A road map for Broadcast technology

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This article describes three main developments in broadcasting technology – digital networks, receiver storage capacity and the convergence of services and networks – and indicates the routes that may lead to what is generally seen as the future of broadcasting: interactive multimedia delivery.

The existence of a Broadcast-technology Management Committee (BMC) in the EBU is not to suggest that developments in broadcast technology can be managed by the EBU alone. Although in the past many technical developments were initiated by EBU Members and developed collectively in EBU working groups, the developments in broadcast technology nowadays take place in organizations which extend well outside the broadcast membership of the EBU. The TPEG system for travel and traffic information may possibly be the very last system to be developed in an EBU BMC project group, although even this has been very much in conjunction with other parts of the industry.

The BMC is under no illusions that it alone can manage technical developments! The management of broadcast technology in the EBU means, rather:

- identifying at an early stage the essential and critical developments;
- contributing at the right time to decision-making bodies in order to try to steer developments in a helpful direction;
- giving advice to EBU Members in time to for them to make their decisions on a national level.

Often these actions require collective work within a project group.

To support these activities, EBU Members and the EBU Permanent Services staff are very active in a number of important industry associations such as the DVB project, but also CEPT groups dealing with broadcast frequency management issues. The EBU makes direct contributions to a great number of such organizations and follows the work of an even larger number of organizations.

Developments in broadcast technology

Broadcast technology in the EBU has been divided into two main streams: ***frequency management*** and ***broadcast systems research and development***. The way of working in the systems R&D stream is rather different from the way that developments take place in frequency management. *Table 1* shows the main differences.

BMC project groups of the frequency management stream contribute to the ITU and CEPT and, increasingly also, to the EC. These groups provide the technical basis for CEPT and ITU decisions. Furthermore, these

Table 1
Development process characteristics

Characteristics	Frequency management	System R&D
Main actors	Government bodies like ITU, CEPT, EC	Industry forums like DVB, TV-anytime
Duration	Long processes	Relatively short projects
Mile stones	ITU conferences like WRC03, WRC07, RRC04/05	Continuous process of creating and updating standards
EBU project group actions	Technical basis for planning; contributions to ITU, CEPT; Advice to Members	Application of systems; advice to Members

project groups give information to EBU Members on frequency planning for digital broadcasting systems, such as DRM, DAB and DVB.

EBU project groups in the systems R&D stream mainly investigate the *application* of systems and provide guidance to EBU Members on the *implementation* of systems.

In considering the multitude of organizations, agreements and systems that are relevant to broadcasting, it is sometimes easy to get lost in the details of a specific development – and miss the general trends that are likely to affect broadcast technology. It is therefore helpful that David Wood (EBU), in his article *Bits "R" Us* [1], identifies three main trends and tendencies in the chaos of technological developments:

- software solutions;
- personalisation;
- globalisation.

The trend towards software solutions has, according to David Wood, two consecutive stages: analogue-to-digital transition directly followed by hardware-to-software transition. Personalisation is characterised by the move from common broadcast programmes for all, to individual on-demand services. Globalisation is the trend that organizations operate on a continental or worldwide basis, rather than at a national level.

Timescales for these trends and tendencies are different. In some markets and for some services, the timescales are relatively short. For instance, webcasting (multimedia production and distribution to the general public via the Internet) is a personalised service using digital delivery media and software solutions; it is currently provided by many broadcasting organizations. However the underlying Internet development has already a rather long history and started around 1970.

The standardization of teletext in 1974 could be considered as the start of the transition from analogue to digital and the first introduction of personalised services (local interactivity). For enhanced personalised services, the transmissions of *digital* broadcasting systems are needed. The introduction of T-DAB and DVB-T has started in some countries, but it will take probably more than 15 or 20 years before all the television transmissions in Europe are digital. In the case of analogue sound transmissions on FM a close-down is not even considered in the foreseeable future.

In the broadcasting services, there has been the notion from the start that globalisation is important. For instance, the first international frequency plan was the LF/MF plan of Prague in 1929 and many planning conferences followed. In other instances, such as analogue television systems, national interests prevailed but – in line with the trends – Europe has now adopted common systems for digital broadcasting (in chronological order: DAB, DVB and DRM).

Currently three main developments in broadcast technology can be identified, that support the trends and tendencies described above.

