Some Historical aspects of broadcasting technology

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The engineering aspects of the development of broadcasting media in Europe are briefly outlined for the period from the mid-1920s to the mid-1980s. The EBU's role in this evolutionary process – both its successes and its failures – are shown.

Origins and traditions

From the very beginning of broadcasting in the early 1920s, the engineers involved in the implementation and development of this new medium were aware of its essentially international character – the then used long-, medium- and short-wave transmissions did not lend themselves to being used exclusively within the boundaries of European countries. Moreover, from the very start, the producers of radio programmes, in particular musical programmes, had many reasons – cultural, political, economical – to exchange their programme material with other broadcasters across national boundaries.

In April 1925, European broadcasters created the International Broadcasting Union (IBU) [1]. Their leading engineers – many of them pioneers of the new technology – formed a Technical Committee. A Technical Centre was created to act as the Committee's secretariat and to co-ordinate the technical studies carried out by IBU Members. Only a few months later, in July 1925, a European conference of engineers was organized to discuss a technical question considered to be essential for the future of the medium: the assignment of frequencies to broadcasting transmitters.

National States and their Governments have always – uncontested – claimed sovereignty over the use of the electromagnetic frequency spectrum. Therefore, the international

1. In French, originally named *Union Internationale de Radiophonie* (UIR), then renamed *Union Internationale de Radiodiffusion*.

aspects of allocating frequency bands to telecommunication services, and frequency assignments to individual transmitters, fell into the domain of the International Telecommunication Union (ITU). However, the IBU and its Technical Committee furnished the technical basis and the preparatory work for the broadcasting planning conferences of the ITU. This activity was recognized by the ITU, and the IBU was nominated officially as "the Expert" at the pre-war European frequency assignment conferences, the last one having taken place during 1934, in Lucerne (Switzerland).

In 1928, the IBU Monitoring Centre was set up in Brussels. It played a major role in the maintenance of order in the broadcasting bands. The frequencies allotted to broadcasting transmitters in the European Broadcasting Area (comprising countries in Europe, North Africa and the Middle East) were measured continuously as to their actual use and stability. The frequency stability of many transmitters was rather poor in those days and often created problems of harmful interference. The regular reports issued from Brussels were generally considered as objective and unbiased statements of the existing situation; they often served to solve problems of transnational interference.

In 1938, the IBU inaugurated its own office building in Uccle (a commune of Brussels), including shielded rooms for the Monitoring Centre *(see Fig. 1)*. When the German Army invaded Belgium, leading staff members left the city for Southern France and Switzerland. The centre, now under German military control, continued to function and issued reports on broadcasting transmitters as usual – a rather surrealistic episode of the Second World War!

Figure 1
The EBU Technical Centre in Brussels, inaugurated in 1938 by the IBU and extended in 1960, 1964 and 1976. *(courtesy of Airprint, Brussels)*

In 1946, the newly created *Organisation Internationale de Radiodiffusion* (OIR) installed itself in the IBU building. Technical activity was taken up again under the authority of two Directors, one delegated by the Soviet Union and the other by France. However, the political situation gradually degraded into the Cold War and this created an uneasy situation of distrust within the staff of the Technical Centre. For example, the Russian Director, without informing his French colleague, Henri Anglès d'Auriac, sometimes simply left his office and another person

presented himself a week or so later as his replacement. Finally, in 1950, the OIR and its Technical Centre relocated from Brussels to Prague. Staff members from Belgium and other Western countries, some of whom had already been active before the war, stayed on in Brussels.

The EBU and its technical activities

In 1950, the European Broadcasting Union (EBU) was created in Torquay (England). Henri Anglès d'Auriac was designated to set up the EBU Technical Centre in Brussels. Some of the IBU/OIR staff were taken over but the IBU building appeared to be too large for the small number of staff foreseen; moreover, frequency monitoring was more and more hampered by electrical interference from the growing urban environment. Consequently, a small villa near the Belgian Broadcasting House was rented for office use and a new Receiving and Measuring Station (the CEM: Centre d'Ecoutes et de Mesures) was constructed in open country at Jurbise, near Mons, some 60 km south-west of Brussels *(see Fig. 2)*.

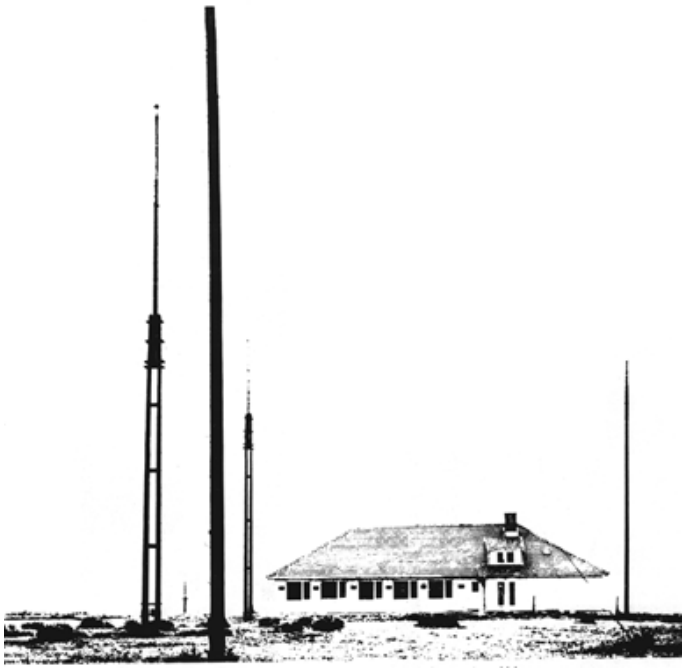

Figure 2
The Receiving and Measuring Station (CEM) at Jurbise.

