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Interactive Multimedia Systems

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Contents

1 Introduction

Until recently, multimedia for home users meant pre-recorded digital data, usually on a CD, which could be played with a PC, making it a pure Information Technology (IT) concept. The increasing number of domestic subscribers to the internet has changed slightly this concept and has introduced interests from the telecommunications industry, as with the World Wide Web it became possible to retrieve online information richer than plain text. Currently, the term home multimedia is further updated, as digital television is launched, considered as the holy grail for the broadcast media industry.

The above overlap is increasing as new services are conceived and introduced, causing yet more unresolved problems, as the recent dispute between the media and IT industries on the MPEG2 standard exposed. Solutions are currently being sought from the industries, governments, and regulation bodies, forming a clear trend towards *convergence* with respect to the services offered to the end users.

This document is organised in two parts. In the first part, the current technical deficiencies and the necessary steps needed to be taken from the three industries to overcome them on their way towards convergence, will be presented. The second part deals with the emergent business opportunities and pitfalls on multimedia service provision for the telecommunications industry.

2 Technical Aspects of Convergence

2.1 The Applications

The fusion of different content types in multimedia enables the creation of a wide variety of end products. For domestic subscribers, it is currently considered that these should satisfy the requirements for the following major categories of applications:

- *Entertainment* audio-video, with the video offered in a variety of qualities, as low as the quality of streaming video currently available over the Internet — see Table 2, page 3 — and as high as the quality of cinema films. The associated audio quality could also range from low bit rate mono encoding, to hi-fi quality. The content could be transmitted live, or could be pre-recorded and stored in databases and delivered on demand.
- *Personal communications,* including voice and video telephony and conferencing. Connections could be point-to-point, or point-to-multipoint, enabling applications such as teleworking, computer supported cooperative work (CSCW), and distance learning.
- *Information push and pull,* which is currently the main use of the Internet. Features as smart searching, which will enable the spotting of multimedia documents and their retrieval, are highly desirable for this category. Webcasting technologies 'pushing' information to the users, according to their preferences or their current activity, are also becoming increasingly popular.

- *Electronic commerce,* which will bring revolution to business transactions, by opening shortcuts in the traditional work flow for selling goods. The most sensitive issue in this category is the secure delivery and storage of the users' transactions.

2.2 The Technical Barriers

The above applications impose different requirements to the network service. These requirements for some multimedia content types, are depicted in Table 1, and cannot be satisfied in full by current network architectures. In other words, there are technical barriers for each of the industries on their way towards convergence. One of the most important is the scarcity of the available **bandwidth**, especially for video transmission.

None of the three industries is ready for the broadband challenge yet. Perhaps the broadcasting industry is closer to meet the challenge, with its fibre and satellite infrastructures having a good penetration to the domestic market. On the other hand, the PSTN and data networks are constantly being upgraded to ATM technology above the Central Office level. With emerging technologies as those belonging to the Digital Subscriber Line (DSL) set, or their wireless local loop, such as LMDS, and satellite based, such as the Teledesic venture, alternatives, it is a safe bet that broadband access will be available to the average home user in the next 3–5 years.

Furthermore, research on audio and video compression has been very fruitful in the last decade, providing efficient and reliable coding techniques for a variety of content qualities, thus shortening the bandwidth obstacle. Due to the high revenue expectation that TV-related projects have, these techniques were adopted as soon as they were released, and there were very soon a lot of standards implementations and support systems available from IT and broadcasting equipment vendors. And as there is generous funding, research is proceeding in very fast pace to even more efficient schemes focusing to special multimedia content. For example, there have been developed codecs optimised for head and shoulders video sequences, intended for the aforementioned personal communications application category.

The compression performances of some of the most popular algorithms used, are summarised in Table 2. Along with the official standards, some *de facto* formats are also tabulated for comparison. It has to be noted that MPEG2 has already adopted

Application	**Traffic Character.**	**Bit Rate** (bits/seconds)	**Delay Tolerance**	**Error Tolerance**
Telephone quality voice	Cont. bidir.	16k–24k	Low	High
Face-to-face video	Cont. bidir.	64k–128k	Low	Medium
Hi-fi sound	Cont. unidir.	192k–1.4M	High	Medium
TV quality video	Cont. unidir.	Up to 10M	Medium	Low
Content data (file transfer)	Bursty	64k and more	High	Medium
Control data (RPC)	Bursty	16k	Low	Low

Table 1: Network requirements of different multimedia applications, source: [1].

