open solutions. DVB has since been very successful in defining standards widely used around the world, even with a strong competition with some US concurrent organisms. DVB standards are in no way mandatory. They are proposed after adoption to the competent standardisation organisms: ETSI (mostly) or CENELEC. ETSI standards are also non-mandatory. They become mandatory only on decision of the European Commission, mostly in order to ensure or accelerate the implementation of principles defined in a directive. Use of DVB standards is mainly promoted via industry groups such as EuroCableLabs, centre of R&D for the European cable Communications Association, which launched a "request for proposal" for modem cable systems conforming to the

DVB standard or DigiTAG (Digital Television Action Group) launched in 1996 in Amsterdam to facilitate the emergence of terrestrial, DVB-T compliant TV.

The standardisation of conditional access allows exemplifying the issues in the domain of television. In 1990-1991, Philips and Thomson, supported by the DGXIII collaborate to define a unique access system to be incorporated in the HD-MAC directive of 1991. The attempt failed, due to strong opposition of broadcasters, through the ACT (Association of Commercial Television) and specially BskyB. DVB attempts to define a unified system failed, and the 1995 directive (95/47/EC of the 24/10/95) imposed the "Common scrambling algorithm", but accepted proprietary access controls under certain conditions.

DVB work is continuing on interactivity issues, which is a key point for broadcasters, services providers and manufacturers.

For policy issues, one should keep in mind that a major concurrent development takes place in the USA: the ATSC group is defining standards for US digital TV, and promoting it strongly around the world. A very strong competition to "win" countries around the world for a digital TV system (DVB versus ATSC) is going on, associated with strong pressures (Argentina and Brazil are current examples).

Another more specific point is the specification of interactivity, where a strong intervention of computer and software manufacturers led by Microsoft and Intel is developed through the ATVEF organisation, which tries to influence both DVB and ATSC.

What could be a public policy? The Commission Communication of the 31 January 1985, defining the New Approach to technical harmonisation and standards, has defined four fundamental principles :

- legislative harmonisation is limited to the adoption of essential requirements of security or other requirements of public interest that products put on the market must meet;
- the competent bodies are responsible for developing the technical specifications needed by industry to produce and market products in line with the essential requirements;
- technical specifications remain voluntary standards;
- products meeting standards have a presumption of conformity with the essential requirements of the directives.

That implies that the Commission may give standardisation mandates to competent bodies to ensure the quality of harmonised standards.

Standardisation is also important since it may allow reaching rapidly a critical mass, and facilitating market development.

4. Importance of standards for companies

One should understand that standards are now an important part of the industrial competition: development of standards is a costly and long process, implying research, prototypes developments, trials. Even when a public and open standard is selected, the companies which have developed the "winning" standard have a strong

competitive advantage: they master its implementation, and are able to address more rapidly the market, thus benefiting greatly from their R&D efforts. Supporting the effort of European standards developing consortiums, or facilitating their creations could be part of an industrial policy to reinforce European competitiveness. Examples of DVB and in a different domain of GSM consortium have to be analysed carefully, in order to define the most efficient set of policy actions.

5. Manufacturing issues

Manufacturing is a very important issue in a domain where cost, in time delivery and volume production are very important.

Industry programmes have addressed these issues.

As an example, the GEPP programme (Global Electronics Partnership Programme) was launched by EACEM. It was aimed at helping component suppliers improve their competitive experience by benchmarking their activities against each other and against best practice in Asia. The programme received a financial contribution from the European Commission.

An evaluation study has been launched by the European Commission in order to draw conclusions from the past experience consider issues relative to a further extension.

6. General policy impact

As all other domains, consumer electronics is subject to the general policy for the European Union such as competition rules, and of course the open market policy. The consequences of open market on industry has been recently subject to discussion and. Its impact on consumer electronics should also be considered. It seems that manufacturers are asking and do benefit from large homogeneous markets.

The help towards start-ups could also be an important part of the support of the consumer electronics, since it is expected that a large number of new products and new designs will appear.

Competition rules are becoming very important, since large corporations, with considerable strength, technical capacities and huge financial capacities are entering the consumer electronics market. The competition rules address the market of consumer electronics (i.e. imposing use of proprietary software), but also the use of proprietary products (such as set-top boxes or APIs) to control customer access.

7. A few suggestions for the future work

We suggest first that a work on public policy should take into account all the results of the previous actions. The goal is not to evaluate the past policy, but to understand it and to use the assessment reports already available. Lessons of the past should not be wasted, even if new situations have to be taken into account.

Public policy will probably need to have different characteristics when dealing with equipment supporting content (radio, video, games,...) and when dealing with "pure" equipment such as fax or web-phone.

The report should concentrate on the effectiveness of each policy in regard with the selected goals. For difficult and controversial issues, it will probably be needed to

propose or to recommend methods for building consensus rather than definite solutions, which will imply a large consultation of the various players.

The report should take into account both national, Eureka and European programmes. A lack of communication between Eureka programmes and European programmes could be wasteful.

We can also distinguish two major types of actions:

defensive actions, aiming at facilitating the evolution of European industry

offensive actions, aiming at facilitating the creation of new innovative SME's.