Right from the start, the EBU's technical activities in the field of research and development, as well as in the operational field, were clearly structured *(see Fig. 3 and Table 1)*:

- The **Technical Committee**, comprising representatives of all the Active Members, with an elected Chairman and a Bureau, and charged with:
  - identifying the domains of technology where common action was required;
  - setting up Working Parties or other groups of experts to deal with the problems encountered;
  - supervising their work and drawing conclusions to be reported to the statutory bodies of the Union.
- The **Working Parties**, their sub-structures and ad-hoc groups, comprising experts chosen from the staff, not only from Members but also from national Administrations and industries actively involved in the corresponding field of operation, research and development.

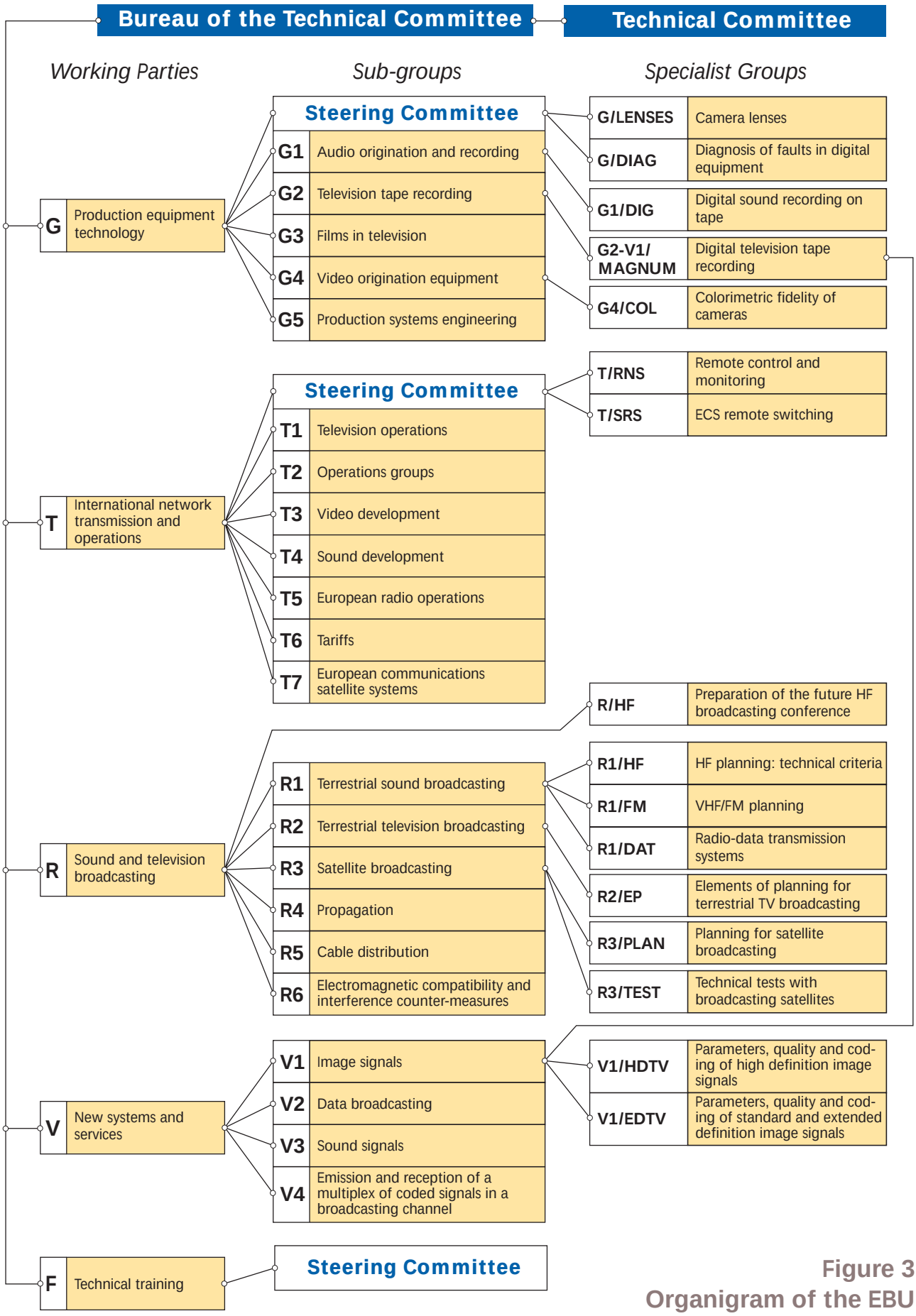

Figure 3
Organigram of the EBU Technical Committee in 1982.