Organisation-Standard	Input	Bit Rate (bits/seconds)	Intended Network Platform
ITU-G.726	Speech	16k–40k	POTS, trunk lines
ETSI-RPE/LTP	Speech	13k	Cellular (GSM)
ITU-G.723.1	Speech	5.3k–6.4k	IP-based
RealNetworks-RealAudio	Generic audio	8k-32k	IP-based, streaming
ISO-MPEG Layer 3	Hi-fi audio	112k–128k	ISDN, offline storage
Dolby-AC3	Hi-fi audio	64k–96k	ISDN, offline storage
ITU-H.261	Low motion video	64k–2M	ISDN
ITU-H.263	Low motion video	14.4k–56k	IP-based, mobile
Real & Iterated-RealVideo	Low motion video	28k–56k	IP-based, streaming
ISO-MPEG1	Generic audio-video	Up to 1.5M	Offline storage
ISO-MPEG2	Generic audio-video	2M–15M	Digital Broadcast TV
ISO-MPEG4	Audio-visual objects	8k-35k	IP-based
RealNetworks-G2	Audio-visual objects	11k–32k	IP-based, streaming

Table 2: A selection of standards for audio and video coding, sources: [2, 3].

for the deployment of the largest of the multimedia applications, digital television, be it terrestrial, cable, or satellite. Apart from its unquestionable compression efficiency, the MPEG2 specification caters for the interactive element in its systems section [2].

Thus, the second major barrier has been identified as the provision of an interactive communications control channel to the user, in other words, the **two-way communication** capability of the network. As self-evident as this is for the PSTN and data networks, so absent it is from the traditional broadcasting infrastructure. This will therefore be one of the most painful steps the broadcasting industry has to make on its way towards convergence.

The same stands for the next barrier: **resource management**. Had effective ways of controlling and signalling been unavailable for telecommunications and data networks, they would collapse every time service demand peaked. Due to the relatively limited content delivered, broadcasters did not need to adopt a switched network architecture, as the other two industries did. The move to full digital content, however, makes it feasible to provide customisable and differentiated products for each customer. In such an environment, there has to be some control of the resource allocation, to exploit them efficiently and avoid service delay and congestion.

Besides resource management, service management is also crucial for interactive multimedia systems, pointing to the barrier of **intelligence** in the delivery architecture. Intelligence is inherent in data networks, concentrated mainly at the periphery of the network, the terminals. In the telecommunications world, the deployment of advanced services and the emergence of mobile networks have pushed for Intelligent Network (IN) architectures, which generally place the intelligence in the core network. The broadcasting industry has a clear deficit here, as in most of the cases hardwired approaches have been adopted in order to cut down equipment and subscribing costs.

The latter are usually charged in an indirect way, for example license fees, or subsidised by advertisements and sponsorships. This content-independent billing does not promote competition in value-added services. PayTV and pay-per-view are the first attempts of the broadcasters to overcome the **charging and security** barrier.

Charging is an issue for the IT industry as well, as it was not a design goal of the Internet. It is arguably not justified to charge for a network service that does not provide any QoS guarantees, such as IP in its current state. Security, on the other hand, is considered currently as one of the major priorities for data networks. Technologies as Secure Socket Layers (SSL) and third party certificates for authentication are considered as the first major steps for secure transactions, which are crucial for online business. Last, the telecommunications industry does apply effectively charging and security for its services, since they are key issues to its business viability.

Finally, the broadcasting and telecommunications infrastructures do provide **real-time capability**, while in the IT industry there has been major progress on real-time delivery over packet networks. An example is the Multicast Backbone (MBone) experimental platform, where audio-video conferencing has been available for quite a while. Streaming audio and video Internet services show the way as well, although quality at the receiver is not yet acceptable for the average user.

Summarising the above, the diverse departure points and evolution approaches for the telecommunications, IT, and broadcasting industries, as far as it concerns the technical aspects of convergence, are depicted in Figure 1.