RPT-II-4 The Nordic Mobile Telecommunication Cluster

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0. Introduction

This paper outlines the history of mobile communications systems and the industry involved in creating the equipment for these systems. A special focus is the role of the Nordic countries and industries located here, as they have become some of the world's leading companies in this area, and still dominate both in market shares and in new developments in the mobile communications area. Some explanations will be given to the dominant position of this Nordic electronics industry cluster. And some of the contemporary developments challenging this position are presented both as they point to new products and services opening for new entrances into the product area, and as the world-wide growth in the market for mobile communication levels out the first mover advantages of the Nordic industries.

1. Historical roots: marine communications and infrastructure

In all three Scandinavian Countries, the role of shipping both for goods transport and as a major source of income for parts of the population made the ground for an early interest in and growth in the marine communication equipment industry. Starting with the production of both spark- and arc-transmitters in the beginning of the 20th century the industry also early adapted to the new technologies based on vacuum tubes.

Although small on a global scale these industries developed a strong technical position in close contact with the shipping business and the ship-building industries and in relation to the military of the Nordic countries. When the first interest in mobile communication for civil use in the developing infrastructures of police, fire-protection and hospitals started the workforce and engineering competence in electronics and radio-communications technology was available and relative easy to transfer and utilise in the new growing industries for mobile communication equipment. Also taxi companies took these new systems to work. Companies like Storno, a subsidiary of Store Nordiske Telegraf Selskab (Great Northern Telegraph Company), and AP Radiotelefon in Denmark and Svenska Radio AB (SRA) in Sweden owned by Ericsson were established as producers of these new closed circle radio-communication systems for private and public users. Until the beginning of the 1980ies mobile phones were named car-telephones. But also other companies producing marine radio systems would later create the basis for new entrances in especially the northern Jutland area. Also other European producers like Philips and Japanese producers like Panasonic entered this market. But it was significant that the Nordic area early was identified as driving these developments so for a time Philips located its development activities in Copenhagen.

An important aspect of this development may also have been the close connections between the military and civil parts of the industry, which made the combined dynamics of growing wealth and infrastructure developments and military supplies lead to mutual benefits. Although this relationship is not very well researched, it seem

to be one of the explanations for the relative strength of the mobile communications industry in the Nordic countries developed in the period after WWII.

2. Telecom's, standards, and industry

The next development phase of the history of the Nordic industry cluster in mobile communications development is closely linked to the construction of standards for mobile point to point radio communication based on cellular structures and switching systems. This change can also be characterised as a transition from developing technical constructions serving specific communication purposes into an integrated system of communication which use was open-ended. Each of the Nordic countries had their few national telecommunication companies providing the network and switching services and often also providing the end user equipment. But as important was the creation of national telecommunication network and service providers shaped through a long process of interconnecting and centralising regional telephone systems in the first half of the 20th century. In close connection to these traditional regional and national telephone and telegraph companies a number of equipment manufacturers prospered and went through an almost similar process of mergers and centralisation. Parallel to these a number of both national and international equipment producer developed having their originating roots in private companies like the Great Northern Telegraph Works in Denmark and L.M. Ericssons in Sweden. For example Ericsson was the producer of telecommunications equipment including switches for exports while some of the production of equipment for national use was produced by the PTT's or companies controlled by these. Cable works were either national producers or owned by or established and owned by ITT, the American owned but multinational producer of switches.

The strength of the monopolistic structure of the infrastructure providers was the ability to negotiate and develop new standards and products. Although in tough negotiation relations to local suppliers of equipment the PTT companies were able to use a growing international standardisation and following competition among equipment manufacturers to maintain both relative low prices and a technological development reaching far beyond the limits of fixed cable-based communication systems. Both radio-link systems and new services were the result. This included the development of the NMT (Nordic Mobile Telephone) standard for a combined mobile radio based cellular communication system that was linked into the cabled telephone system from the very beginning. Not least was the co-operation between the Nordic PTT's an important part of this development. Based on the experiences with mobile radio-communication systems starting soon after WWII ended, the Nordic PTT started developing an automatic mobile telephone system - automatic as compared to earlier systems based on manually operated (switched) open radio-communication lines (channels) that in principle everyone could listen to. The new standards and the equipment tested in 1980 and the first systems put to work in Stockholm in 1981. While the first systems were using a 450 MHz band for communication, an extension was introduced in 1987 based on a 900 MHz band.

The relative success of the NMT-system was supported by both the growing wealth and the use of mobile communication in both public infrastructure services and in business, where mobile contact to repair teams, salesmen etc. were an important part of building efficient business concepts. This made the Nordic countries the leaders in

use of mobile telephony with the worlds highest density of mobile telephones in the population.

In the first years the Danish market was almost dominated by the two existing producers of mobile car-telephone equipment, Storno and AP Radiotelefon. But with the rapidly growing markets these relatively small companies were taken over by multinational players. Storno was bought by American Motorola, and AP Radiotelefon by Dutch Philips. In Sweden SRA was used as a base for creating a growing business in mobile communications later more and more integrated into the activities of Ericsson. In Finland a new entrance was created by Nokia when they established their division for mobile NMT phones named Mobira in 1979.