- The **Technical Centre**, manned by permanent staff and charged with:
  - undertaking any operational tasks in the technical field, decided by the authorities of the EBU;

Table 1
Internal organization of the Technical Centre in 1982.

Director *Rudolf Gressmann*		
	Technical studies	**General services**
		⇨ Staff administration ⇨ Accounting ⇨ Library ⇨ Advertising – EBU Review Technical
Division I *Dietmar Kopitz* (R, R/HF, R1,R2, R5, R6, G1, G5, V3, F)	⇨ Terrestrial transmitter network planning ⇨ Technical training ⇨ Collaboration with other Unions ⇨ Collaboration with ITU, UNESCO, etc. ⇨ Cooperation and assistance	⇨ Data processing ⇨ Word processing
Division II *Georges Valet* (G, G2, G2-V1/MAGNUM, G3, G4)	⇨ Recording and Production Technology ⇨ Collaboration with IEC, ISO ⇨ Monitoring Station (CEM) ⇨ Technical publications: ❊ EBU Review – Technical Monographs ❊ Technical documents ❊ Official technical texts	⇨ Translation services ⇨ Logistic services: ❊ Drawing office ❊ Printing workshop ❊ Post room ❊ Microfiches, archives ❊ House services
Division III *Henri Mertens* (V, V1, V2, V3/MUX, R3, R4)	⇨ New technologies ⇨ Satellite broadcasting ⇨ Propagation ⇨ Collaboration with ESA	
Division IV *Alan Brown* (T, T1, T2, T3, T4, T5, T6, T7)	⇨ Network transmissions for sound and television ⇨ Satellite transmissions ⇨ Collaboration with Intelsat, Eutelsat ⇨ Collaboration with CCITT, CMTT, CEPT	
Division V *Paul Turbang*	**Eurovision operations**	
	⇨ Planning ⇨ Eurovision Control Centre (EVC) ⇨ Administration Finance	⇨ Telex

- co-ordinating the activities in the field of broadcasting technology, by providing the secretariat for the Technical Committee and the Working Parties, and by participating actively in their work.

These structures ensured the flexibility necessary to cope with the accelerating progress of technology. Technical research institutions operated by national broadcasters, mainly in the larger European countries, realized more and more that co-ordination and collaboration did not necessarily contradict competition among professional experts. In many cases, unnecessary duplication of work could thus be avoided through the activities of the Working Parties.

In the period between 1950 and 1985 the acceleration of technological progress led to a growing structural complexity, requiring more or less frequent reorganization. In 1982, for example, studies in the field of operations, research and development (including training) were carried out within five Working Parties, subdivided into 22 Sub-Groups and 16 Specialist Groups, as shown in *Fig. 3*.

The Technical Committee was chaired successively by F. da Cunha de Eça (ENR, 1950 - 1952), Edward Pawley (BBC, 1953 - 1970), Claude Mercier (ORTF, 1971 - 1976) and Carlo Terzani (RAI, 1977 - 1986).

The Technical Centre, directed by Henri Anglès d'Auriac from 1950, followed by Georges Hansen (1956 - 1974) and by Rudolf Gressmann (1974 - 1985), of course reflected this development in its organizational and staffing structures. In the early 50s, staff amounted to about a dozen members. In 1985, the Technical Centre employed some 130 members of staff, about half of whom were working for the *Eurovision* operations, while the other half were occupied with matters of technological research and development, and with ensuring liaison with other EBU bodies and international organizations in the technical field.

The more important activities of the EBU's technical institutions during this period are briefly described now.

Operations

Transmission monitoring

In 1949, the Copenhagen LF/MF Conference of the ITU had established a new Plan for Long and Medium Wave Broadcasting in Europe and, although the international associations of broadcasters had lost their function of official Expert, monitoring the broadcasting spectrum continued to be carried out by them. In fact, the newly-created International Frequency Registration Board (IFRB), whose main task was to keep a record of the transmitters and their characteristics, had to rely on the information given by the ITU Members, i.e. by national and governmental agencies (in most cases the PTT

administrations). Therefore, the International Frequency List could only reflect the de jure situation, which in many cases deviated from reality. Quite a number of broadcasting transmitters appeared in that list over many years, without ever having been on-air. Similarly, other transmitters would broadcast their programmes regularly without appearing in the list.

On the other hand, the EBU transmitter lists were generally recognized as reliable and unbiased reports of the de facto situation in the frequency bands allocated to broadcasting. Of course, the reporting of frequency stability became less important, as more and more transmitters were equipped with quartz-controlled devices.

These EBU lists were essentially based on 24-hour monitoring carried out at the Jurbise Monitoring Centre, in collaboration with a number of similar national centres operated by EBU Members in several European countries [2]. In addition, the CEM provided EBU Members with Monthly LF/MF Observation Reports, describing the situation in these bands. As far as the Short Waves were concerned, each of the nine HF frequency bands allocated to international broadcasting services were monitored at least once per year and the observation reports issued to EBU Members on request.

One of the consequences of the 1949 Copenhagen Plan was the introduction of frequency modulation (FM) in VHF band II, pushed forward in particular by the German broadcasters, who had seen themselves deprived of their most important Low and Medium frequencies as a consequence of the War. Monitoring of the FM transmitters – as well as of the rapidly growing number of television transmitters in VHF bands I and III (and, later, on UHF) – was no longer possible by one central point in Europe and the publication of transmitter lists was possible only by organizing an exchange of information between national monitoring stations mainly operated by EBU Members. The Jurbise station was charged with collecting these data. Consequently, transmitter lists for these different wavebands could be published on a regular basis.

