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The WARC-92 Decisions and the Future for Digital Audio Broadcasting (DAB)

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The WARC-92 was a crucial step for the strategies of implementation of Digital Audio Broadcasting (DAB). The Conference had to decide about the possible allocation of the frequency band for direct broadcast satellite sound (DBS(S)). This paper summarizes the importance of the issue for DAB, the strategies before the conference and the reactions after the Conference, as they were observed during the First International Symposium on Digital Audio Broadcasting, organised by EBU, in collaboration with Eureka 147 and the NAB/Radio Montreux (Montreux, 8-9 June 1992) (1).

The Need for Satellite Frequencies

The direct broadcast satellite (sound) concept has been advocated since the sixties. Different R&D studies by CCETT, CCIR, EBU, ESA have emphasised the advantages of the satellite use for DAB. Such a system offers the prospect of delivering audio broadcast to large audiences very quickly and at costs lower than or at least comparable to those using the current terrestrial broadcasting means. The maturation of mobile communications technologies, the advances in microelectronics and digital signal processing now make it possible to bring this technology to the market place.

(1) This paper is based on the study *Frequencies for DAB in Europe*, realized by IDATE, in collaboration with BBC Research Department, CCETT, CERIM-TDF, IRT for the European Commission (DG XIII). The paper doesn't necessarily reflect the views of the Commission and of IDATE's partners.

The use of satellite for DAB transmission needs different requirements:

1) to compensate for "propagation losses", the satellite transmitter power has to be sufficient and the system has to be designed to work under multipath environment;

2) according to the CCIR, satellite transmitter power is a key parameter of a direct broadcast system. One direct broadcasting satellite can only be designed to cover rural or cleared areas;

3) studies by CCIR and Jet Propulsion Laboratory has shown that the necessary satellite transmitter power increases rapidly with frequency.

The link budget is a key parameter of a DBS-R system. New tests and assumptions on the receiving station have decided the CCIR to lower power requirements in its report to the WARC-92: a 5W satellite antenna input power per stereo program has been assumed. Taking into account the antenna diameter and the satellite transmitter power, the 1,5 GHz frequency gives the widest range of implementation flexibility.

Satellite concepts for DAB

The satellite power requirement is the critical parameter for a satellite system for DAB. As a direct broadcasting satellite can only be designed to cover rural or cleared areas, to obtain a satisfactory services area, two technical solutions are under study:

1) the first idea is to use Highly inclined Elliptical Orbit (HEO) instead of using geostationary orbit; the more favourable HEO link budget permits a good service in rural and suburban areas, but does not completely serve urban areas;

2) the satellite coverage can be improved though the use of terrestrial retransmitters in the same frequency band: this idea is known as "mixed" concept and "hybrid" concept.

The HEO concept

The HEO concept has been particularly studied by ESA under the project name "Archimedes" for sound broadcasting and mobile communications. ESA is considering the possible launch of Archimedes satellites in 1997 and will consider after the WARC-92 the market opportunities for both sound broadcasting and mobile communications.

The technical advantages of the HEO are:

- 1) less propagation losses due to the high elevation angle of the downlink signals;
- 2) higher receiving antenna gain as it no longer needs to be omnidirectional in the vertical plane;
- 3) a smaller satellite transmitting antenna diameter than those of GEO for a same service area.

Some difficulties have to be overcome:

- 1) necessity of an extra load of the satellite to protect the satellite from the strong radiations of the Van Allen belt;
- 2) necessity of at least three satellites (excluding reserve facilities) to assure a service all day long. The Archimedes project proposes four satellites to maximize the high elevation angle of reception and thereby minimize building shadowing or losses for the mobile receiver ;
- 3) the up link station must have two antennas adjusted in the direction of the "going down" and "going up" satellite;
- 4) necessity of compensation of the "Doppler effect";
- 5) necessity of completing the coverage area by terrestrial retransmitters using the hybrid concept.

From the above remarks, one may conclude that the HEO concept could be an alternative to the GEO one in high latitude countries as in Northern Europe (latitude $> 55^\circ$). As the HEO are a possible option for BSS (sound), WARC-92 has to elaborate the regulatory frame for the use of such orbits.

The hybrid approach

As the satellite transmitter power cannot compensate the high propagation losses without resulting in excessive system cost and an impractical system design, one way to improve the coverage is to use low-power retransmitters on the same frequency (the "gapfillers"). With such an approach, the same receiver can capture both emissions from satellite and terrestrial transmitters.

The hybrid BSS concept can be a special application of COFDM suited to operate in a multipath environment by making constructive use of these echoes. Active echoes deliberately introduced by co-frequency repeaters to fill the shadowed areas are treated as if they were passive echoes. This results in a reduction of the required satellite power to typically the level needed to cover rural areas. The retransmitted power can be very low, of the order of a few milliwatts, depending on the size of the shadowed area to be covered.