It cannot be questioned that monopoly actors are important in establishing such new systems where the simultaneous access to a combination of standards, networks, switching equipment, and end user equipment are preconditions for success. Therefore it was obvious that such a system would be based on negotiated common efforts of national PTT's when it was first introduced in the Nordic countries. The alternative to this would be very big and commercially strong (monopoly like) conglomerate companies developing similar systems. This was the case in the first years of establishing both wired and wireless telegraph lines, and it has lately been seen in the development of satellite based communication networks. In both cases these systems were established in areas where national operators and competitors were weak or where competition - at least in the beginning - was almost non-existing.

Especially in the Kista-area close to Stockholm, in Copenhagen and in northern Jutland the mobile telephone companies showed a fast growth and sustained the picture of a Nordic leadership in these areas of telecommunication equipment. Companies like Ericsson, Storno, and later Dancall were amongst the first to introduce the new telephones models with new features, and their strength in these areas can still be traced to the regions, where they developed their competence. Also US, German and Japanese producers of mobile telephones entered the arena but in the first phase lacking the direct access to the biggest market for mobile telephones. Other standards were developed, but they never became as important for this first phase of mobile communication as the NMT standard. This system was introduced in a number of other countries as a first entry into mobile telephony.

Most of the companies entering into mobile telephone communications were already established companies in telecommunications or in radio communication. And especially concerning the production of base stations and switching equipment the traditional telecommunications companies dominated with NEC, AT&T (later Lucent), Ericsson, Siemens and Motorola as the biggest players. In this context Nokia with their Mobira division were relative newcomers. In the case of Ericsson they combined their competence from SRA in building radio base stations and radio telephones with the expertise in the mother company in building switching equipment based on their latest AXE switching equipment for the traditional telecommunication systems to build a complete system delivery capacity. Compared to Motorola Ericsson's strategy was different. When Ericsson tried to keep the complete system competence in house but out-source a growing proportion of the component supplies, Motorola stopped producing switches and chose in this area to cooperate with Northern Telecom, Siemens and NEC who were all traditional switch producers for

telecommunication. This followed the logic that Motorola's competence primarily was in microelectronics and radio systems.

3. NOKIA and the Finish entrance

NOKIA was founded on the capital surplus from Finish machinery industry producing chemicals for wood and paper processing, machinery for cable manufacturing, tires, and cables. Their first move was into the consumer electronics industry, where growing markets both in Finland, in the Nordic countries and in the Soviet Union provided a good platform for establishing a television set industry. This establishment was somehow supported by take-over's of Swedish consumer electronics companies which made the expansion into first Sweden and then via Germany into a growing number of other countries possible.

The strategic investments in electronics followed the new upcoming areas when Nokia in 1988 took over the Swedish company Ericsson's data-division. By a combination of take-over's and Nokia own innovative strategy the continuous move of Nokia from consumer electronics to computers and the mobile telephone market. But their basis in mobile communications was founded by the subsidiary Finish Cable Works when they produced their first car telephone in 1966. This was a relatively late entrance into the mobile and radio communications area, but their capital funds and ability to renew and change priorities have shown to give Nokia a very strong position in mobile communications today.

In the late 1970ies the new subsidiary Mobira was established by Nokia to enter into the upcoming market for NMT based mobile telephones. Already in 1988 Mobira, Nokia's mobile telephone brand, was expanding sales in North America and had a 50% market share in Finland and approx. 25% in the Scandinavian countries. As the electronics divisions continued a growth larger than other parts of the company, and among these the mobile phones division were the leaders in growths.

Although the television set business was entering into fierce competition Nokia stayed in this market until 1997 and continued to rationalise and combine this with take over of competitors like Swedish Finlux in 1992. While the mobile phone business continued to grow and now is the core of Nokia's business, first the television set division of Nokia and then the computer division were closed down in the early 199ies after having almost ruined Nokia leaving the company only with a continued production of high end computer screens. A market in which they had developed a niche.

Also the strategic support from the Finish government both to the technical university and to technological institutes close to Helsinki has been an element shaping the ground for Nokia's expansions into electronics. Without the strong PTT's in Finland NOKIA was both forced to, and could utilise the opportunities of entering the new markets opened by the liberalisation policies in the European Union.

4. GSM and the international development

The next phase of development was already showing a shifting picture of international technological positions and market strategies. Although the NMT standard and system

was introduced in a number of other countries, in Europe especially the Benelux countries, other even more national closed systems were developed in the UK (TACS), in Germany (C-Netz), in France (Radiocom 2000), and in Italy. In response to this and to overcome capacity bottlenecks in a number of the established systems, a working group was established in 1982 by CEPT, the national PTT's common standardisation body. This Groupe Speciale Mobile (GSM) was given the task of developing a pan-European mobile communication system. This activity got support from the European Commission in 1984 later even making it the cornerstone of its telecommunication liberalisation policies. In the following years the large central European countries signed an agreement for the development of GSM, and eventually it became clear that the new standard should be based on digital technology and operate in the 900 MHz band. To support the introduction of the GSM system a directive was made by the Commission pointing to an introduction of the new system in the early 1990ies. And finally 15 countries in Europe signed an agreement on the common system in Copenhagen in 1987. The telecommunications standardisation body ETSI finished the standard specifications in 1990 and few years later the first GSM systems were put to work.

While the Nordic PTT's were supporting the fast introduction of GSM the expectations were that the still well functioning NMT system would continue as the core of the mobile network for a number of years. But the growth in subscribers to the GSM system came as a surprise to most of the actors and it already after few years passed the size of the NMT system.