In the early Sixties, the need arose to assist members in field-strength measurement campaigns which were deemed necessary, for example, to study the possibility of mobile VHF and UHF reception under various topographical, structural, meteorological and climatic conditions. A van was bought and equipped with the necessary material and this measurement vehicle participated in measurement campaigns in Europe and in the Middle East.

When the political tensions in Europe eased off gradually, the necessity for objective and international monitoring lost its importance and, after an unsuccessful attempt to extend monitoring to satellite broadcasting, this section of the EBU's technical activities was abandoned definitively in 1986.

2. Tatsfield (BBC), Monza (RAI), Limours (ORTF), Helsinki (Yleisradio) and Wittsmoor, Nürnberg and Cologne (ARD).

Programme exchanges

Early transmissions of international television programmes, such as the Coronation of Queen Elizabeth II in 1953, were organized according to multilateral agreements between individual broadcasters. In 1954, the EBU decided to charge the Permanent Services with organizing these exchanges, which had been termed *Eurovision*. The Technical Centre therefore became the network manager of a fast-growing communications network of terrestrial and – some years later – spatial links operated partly by Telecommunication Administrations and partly by EBU Members, and rented either permanently or occasionally by the EBU.

A Planning Unit was installed in the Technical Centre office building in Brussels. Its role was to establish time schedules, and the routeing and switching configurations necessary for all *Eurovision* transmission plans – co-ordinated by a team of Programme Co-ordinators at the Geneva seat of the Union. The exchange operations themselves were carried out at the Eurovision Control Centre (EVC). This Centre was installed in 1956 in the Dome of the Palais de Justice in Brussels and equipped with custom-made communications, switching and monitoring facilities. Thus, the Technical Centre very quickly became the main nodal point of a growing international network for the distribution of television news and other programme material.

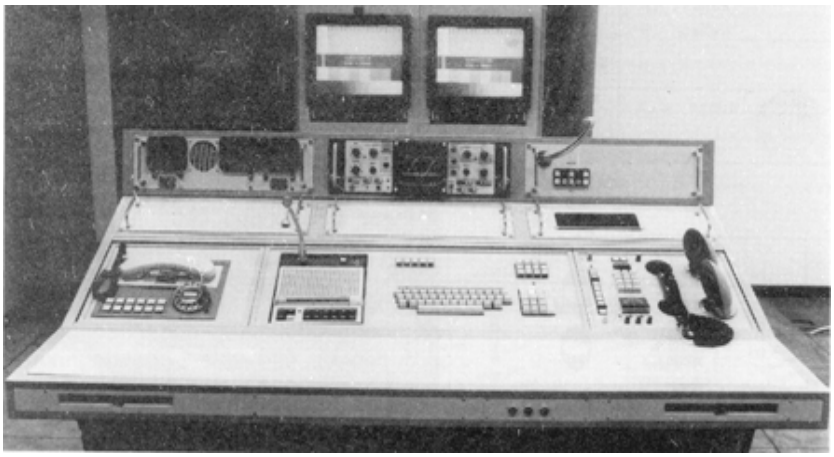

Figure 4
The control desk for programme co-ordination, located in the Brussels Technical Centre.

The novelty of this network, as compared with the traditional linking methods used for the exchange of radio programmes (by means of telephone lines with enhanced sound quality), or compared with national television distribution networks, lay in the condition that the nodal points in each country must be able to act at any time as programme *sources* as well as programme *reception points*: the network's function was distribution and contribution. Another complexity arose from the fact that the (micro-wave) links in most countries were used for television or even video signals only, and that the audio signals to accompany the programme which was finally broadcast (e.g. the comments by national sports reporters on location) as well as the service signals were transported by separate audio links such as those used for the public telephone service. In the beginning, therefore, the EVC frequently ignored the national routeings of sound signals. In the case of sound failures, the only way to detect their origin was by making calls over the public telephone network! In the course of time, however, the reliability of the operation increased together with the expansion of the network, thanks to the introduction of more sophisticated transmission and switching methods. These comprised in particular

the “sound-in-sync” modulation technique developed in the United Kingdom and, more generally, the use of computer and digital technology for the planning and supervision activities, and of communication satellites for distribution.

Programme exchanges beyond the boundaries of EBU countries took place when the OIRT started its *Intervision* network in 1960 and close liaison with its Technical Centre in Prague very quickly became common practice. The exchange of news items between Members, of their own production and, later, also originated by external News agencies, was organized on a daily basis from the beginning and its importance and extent grew from year to year. Regular worldwide programme exchanges became possible when the Intelsat satellite system (“Early Bird”) became operational in April 1965 and thus News and Sports events in all continents could be offered to viewers all over the world.

The equipment used by the EVC for its daily operations had to be modernised and extended almost continuously. The space for this expansion in material and staff was no longer available at the Palais de Justice and therefore, in 1979, the Centre was transferred to the newly-built broadcasting complex of the Belgian broadcasters, BRT (now VRT) and RTBF, in Brussels *(see Fig. 5)*.

