The Transition years

George T. Waters
Director, EBU Technical Department, 1986 - 1997

George T. Waters oversaw many developments during his period as Director of the EBU's Technical Department. Not least was the relocation of the Technical Department, Technical Publications and other support services from Brussels to Geneva in 1989. Then in 1993, it was the turn of Eurovision operations to relocate from Brussels to Geneva.

Here, Dr Waters describes just some of the important technical developments in broadcasting that took place in the EBU during this period.

> ***"Forward, forward let us range,***
>
> ***Let the great world spin forever,***
>
> ***Down the ringing grooves of change."***
>
> *Alfred, Lord Tennyson (1809 - 1892)*

As the great world spins, the environment in which we live is constantly changing. Our lifestyles adapt to meet the challenges that these changes bring. In our world of communications, the 20th century has seen the most profound progress – marked by such milestone developments as telephony, wireless communication, radio broadcasting, television broadcasting, satellite communi-cation and, more recently, the Internet. These developments were facilitated by inventions such as the thermionic valve, the transistor and microelectronics.

Technology, like time, marches on. The years between the mid-eighties and the late nineties saw a profound change, not only in the technology of broadcasting, but also in the way that technology was developed.

The era of analogue systems was coming to an end, to be replaced by the much more versatile digital era. Techniques developed in the computer industry were finding new applications in the world of radio and television. By the end of the millennium, the ubiquitous digit was beginning to reign supreme, with digital systems gradually replacing the tried and tested analogue systems which had served us so well for almost a century. Over ten years, from about the mid-eighties onwards, intense research and development brought us to the point where digital broadcasting was feasible. We were suddenly confronted with a situation where the constraints of the radio frequency spectrum were eased, and better technical quality of both radio and television programmes in the home were assured.

Traditional R&D was, in the past, the closely guarded prerogative of individual laboratories. Even within the EBU, members with their own R&D laboratories tended to pursue their own individual projects. There was, of course, collaboration at committee level and full discussion took place in the various specialized Working Parties and Sub-Groups of the Technical Committee. Gradually, however, as the technology became more complex, collaboration became more necessary – leading to today's highly successful collaborative projects where hundreds of participating organizations are not uncommon.

This development also brought about a better understanding between the different sectors of the, now expanding, industry. Where previously, for instance, broadcasters and manufacturers tended to work in isolation, they now shared common objectives in the development of systems and equipment, and worked together to achieve the optimum results. In Europe, this trend was encouraged and assisted by the various European grant-aided projects such as those under the RACE, Eureka and ACTS programmes [1]. The EBU participated in many of these projects, either by the involvement of it's Permanent Services or of individual members.

It is a well-known maxim that the broadcasters' most valuable asset is their spectrum space. This has become even truer in an age when the competing demands have expanded to include mobile telephony, Internet access, etc. Today's auctions and "beauty contests" are evidence of the value placed on this unique natural asset.

In the late 1960s and early 70s, during the discussions on the introduction of the superior VHF/FM sound broadcasting system, the future of the – apparently soon-to-be-obsolete – long- and medium-wave bands was a hot topic within the EBU and, particularly, at Bureau and Technical Committee meetings. Opinions varied, the prevalent ones being that the bands would be abandoned for other uses and/or that they would be used for speech only, where the limited bandwidth would still be sufficient for reasonable intelligibility. Some thirty years later, most countries still use the LF and MF bands for broadcasting, in many cases carrying the same programme streams as before.

Today, with the introduction of digital radio and television, much the same discussion is taking place with regard to the future of the VHF band. Valiant attempts have been made by governments to forecast the dates by which the analogue services must be terminated, thus freeing up valuable spectrum. Broadcasters know, of course, that the public interest will prevail in the end and that, whilst there is still a reasonably-sized minority relying on the analogue services, their prolongation is assured. Nevertheless, it is in everyone's interest to encourage the take-up of digital services in the shortest possible time.

It would be impossible in the space available here to chronicle all of the developments brought about either within the EBU or in which the EBU played a major part, during my years as Director of the EBU's Technical Department. Suffice it to say that activity never slackened, and although over the years the Committee structures changed to meet the changing needs, the Technical Committee and its various specialist groups had a proud record of success.

The following sections describe some of the major topics, which were studied during the transition years. This is by no means an exhaustive presentation and neither does the selection infer that other topics were of lesser importance.