The key developments are:

1) planning of digital broadcasting networks;
2) increases in receiver storage capacity;

3) convergence of services and networks.

Most of the activities of the BMC and its project groups relate to these three key developments. An overview of BMC project groups is given in *Appendix A*.

Planning of digital broadcasting networks

"Transmission of digital broadcasting systems is the condition for personalised and interactive multimedia services"

The service requirements of digital broadcasting networks and the time schedules for their introduction differ from country to country. Nevertheless, in almost all European countries, there is an interest in introducing digital terrestrial broadcasting networks. *Figs 1* and *2* show the status of implementation of T-DAB and DVB-T in Europe, drawn up by the CEPT. More information on T-DAB and DVB-T can be found at http://www.ero.dk.

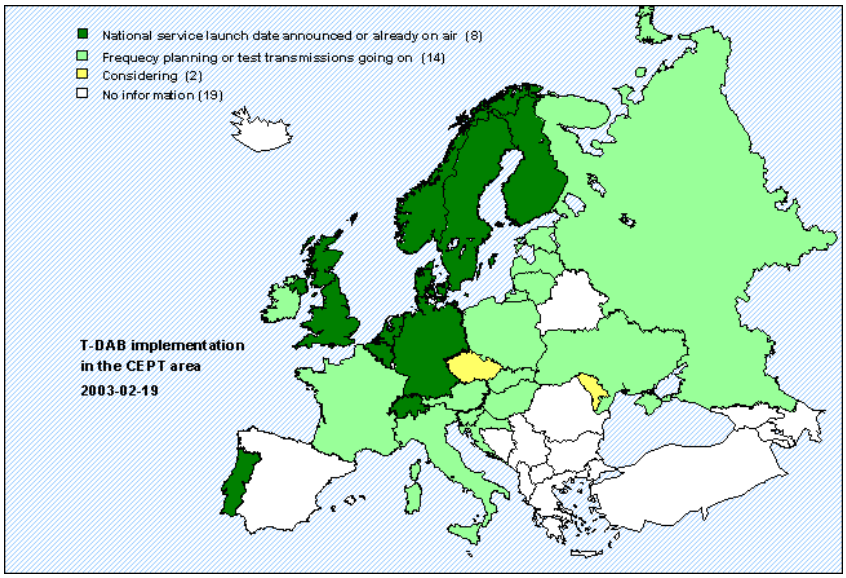

Figure 1
T-DAB implementation in the CEPT area

The introduction of DVB is also being stimulated by the European Parliament. A resolution *(click here)* was adopted in October 2002 that insists on a successful introduction of digital television in Europe. The parliament has been convinced that DVB in conjunction with the Multimedia Home Platform (MHP) standard is an essential instrument to guarantee access for European citizens to the services of the information society. The European Commission was asked to draw up an action plan before the end of 2002.

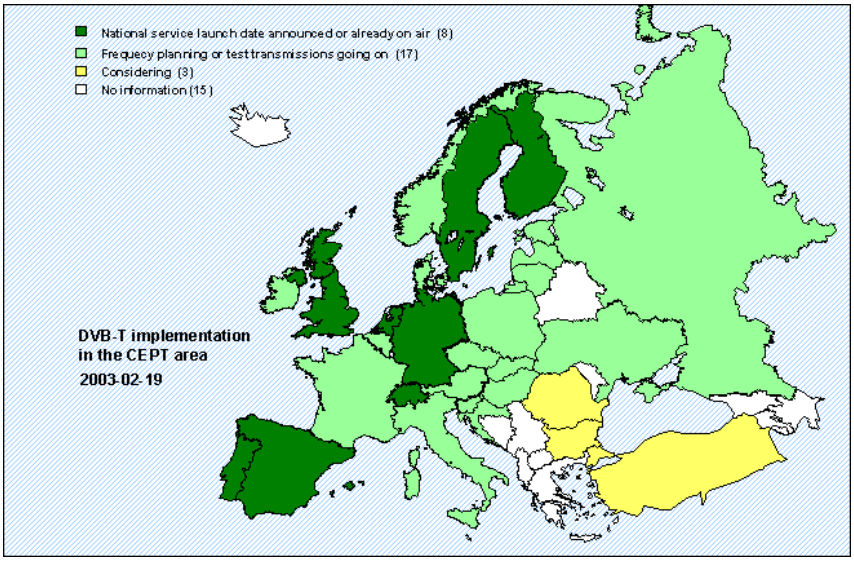

Figure 2
DVB-T implementation in the CEPT area

The main issues in the EBU work on the planning of digital broadcasting networks relate to DRM, T-DAB and DVB-T. Results of collective EBU work were the basis for the CEPT T-DAB planning meetings of Wiesbaden (1995) and Maastricht (2002) and also for the CEPT agreement on DVB-T frequency coordination of Chester (1997). Current EBU activities concentrate on the items shown in *Table 2*.