Figure 5
General view of the EVC in Brussels.

Research and Development

Transmission and reception

Broadcasting engineers have always been aware of the fact that the development of their medium is closely linked to the optimal use of the rather small sections of the electromagnetic spectrum allocated to broadcasting services by the national and international administrations. The Copenhagen Plan mentioned above had been established in the traditional way whereby verbal negotiations take place among the Telecommunications Administrations during a Conference. This method of assigning frequencies to a large number of transmitters at pre-determined sites, whilst meeting the technical coverage criteria adopted beforehand, cannot lead to an optimal result.

The first ITU Conference to assign frequencies to VHF/FM radio and VHF television transmitters in Europe took place during 1952 in Stockholm. Technical parameters and wave propagation characteristics had been studied beforehand by individual broadcasters

and PTT administrations in those countries where these services had already started on an experimental or regular basis. Television frequency planning proved to be difficult because the different monochrome television systems used in the United Kingdom, in France and in the other European countries had led to ten different channelling systems in Europe, their widths ranging from 5 to 13.15 MHz. However, due to the fact that most of the national transmitter networks were still in their initial phase, the traditional procedures of bilateral and multilateral negotiations succeeded in producing an acceptable Plan.

After that conference, frequency-planning methods were discussed within the EBU, thereby forming a rational basis for further ITU frequency assignment conferences. These methods comprised elements of mathematics so far unfamiliar to telecommunications engineers, such as the combination of geometry and the theory of numbers. They were first used in 1961, at the second Stockholm Conference for the VHF and UHF Bands, in conjunction with the use of computer facilities; at that time the computer developed by Stockholm University was considered to be the most powerful in Europe. At subsequent conferences these operations became common practice.

Field-strength measurement campaigns in the LF, MF, VHF and UHF bands were also organized, with the participation of broadcasters as well as telecommunications administrations. Because of the very large variations in space and time – due to the topographical, geographical, meteorological, climatic, tropospheric and ionospheric aspects of wave propagation – these campaigns had to be carried out over several years (ionospheric propagation, for example is influenced by the 11-year sunspot cycle) and had to cover regions of continental dimensions (for example, trans-Mediterranean transmission paths proved to be important). The results, in the form of statistical field-strength curves submitted to the CCIR, provided the ITU with essential tools for its frequency-planning conferences.

The technical quality parameters of sound and picture signals, as received by listeners and viewers, constituted another basis for these conferences. Protection ratios between wanted and unwanted broadcasting signals could only be determined by organizing listening or viewing sessions with a statistically relevant number of test persons in various countries, thus covering a great variety of listening and viewing habits. Collaboration between the receiver manufacturing industry and the EBU Radio and Television Programme Committees was essential to ensure acceptable quality standards at both a national and an international level.

Extended and new broadcasting services became increasingly objects of preoccupation by the Technical Committee. It realized that the accelerating technological progress could only be managed in conjunction with the Programme Committees, with the Telecommunication Administrations and, most importantly, with the relevant manufacturers. Indeed, the first post-war decade had been determined by straightforward amplitude and frequency modulation methods, but already the introduction of stereophony in FM sound broadcasting and of colour images in television required a much higher degree of international collaboration than had been organized before.

In the case of stereophony, a Working Party studied and tested various systems and proposed one of them (essentially the system introduced in the USA), as a common standard for EBU Members: this system is now in use worldwide.

Colour television proved to be a far greater problem. The Technical Committee created an Ad Hoc Group composed of practically all the experts active in this field, employed by EBU Members, PTT administrations and commercial enterprises. After establishing an extensive catalogue of objective technical criteria, according to which any proposed system should be judged, a great number of tests and experiments were organized to evaluate the three proposals that had been put on the table:

- ⇨ adaptation for 625-lines of the American NTSC system;
- ⇨ the French SECAM system;
- ⇨ the German PAL system.

The dramatic story of this operation has been published extensively and cannot be repeated here. It is interesting to note, however, that EBU activity in this field was characterized throughout by a strong will not to take into account considerations of a political nature. This attitude found its expression in a final report, where all relevant characteristics of the SECAM and PAL systems were evaluated numerically. Both systems, in different areas of concern, showed either slight advantages or shortcomings when compared with the other one. Therefore, any attempt to establish an overall judgement by summing up the individual results would have depended on the weight attached to each area of concern. The EBU, for this reason, was not in a position to propose one single system as a European standard to the international body charged with establishing such standards (the CCIR). All efforts to solve the problem, on the diplomatic and political fronts, did not succeed and, in 1966, the CCIR could not do more than to acknowledge the existence of two recognized colour television systems in Europe, both with a number of variants depending on decisions taken on a national or regional basis.

In the following years, EBU activity in this field concentrated on minimizing the consequences of the absence of a common standard. Colour transcoding and standards conversion methods were developed in the field of production, recording and signal distribution techniques, whilst the receiving equipment industry concentrated on the construction of multi-standard receivers.

Teletext services were developed subsequently, mainly in the United Kingdom and France, but the EBU did not make strong efforts to harmonize these new systems.