Radio Data System (RDS)

One of the first applications of digital technology to broadcasting was in the Radio Data System, developed to enhance the FM services. RDS is a means of transmitting ancillary information in association with an FM radio programme. This information can have many objectives such as programme service identification, traffic announcements, paging, automatic receiver retuning for mobile receivers, and programme-type identification. RDS is a regular feature of most car receivers today, with an estimated total in excess of 100 million in service throughout the world [2].

The EBU Technical Committee became involved in the development of RDS in the late 1970s. At that time there were a number of competing data systems beginning to emerge and it became obvious that the EBU would have to take a hand in rationalizing the situation, so that one common standard could be developed. A Specialist Group was set up within the, then, Working Party R of the Technical Committee. This dedicated group of experts worked diligently for many years to develop and harmonize a universal specification which today is used throughout the world, with minor variations in some regions.

RDS is particularly effective in mobile situations and today almost all new car receivers are equipped with it.

RDS offers a series of additional features, all of which contribute to the enhancement of the FM radio services. The most important features can be summarized as follows:

- **Programme Identification** (PI), which identifies the broadcaster and the programme channel name;
- **Programme Service** (PS), which conveys the programme name;
- **Alternative Frequency** (AF), which indicates a list of frequencies carrying the same programme;
- **Traffic Programme** (TP), which indicates programmes that carry traffic information;
- **Traffic Announcements** (TA), which gives priority to traffic messages.

This versatile technology supports a number of other features such as paging and programme-type identification, which can be introduced if required.

A feature of the work on RDS was the close relationship developed with the consumer manufacturing industry. The EBU invited representatives from EUROTECH, later to be renamed EACEM (the European Association of Consumer Electronics Manufacturers) to join in a series of field trials in the early 1980s.

Over the years, this relationship strengthened to the point where regular meetings – designed to ensure a common approach to new technologies and equipment – now take place between the EBU Technical Committee and EACEM.

Digital Audio Broadcasting (DAB)

The Compact Disc (CD), developed by Philips, was first introduced on the market – jointly by Philips and Sony – in 1983 and it quickly grasped the imagination of the public. Within ten years it had become the dominant medium for the distribution of recorded music, outselling both the vinyl record and the magnetic tape cassette. Its popularity stemmed from its superior audio quality, extended playing time and portability. CD technology is, of course, digitally based and employs advanced compression and encoding techniques.

It became evident that if radio was to retain its popularity as a medium for the distribution of music, a new system capable of superior quality would have to be developed to replace the standardized and universally-used FM system, which was planned in the 1960s. FM, which – among other drawbacks – suffers from multipath distortion, does not meet the demands of portable and mobile reception, which has become increasingly popular with the availability of smaller and less expensive receivers.

It was as a result of these considerations that EBU members encouraged the industry to collaborate in the development of a new digitally-based system of sound broadcasting.

The Eureka-147 consortium was established in 1987 with the objective of developing a digital radio system, capable of providing a high-quality, multi-programme service to fixed, portable and mobile receivers. The objective, loosely stated, was to provide a service of CD-quality sound within the service area of a given transmitter. This was an ambitious project, which included the participation of broadcasters, manufacturers, network operators and research & development institutes.

By 1995, the work of the consortium had resulted in the standardization, by ETSI, of a digital sound broadcasting system, which can be applied to terrestrial, satellite and cable delivery.

The Eureka-147 Digital Audio Broadcasting system (DAB) offers many advantages over its predecessors. These can be summarized as follows:

- High audio quality;
- Freedom from interference;
- Freedom from multipath distortion;
- High spectrum efficiency;

- Dynamically reconfigurable, offering a range of bit-rates per programme;
- Suitable for use in any frequency band between 30 MHz and 3 GHz;
- Supports single-frequency networks (SFNs).

The initial emphasis was on satellite broadcasting but the consortium soon realized the great benefit of DAB was in the terrestrial applications.

Following the successful completion and standardization of the Eureka-147 DAB system, the EBU was again instrumental in setting up EuroDAB – an organization dedicated to the implementation of digital radio. When it was realized that there was a growing interest in the Eureka-147 standard in parts of the world other than Europe, the name of this organization was changed to WorldDAB and its membership expanded accordingly. Today, WorldDAB has some 100 Members throughout the world and its membership continues to grow.