Table 2
BMC Project Group action in planning DRM, DAB and DVB

System	Issue	Milestone
DRM	Use in LF/MF bands and need to change GE75	Future conference to modify technical rules
	Use in HF bands	WRC-03
T-DAB	Transfer of Band III allotments of WI95 to new plan for digital broadcasting and sharing Band III between T-DAB and DVB-T	RRC-04/05
DVB-T	Preparations for new frequency plan for digital broadcasting in Band III, IV and V; replacement of ST61 and CH97	RRC-04/05

The Regional Radio Conference to be held in 2004 and 2005 (RRC-04/05) is of paramount importance. It will make frequency plans for digital broadcasting in Bands III, IV and V for all the countries indicated in *Fig. 3*. The first session of this conference will be held in May 2004 and will establish the technical criteria. The second session will draw up the new frequency plans. The dates of the second session will be decided after the first session. It could well be that the second session will take place in 2006, regardless of the current indication of 2005.

Figure 3
Indication of the RRC-04/05 planning areas

Probably six months before the second session takes place, the national administrations will have to submit their requirements to the ITU. This means that, within the next two to two-and-a-half years, each country in the planning area (Europe, Africa and the Middle East), should develop plans for its future digital broadcasting networks, even if there is no urgent need for the introduction of terrestrial digital broadcasting services.

Before developing the frequency plans, there are some principal questions that should be considered:

- **Universal coverage?**

  EBU members have a universal coverage mission, but what is the position of T-DAB and DVB-T in that requirement – in the short, medium and long term?

Abbreviations

ADSL	Asynchronous Digital Subscriber Line	**IC**	Integrated Circuit
AM	Amplitude Modulation	**IEC**	International Electrotechnical Commission
BMC	(EBU) Broadcast-technology Management Committee	**IP**	Internet Protocol
		ISO	International Organization for Standardization
CEO	Chief Executive Officer	**ITU**	International Telecommunication Union
CEPT	European Conference of Postal and Telecommunications Administrations	**LF**	Low-Frequency
		MF	Medium-Frequency
DAB	Digital Audio Broadcasting (Eureka-147)	**MHP**	(DVB) Multimedia Home Platform
DRM	Digital Radio Mondiale	**MPEG**	(ISO/IEC) Moving Picture Experts Group
DVB	Digital Video Broadcasting	**PDR**	Personal Digital Recorder
DVB-RCT	DVB - Return Channel via Terrestrial	**PLT**	Power-Line Transmission
DVB-T	DVB - Terrestrial	**PVR**	Personal Video Recorder
EC	European Commission	**T-DAB**	Terrestrial - Digital Audio Broadcasting
ETSI	European Telecommunication Standards Institute	**TPEG**	Transport Protocol Experts Group
		TWIM	Terrestrial Wireless Interactive Multimedia
FM	Frequency Modulation	**UHF**	Ultra-High Frequency
FWA	Fixed Wireless Access	**UMTS**	Universal Mobile Telecommunication System
GPRS	General Packet Radio Service	**VHF**	Very High Frequency
GSM	Global System for Mobile communications	**WLAN**	Wireless Local Area Network

- **Reception by rooftop, portable or mobile terminals?**

  Should services be planned for rooftop, indoor and mobile reception – and to what extent? The answer to this question may have a great impact on the transmitter network structure.

- **Number of services?**

  How many services (national, regional) are needed for public and commercial broadcasters and what are the quality requirements? The quantity and quality of the services determines the required bitrate and the number of multiplexes.

- **Available frequencies?**

  To what extent is the protection of analogue services needed when digital broadcasts are introduced and how will the analogue switch-off be organized?

On the basis of these and other considerations, national frequency plans have to be developed and as far as possible coordinated with neighbouring countries.