In the early Seventies, the broadcasting of traffic information in VHF band II was studied by the EBU while, in Germany, the ARI traffic information system was developed and subsequently introduced by several broadcasters in German-speaking countries. The EBU Technical Committee then charged a Working Party to study more sophisticated systems whereby various digital data services (including traffic information) could be added to conventional FM broadcasting signals. Consequently, the Radio Data System (RDS) was developed and submitted, in 1986, to the CCIR to become a worldwide

standard. It is a complex and very flexible digital system, permitting the successive introduction of a large number of data services. Close liaison with the manufacturers and with the Radio Programme Committee proved to be essential in this successful undertaking.

Abbreviations

ABU	Asia-Pacific Broadcasting Union
ARI	*Autofahrer Rundfunk Information*
CBC	Canadian Broadcasting Corporation
CCIR	(ITU) International Radio Consultative Committee
CCITT	(ITU) International Telegraph and Telephone Consultative Committee
CEM	(EBU) *Centre d'Ecoutes et de Mesures* (Jurbise, Belgium)
CENELEC	European Committee for Electrotechnical Standardization
CEPT	European Conference of Postal and Telecommunications Administrations
CISPR	*Comité International Spécial des Perturbations Radioélectrique*
CMTT	(ITU) Joint Study Group for Television and Sound Transmissions (CCIR/CCITT)
EFP	Electronic field production
EMC	Electromagnetic compatibility
ENG	Electronic news gathering
ENR	(Former) Portugese Radio Company (now RTP)
ESA	European Space Agency
EVC	(EBU) EuroVision Control centre
FM	Frequency modulation
IBU	International Broadcasting Union
IEC	International Electrotechnical Commission
IFRB	(ITU) International Frequency Registration Board
ITU	International Telecommunication Union
LF	Low frequency
MAC	Multiplexed analogue component
MF	Medium frequency
NANBA	North American National Broadcasters' Association (now NABA)
NHK	Nippon Hoso Kyokai (Japan)
NTSC	National Television System Committee (USA)
OIR	*Organisation Internationale de Radiodiffusion*
OIRT	*Organisation Internationale de Radiodiffusion et Télévision*
ORTF	*Office de Radiodiffusion / Télévision Française*
OTI	*Organización de la Televisión Iberoamericana*
PAL	Phase alternation line
RAI	*Radiotelevisione Italiana*
RDS	Radio Data System
RTBF	*Radio-Télévision Belge de la Communauté française*
RTP	*Radiotelevisão Portuguesa*
SECAM	*Séquentiel couleur à mémoire*
SMPTE	Society of Motion Picture and Television Engineers (USA)
TDM	Time-division multiplex(ing)
UHF	Ultra high frequency
UNESCO	United Nations Educational, Scientific and Cultural Organization
URTNA	Union of National Radio and Television Organisations of Africa
VHF	Very high frequency
VRT	*Vlaamse Radio en Televisie* (Belgium)

Satellite broadcasting came to the centre of attention when the ITU decided, in 1971, to allocate the frequency band 11.7 - 12.5 GHz to this service (it had been allocated to general broadcasting in 1959). EBU Members at that time generally thought that *high quality of the programmes* (in the cultural as well as in the technical sense) was more important than *increases in the number of television programmes* offered to the public. This principle, applied to satellite broadcasting, was a determining factor for channel widths, modulation methods, transmitter power and channel-sharing criteria. Moreover, coverage of national programmes within the national boundaries was to be aimed at, in the first instance. Any planning methods also had to take into account that only a limited number of positions in the geostationary orbit could be assigned to the national authorities taking part in a frequency assignment conference.

This conference took place in 1977 in Geneva. It assigned orbital positions and, with few exceptions, five 27-MHz channels to every country worldwide (with the exception of the American continent). This could be achieved thanks to the planning methods mainly developed within the EBU, and by strictly observing the (political) principle of equal rights for each country. The latter, applied to geographically small states such as the Vatican City, Monte Carlo, Andorra or San Marino was of course in contradiction with the principle of optimal use of the frequency spectrum, but the overall result was considered a success at the time.

Meanwhile, the European Space Agency (ESA) was planning to launch a heavy satellite named H-SAT (which later became L-SAT, then OLYMPUS). When contemplating possible payloads for this experimental satellite, the installation of a high-power direct broadcasting transponder was seen to be attractive and the EBU was approached as a possible user of this facility. This proposal led to very close collaboration between experts from both organizations, within the framework of their respective Working Parties and Committees. All technical aspects of direct broadcasting by satellite were clarified during the following years and a great number of problems, particularly in designing a specific broadcasting system for this new service, were solved. However, although ESA was offering the use of its experimental satellite free of cost, the EBU finally did not make use of this offer because EBU Members neither agreed to bear the cost of providing the programme material and for its distribution and up-linking, nor on a common policy for a follow-up of any experimental or pre-operational phase.

The system for direct broadcasting by satellite of conventional television programmes was developed by experts from research departments operated by EBU Members, by ESA, by Telecommunications Administrations and by the industry, but also individual engineers and other specialists in the field from all over Europe took part in this enterprise. In the presence of a very large variety of ideas and proposals, and after numerous discussions and experiments, consensus was finally reached to base the system on the generalized adoption of a Time Division Multiplex (TDM), in which the analogue video components (luminance and colour-difference signals) are themselves transmitted in a time multiplex (the MAC system) and where the digital sound and data components are organized in a multiplex of data packets. Detailed specifications were worked out on the basis of extensive testing in various laboratories and finally, the C-MAC/Packet system, one of the MAC/Packet family of systems, was proposed to the CCIR in 1983.