Eurovision

Surely the "jewel in the crown" of the EBU is Eurovision. The Eurovision network – initially providing a service primarily for EBU members, whereby television programme items were freely exchanged – is today an open facility, providing the very fabric of international television and radio. Some 130,000 news transmissions and individual news items, as well as 12,000 hours of programmes, are carried on the network annually.

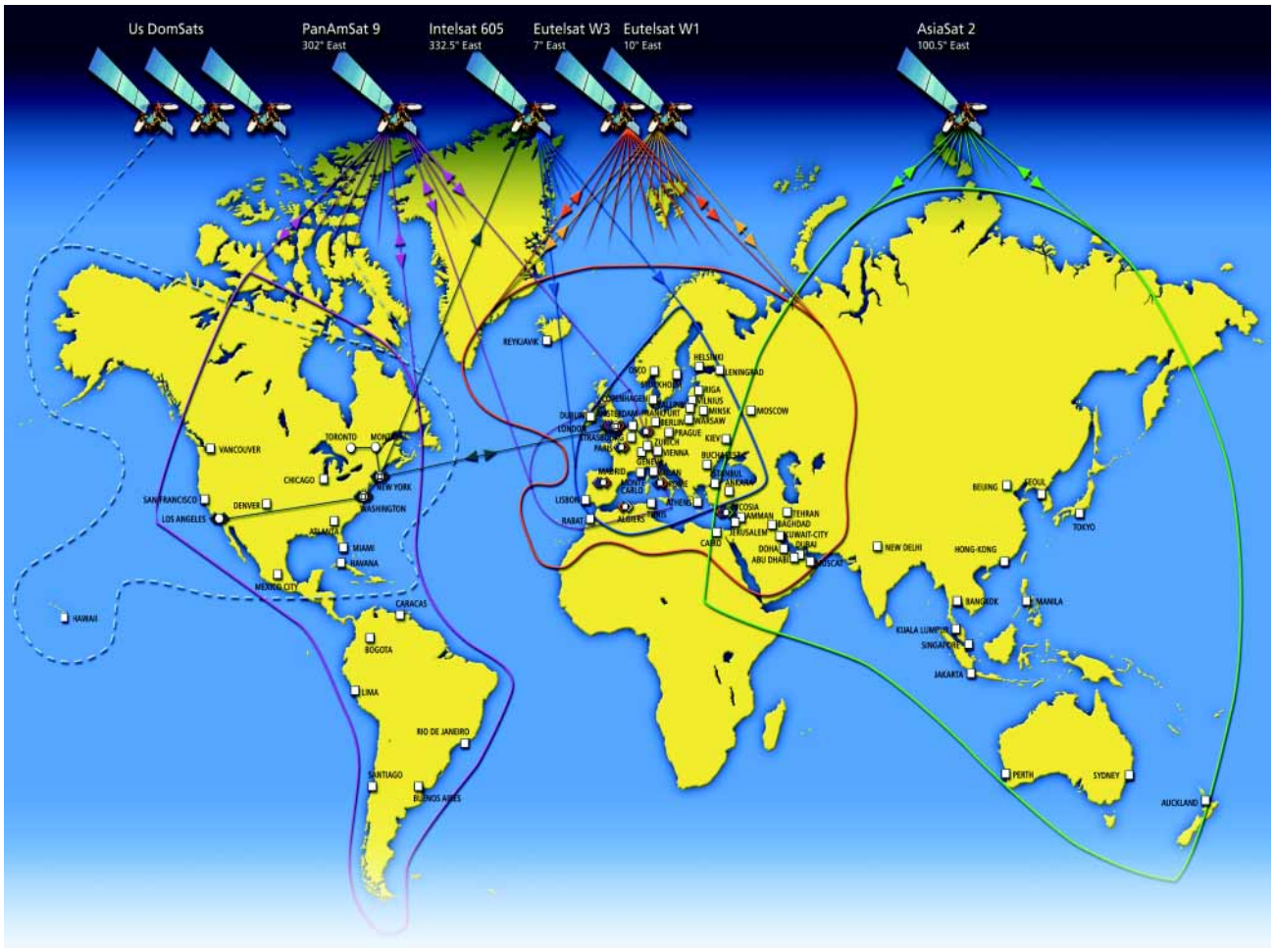
Initially the network was made up entirely of terrestrial microwave circuits but, during the 1980s, it gradually migrated – through the hybrid phase of terrestrial and satellite circuits – to the largely satellite-based network in use today.