Receiver storage capacity

"Use of receivers with processing and memory functions including a hard disk, in combination with transmissions of digital broadcasting systems, will enable personalised multimedia services"

Gordon Moore, co-founder of Intel and now chairman emeritus of that company, predicted already in 1965 an exponential growth of the number of transistors per IC [2]. This became known as Moore's law *(see Fig. 4)*. Intel expects the curve of *Fig. 4* to continue at least through the next decade.

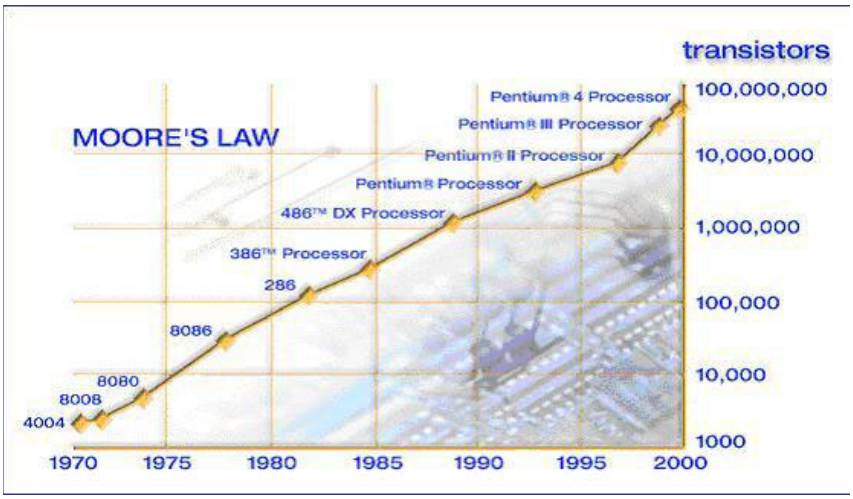

Figure 4
Moore's law

As the price of ICs is mainly determined by the area of silicon, it means that relatively low-cost powerful processing and memory ICs will become available and will be used in consumer equipment including broadcast receivers.

Processing and memory functions in the receiver will initially be used for new functionalities related to personalised services. The key to personalised services in DVB is the Multimedia Home Platform (MHP). The EBU recommends DVB-MHP as the preferred solution for new digital TV platforms and recommends that broadcasters who are using other APIs on existing platforms should give serious consideration to migrating over to DVB-MHP [3].

With decreasing IC costs and increasing processing power, the demodulation and decoding parts of receivers may become software-based. Current hardware receivers are incapable of taking advantage of improvements in audio and video coding, because new advanced coding algorithms, in general, are not backwards compatible. With software-based receivers, new decoding software could be downloaded and installed as and when required.

The hard disks for recording video programmes are known as Personal Video Recorders (PVRs) or Personal Digital Recorders (PDRs). The PVR will greatly change broadcasting, as already noted by Philip Laven in his article published by EBU Technical Review in December 2000 [4]. PVRs will allow the consumer to:

- pause a broadcast programme then continue watching it later;
- skip parts of a programme including advertisements;
- record programmes automatically and watch them at a more convenient time.

From the broadcaster's viewpoint, PVRs will allow them to transmit additional information, e.g. during the night, for storage on the consumer's hard disk and retrieval later at the desired moment. It has been shown, for instance in the DVB-T pilot carried out by VRT in Flanders [5], that the use of interactive services and a hard disk can be very simple to operate via the remote control of a TV set.

On another front, copy-protection regulation and measures may have a great impact on the use of PVRs by consumers. An important aspect for study in the EBU is the application of PVR services in free-to-air broadcasting.

Recognizing the importance of receiver storage capacity and the use of PCs for broadcast reception, EBU project groups have been carrying out activities in this field for a number of years. Current activities concentrate on (i) the transmission of advanced coding schemes, (ii) aspects regarding the downloading of software and (iii) the implementation aspects of services using hard disk memory.

Convergence of services and networks

"Telecommunication services in combination with transmission of digital broadcasting systems and use of receivers with processing and memory functions, including a hard disk, will enable personalised and interactive multimedia services".

There are many ways of delivering multimedia content to the consumer *(see Fig. 5)* and in the near future the possibilities will increase and improve.