All Nordic producers of mobile equipment were prepared for the introduction of the GSM system and its success in the Nordic countries gave them a home market set off that turned out to sustain there position in the mobile communications market and even extend this position as the world market now was open due to the common standard. The characteristic feature of this change was besides the switch to digital technology the establishment of an (almost) world wide standard for mobile communication. It was a change from a functioning system in the Nordic countries into standardised and certified system that could be implemented by operators of very different background and for which the production of phones (terminal equipment) could be taken up by in principle every interested electronics producer.

Networking in northern Jutland both between companies and in relation to the newly established university in Aalborg where NOVI (Northern Jutland Knowledge (Science) Park) was created in the mid 1980ies to support university-industry co-operation. In 1992 was established as a innovating company located at NOVI DC-Development a co-operation between Cetelco and Dancall both heavily engaged in producing NMT telephones, but facing the new market possibilities with GSM joined forces in developing an integrated GSM-chip for their new products partly as a consequence of the upcoming fierce competition in the new market not least from companies like the American Motorola, who had taken over Storno in Copenhagen, and Ericssons in Sweden and Siemens in Germany.

The upcoming competition can be seen from the number of strategic alliances that were established in the later 1980ies between some of the important players in the mobile communication market. Ericssons formed a consortium with Orbitel (a joint venture between British Racal and Plessey), Nokia formed a consortium with French

Alcatel and German AEG. The next consortium was negotiated between German Siemens, French Matra, and British GEC (General Electric Company). Other important players in this phase were US Motorola and a number of Japanese producers.

The miniaturisation of components and end user products has been one of the important drivers of the development of mobile phones and for certain developments a precondition. The size and capacity of the mobile phone is closely linked to the development of still smaller and more integrated components. Consequently the history of the mobile phone is also a history of component development from standard components to customer designed ASIC's and again to integrated standard components including also the innovation of new hybrid and integration technologies and new circuit print and mounting technologies. These new technologies have all been introduced in this industry as soon as they were available. The strategic role of the core components can be seen from the DC Development case and from the actions of Motorola, Ericssons, and Nokia in controlling their component supply, although by different means. It also explains why the production of mobile phones has not become just another standard product produced in low wage areas.

Mobile phones are produced in both high wage and low wage areas, but the innovative part of the industry has kept core parts of its production close to the centres of innovation, which means northern Europe, Japan and Motorola, US. This is because the newest production equipment is taken into use, where labour costs are small compared to the needed skills to make the machines work without too many down-periods. So skills both in design of miniaturised components first the core GSM-chip, later the supplementary elements introducing new features. Design can be related both to ASIC's developments (application specific integrated circuits) and to strategic alliances with microchip producers (the reason for Motorola's and some of the Japanese companies in-house strategies).

5. Liberalisation and its impact

It can be questioned whether the development of any of the important standards and basic network services are the result of the liberalisation policies in telecommunications. But there is no doubt about, that this policy has opened for a new wave of mergers and restructuring of the industry and the service providers. The characteristics of this change was the opening of market regulations which again made it possible to utilise the standardised system by a growing number of nationally and internationally competing network and service providers. In the end this leads to a growing internationalisation of mobile telecommunication operators and mergers following this process.

While first the professional and specialised user groups were targeted like fire brigades, surveillance companies, service technicians, the next step was to extend the user segment into ordinary professionals, tradesmen, and craftsmen. This was the primary target groups for the NMT system although also the substitution of stationary telephones and the additional feature of mobile communication attracted new users, who could afford the investment. In the first period of introduction of the GSM-system it was seen as an extension and potential renewal of the NMT system mostly relevant for new customers who wanted to be able to use the mobile phone in

different countries. But soon private users came on board and the new trend of using the mobile phone as an integrating device in daily practices began to show. The dramatic change in the market showing also the move from being professional equipment to consumer electronics can be seen from the development in prices, where a car-telephone would cost approx. 25.000 D.Kr. (3.000 EURO) for a truck driver in 1980 it may now be a Christmas present to a kid in primary school.

With the liberalisation new user segments entered as interesting targets for the new service providers. These providers could use the new market entrance possibilities established to regulate the liberalised markets and at the same time could establish an investment capital supply building on the expectations of future market positions and traffic. Even if the initial investments were high and the new consumers amongst non professional user and not least young people would not pay as much as the earlier professional users did for the services the expectations based on the future market was high enough to let new entrants make red line results in the first couple of years. This opened for a low priced introduction of mobile telephony to a extremely rapid growing market of private users and youngsters using the mobile phone both as a symbol and to make possible a quite new way of organising social interactions continuously through day and night.

There is also an undoubted gismo-effect connected to the fast penetration of small mobile phones as lifestyle products. When Nokia pays for announcements taking up the space of ten pages in different magazines under the introductory heading of 'Modern things' and followed by the statement: 'Next year Scandinavian families will be able to plan their daily activities around an electronic calendar' it tells important things about both the lifestyle component of mobile equipment's today and the penetration of these gismos in the Nordic societies. The advertising is concluded with ideas of the future of mobile information systems to be both 'more like jewellery' and at the same time the company sketches some of the potential new areas of development to include net-based information systems and personal digital assistants. These new integration's are significant as the future areas of product and service convergence facing the market for mobile equipment (all including the 'phone' as transmission unit for data and communications, but making the phone-element just one feature among others).