The launch of Eutelsat I-F2 provided the EBU with an opportunity to use, for the first time, an alternative to terrestrial circuits [3]. In fact, the EBU was among the first customers of Eutelsat. In late 1984, the Eurovision Satellite Service commenced with five earth stations and within two years this number had increased to thirteen. The EBU's objective was to have the earth stations located on the broadcasters' premises but initially this was not always possible, because of the local regulatory situation, or the contractual arrangements with the national PTTs. The earth stations in use by the PTTs tended to have antenna diameters of between 15 and 20 metres. However the Technical Committee, on the advice of Working Party T, approved a specification for "Eurovision Standard" earth stations, with antenna diameters of between 7 and 9 metres, the actual diameter depending on location within the footprint.

Over the years there was always close cooperation between Eurovision and Intervision, the network that served Members of the OIRT in Central and Eastern Europe. The unification of the two Unions in 1993 provided the prospect of a truly consolidated satellite network becoming a possibility. With the financial help of the European Bank for Reconstruction and Development, an intensive programme of ground station installations was undertaken in the previous OIRT countries [4].

Today the Eurovision network is truly global – encompassing Europe, North Africa and the Middle East, the Americas and Asia. It is almost entirely composed of satellite circuits (Eutelsat W3 and W1, PanAmSat 9 and AsiaSat 2) – bringing daily diets of world events, including news and major sporting events, to EBU members and other users.

Another milestone in the evolution of Eurovision was the digitalization of the network. This took place in the late 1990s when digital compression techniques had matured. The EBU selected the MPEG-2 (4:2:2) system. Quality standards are assured by the utilization of a variable bit-rate, and the selection of a bit-rate that is deemed appropriate for the programme material being transmitted. (Today, 12 Mbit/s is the default for most



Current Eurovision coverage of the Americas, Europe and Asia – primarily via the PanAmSat 9, Eutelsat W3 and AsiaSat 2 satellites.

news items, whilst 24 Mbit/s is used for sport and other important events such as the New Year's Eve Concert from Vienna and the Eurovision Song Contest.) With digitalization, the network has thus been liberated to the extent that many more simultaneous transmissions of high quality are possible.

The main features of the Eurovision network are:

- In Europe, it uses Eutelsat W3 at 7° East – the footprint covers a wide area from Iceland to the Urals and from Scandinavia to the Sahara;
- Extensions to Asia are provided via AsiaSat 2 and to the Americas, via PanAmSat 9;
- The network has 56 permanent ground stations;
- It can deliver up to 30 simultaneous television transmissions.
- It uses MPEG-2, 4:2:2 encoding;
- It carries about 130,000 news transmissions and news items per year, as well as 12,000 hours of programmes;

The evolution of the Eurovision network has been carefully managed over the years by the EBU Permanent Services, guided by the succession of groups set up by the Technical Committee: Working Party N was succeeded by Working Party T and this, in more recent times, was replaced by The Network Management Committee.

High-definition television (HDTV)

Europe's "flirtation" with HDTV commenced in the summer of 1982, on the occasion of the meeting of the EBU General Assembly in Killarney, Ireland. A demonstration organized by RTE, with the help of CBS and

NHK, impressed members of the General Assembly and members of the Technical Committee (who attended specially for the occasion).

Subsequently, studies were commenced within Working Party V (Specialist Group V1/HDTV) with a view to determining a standard for production. These initial studies were superseded by an industry-wide project called Eureka-95.

The Eureka-95 Project, which was strongly supported by the European Commission, involved a group of European equipment manufacturers, broadcasters, research laboratories and universities. The Eureka-95 mandate was to develop all elements of an HD television system, from origination right through to the home receiver. Concentration at the initial stages was on the production standard.

There was an interest at that time in establishing a unique worldwide standard, so as to facilitate the exchange of programmes. It soon became apparent, however, that this ambition would not be fulfilled. The only element of the scanning standard which got universal approval was the 16:9 aspect ratio. Japan and North America opted for a scanning standard of 1125-lines/60 Hz whilst Europe adopted a standard of 1250-lines/50 Hz. In these pre-digital days, this divergence seemed to many people to be a major stumbling block to the introduction of HDTV, as it was felt that the necessity of standards conversion for the interchange of programmes could only compromise the technical quality.

However, Eureka-95 pressed ahead with the development of equipment for the origination and recording of programmes in 1250/50. The result was a full range of production equipment, which was used to record and transmit, in particular, high profile events such as the Summer and Winter Olympic Games as well as individual programmes in various parts of Europe.