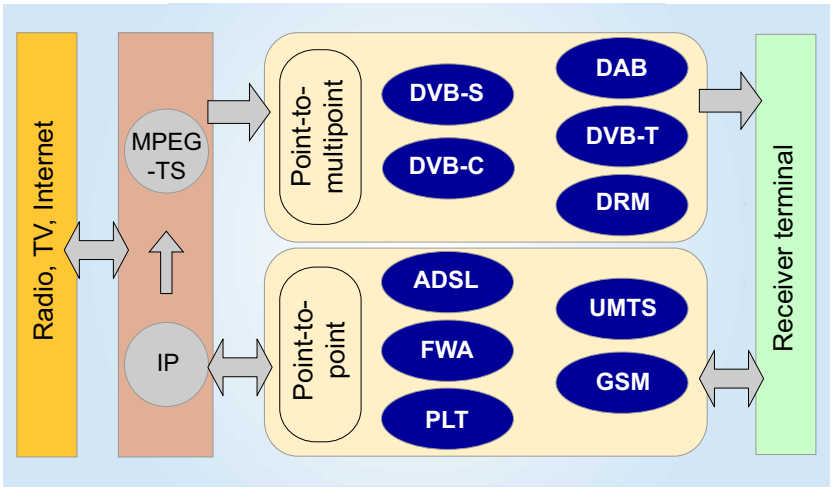

Figure 5
Multimedia delivery

The term "convergence" means the coming together of the services, systems and networks of the broadcast, telecom and computer industries. Different views have been expressed in the last decade in relation to the way this convergence may take. Clearly, internet services, systems and networks have reached a high degree of convergence. But it does not mean that everything related to multimedia will convergence into a single industry, a single service concept and a single network. More likely is a certain amount of cooperation between the broadcast, telecommunications and computer industries, resulting in a wide range of services and a wide range of terminals [6]. Actually, what is seen as convergence by the content and network providers, may be seen by the consumers as a divergence of services and terminals.

Broadcast systems like the DVB family of systems, along with DAB and DRM, are designed and operated for downstream point-to-multipoint services. The characteristics vary; DVB-S (satellite) and DVB-C (cable) have a relatively high capacity of about 30 Mbit/s but reception is restricted to fixed receivers. DRM, DAB and DVB-T have bitrates ranging from about 0.02, 1.2 and 5 - 24 Mbit/s respectively and can be received by fixed, portable and mobile receivers.

The content (radio and television programmes) is MPEG-coded but can also be transmitted via the Internet Protocol (IP), encapsulated in the MPEG Transport Stream. IP is independent of presentation and transport layer; it can be used over any network, including broadcasting networks without protocol conversions. Therefore, IP-based transmissions facilitate the convergence between telecom and broadcasting networks.

Telecommunication systems are designed and operated for both downstream and upstream point-to-point services. Systems for wired transmission – such as Asynchronous Digital Subscriber Line (ADSL), Power Line Transmission (PLT) and Fixed Wireless Access (FWA) – are for fixed reception only. The bitrates are in the range from 2 to 8 Mbit/s. Mobile systems, such as GSM and UMTS, have bitrates in the range from about 0.01 to 0.4 Mbit/s.

A number of telecom operators are developing plans to transform ADSL from providing just fast internet access into a "conduit" for supplying entertainment services – with consumer terminals similar to a future broadcast receiver (i.e. a software platform with a hard disk, as described above).

According to Mr Verwaayen, CEO of BT:

> ***"Broadband [ADSL] will change industry, government, television – it's not the next product, it's the next big thing in telecommunication".***

Do telecom operators consider ADSL as the future delivery medium for multimedia content? The electricity suppliers now see PLT as a promising way to deliver internet access. However, telephone lines and electricity wires were never designed to carry high-frequency data signals. The cables are far from being adequately shielded and the result is that ADSL and, in particular, PLT can cause severe interference to broadcast reception – as well as reception of other radio services in the LF, MF and HF bands. Criteria to limit this unwanted radiation is currently under discussion in ETSI but are insufficient to protect AM and DRM broadcasting [7].

Mobile telecommunication services such as GSM and UMTS are also able to deliver multimedia content. Swedish Radio has estimated that the costs of providing a radio programme stream per person per day, when compared with FM or DAB broadcasting, is more than 8000 times more expensive in the case of GRM-GPRS; with UMTS, it is more than 15,000 times more expensive. It is therefore most unlikely that point-to-multipoint services via mobile networks will ever happen. However, broadcasting networks in combination with point-to-point networks (intended for either fixed or mobile reception) will form a powerful duo for providing interactive services in the future. Various aspects of cooperation between broadcasting and mobile services – such as regulation, IP datacasting and network management – are being studied by BMC project groups.