This very rapid growth of the market has been 'cashed in' as the ultimate argument for the impact and need for a liberalised market, but the costs of this process cannot be accounted for yet. It has opened for new user groups but the competitive aspect has only partially shown in lowered prices, but more in the interest in investing in future market potentials. For most international telecommunication traffic the prices have not changed dramatically yet, and the lowered prices in national communication are difficult to argue have been more dramatic than could have been expected alone from the growth in the traffic and the growing number of ordinary subscribers. In fact it can be argued that the still high prices for mobile communication covers the costs in companies in introducing new mobile phones to customers at prices below production costs. As a consequence of the interest in investing in potential new services and areas of use, the liberalised markets can be assigned a role in opening for new uses and experimenting with new services.

One element in the aggressive policies of the new entrants in the mobile communications market is also the hidden competition between the traditional wired network and the mobile systems. While the mobile systems typically have been liberalised almost from the beginning the opening of the traditional wired services is slower. This also explains some of the speed in the introduction of mobile telephony

It is although interesting to see that the basic standards opening for the new mobile services were already constructed and decided upon before the liberalisation took of. The use of GSM as a test case for the Commission in arguing for the usefulness of a liberalised market was taken an already - under national monopoly conditions - established new development avenue in as a supporting argument. Even the high-speed data-transmission technologies and standards were in the pipeline before the liberalisation took speed. As we shall see in the following lately new technologies and standards are developed opening for new types of integration (convergence) building on the success of the mobile telephone technologies and systems.

It is although still interesting to ask why especially the northern part of Europe has been developing these systems and services before both Japan and the US. In the US e.g. the infrastructure based need for state-crossing mobile services is present and the number of business people and specialists spending lots of time on the road is there too as a customer potential. But eventually the need for system builders was supported as US - for other reasons - was quite early in liberalising telecommunications and had to catch up with the European development. In Japan and in the South East Asian region this catch up process has been tremendously fast after first Australia entered the GSM consortium in 1992. Opposite the development in the US where FCC tried to support a national development by licensing a 1900 MHz band to open competition between different personal communication services. This has opened for the introducing of a slightly different version of the GSM standard using 1900 MHz gaining support from a majority of actors instead of the European and Japanese 900 and 1800 MHz.

6. The structure of the mobile cluster today

German and US investments in Denmark, the position of Ericsson, and Nokia's continued expansion. Storno is closed down, but the staff has been taken over by development departments in Ericsson and Nokia established in Copenhagen. Dancall first taken over by Amstrad and then sold to German companies. Although foreign owned the northern Jutland cluster is still growing. NOKIA has also established some activity in Kista close to Ericssons factories and development units.

The most important players in today's mobile phone equipment industry seem to be Panasonic, Siemens, Motorola, Nokia, and Ericsson.

Dancall Telecom, Cetelco are still producers but subsidiaries of ...

The size and power (although vulnerable) of the major players in this arena can be taken from some of the later registered company bond values - although they change these days. Microsoft, Cisco Systems, Intel, Vodaphone Airtouch, Deutsche Telecom and Nokia were among the ten most valuable companies in the first half of March this year, and in close range we find AT&T (Lucent), Nippon T&T and L.M. Ericsson.

Nokia still being the world market leader with approx. 27% of the market share in 1999, while Ericsson had a market share of 10.5% (?) and Motorola 17%.

7. New challenges and types of convergence?

This could be a success story about the history and victory of the Nordic Mobile Cluster. The Nordic have been able to build on their first mover advantage and the extended markets for mobile communications, which has created a strong industry cluster and made it interesting for other producers to locate part of their development facilities in the Nordic area to gain access to this advanced market and to the available competencies. But it would be misleading from several perspectives to make this the end of the story. With the global growth in mobile communications the first mover advantage of the Nordic industries will weaken, and their ability to renew their products and services will become crucial for their survival as market leaders. But also the integration of new facilities in the mobile phone or the combination of the more and more trivial mobile radio connection into a number of other products like e.g. the personal digital assistant, will open for new producers with other backgrounds and competencies than those coming from the specialised mobile communications area.

In the Japanese context a new system for extended services for mobile web-phones (or better communication devices) has been introduced under the name of i-mode. It can be seen as similar to or a forerunner to the European WAP services introduced last year. Especially young people seem to have taken the new i-mode web-phone into use. Millions have already been sold, and the market is growing fast. The developments were made by Nippon Telegraph and Telephone and have paved the way for new mobile services based on the relative success of this new standard. Based on a simplified HTML page layout the cellular phones can both transmit web-based services, work with e-mails and be used as ordinary mobile phones. The special feature in this standard is that the web-phones are on-line continuously and communications is done in a packet-switched system where the user only pays for traffic. It has opened for new uses in music distribution and entertainment, by letting users download both music and games on-line. This shows a new area of use and the consequence will be that more and more differentiation in the specifications and features of the mobile phones are to be expected. While the i-mode system is operating with special standards, the NTT company has agreed to enter the development of so called 3rd generation GSM systems offering faster data transmission rates than the 9600 bps in the now working standard.