In rural or suburban areas, the signal comes mainly directly from the satellite. In urban areas, it comes either from the satellite or from the "gapfillers".

The coverage area of the low-power terrestrial retransmitters in a hybrid system decreases with frequency and consequently this number increases with frequency. Their may become a critical factor for the cost of their terrestrial network associated with the satellite.

Effects of frequency on terrestrial relays of a satellite COFDM system

Frequency (GHz)	0,5	1	1.5	2.5
Coverage radius (Km)	10	5	3.3	2
Retransmitter distance (Km)	30	15	10	6

It appears that the implementation of the complementary terrestrial network of a hybrid system is governed by specific topologic constraints that may imply an excessive system cost if the frequency is too high.

The mixed concept

The concept of a mixed satellite/terrestrial sound broadcasting service is based on the use of different blocks in the same frequency band by satellite and terrestrial broadcasting services delivering different programmes in the same area, or the same block in different areas. It can maximise the spectrum use by allowing these two broadcasting services to closely coordinate their service development rather than attempting sharing of the frequency band by totally unrelated services. The assumption is that with a near omni-directional receiving antenna, the receiver would capture the emissions of both satellite and terrestrial transmitters. Furthermore, if the same transmission format using the same modulation parameters is used, then a same receiver can be used.

The combined mixed/hybrid approach

The mixed satellite/terrestrial service concept can also be augmented with the use of terrestrial re-transmitters at the same frequency for both satellite and terrestrial services. The use of re-transmitters either as a gap-filler or coverage expanders to improve the terrestrial coverage would allow a further decrease of the required terrestrial transmitter power and, in addition, create a sharper discrimination profile, thus allowing greater frequency re-use. To gain full benefit of this concept, the system should provide a great deal of flexibility implementation.

Allocation of frequencies for BSS (sound)

Interference with other services

To examine the possibility of an allocation for BSS (sound) in the range 500-3000 MHz, one important factor is the capacity of sharing between BSS (sound) and the other services.

Studies of the feasibility of sharing frequencies have indicated that different conditions for non-interference between different services require a certain separation distance between the boresight of the BSS (sound) service area and the receiving stations in the other services.

The magnitude of the geographic separations required depends on many factors:

1) of the DBS-R: size of the service area, angle of arrival of BSS signal, DBS-R configuration (satellite only, hybrid, mixed, mixed/hybrid, GEO or HEO);

2) characteristics of the system, the operating frequency,....;

3) characteristics of the service with which sharing is studied.

The CCIR concludes that in nearly all of the cases considered, such protection will require significant geographic separation between the boresight of the BSS (sound) service area and the receiving stations in the existing services. The separations range from 200 Km to 7.000 Km when BSS is considered as the interfering system.

An important feature is that a DAB receiver working in the frequency range 2,5 GHz is likely to suffer interference when it operates in the same room as a microwave oven. This may preclude use of this band for portable domestic DAB receivers.

Estimation of frequency requirements for BSS (sound)

Estimation of frequency requirements for BSS (sound) have been made by EBU and by Canada. The total frequency band required to cover a number of service areas can be determined by developing coverage scenario exercises and will, of course, depend on the assumptions made for coverage and for intra-service protection ratio. The results for the total frequency bandwidth required for at least 12 CD quality stereophonic programmes per country varies from 64 MHz to 120 MHz. In its memorandum "Principles for the guidance of EBU members for WARC-92", the EBU formulated a requirement of at least 64 MHz, and preferably 100 MHz, in order to provide sufficient programmes to all service areas to ensure service viability.

Potential for redeployment in sub-bands for BSS (sound) within Europe

Two frequency bands are mainly under considerations in the different administrations for a possible allocation to BSS (sound): the 1.5 GHz frequency band and the 2.5 GHz frequency band.

The corresponding sub-bands in the Radio Regulations are:

- (1) 1427 - 1530 MHz
- (2) 2500 - 2690 MHz

There is a great consensus in the broadcasting world to prefer the 1.5 GHz frequency band since this gives the widest potential for broadcasting satellite system implementation.

This solution is considered as the more interesting in CERIM's contribution to this study, is strongly supported by EBU and its members. It is also considered as the more favorable by EACEM and recommended by the CDMM (Council of Europe). Some Member states of the Community had also support this solution before the WARC-92: notably France, Belgium; some PTT Administration: PTT (Belgium); some Broadcasting regulatory bodies: Conseil Supérieur de l'Audiovisuel (F) and the Radio Authority (UK).