The regulatory aspects of converging wireless services (broadcasting, mobile and fixed radio services) are being studied in the ITU under the name of "Terrestrial Wireless Interactive Multimedia" (TWIM) applications. TWIM is not defined as a service; it is a concept of multi-network, multi-access, multi-service and interactive arrangements. The concept includes different services in different bands, ranging from 540 kHz (MF broadcasting) to 66 GHz (Fixed Wireless Access). The capacity of the systems could range from a few kbit/s to more than 100 Mbit/s.

Broadcasting is clearly an important part of the TWIM concept. Essential to the concept is the availability of both downstream and upstream (return path) communications. For that reason, some administrations feel it necessary that fixed and mobile services should also be allocated spectrum in UHF bands IV and V, in addition to broadcasting. Although in some countries there may be a need for mobile and fixed allocations in bands IV and V, to allow for upstream communications according to the TWIM concept, a consensus is emerging within CEPT that upstream links should not be taken into account in the digital broadcasting plans to be made at RRC-04/05. The allocation of mobile and fixed services to bands IV and V for use in TWIM applications may be a subject for the World Radio Conference of 2007.

The route forward

Main route

Considering the trends and tendencies as well as the main developments that are taking place, the broadcasting community is heading towards interactive multimedia services with:

- downstream transmissions provided by digital broadcasting transmitter networks;
- receivers with storage and processing functions to provide interactivity and access to programmes at a time more suitable for the user;
- upstream transmissions provided by telecommunications networks.

This does not mean that in future there will only be "on-demand" services. It is likely that the main part will still be point-to-multipoint broadcasting, with additional services providing extra information.

Alternative routes

There are alternative routes for the distribution of interactive multimedia services, including wire and wireless telecommunication networks. In particular, non-real-time programme services that are downloaded and stored in the receiver are expected to be offered via these networks. However, compared to broadcasting networks, the downstream path lacks the attractive cost/capacity ratio. There are also alternatives for upstream transmissions in relation to broadcasting networks; for example the DVB-RCT system, an in-band terrestrial return channel. But it is unlikely that the DVB-RCT system will achieve wide application because of frequency usage limitations.

Roadblocks

There are a number of possible roadblocks that could delay the developments or restrict the services. A successful outcome of the RRC-04/05 is a prerequisite, as well as the switch-off of analogue television networks. As long as hardware receivers are in use, new systems and system additions should be backwards compatible. Digital rights management issues need to be resolved in relation to the receiver storage functions. Interactive multimedia services may require new regulatory provisions. Above all, open systems and horizontal markets are needed in order to achieve low-cost equipment and services that are offered to the general public.

Work in progress

The BMC and its project groups will contribute in paving the main road, indicating the alternatives and avoiding the obstacles, and will give advice to EBU Members on the directions that can be taken.

Has the broadcasting road map changed in the last few years?

Broadcasting, and certainly free-to-air broadcasting, is in general based on a horizontal market structure. Each part of that market makes its own decisions and, in particular, the enormous base of users (viewers and listeners) is slow in adopting new technology. Therefore, in broadcasting, we are used to long development and implementation times and the prediction for the future does not change from year to year. Philip Laven wrote an article called "Predicting the future of broadcasting" [8] in the Summer 1998 edition of EBU Technical Review. Now, almost 5 years later, it can still be noted that:

- Moore's law is relevant;
- receivers with hard disk are promising;
- analogue services will continue for another 15 to 20 years;
- convergence is an important issue.

What has changed? Certainly not the trends or the key developments. However, the internet hype has now ended. The internet is still very important, also for broadcasting applications, but there is no such thing as a "new economy". Telecommunication companies and governments made wrong estimates on spectrum costs for UMTS. GSM and UMTS are still believed to be important for multimedia delivery but not on their own strengths; rather, in combination with broadcasting networks. New systems such as Wireless Local Area Networks (WLANs) are becoming popular and may take a part of the business originally envisaged for UMTS. The place of WLANs in the broadcasting chain needs to be studied.

Some "software-receivers" have entered the market. Also, receivers with a hard disk are available in some countries; however the business model for these PVRs appears to have strong vertical market elements.