As already mentioned the growth in use of SMS-services (7 times in one year) opens for an understanding of a more diverse set of services to be seen in the future. The growth in the use of SMS is at this point showing a potential for WAP - the new Wireless Application Protocol bringing Internet like services to new versions of the mobile phone. WAP can in this perspective be seen as an extension of that kind of services. But the problem is also that the cost aspect is important which makes WAP usage among youngsters a crucial question as prices for using the mobile services are in the centre of their control of usage. When Nokia in its vision talks about the 'wireless communication terminal' it only one of many development avenues for mobile equipment that will be tested in the market the coming years. In line with this

idea of focussing on mobile terminals, Nokia is also developing what they call car telematics systems.

WAP was initiated by Ericsson, Motorola, Nokia and Unwired Planet (now Phone.com) in 1997 after they earlier had been involved in developing their own different systems. The WAP consortium has now more than 90 associated companies. The basic idea was to establish a system similar to the WWW of the internet based on IP and using a simplified HTML-structure called WML for use on small mobile units with limited bandwidth and screen size. WAP for special types of communication and guidance now extending the mobile phone but soon becoming an integral part of the personal planner and communicator the internet as vision is misleading and guiding the developers in a too broad direction, but testing of the limits is important in a period where trends and hype is difficult to distinguish WAP is planned to work with operating systems like PalmOS, EPOC and Windows CE Lately both Microsoft and Intel have decided to place WAP-related developments close to Stockholm.

The WAP based service providers will prepare the ground for a number of new intelligent devices ranging from mobile phones, handheld miniature PC's and hybrid products including PDA-functionality to test out the trends in this new service driven arena. An example of this is the Nokia 9110 Communicator integrating the mobile phone with e-mails facilities, a build-in miniature keyboard and supported with PDA-like programmes and functions.

The EPOC operating system platform has been initiated by the Symbian consortium including Panasonic (Matsushita), Nokia, Philips, Palm (3com), Sun, Motorola, Oracle, Ericsson, Sybase, and Psion. The founders were Psion, Nokia and Ericsson and the idea is quite clear: to establish a common platform for programs to be used by a number of PDA-like systems, communicators, and mobile phones using different hardware platforms. The Symbian network of co-operation is closely linked to the WAP platform but is also seen as a major attempt to establish a third platform to take over from or interface to Palm-OS and Windows-CE.

Another development arena is the consortium and new product introduction using the Bluetooth-standard for short distance communications and networking. The companies behind the Bluetooth alliance that was established in 1998 after 4 years of development made by Ericsson has included also Nokia and Motorola from the group of mobile phone producers and Intel, Toshiba, Lucent, IBM, 3com, and Microsoft from the network and PC-equipment side. The standard opens for new alliances and new areas of integration. Being a short distance radio communication standard (operating at 2.45 Ghz and with a range of 10, 30 or 100 m) its application is primarily intended to be in local networks as an alternative to cable based networks and interconnections of equipment. Besides the joke in giving the new standard the name of an old Viking, the chip is supposed to be sized like a tooth and blue.

As such the Bluetooth standard does not especially interfere with GSM and newer developments in standards for mobile communications like the third generation mobile data system UMTS, but there is an overlapping area, where mobile phones and equipment easily can be integrated and used in local networks as stationary part of these besides their capability of being mobile units. Examples are the use of the mobile phone as a DECT-like phone by connecting to local wired connections via

home-base stations connected to the telecom network. As such Bluetooth is a challenge to all new types of mobile products as one of the competing standards to secure the integration with stationary networks and equipment's. This also comprises the integration of PDA's (Personal Digital Assistants), printers etc.

Nokia has also started co-operation with Cisco Systems to facilitate the new developments in mobile data and communication equipment which will include a growing need for modems and terminals to handle networked activities with a strong mobile component. A co-operation has already earlier been established between Motorola and Cisco.

Samsung is now offering mobile phones integrating either TV or MP3 in the products. They are a newcomer in the field of mobile communications but testing out trends by offering these new convergent products. While the TV like the portable gameplayers focus on the single user and the gismo effect of the product, the MP3 integrates a typical single user facility that can substitute a portable minidisk or CD player by combining the music player facility into the phone.

Mobile phone users are expected to double in two years, but the factual existence and distribution of certain technologies and systems plays a crucial role both for market expectations and for the companies involved and how they construct visions by extending from and based on already existing platforms. The entrance of Samsung also tells that the mobile phone and equipment market is opening up for a number of new producers, that may not have the experiences and may not have been drivers in the development hitherto, but can manage to set up a production of cheap standard equipment and test new product combinations.

The next generation of transmission standards - also sometimes called the 3rd generation mobile communication system, where NMT counted as the 1st and GSM as the 2nd - are phrased UMTS (Universal Mobile Telecommunication System) and were already in the mid 1990ies taking of as one of the areas for innovative efforts in the development laboratories of the mobile phone producers. This new area of mobile communications offers the possibility of a better integration of data-transmission into the network. From the regulating authorities this new area of mobile communication has been seen as offering the possibility of licensing the access to the new frequency bands through auctions and thereby serve as a new source of income for government and regulators.