However a vote inside the Ad-hoc Working Group WARC-92 of CEPT (12 June 1991) has indicated a majority in favour of Resolution BBB relating to the introduction of BSS (sound) Services. This Resolution considers that *"the frequency bands concerned shall not be available for general use by BSS-Sound until the year 2005 but for the accomodation of*

experimental systems starting not before 1.1.2000 the sub-band 2580-2596 MHz only should be utilised; (...)".

The result of the vote was:

- 1) 7 foreseen cosignatories (Austria, Hungary, Norway, Portugal, Romania, Sweden, United Kingdom);
- 2) 4 potential qualification to foreseen co-signatories (Czechoslovakia, Denmark, Germany, Switzerland);
- 3) 2 with uncertain outcome (France and Italy);
- 4) 5 not foreseen as co-signatories (Belgium, Finland, Ireland, Netherlands, Spain).

If we consider only the EEC Members states, there was no majority in favour of this Resolution inside the Community:

- 2 foreseen signatories: Portugal and United Kingdom,
- 2 potential qualification to foreseen co-signatories: Denmark and Germany,
- 2 with uncertain outcome (France and Italy),
- 4 not foreseen as co-signatories (Belgium, Ireland, Netherlands, Spain),
- 2 countries did not take part in the vote.

The result of the vote within the CEPT working group was viewed as a deception by DAB supporters, in particular the EBU. It is sometimes considered as a preference given by P&T administrations to mobile communications, even if mobile communications proposals was also rejected.

Concrete interest of broadcasters for BSS (sound) for DAB

There is theoretical evidence that operational frequencies for DAB in a DBS (sound) way are necessary for a cheaper coverage of the rural and suburban areas. When asked about the interest for satellite use for DAB, broadcasters generally answer with theoretical arguments which are common to CCIR, EBU, ESA.

Another question is whether broadcasters really envisage using a satellite frequency. Views of the technical managers do not necessarily reflect the views of the Directorates and also the financial turmoil in the public service organizations could delay decisions on investment in DAB technology and leasing of satellite transponders. It has to be considered that most of the public broadcasting organisations in Europe face financial problems. The US private radio sector has also severe financial problems. It is estimated that half of the stations in the USA made a financial loss in 1991.

An assurance of the use, after 1997, of frequencies on satellite, was generally considered as a guarantee to launch DAB through terrestrial transmission as soon as 1995.

From a theoretical point of view, the number of services required is determined by an estimation of the number of:

- national channels in large countries,
- channels operating in a large regional area (eg. Bavaria, Catalonia,...),
- channels with pan-European ambitions.

A number of radio services already use satellite, most of them for contribution links; also some for direct reception in the home using dish antennas: 80 radio services on satellite were listed in August 1991, some of which employ simulcasting on 2, 3 or even 4 satellites.

International radio services by satellite

DAB satellite could allow new international services with pan-European ambitions or aiming to serve a linguistic area. However, the availability of pan-European market for radio channels has to be considered:

1) the experience of private pan-European TV channels has been disappointing for the investors. Lack of pan-European advertisers, cultural and linguistic barriers, copyrights problems have undermined the prophecy of the early '80s about a pan European Market;

2) difference of national tastes in music (even in specific music like rock, jazz or even classical music) is emphasized by the experience of Euradio (EBU's exchange of musical programmes) and by the record industry;

3) pan-European advertising could even be more difficult to realize in radio than in TV.

However, it is probable that there will be applicants for channels with European ambitions. For example, some French FM commercial networks are already present in the French Community of Belgium or in the Suisse Romande. They could be interested in the possibility of using a unique coverage (even with the consequence of missing local/regional advertising). Other channels with specific "formats" and using the English language could start up as MTV Europe is doing in the TV sector.

DAB for replacing international short waves services

Diverse projects exist in the world for satellite systems using DAB which could replace the current shortwave transmissions for international services: Africaspace, Radiosat international, Radiosat. An agreement between Voice of America and NASA was established to coordinate a program on DBS-R. The Radiosat project seems the more advanced and has already received declarations of interest from the main international services. Through a flexible regional or zonal approach to the exploitation of BSS(s) allocation, a number of systems could coexist worldwide on the same satellite. In this perspective, a common worldwide frequency allocation in the same band could have a decisive impact on the radio industry involvement in DAB.

According to EACEM (European Association of Consumers Electronics Manufacturers), *"if worldwide frequency allocations in the same band are made available for satellite DAB and agreement can be reached on a single world standard, then with large scale production, the cost of receivers would be extremely low. It is very important that this technology be inexpensive and readily available if it is to be attractive to developing countries, since in many of these countries it will be cheaper to install such a DAB service than terrestrial VHF-FM"*.

The International Debate Before the WARC-92

Possibilities for a worldwide system for international services depend on the common interest of the States to find a common allocation for BSS(s) taking into account the possibilities offered by DAB. The evolution of global international relations and the growing collaboration between international radio services which were antagonistic in the period of the Cold War, could make possible such an agreement.