It is not surprising that Eureka-95 selected a hybrid analogue/digital system for the transmission of HDTV. The EBU had developed the MAC Packet standard for satellite broadcasting in the 1980s and this was now re-engineered to accommodate the higher definition pictures. HD-MAC was the logical extension – having many similarities to the MUSE standard already adopted in Japan.

The CCIR defined HDTV as ...

> ***"… a system designed to allow viewing at about three times picture height such that the transmission system is virtually or nearly transparent to the level of detail that would have been perceived in the original scene by a viewer with average visual acuity."***

Abbreviations

ACTS	Advanced Communications Technologies and Services
AM	Amplitude Modulation
CCIR	(ITU) International Radio Consultative Committee
COFDM	Coded Orthogonal Frequency Division Multiplex
DAB	Digital Audio Broadcasting
DigiTAG	Digital Terrestrial Television Action Group
DVB	Digital Video Broadcasting
EACEM	European Association of Consumer Electronics Manufacturers
ETSI	European Telecommunication Standards Institute
FM	Frequency Modulation
HD	High-Definition
HDTV	High-Definition Television
HF	High-Frequency
ITU	International Telecommunication Union
LF	Low-Frequency
LW	Long-Wave
MAC	Multiplexed Analogue Component
MF	Medium-Frequency
MPEG	Moving Picture Experts Group
MUSE	Multiple Sub-Nyquist sampling Encoding
MW	Medium-Wave
OIRT	*Organisation Internationale de Radiodiffusion et Télévision*
PTT	Post, Telephone and Telegraph administration
RACE	R&D in Advanced Communications technologies in Europe
RDS	Radio Data System
RTE	*Radio Telefís Éireann*
SW	Short-Wave
VHF	Very High Frequency

Many demonstrations of HDTV were organized by Vision 1250, an organization set up to promote high-definition television using the newly-developed equipment. For many reasons, however, the concept failed to grasp the imagination of the public.

For their part, broadcasters showed little enthusiasm for the new medium, mainly because it came at a time when most public broadcasters were struggling with newly emerging competition from the commercial sector – made possible by the availability of new channels brought about by the introduction of satellites.

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" Invaluable technical information and production expertise resulted, which made the transition to the digital era that much easier. "

The main criteria for HDTV are as follows:

- Spatial resolution, in both the vertical and horizontal directions, of about twice that available with CCIR Recommendation 601;
- At least 1,000 active lines required;
- Wide-screen aspect ratio of 16:9;
- Large screens can be viewed at three times the picture height.

Let it be said that the effort which went into the years of development of high-definition television in Europe was not wasted. Invaluable technical information and production expertise resulted, which made the transition to the digital era that much easier.

Digital Video Broadcasting (DVB)

Without question, the most important and successful collaborative project the broadcasting industry has ever known is that of the Digital Video Broadcasting system [5].

Towards the end of the 1980s, a strong body of opinion was growing throughout the broadcasting world, that the future of broadcasting lay in the digital domain. Crystal-ball gazers were predicting digits all the way from the camera to the home receiver. Within the EBU, both the Technical Committee and its Bureau were anxious to explore the possibilities and a small group of Bureau members were charged with the task of holding preliminary discussions with representatives of the consumer electronics industry.

As these discussions were proceeding, a new initiative, to be known as the European Launching Group for Digital Television, was started. This group brought together the many and disparate constituents which make up the broadcasting world. It included public and private broadcasters, consumer electronics manufacturers, cable network operators, telecommunication companies, satellite operators and regulatory bodies. These groups were at a later stage joined by representatives of the Information Technology sector.

Digital Video Broadcasting

The Launching Group was established in the early 80s and had as its objective the development of a series of standards, which would govern satellite, cable and terrestrial television broadcasting in Europe. A Memorandum of Understanding was drawn up between all participating members.

The experiences of Eureka-95, MAC and HD-MAC had galvanized the industry against embarking on new developments – simply because the technology looked good. There had to be a sound business foundation. So, from the outset, the DVB Project was market-driven and the committee structures reflect this requirement: all adopted projects have to pass muster with the Commercial Module, whose job it is

to ensure that there is a requirement in the market place – before being passed to the Technical Module where the main development work is done.