The UMTS system is planned to be a world wide system substituting both GSM and the different American/Korean system (CDMA). The standard was developed by ETSI as a compromise to get everyone on board. UMTS is planned to become a wide band system operating at high speed up to 2 Mbit per second opening for up to 200 times faster data transmission than GSM and thereby opening for video-transmissions etc. Compared to e.g. WAP the introduction of UMTS is a basic shift of system and as such a radical shift, which leaves the change very unpredictable. The uptake of WAP is seen as a possible sign of future interest, but as the introduction of UMTS is left to companies to decide based on the liberalised markets, the introduction is quite risk ridden.

At a longer distance the use of satellite systems for mobile communication and data transfer may open for new standards and new types of competing systems. But these systems may still need some years to gain support and get beyond the first phase of entering markets for specialised and professional uses. Already in 1987 the idea was presented by two engineers from Motorola who launched the concept in 1990 under the name of Iridium. The system is (was) based on transmissions of signals that should cover the globe with 66 satellites. But the consortium went bankrupt last year after heavy losses and is going to be closed down. The catastrophic economic results is partly based on the success of the surface based cellular GSM system whose growth and continued lowered prices has make the investments in a satellite based systems less feasible. There are still competing satellite based system active and under construction. Globalstar offers services since late last year in mobile communications, but at much higher prices than GSM. And a new system is under construction by Teledesic which also includes Motorola among its investors. They want to offer broadband Internet facilities to start in 2004. All of these satellite consortia have joined the GSM standard interested in offering complementary services.

RPT-II-5 Digital broadcasting: situation and evolutions by geographic area

Alain Puissechet, Idate

1. Japan: mainly satellite

There are around 44 million homes in Japan and an average of 2.5 TV receivers per home. 9 to 10 million colour sets are sold annually.

Several features differentiate Japan from Europe and the United States:

A large spread of high-definition analogue TV

NHK gives a figure of 700 000 Hivision sets (analogue high definition), which presumably corresponds to the number of people paying licence fees. Manufacturers of sets claim higher sales figures of between 1 and 2 million receivers.

A poorly developed cable service in analogue format only

The situation for cable in Japan seems extremely difficult and the future looks dark, given the digital terrestrial and satellite projects on the agenda. Cable is found mainly in community networks interconnecting buildings for improving terrestrial reception. Recent efforts from large companies (Sony, Toyota and others) will probably accelerate the digital deployment in 2000.

Digital satellite services known as CS (Communication Satellite)

These two services, DirecTV and SkyPerfecTV do not include the major channels broadcast terrestrially or via BS satellites and that they are aimed at the individual viewer who is offered a multitude of specialised channels. They merged recently, and may reach shortly together 2 million subscribers.

Set-top boxes are on sale in the stores at non-subsidised prices of between ¥40 000 and ¥50 000 and are manufactured by Sony, Matsushita, Toshiba and Sharp, among others.

Widespread analogue satellite TV

Known as BS (Broadcasting Satellite), this has been in existence for a long time and serves 12 to 14 million homes via 4 channels (NHK: 2, NHK high definition and the pay channel Wowow). Viewers use TV sets or VCRs but only with built in receivers.

Digital BS to start in 2000

Market evaluations by equipment manufacturers indicate strong growth: 3 million homes in 2003, 8 million in 2005 (65 % equipped with integrated receivers) and 20 million in 2010. It is considered likely that the integrated TV receivers will be mixed satellite and terrestrial. By 2010, all Japanese households (still according to industry forecasts) should have at least one digital set.

Digital terrestrial TV

Tests are to start at the end of 1999, with a commercial launch scheduled for 2002-2003.

2. USA : mainly cable

Domination of cable

With close on 66 million subscribers and a penetration rate of around 75%, the US cable market is the biggest in the world. Virtually all homes in the United States (95%) are connectable.

Satellite

Nevertheless, digital TV made its debut in the USA via satellite: DirecTV launched its service in 1994. DirecTV has seen in 1998 and 1999 a very strong growth.

Cable

It was not until 1997 that the first digital offerings appeared, TCI first, followed by Time Warner. While any large-scale deployment of digital, interactive cable TV is still awaited, serious efforts were made in 1998 and continued into 1999.

The marketing of set-top boxes has up to now been the domain of cable operators, who have negotiated the specifications, quantities and prices with suppliers. This has resulted in a tightly locked up market dominated by General Instrument and Scientific Atlanta, with Pioneer from Japan in third place. The FCC has stipulated that, by the year 2000, set-top boxes for cable are to be available for purchase by the user, which means they will have to be standardised, which may open the US market.

Digital terrestrial TV

It started end 1998, but its development were very disappointing, due to several factors, and among them : a lack of enthusiasm from the broadcasters, expensive TV set (around 6000\$), and technical problems with the selected modulation system. The FCC has stated that analogue broadcasting should stop in 2006. It is now expected by several analysts that 2006 will only be the year of digital take-off.

One should note that two standards for terrestrial TV have been defined : one from the USA (ATSC) and one from Europe (DVB). It seems now possible that the European standard will be widely selected around the world.

Cable, however, has recently become a stake in another game: its interactivity capabilities also provide for high speed Internet access and telephony. It is in this context that AT&T has invested in cable with a view to entering the market for local services To this end, it has employed different means:

- the acquisition of TCI, leading US cable operator;
- the establishment of a joint venture with Time Warner for offering telephone services on cable networks in 33 States. Time Warner has 12.6 million subscribers and covers 20 million homes. The consequences of these moves will be of importance: through TCI and the joint venture, AT&T will be able to offer cable and telecommunications services to approximately 40% of American homes and possibly more.