The debate in USA

The preparation of WARC-92 in United States has been focused on the DAB issue and is involving different administrations and lobbies. The FCC, on behalf of commercial broadcasters, and the National Telecommunications and Information Administration, on behalf of military and other government users, are attempting to work out their differences over DAB spectrum.

The FCC and NTIA staffs have been exchanging information before the WARC-92. However, the final word came from the State Department, which relies on the FCC and NTIA for recommendations, but is ultimately responsible for setting and advancing the US position. The military uses the L and S bands for telemetry in testing aircraft. It argues that DAB should be restricted to the unfavoured S band (2,5 GHz).

In June 1991, the FCC recommended to the State Department that it seek a spectrum allocation for terrestrial and satellite DAB in the L and S bands. But, the FCC has announced in a Public Notice (31 October 1991) its strategy for Digital Audio Broadcasting. FCC Chairman SIKES announced an agreement with the Executive Branch of FCC that the USA will seek an allocation for satellite and complementary terrestrial DAB at 2.3 GHz. The specific band to be considered is 2310-2360 MHz. According to a statement of the NAB President this decision appears to pave the way for satellite DAB, which US broadcasters have strongly opposed (to protect the regional configuration of the radio sector), but at frequencies not as desirable as satellite proponents might have hoped. According to President FRITTS *"how DAB might perform in these frequency ranges is unknown, but we suspect this spectrum may prove undesirable for any type of DAB - satellite or terrestrial"*.

However according to a memorandum of Mr. RAU (NAB Senior Vice President, 5.11.1991, *"the future of a 1.500 MHz allocation is in some doubt, at least in the US. However the Public Notice does not exclude this band from consideration. As a fallback position, the United States may accept scheduling of a future WARC to deal specifically with the question of DAB allocations, in the event that WARC-92 agreement cannot be reached, or with pressure from Canada and Mexico, the USA may agree to some kind of an allocation at 1.500 MHz"*.

According to *Broadcasting* (7.10.1991), *"the US is sour on a European proposal to allocate spectrum exclusively for an international mobile*

service, which will allow users to move from country to country with the same equipment and frequencies. Such an allocation would lock the US into a service that is not yet sure it wants, said BARAN, who will be heading the US WARC delegation. There are currently so many alternative global communications services, the US feels it is unnecessary to reserve spectrum just for the "global roaming" capability, he said. What is more, he added, such a service would benefit only those relatively few people who travel internationally and do not have access to other types of telephone services".

Other countries the following decisions were taken:

Some other American States (Canada, Mexico, Brasil,...) were indeed lobbying for the 1.5 GHz solution. In general the same duality between P&T Administrations and Broadcasting Authorities and Organizations could be noted. For developing countries or countries with a large territory, DAB could be an useful alternative to short waves and those countries may be interested by the 1.5 GHz solution.

Decisions of the WARC-92

The WARC-92 resolution dedicated to BS(s) has decided the following provisions:

- The principal allocation available worldwide was decided as 1452-1492 MHz. However the United States opted out of this decision with a national footnote provision which indicated that satellite sound broadcasting in the US would utilise the band 2310-2360 MHz. The CIS countries together with some Asian countries, including China, Japan and India preferred a third solution, taking a footnote provision for the band 2535-2655 MHz. In order to show flexibility and to avoid a potentially damaging deadlock CEPT countries changed their position during the WARC, transferring their support from 2.5 GHz to 1.5 GHz. In many countries, among with several European, the Broadcasting Satellite Service and the Broadcasting Service will remain with a secondary status until 2007 (1).

(1) Secondary allocation of the band 1452-1492 until 2007 in the following European countries: Denmark, Germany, Greece, Ireland, Italy, Portugal, Spain, United Kingdom.

They then will become primary :

- a competent conference should be convened, preferably not later than 1988, for the planning of the broadcasting-satellite service (sound) in the bands allocated ;

- in the interim period, BSS systems may only be introduced within the upper 25 MHz of the appropriate band in accordance with Resolution 33. The complementary terrestrial service may be introduced during this interim period subject to coordination with administrations that may be affected.

In addition, the following decisions were taken:

- Resolution 33 determines the conditions of coordination of satellite systems with existing services on the basis of established power flux density limits.

- Non geostationary use of the allocated bands is not explicitly foreseen. However, the precise decisions on how to implement the services will be taken by above mentioned future conference and therefore no definite information exists.