The initial intention of the project was to develop a digital broadcasting system for terrestrial television but, at a very early stage in the deliberations, it became evident that the immediate demand was for satellite broadcasting. Consequently, in accordance with the stated policy of being market-driven, it was decided to prioritise the satellite system. The specification was eventually submitted to the Joint Technical Committee for standardization by ETSI.

The standards for cable and terrestrial systems duly followed and now all three are in operation, not only in Europe but in many other parts of the world as well.

Here are some important points about the DVB Project:

- It is a digital broadcasting system for satellite, cable and terrestrial delivery;
- The systems are spectrum efficient;
- The systems utilize MPEG-2 encoding;
- The terrestrial system uses COFDM;
- All the systems developed are now in use, not only in Europe but also throughout the world.

The DVB Project continues to develop specifications for systems related to the basic transmission standards and, where appropriate, these are submitted for standardization.

There are now some 300 members of the DVB Project and this number continues to grow, new members being proposed at every meeting of the Steering Board. This is a strong indication of how important the project is regarded by the greater broadcasting community.

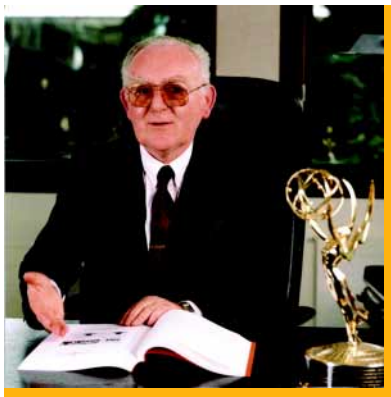
DigiTAG

DigiTAG (the Digital Terrestrial Television Action Group) – an initiative of the EBU – was set up in 1996 to encourage and guide the adoption and application of the DVB standards. With objectives similar to World-DAB, DigiTAG is most active in the promotion of terrestrial television systems. It currently has around 75 members, including companies and organizations in other parts of the world, as well as in Europe.

Conclusions

The EBU Technical Committee (now renamed the Technical Assembly), its Bureau (now called the Technical Committee) and the many Working Parties, Committees and Sub-Groups have played a major role in the development of broadcasting technologies in the twentieth century. The EBU membership (currently 70 Active Members and 46 Associate Members) always provided a reservoir of technical experts, ready to devote time and energy in the furtherance of these technologies. At any one time, taking all the projects together, there were likely to be 200 to 300 engineers involved. Without the EBU's efforts, many of the innovative developments would never have taken place, and the world of broadcasting would not have progressed as it did.

The technical developments described in this article are just a few chosen from the many developments taking place in the 1980s and 90s: there is no implication that the projects described here are the most important.



Dr George T. Waters has spent his whole professional career in broadcasting. He held many posts in RTE, the Irish broadcasting service, including those of Director of Engineering and Director General.

He served on the Bureau of the EBU Technical Committee for ten years, before joining the EBU's General Assembly. He was elected Vice President of the EBU in 1982, where he served until his appointment to the EBU Permanent Services in 1985 as Director of the Technical Department, a post he held until his retirement in 1997.

George Waters holds a primary degree in Electrical and Mechanical Engineering from University College Dublin, and a Master of Business Administration degree from the same university. In 1990, he was awarded the degree of Doctor of Philosophy from Trinity College, Dublin, for his doctoral thesis on High Definition Television. Among his many international awards are The Sir Charles Harvey Award for Management Studies, The International Broadcasting Convention Award, The Award of Honour from the National Association of Broadcasters in the United States, and The Presidential Proclamation from the Society of Motion Pictures and Television Engineers, also in the United States.

Dr Waters is currently President of the International Academy of Broadcasting in Montreux, Switzerland.

Personalities have, deliberately, not been mentioned here in relation to the individual projects, because there were so many involved and it would be invidious to make a selection. However, tribute must be paid to the successive Chairmen of the Technical Committee under whose leadership and guidance the work proceeded in a seamless fashion during the period in question. They were Carlo Terzani, (Chairman, 1977 - 1986), Norbert Wassiczek (Chairman, 1987 - 1990), Alexandar Todorovic (Chairman, 1991 - 1992) and Ulrich Messerschmid (Chairman, 1993 - 1998). Sadly, Carlo and Norbert are no longer with us.

Each of the four brought his own particular body of expertise and experience, which enriched the Committee's deliberations and work – during a period of fundamental developments in the ever-evolving technological environment.

More than any other factor, it is this environment which forges the "ringing grooves of change".

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