Meanwhile, discussions on the desirability of introducing digital television, high-definition television and wide-screen pictures (i.e. pictures with aspect ratios larger than 4:3) had started. Japanese and North-American broadcasters and industries played a major role in these developments. Moreover, the European receiver industries, in the absence of a broadcasters' strategy for providing new programmes for satellite broadcasting, appeared to be reluctant to mass-produce MAC receivers; also, the semiconductor industry took more time than expected to produce the necessary chips. Finally, communication satellites outside the satellite broadcasting bands (e.g. Astra) began to transmit conventional FM-modulated PAL and SECAM television programmes to the cable systems emerging in various European countries – and to individual viewers. Disregarding the ITU's Radio Regulations, these satellites offered an increasing number of mainly commercial programmes to the public. Arguments for high-power transponders on satellites and for higher technical picture and sound quality became less and less convincing and the MAC-system could finally not be implemented.

Man-made electrical noise was with broadcasting from the very beginning. In 1933, broadcasters, manufacturers of electrical equipment and PTT organizations met in Paris and recommended the creation of a joint committee to establish rules and regulations to minimize interference from household, medical and industrial equipment and other sources of interference. The CISPR (Comité International Spécial des Perturbations Radioélectriques) eventually became a Committee of the IEC (International Electrotechnical Commission), composed mainly from national IEC Committees, but the EBU was also admitted as a full member. An EBU Working Party was charged with studying all questions linked to what some years later was termed Electromagnetic Compatibility (EMC). Numerous EBU contributions were submitted to the CISPR, whose main objective had become to facilitate international commerce. These contributions constituted an important element when establishing radiation limits capable of giving maximum protection to listeners and viewers.

Production

In the field of Production, work in the early Fifties mainly concentrated on establishing standards for the professional recording of programme material. This was necessary not only because live productions were more and more replaced by pre-recorded programmes, but also because of the growing need to exchange programmes at both a national and an international level. Standardization on a worldwide scale of the essential characteristics of professional recording equipment appeared to be essential. Collaboration with all relevant manufacturers and other national and international organizations concerned was seen to be necessary and was put into effect progressively.

Soon after the War, the traditional sound recording on disk was replaced by magnetic recording on tape. It was clear from the beginning that any exchange of recorded material, its post-production treatment and its final distribution would require specifications with tight tolerances, in particular regarding tape *widths* and tape *speeds*. Technological

progress resulted in reductions being made to both these tape characteristics, whilst maintaining or even increasing the reproduction quality. This development was followed very closely by one of the EBU's Working Parties and the standards so obtained were subsequently submitted to the CCIR. Although the subject matter had little to do with telecommunications or radiocommunications, it was found practical to issue the EBU specifications (in most cases textually) in the form of CCIR Recommendations, thus making them global standards.

Television programme recording started, of course, by using cinema film technology. In this field, the EBU and the American SMPTE soon established close links. This resulted in common specifications for recording television material on 35-mm and 16-mm film, whereby the synchronized sound components were to be recorded on either a magnetic track on the film itself or on separate magnetic tape. Magnetic recording of video signals, initiated by extensive research work carried out initially by the BBC, was very quickly recognized as becoming an essential production tool for television programmes. Again the EBU played its role by closely following the commercial developments taking place mainly in Europe, in the USA and in Japan and by bringing together all parties involved in international standardization. As in sound recording, international programme exchanges required the specification of basic parameters and their tolerances, particularly with regard to tape width and speed. Professional cassettes made their appearance and this development required a study of their relationship to the traditional spool techniques.

Meanwhile, in the late Seventies, digital techniques started to enter forcefully into the considerations of broadcasting producers: the idea of a digital studio began to take shape. In 1982, the CCIR adopted a television production standard proposed by the EBU. The so-called "4:2:2" standard was considered to be a milestone on the path to the digital studio. Its further development into digital tape recording formats, common interfaces and other aspects of production elements, such as camera and telecine equipment, is described elsewhere. In 1982, the EBU was honoured with an EMMY Award for these achievements.

Figure 6
The main Conference Room at the Brussels Technical Centre.

Another field of television programme production began to take shape in this period. EBU Members and Associate Members in North America and Japan, such as CBS and

NHK, started to discuss novel methods for Electronic News Gathering (ENG) and Electronic Field Production (EFP).

Distribution

The development of *Eurovision* activities had been followed and directed from the beginning by two Working Parties of the Technical Committee, composed essentially of experts nominated by EBU Members and owners of telecommunication links, both terrestrial and spatial.

The technical, organizational and operational complexity of the *Eurovision* network, and the corresponding diversity of responsibilities, required a set of clearly-formulated compulsory rules and, from 1958, these were published by the Technical Centre in form of the *Eurovision Code of Practice*, a constantly updated volume, sometimes called the *Bible of Eurovision*.