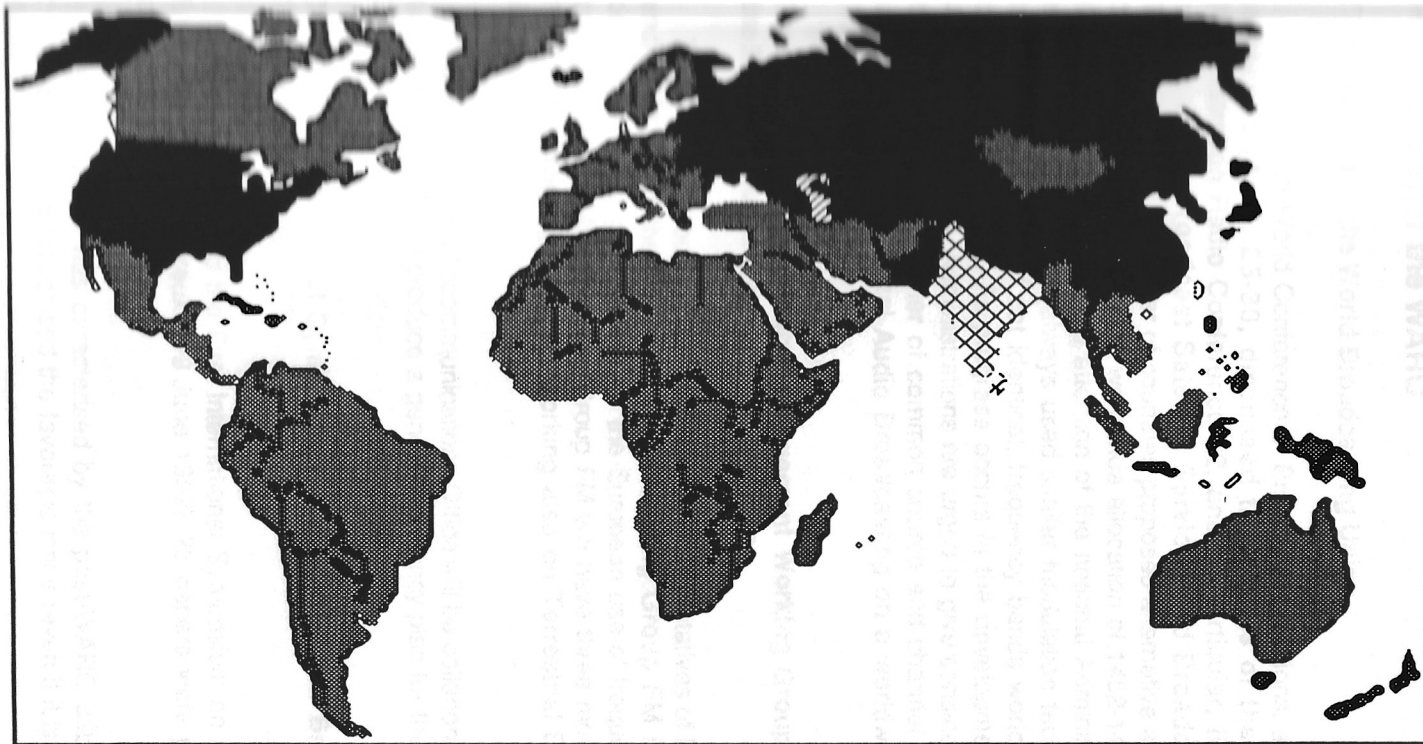
WARC-92 Decisions Relating to Satellite Sound Broadcasting

The resulting situation is shown in the following Table and world map.

Table of band allocations

1.5 GHz	2.3 GHz	2.6 GHz
Worldwide except USA	USA India	Russia Ukraine Belarus China Korea India Japan Pakistan Singapor Sri Lanka Thailand

World map of WARC-92 band allocations



■ 1.5 GHz and 2.6 GHz

■ 1.5 GHz

▤ 2.3 GHz

▨ 1.5 GHz and 2.6 GHz

Source : EBU

Reactions after the WARC

The reactions of the World Broadcasting Union

The Seventh World Conference of Broadcasting Unions, at its meeting in Mexico (April, 25-30, discussed the results of the ITU World Administration Radio Conference 92, and, in particular, the spectrum allocation for Broadcast Satellite Services and Broadcast Sound. Recognizing that a number of countries proposed alternative allocations for this service, in addition to the worldwide allocation of 1452-1492 MHz, the Conference has bring to the attention of the national Administrations that sound broadcasting has always used similar modulation techniques, AM and FM, and similar, if not identical, frequency bands worldwide, to the benefit of the listener. As progress occurs in the development of Digital Audio Broadcasting, Administrations are urged to give consideration to the benefits for the consumer of common source and channel coding, and implementation of Digital Audio Broadcasting on a worldwide basis at 1.5 GHz.

The Work of the Frequency Management Working Group FM and of the European Radiocommunications Office

The Working Group FM is composed by representatives of EBU, ECTEL and ETSI. After the WARC-92, the Working Group FM initiated the development of a general plan for the European use of frequencies in the band 1350-2690 MHz. Working Group FM will have three meetings during 1992. This Working Group is working also on Terrestrial Digital Audio Broadcasting.