T-DAB and DVB-T still have low penetration levels but there is an increasing number of T-DAB and DVB-T transmitters on-air, and interactive broadcasting services are in operation in some countries and tested in others. More important is the fact that receiver prices have come down to less than € 150. The regulatory framework for T-DAB and DVB-T introduction in Europe was established in 1995 (Wiesbaden T-DAB Arrangement) and in 1997 (Chester DVB-T Agreement). In addition, the T-DAB Agreement of Maastricht (in 2002) provides for extra T-DAB coverage in the 1.5 GHz range. The European Commission is working on policies to encourage the introduction of digital broadcasting services – and to accelerate the closure of the analogue transmissions. Moreover, a crucial step towards digital broadcasting in Europe, Africa and the Middle East has been taken by the ITU, on the initiative of the European administrations, to organize a conference in 2004 and 2005 for making a frequency plan for digital broadcasting in the VHF and UHF bands.

Although the road map has not changed much over the past five years, the trends and tendencies have been confirmed and the position of broadcasting along the route to multimedia home delivery has been considerably strengthened.

Acknowledgement

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References

[1] David Wood: **Bits "R" Us — new economics and approaches for digital broadcasting**
EBU Technical Review No. 289, January 2002.

[2] Gordon E Moore: **Cramming more components onto integrated circuits**
Electronics, Volume 38, No. 8, 19 April 1965.

[3] EBU Technical Recommendation R106-2001: **Use of DVB-MHP**.

[4] Philip Laven: **Personal digital recorders**
EBU Technical Review No. 285, December 2000.

Jan Doeven received a bachelor degree in Electrical Engineering in 1971. After working in Surinam on HF radio links and frequency management, he joined (in 1975) the broadcasting department of the then PTT in the Netherlands. In 1993, he followed the transfer of PTT's broadcasting department to Nozema, the Netherlands Broadcasting Transmission Company.

In PTT and Nozema, Mr Doeven held several posts, mainly dealing with frequency management and the application of new technologies. He is currently the Senior Technical Advisor of Nozema. In 1997, he became chairman of the Broadcast-technology Management Committee (BMC) of the EBU and, since 1998, has been the chairman of CEPT project team FM 24, dealing with the preparations for the conference to revise the 1961 Stockholm Agreement.

[5] Peter Goyvaerts: **DHP Bridging the digital divide**
EBU "Diffusion", 2002/4.

[6] Document TM 2465**, The Convergence of Broadcast & Telecomms Platforms, Executive Summary**
Ad hoc Group DVB-UMTS of the DVB Project, 13 January 2001.

[7] J.H. Stott: AM broadcasting and emissions from xDSL/PLT/etc.
BBC R&D White Paper WHP 012, November 2001.

[8] Philip Laven: **Predicting the future of broadcasting**
EBU Technical Review No. 276, Summer 1998.

Appendix A:
Overview of BMC Project Groups

BMC project groups have a limited lifetime. In general, after two years the mandate is reviewed. Some project groups have a lifetime of less than two years, others more, depending on the situation. The table below gives an overview of the BMC project groups as existed in January 2003.

Stream [a]	Group	Subject	Chairman
F	B/CPT	Conference preparation – television	N Laflin, BBC
F	B/CPR	Conference preparation – radio	J. Andersen, DR [b]
F	B/DLMF	Digital broadcasting in the LF and MF bands	P Jackson, Merlin
F	B/EES [c]	Electro-magnetic exposure and safety	K Beeke, CCI
F	B/EIC	Electromagnetic interference and compatibility	K Beeke, CCI
F	B/INB	International broadcasting	P Guidici, VR
F	B/SMI	Spectrum management issues	P Petterson, Teracom
F	B/TDP	Terrestrial propagation predictions using terrain data banks	R Grosskopf, IRT
S	B/AIM	Audio in multimedia	G Stoll, IRT
S	B/BMW	Broadcasting multimedia on the web	S Anichini, SRF
S	B/SYN	Synergies between broadcasting and telecom services and systems	J Delmas, TDF
S	B/TPEG	Transport protocol expert group	B Marks, EBU
S	B/VIM	Video in multimedia	P Sunna, RAI

a. F = Frequency Management stream
S = System Development stream.

b. Regrettably, J. Andersen passed away in January 2003 and P. Vercoe-Rogers (RTE) has been appointed as his successor in this group.

c. Correspondence group.