The complexity of *Eurovision* operations was also due to the fact that most technical problems could not be handled without considering questions of policy and finance. Their solution therefore required close co-ordination of the administrative, programme, legal and technical institutions of the EBU and its Permanent Services.

Thus, for example, the configuration of *Eurovision* networks largely depended on the tariffs applied to national and international links. Traditionally, telecommunication links in Europe were owned by governmental administrations and they were reluctant to discuss tariff matters with users. In fact, all international tariff structures and figures were fixed within governmental organizations such as the ITU's Committees (CCITT and CMTT) and the CEPT, in whose meetings non-governmental organizations such as the EBU could only be admitted as observers. At CEPT meetings, EBU observers were not permitted to take part in deliberations on tariffs: they were simply informed about the result of these discussions. Planning of the network configuration, in the case of both bilateral and multilateral programme exchanges including the News exchanges, had to be carried out on the basis of minimum cost. This, as well as the constant increase in traffic, led to the development of computer-assisted planning methods and corresponding hardware, which were brought into service in 1993.

The co-existence of different television systems in Europe also caused a problem for the *Eurovision* network managers. System converters (405/525/625/819-lines, NTSC/PAL/SECAM with their variants) had to be developed and installed at nodal points in the network in such a way that programme exchanges could take place with a minimum of successive system conversions or colour transcoding.

Another problem, where cost optimization became important, arose when satellite links came into use. The positioning of earthstations for the Intelsat and Eutelsat systems could not be qualified as being optimal as seen from the *Eurovision* network management point of view. At an early stage, the EBU put forward proposals to incorporate

earthstations and satellite transponders, either owned or leased by the broadcasters themselves, into the *Eurovision* network. However, these proposals met with strong resistance from PTT administrations. Only when privatization of telecommunications services became a general trend in Europe, could such improvements become reality.

Large operations overseas co-ordinated by the EBU, such as the Olympic Games or the World Football Championships, could only be handled by a team on the spot at the event. This unit had to handle the necessary switching operations between various locations and other programme distribution activities. Local authorities could not always provide these teams with the equipment required and therefore a switching and control installation was developed, which could be shipped to the location and installed in the premises provided by the local organizers. This equipment was first used at Montreal in 1976.

Collaboration with other international organizations

A great number of international organizations are active, directly or indirectly, in broadcasting matters; some of them have already been mentioned. The EBU has always sought close collaboration with all of them, by actively participating in their work. Written contributions were presented at their meetings by experts or observers chosen from the staff of Members, or of the Technical Centre. Thus, close liaison was established and maintained with other international broadcasting organizations such as OIRT, ABU, URTNA, NANBA (now NABA) and OTI, but also with the ITU (and its bodies), CEPT, Eutelsat, ESA, CISPR, ISO and occasionally with some of the bodies created by the European Commission (for example CENELEC), by the Council of Europe or by UNESCO.

Training and assistance to Members

Professional training departments had been established by several EBU Members and, starting in 1976, it was found useful and necessary to organize meetings of those responsible for these departments, in order to exchange experiences and ideas, thus avoiding duplication of work. Towards this end, a Working Party (Working Party F) was later set up in 1982.

The Technical Centre, established mainly to serve Members' common interests, was also occasionally charged with assisting individual Members and Associate Members in solving specific problems. For example, mutual interference between the transmissions of EBU Members in countries finding themselves in the midst of a political conflict which prevented direct contact between those Members, could in several cases be handled by using the Technical Centre in a mediating function. Another field of assistance, in particular to broadcasters in smaller countries, consisted of special studies in various fields. Thus, for example, a feasibility study concerning the introduction of FM broadcasting in Cyprus was carried out on behalf of CyBC in 1969 by specialists from the BBC, RAI and the EBU Technical Centre. In a more general way, Associate Members – especially in Africa – were assisted when their countries undertook to establish frequency plans, by

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In 1974, Mr Gressmann was appointed Director of the EBU Technical Centre in Brussels, and remained in this post until his retirement in 1986.

giving them direct assistance and by participating in an expert role in the corresponding ITU Conferences and their preparatory meetings.

Conclusions

Broadcasting in the period between the end of World War II and the mid-1980s can be seen as a mass medium, developing from a simple, amplitude-modulated audio service to a set of sophisticated systems to provide video, audio and data messages to the general public. The rapid scientific and technological progress underlying this evolution required close liaison between those responsible for the content of the messages to be provided and those charged with devising and operating the means to produce, distribute and transmit them.

The EBU took account of this necessity by creating Permanent Services and consultative Committees to cover all aspects of broadcasting. The Technical Centre and the Technical Committee have mainly been active in fields where either common action or co-ordination of individual actions appeared to be necessary. The foregoing survey of these activities shows, independently of their final success or failure, a prevailing sense of collaboration and solidarity in providing broadcasting signals of the highest possible technical quality to listeners and viewers.

Historically, the second half of the Twentieth Century can be characterized by the unification of Europe, economically, culturally and politically. The pioneers of this undertaking have always been conscious that union should not lead to uniformity and that a balance must be found between centralization and the principle of subsidiarity, between national interests and European solidarity, between individuality and communality, between standardization and competition, between European interests and global open-mindedness.

The activities of the EBU over the years can be seen as an exemplary performance – demonstrating that such a balance can work to everybody's benefit.