The European Radiocommunications Office will be collaborating with the Working Group FM to produce a general frequency plan for the band 1350-2690.

The First International Symposium on Digital Audio Broadcasting (Montreux, 8-9 June 1992)

EBU has organized the First International Symposium on Digital Audio Broadcasting in Montreux (8-9 June 1992). 28 papers were presented to around 500 participants.

The Symposium was characterised by the post-WARC debate. Most of the speakers have recognised the favorable issue (even if it is not ideal) of

the Conference for DAB implementation. Allocation of the 1.5 GHz position for satellite DAB from year 2007 in most of the world countries is considered as a determinant step towards the new technology implementation.

Interest for DAB outside Europe

The main case of concern seems to be the present absence of consensus on how DAB should be implemented in North and South America. Canada and Mexico confirm their preference for the L-Band (1.5 GHz) position and are confident in a possible US revision of their non-adoption of the L-Band allocation for DBS. Reasons for this choice were explained by Mr. ABEL, Executive Vice President of NAB. According to Mr. ABEL, elusiveness of a consensus around US broadcasters about DAB implementation are due to DAB's potential to radically change the structure and economics of broadcasting. A risk-averse sentiment has emerged and has coalesced around approaches for implementing Direct Satellite Broadcasting that involve the least possible disruption to the industry. NAB's initial position in favour of allocation of L-Band has evolved from 1980 to 1992 as it was not supported by broadcasters and was vehemently opposed by the Defense Department. NAB is now considering the proposals for "in band" systems. Several proposals are made (either "on channel systems" or "Adjacent-Channel Systems"). The more considered proposal is that of USA Digital Radio ("Project Acorn"): at the 1992 NAB Convention, USA Digital demonstrated the ability to extract, demodulate and reproduce a digital audio signal that was placed 30 dB below the FM signal level. They are in the process of optimising their modulation scheme and plan to conduct demonstrations over-the-air in New Orleans at the NAB Radio Show in September 1992. However, "in-band solutions" continue to raise scepticism from the Eureka 147 engineers. Some American observers recognise privately that most of the "in-band" proposals are just a lure. FCC will have to decide in 1993 about eventual choice between Eureka 147 proposal and the "in-band" proposals.

Canada's interest in DAB was confirmed by Mr. ZEITOUN (Department of Communication). Canada is working on the mixed satellite/terrestrial concept. According to Mr. ZEITOUN, *"In Canada, the public and private broadcasters are very anxious to start a terrestrial DAB service in the allocated 1452-1492 MHz band, even when this eventually means giving up their existing AM or FM stations. They feel that this is the only way to compete with, and reclaim the market lost to, other entertainment media such as compact disk players. Once a terrestrial service is established with*

a certain base of receiver population, it would be easier and more convenient to add the satellite concept". Canadian are experimenting possibilities of terrestrial DAB on 1.5 GHz. According to Mr. ZEITOUN, "Field trials and measurement programmes both indoors and outdoors have given very encouraging results regarding the feasibility of implementing a terrestrial service at 1500 MHz. The power levels required to implement such a service are expected to be modest and practical."

According to Mr. RATLIFFE (BBC Research Department), other countries with a large surface area (Australia, India, Indonesia, several Arab States) are interested in satellite broadcasting with reference to the Canadian concept.

The Symposium was the occasion of the first paper being presented by a Japanese researcher about DAB. Mr. TARO KOMOTO, from the NHK Science and Technical Research Laboratories, has introduced a paper about current Japanese experience (laboratory tests, field transmission tests in Tokyo). The Communication Research Laboratory (CLR) of the ministry of Posts and Telecommunications is performing basic studies on a channel plan for digital broadcasting on vacant channels of TV broadcasting using topographical data from Tokyo and Osaka areas. NHK plans to conduct broadcasting transmission tests using the VHF TV Channel 3 by the end of December 1992. To evaluate the feasibility of satellite DAB, transmission tests in the 2.5 GHz band using the ETS VI satellite are scheduled to be launched in 1993 and measurements of terrestrial propagation characteristics assuming a hybrid system are also scheduled. The Japanese speaker has expressed the need for international cooperation for unifying world standards of DAB.

Papers by Mr. WITHEROW (BBC International Services) and Mr. UNTERMEYER (Voice of America) have confirmed the interest for international services in using satellite DAB as an alternative to shortwaves services.