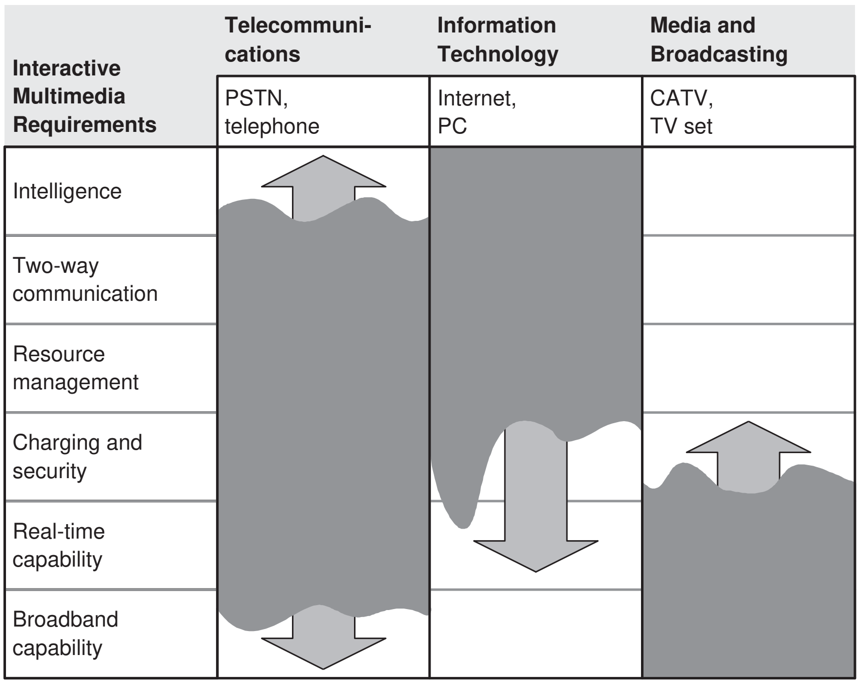

Figure 1: The diverse approaches towards convergence, adapted from [1].

2.3 The Steps Towards Convergence

Referring to Figure 1, it is obvious that the broadcasting industry has the largest technology deficit. Therefore, a quick approach suggests that revolutionary changes have to be made for the industry to meet the challenge of interactive multimedia services. However, such revolutions are unacceptable in business planning, as they involve huge investments, both from the service providers and the end-users, running great risks on market acceptance and revenue generation. A more pragmatic, evolutionary approach would rather be applied, and this stands for the other two industries as well.

2.3.1 Broadcasting

Applying that pragmatic approach to broadcasting, the first step could be the exploitation of the bandwidth savings offered by digital video technology. For example, it is estimated that for satellite broadcasting, the spectrum occupied by one analogue channel could accommodate seven digital ones, with much better audio and video quality. This alone could lead to an emulation of video on demand, with simultaneous transmission of several programmes, scheduled to start at predetermined discrete, but very frequent times.

Another potential application involves the integration of relevant information with the selected programme, a form of push technology. This is realised with web surfing capable set-top units, enabling users to use both broadcasting and Internet infrastructures. These devices, could form the basis for interactive communication as well.

2.3.2 Information Technology

The IT industry is departing from a better point towards convergence. This is of course the Internet, which has grown dramatically and in theory supports all the applications mentioned in Paragraph 2.1. In practice, however, there are great deficiencies in today's Internet, hindering the effective delivery of interactive multimedia services. These include the scarcity of core capacity, the lack of reliable delivery and effective charging schemes, and the immature secure transactions functionality.

First steps to override the above deficiencies have already been taken from the Internet Engineering Task Force (IETF). Among them are features as enhanced addressing and resource management with IPv6 and RSVP, real-time capability with RTP, and multicasting capability, which, when fully integrated to the Internet, will offer an overall functionality that no other platform offers currently. Exploiting this functionality, and the increasing penetration of personal computers to the domestic market, the IT industry will be able to offer, apart from the live streaming multimedia information push and pull, personal communications services, such as voice telephony and low quality video over IP.

2.3.3 Telecommunications

A first glance to Figure 1 reveals that the telecommunications industry seems the most well prepared to meet the requirements of interactive multimedia systems. This seems over-optimistic, but, with the wide availability of ISDN currently, and the increasing number of advanced services reaching home customers, it does not lack pragmatism.

The next steps are the adoption of ATM as the future multiservice broadband platform, and the elimination of the local access bandwidth bottleneck with technologies as DSL. From then on, and if regulation allows, most telecommunications operators will provide value added services, including Internet services, entertainment services such as video on demand and online games and point-to-point videotelephony.

2.4 Discussion

The analysed approaches range from the bulky broadcasting approach, which exploits technology advances by delivering bundles of relevant, but not always significant information, to the sophisticated approaches by the other two industries, with content-based resource allocation and increased signal to noise ratio of the information delivered. Both approaches allow for service differentiation and have the functionality to provide user-customisable interactive services.

Another conflict exists between the careful and time consuming standard-setting procedures for the telecommunications and the more free-form, demand driven approach of the IT world for new technologies. The same stands for the grade of service driven overengineering approach of the telecommunications world, and the currently inadequate for multimedia, but constantly improving, best-effort approach of the Internet world.

With these contrasting approaches, it is very unlikely that the three industries will converge to a unique infrastructure. However, they might develop networks that will have comparable features and performances [1]. Above all, the goal is convergence of *services* and not technologies, according to the subscribers' interests.