This agreement can be likened to the one negotiated at the same time with Microsoft: the company run by Bill Gates acquires a 2 - 3% stake in AT&T for around \$5 billion, in return for which, AT&T will give preference to Microsoft software for its digital boxes.

3. Europe : a very diversified situation

European countries differ widely in their situation : northern countries have usually a large cable infrastructure. On the contrary southern countries have almost no cable. So the comparative development of cable, satellite and terrestrial digital TV differs widely from one country to another.

In terms of installed digital TV sets, Europe is late compared to the US with almost half the number of both digital cable and digital satellite TV sets (but in advance compared to Japan), but is catching up rapidly :

- In several countries digital TV, whether terrestrial or cable has just started or not started yet.
- The growth of digital TV is much higher in Europe than in the US. If we consider digital terrestrial TV, in the UK, OnDigital, has reached 400.000 subscribers end 1999. In a different context, less than 130.000 digital TV sets or STBs have been

shipped to dealers in the US, although terrestrial TV started there one year before. Growth of digital satellite, both in France and UK is currently much faster than in the US,

- The most advanced interactive services are not to be found in the US, but in France and UK through TPS, CanalSat, BskyB and others.

All this facts explain that Europe, which started later digital TV, will probably catch up the US in terms of total digital TV sets, and is ahead in terms of advanced services.

4. Evolution of the digital TV situation

The change in the different markets towards an increasingly wide range of digital services on offer will trigger a steep take-off of the world market for digital TV in 2003.

By 2005, the number of homes with access to a digital broadcasting service will pass the symbolic 100-million mark. Most of these will be found in the United States and Europe, i.e. 38 % and 35 % respectively. This initial acceleration of the market will in all likelihood lead to an even faster spread of the use of digital TV services but which again will be concentrated in the two dominant geographical regions.

Homes with access to a digital broadcasting service in 2005 (million): WORLDWIDE

	<i>Europe</i>	<i>United States</i>	<i>Asia</i>	<i>Latin America</i>	<i>World Total</i>
1999	4.7	12.2	3	0.5	20.4
2005	34.7	38.4	20	7	100.1

Source: IDATE

It should be noted that the main transmission support for digital TV will not be the same in the different geographic areas. Digital TV in Japan will be mainly satellite, in the US and in Europe satellite and cable will share most of the market. Terrestrial digital TV will probably stay behind in all areas. These estimations are based on several hypothesis about terrestrial development and may evolve accordingly.

RPT-II-6 Mergers and alliances

Alain Puissechet, Idate

1. Alliances

In the domain of consumer electronics, main industry leaders were already very large and well established companies, such as Sony, Matsushita, Philips or Thomson Multimedia. But they needed to acquire new competencies in several domains, including communication, software and integrated circuits. So they have developed and will continue to develop alliances, created joint ventures, and set up common R&D.

Strategies are largely diversified, according to the existing competencies of the various companies and to the fundamental choices of the companies. Of course, many of the alliances are attempts to cooperation, or aim at exploration of new domains.

We illustrate here with a few examples. They are by no mean exhaustive

Thomson Multimedia

Development of two joint-ventures, one with Microsoft for developing interactive integrated TV set (the TAK project, to start in 2000), one with Alcatel for developing communication terminals (excluding GSM terminals).

Microsoft

Microsoft in order to sell its operating software Windows CE in set-top boxes, and to provide all the new software for digital TV, has invested largely in cable industry : MediaOne, Comcast in the US, Telewest, NTL, UPC, TV Cabo in Europe, Rogers Communications in Canada, Globa Cabo in Brazil, Titus Communications in Japan. Microsoft has also invested 5 billion dollars in AT&T, in order to benefit from the dominant AT&T position in the US cable.

Sony

Sony is one of the few consumer electronics companies with an important content activity through its division "Entertainment Business Group". Sony has developed alliances mainly in Japan to enter new domains such as banking or e-commerce, as well as communication (JV for satellite data transmission with SkyPerfectTV). The company tried to develop its share in the US market by buying part of General Instrument (before Motorola took control of General Instrument), and even by subsidising CBS for high definition broadcasting of NFL (National Football League).

Philips

Philips sold in 1998 its record and movie company Polygram. The merge of its consumer communication activities with Lucent in 1997 was dissolved in 1998.

Pace

Pace is collaborating with LG and Toshiba, in order to incorporate its technologies into integrated digital TV receivers. It also developed an alliance with Cisco to develop terminals for receiving TV and interactive multimedia services via cable networks, especially data services and Internet telephony.

2. Consortiums

Apart from obtaining the needed technological competencies and the access to content, an important part of the competitiveness is based on developing the right products at the right time. This in turn is related to the development of standards.

Among these consortiums, we may mention:

- those dedicated to the specifications of digital TV : DVB in Europe, ATSC and CableLabs in the USA, ARIB in Japan
- consortia dedicated to standards for domestic local networks : OSGI (Open Service Gateway Initiative), HomePNA based on the use of copper, HAVi (Home Audio Video interoperability), and others.

**Annex II Convergence in the European Consumer Electronics Industry:
Impact and Policy Options for Competitiveness. IPTS Workshop, Seville
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