Implementation strategies in Europe

The Symposium has confirmed that the main concern for the implementation in Europe is now the question of terrestrial frequencies. As was recalled by Mr. HALBE (Philips Consumer Electronics International BV), *"with respect to the frequency bands it is obvious that a multi band tuner from band I up to band V, preferably also including the 1.5 GHz band does not offer the most economic solution. For that reason and also to be*

able to get the development started in the first place, it was decided in Jessi AE-14 already some time ago to firstly concentrate on a concept for band I up to band III combined in one tuner. Tuners and/or convectors to the other bands will follow depending on the timing of application."

Dr. RATLIFF (Head of BBC Research Department) has summarised the EBU study of potential spectrum availability in the VHF/UHF broadcasting bands.

Number of countries in the European broadcasting area expressing a preference for a DAB frequency band

Frequency band	I	II	III	IV-V
Good chance	3	5	9	2
Some chance	12	7	19	13

According to Mr. RATLIFF, "the best chance is given as television channel 12 (223-250 MHz) in Band III, with good prospects for some countries in a part of Band II (104-108 MHz) so far uncommitted for FM. Few other countries see an opportunity to start in Band II, though many foresee possible opportunities in Band I or Band IV/V. Bands I, II and III would seem ideal for terrestrial area-coverage networks using the spectrum-efficient single frequency network concept. However, man-made noise in urban areas is a particularly serious problem at the lower frequencies, as in anomalous long-range interference during hot weather, and thus Band I does not seem an attractive option".

There was no paper from CEPT's speaker about this topic. However, Mr. SZESKY (from ERC/ERO) has confirmed that ERO is working on a study with national P&T Administrations about terrestrial frequencies for DAB.

The current implementation projects were summarised by Mr. TERZANI (RAI):

- in Finland, the YLE plans some experimental DAB in the upper part of band II for 1993;

- in France, TDF radiates on 60 MHz on SFN with 2 transmitters in Rennes; in Paris on television Channel 24; furthermore with Switzerland 1 transmitter has been set up in St Gingolf. With Germany, 1 transmitter in Channels 12 or 13 in Alsace is planned for this year to carry out experiments together with a transmitter of Germany in the Rhine Valley. It should be noted that several French specialists (from TDF and the Conseil Supérieur de l'Audiovisuel), with reference to the Toronto experiments by CBC, argue that terrestrial use of the 1.5 GHz frequency could provide an immediate solution for implementation in France. However this possibility is criticised by British and German specialists:

- it will be a necessity for transmitters from 20 to 20 Km, but will be rather expensive (French and Canadian argue that intervals of 40 Kms will be possible) ;

- footnotes of the CAMR-92 decision allocates 1.5 GHz on a secondary basis only in most of the countries until 2007. In this sense, terrestrial use of the 1.5GHz could not be an European solution.

Germany has confirmed that it will launch terrestrial DAB through channel 12 in Band III. The first experiments by ARD's members are in Munich (3 transmitters in Band II) in Hannover (1 transmitter on Channel 12) and next in South Bavaria (5 transmitters on Channel 12 and in Berlin (Channel 3 or 4).

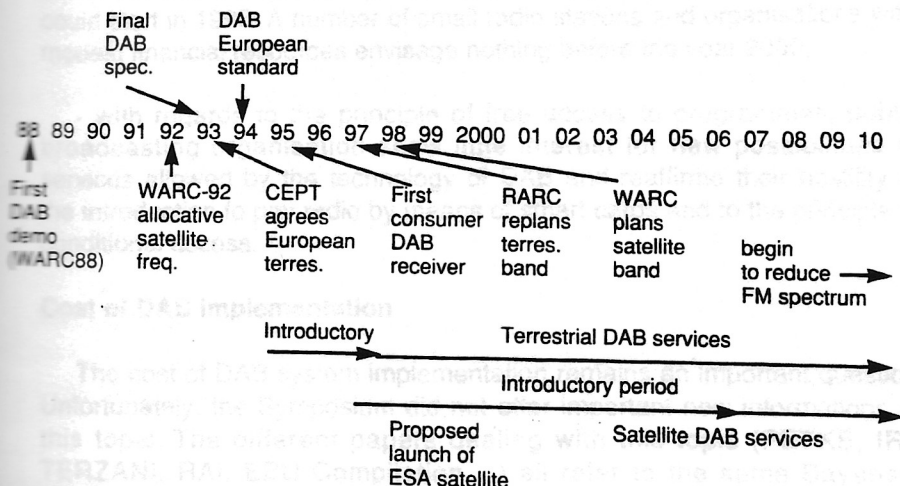
Italy plans to radiate on a single frequency on television Channel 12 with 2 transmitters at the beginning and with 5 transmitters and different frequencies later on in the Aosta Valley.

In the Netherlands, NOS and PTT are broadcasting in Eindhoven Channel 57 and later will continue in Amsterdam on Channel 9.

In Sweden experiments are foreseen on Channel 12 with 1 transmitter.