3 Business Aspects of Convergence

3.1 Introduction

The multimedia era brings a revolution to applications, requiring an evolution of the business perspective of the key market players in the networking world. Businesses in different parts of the EU Convergence Value Chain form mergers and alliances, while others are extending their presence within the chain [4]. The telecommunications industry traditionally resides in the Service Provisioning and Infrastructure Provisioning parts, but is currently re-evaluating its position under the light of new technologies and market demand, trying to identify and seize the emerging business opportunities.

3.2 The Need To Evolve

There are great risks to the business of the telecommunications industry if it does not involve to the emergent multimedia markets. Assuming that the Internet is the most popular multimedia carrier, at least in the short to medium term, this means that the traditional ISPs will continue to offer their services over the operators' infrastructure. As the Internet increases its penetration to the domestic market, and is on the way to offer more advanced services as voice and video over IP, it challenges the operator's business by diverting substantial high-revenue traffic away from the PSTN/ISDN [5].

Examples are long holding times at flat rate and cross-subsidised local tariffs, lost calls to busy Internet subscribers, local calls pushing away profitable long-distance and international calls, migration of traditional PSTN/ISDN services to the Internet, such as fax replaced by email. There are technical risks as well, as congestion at the local exchange and performance degradation of the trunk network due to the increase of average call holding times, which violates the classical rules for network dimensioning.

3.3 The Business Challenge

Considering the significance of the Internet, and its potential as one of the main platforms for the emergent markets, currently and in the foreseeable future, the approaches that favour the telecommunications operator-ISP integration seem very promising. Some business considerations concerning the realisation of this integration, are presented in the following paragraphs.

3.3.1 Infrastructure

The wide availability of ISDN currently, could be exploited, as one of the most cost-effective platforms for accessing online services. An aggressive marketing strategy could be adopted, according to the successful example of cellular telephony roll out, with equipment subsidisation, and benefits for new subscribers. Charging should stimulate usage of the ISDN, with a variety of packages to choose from, including free 'airtime' and privileged access to value-added online services.

DSL technologies, which are currently under extensive trials, could be promoted to business and home 'power' users, who need the extra bandwidth for serious surfing or home access to corporate networks. However, the charging for DSL cannot be based only on time usage, as it would not be affordable if ISDN prices were projected to the DSL domain according to the offered bandwidth; thus, volume-based charges could be applied. However, it is desirable that the tariff scheme is straightforward, and easily understood by customers.

3.3.2 Services

As the experience of the deployment of intelligent network advanced services has shown, value-added services can contribute to a substantial portion of the operators' revenues. Such services are categorised according to Paragraph 2.1, and could include Internet portal services, news and 'push' services, online games and meeting points.

These services should be promoted in close cooperation with the marketing department, targeted to carefully identified specific groups of subscribers. For example, online games advertisements could appear to teen magazines, while online briefing services should be promoted to business professionals. It is important for the service providers' public image to make some of these services available for free to everyone, subsidising their cost with advertisements, while retaining 'premium' services for users who are willing to pay.

3.4 Conclusion

The transition to the multimedia era should not be more painful for the telecommunications industry than for the other major market players, namely the IT and broadcasting worlds. A positive indication is that the industry has successfully entered the competition era, after a long state-owned monopoly period.

In order to maximally exploit the emergent opportunities, contractual relationships or alliances between the telecommunications operators, and the equipment vendors and content providers have to be built, spanning the entire EU Value chain. The former alliances will enable operators to exchange information on potential overlapping customers, and probably subsidise basic versions of their equipment for newly connected customers. The latter, will enhance relationships to the content creation industry, for example news and media agencies and video games developers, for the provision of customer-attractive content in the aforementioned online services.

References

[1] H. Armbrüster, "Information Infrastructures and Multimedia Communications: Different Approaches of the Telephone, Data, and Radio/TV Worlds," *IEEE Communications Magazine*, pp. 92–101, September 1997.

[2] L. Chiariglione, "Impact of MPEG Standards on Multimedia Industry," *Proceedings of the IEEE*, Vol. 86, No. 6, pp. 1222–1227, June 1998.

[3] R. V. Cox, B. G. Haskell, Y. Lecun, B. Shahraray, L. Rabiner, "On the Applications of Multimedia Processing to Communications," *Proceedings of the IEEE*, Vol. 86, No. 5, pp. 755–824, May 1998.

[4] "Green Paper on the Convergence of Telecommunications, Media, and Information Technology Sectors, and the Implications for Regulation," European Commission, Brussels, December 1997.

[5] U. Schoen, J. Hamann, H. Kurzawa, C. Schmidt, "Convergence Between Public Switching and the Internet," *IEEE Communications Magazine*, pp. 50–65, January 1998.