In United Kingdom, the BBC is making experiments for a study on a single frequency-network in Band III with 6 transmitters. The BBC is negotiating with the Radio Telecommunication Office to obtain the attribution of a channel in Band III.

Mr. RATLIFF has summarised what is the current EBU agenda:



Programmes department interest

DAB technology is mainly an engineer proposal inside the broadcasting organizations. To assess the interest of the programmes departments, the EBU has launched early 1992 a questionnaire to its member. Survey of this study was presented by Mr. DASNOY (RTBF, Chairman of the EBU Committee of Radio Programmes). The survey is based on 33 answers to the questionnaire. The main conclusions are:

- most broadcasting organisations prefer national networks of earth stations and the possibility of developing local stations;
- 14 organisations envisage ensuring coverage of the national territory by using of the hybrid satellite/terrestrial circuit system. Only eight organisations plan to use this hybrid system for multinational coverage;
- the majority of organisations do not regard "CD sound" quality as the chief factor in the development of the system. They consider the advantage arising from an improved service performance in multipath and shadowing environments more important, and give equal importance to a larger number of sound programmes being possible in a given bandwidth;
- public broadcasters express concern about the necessity of sharing a frequency block with private competitors and about the possibility for them to be the first to implement the system in their respective countries;

- 70% of radio organisations have already begun to introduce DAB. For most organisations, the transnational phase (with simulcasting) would begin between 1996 and 2000, but for 20% (including the large organisations) it could start in 1995. A number of small radio stations and organisations with modest financial resources envisage nothing before the year 2000;

- with regards to the principle of free access to programmes, public broadcasting organisation show little interest for new possibilities of services allowed by the technology of DAB and reaffirm their hostility to the introduction of pay radio by means of smart cards and to the principle of conditional access.

Cost of DAB implementation

The cost of DAB system implementation remains an important question. Unfortunately, the Symposium did not offer important new informations on this topic. The different papers dealing with this topic (PETKE, IRT, TERZANI, RAI, EBU Compilation,...) all refer to the same Bayerische Rundfunk study.

In his paper, Mr. PETKE synthesises the cost parameters:

"The cost for a DAB transmitter network will mainly depend on the number of stations necessary to provide full area coverage. Since the number of frequency blocks is rather limited, the power of DAB transmitters has to be kept low, in order to reduce the frequency reuse distance. The margins necessary to ensure reliable operation of the DAB network may lead to similar values for the minimum usable field strength as for the analog FM service. The results of field trials will show whether these margins can be reduced.

The costs will also be influenced by other factors as:

- availability of transmitter site,*
- spare capacity at the antenna masts,*
- programme delivery.*

A higher number of transmitter sites or the extension of buildings or construction of additional antenna masts may lead to considerable investments.

If the programme delivery of an SFN can be provided by satellite, these costs may not be higher than for the existing FM network, in particular if lines instead of rebroadcasting are taken into account.

As far as the necessary number of transmitters per programme is concerned. DAB is, however, more economic than FM. Two transmitters will be sufficient for 6 programmes (spare transmitters included), whereas 12 are needed for 6 FM programmes. Experience will show to what extent this advantage will be compensated by the factors above".

According to Mr. KOZAMERNIK (EBU Technical Department), the question of cost of implementation is not the central one: broadcasting organisations will have to organise the transition to DAB anyway, whatever the cost.

National evaluation of implementation cost are undertaken by several organisations (TDF in France, BBC in Britain, SSR in Switzerland,...) but those studies are still not available.

Conclusions

Most of the contributions to the Symposium converge with the IDATE report and conclusions. All participants are confident in DAB's future. As pointed out by Mr. BLINEAU (Thomson), the question is not more if DAB will be implemented but when it will be. Availability of a satellite frequency and convergent analysis of the advantage of the DAB system and of the market opportunities as well as common proposal of collaboration (including from Japanese representative) has given this Symposium a flavour of optimism for DAB supporters.

Central concern remains however for the question of terrestrial frequencies in Europe and North America.

At this stage, it occurs that there are mainly three types of strategies for the implementation of DAB:

- research on "in-band" system in USA,
- use as soon as possible of the 1.5GHz frequency in a hybrid terrestrial/satellite system, with start on terrestrial (Canada and possibly France and Australia),
- start in 1995 in terrestrial transmission in Band III, with possible coverage by satellite in 1.5 GHz band after 2007 (Germany, UK,...).

The combination of this three scenarios involves the risk of a gap emerging between North American countries (Canada-Mexico/USA) on one side and also a gap between European countries (FRG-UK-Italy/France).

Possibilities of resolving this potential European gap by political discussions should be considered. IDATE made the proposal to set up an European Task Force which could provide a better integration of national policies for the implementation of DAB. The European Commission could play a positive role in contributing to the elaboration of a coherent European industrial policy able to valorise a technology from European patents.