

	Working Group Frequency Management Project Team FM PT45 Digital Broadcasting Issues	FM45(10) 235 Annex 4
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<p>Date issued: 10 December 2010</p> <p>Source: Chairman of DG1 of FM PT45</p> <p>Subject: Outcome of the drafting group to develop a report on the possibilities for the future delivery of radio</p>		

Summary:
This document contains an updated version of the current working document on the future delivery of terrestrial audio broadcasting
Proposal:
FM45 to base its future work concerning this issue on this version
Background:
FM45 is tasked to prepare an ECC report on the future delivery of terrestrial audio broadcasting

Electronic Communications Committee (ECC)
within the European Conference of Postal and Telecommunications Administrations (CEPT)

ON
POSSIBILITIES FOR FUTURE TERRESTRIAL DELIVERY OF AUDIO
BROADCASTING SERVICES

Place, Month, Year

Executive summary

This report considers the possibilities for continuing Radio Broadcastings into the future. While recognising that technological developments are opening a wide range of potential platforms' for the distribution of audio content, it is felt that 'terrestrial' distribution with strategically placed transmitters simultaneously serving a large number of independent receivers will continue. This is particularly true for portable and mobile reception. With this in mind, this document concentrates on terrestrial distribution platforms and especially the relevant digital technologies that exist and are being developed. Terrestrial distribution is a particular focus of the Frequency Management (FM) community in CEPT.

By way of introduction the report offers a brief historical perspective showing that the radio audience has evolved. Radio is now very much a medium which can be, and is, accessed by an audience that is both (potentially) mobile and (typically) doing something else at the same time. The motorist is a good example of this. The report looks at how this audience might be served in the future. While, in the past, conventional terrestrial radio broadcasting was the only viable way to serve this audience, technological convergence and changing habits mean that other platforms such as satellites and wired infrastructures can now be used under the right circumstances.

In spite of this, terrestrial broadcasting does offer certain advantages and it is felt that this will continue for the foreseeable future.

Terrestrial broadcasting is itself changing with the advent of digital modulation systems. The report goes on to compare and contrast these modulation systems in some detail, looking at the strengths and weaknesses of each one. This is done on the against the background considerations of audience size, geographical concentration and demographics, and how each system is able to exploit the available spectrum.

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LIST OF ABBREVIATIONS

Abbreviation	Explanation
3GPP	Third Generation Partner Project
AM	Amplitude Modulation
CEPT	European Conference of Postal and Telecommunications Administrations
DAB	Digital Audio Broadcasting
DRM	Digital Radio Mondiale
DTT	Digital Terrestrial Television
DVB-H	Digital Video Broadcasting - Handheld
DVB-NGH	Next Generation DVB-H
DVB-SH	Digital Video Broadcasting – Satellite services to Handhelds)
DVB-T	Digital Video Broadcasting-Terrestrial
FLO™	Forward Link Only
FM	Frequency Modulation
HF	High Frequency
IMB	Integrated Mobile Broadcast
IMDA	Internet Media Device Alliance have defined a basic receiver profile for internet radios
IP	Intellectual Property
ITU	International Telecommunication Union
LF	Low Frequency
MBMS	Multimedia Broadcast/Multicast Services
MF	Medium Frequency
IRT	The International Radio and Television Organisation (official name in French: Organisation Internationale de Radiodiffusion et de Télévision)
PC	Personnal Computer
QoS	Quality of Service
VHF	Very high frequency

Draft ECC Report on Possibilities for Future Terrestrial Delivery of Audio Broadcasting Services

Introduction

The term audio broadcasting is taken to be the distribution of content consisting of an independent audio signal which optionally can also contain text, pictures or even movie clips. Commonly known as Radio it any location can be reached at all times.

Along with the printed press, television and the Internet, radio constitutes as one of the mass media to guarantee freedom of information. Freedom of Information is defined as the universal right to access information held by public bodies.

Radio wakes people up in the morning and accompanies people around the house - in the bedroom, in the shower, in the kitchen - entertaining and informing everyone. It helps people get to work, advising on traffic problems and calming the nerves of those that commute in a car or on public transport. For others, at work and at home it is a readily available source of information, and companionship; entertaining and making people think. At the end of the working day it helps people get home again. Only then does television take over people's attention.

Radio has been around for over 80 years and, despite the arrival of new technologies, from television to computers and the internet, radio still plays a major role in people's lives.

The audience's relationship with radio is different from that with television. In Europe radio is a secondary and personal medium; usually listened to while people are doing other things - getting ready to go out, commuting or even working. Radio is also a medium of community which many feel very passionately about and also have a strong affinity with the stations they listen to. Furthermore in all countries, sound broadcasting services are part of the actions for development of population with an expectation that these services will be available available with freedom of

expression.

In recognising the economies of scale, in a pan European market it must be recognised that there is the potential for a much larger market or audience in other regions and continents. The 'FM band', for example, is essentially available on a world wide basis.

Radio is changing; the advent of digital technology means that not only are there more stations than ever to choose from, but they can be accessed in new ways - via television, on the internet, on mobile phones, etc. - as well as on the more traditional portable sets, hi-fis, and car radios. The services digital radio can offer could change the medium forever; already digital radio offers:

- much easier navigation between stations;
- the ability to pause and rewind live radio;
- the opportunity to listen at a time of an individuals choice;
- access to programmes that have been missed;
- the ability to download and store songs on personal players;
- Access to supplementary data regarding the current track or programme.

Future services could include video clips and much enhanced text services. With these possibilities, radio will be at the forefront of the media and technology convergence.

Wherever the development of Radio might lead it should at least offer the following targets:

- free access (meaning without a subscription or registration);
- universal availability in time and location;
- instant access to live programming (e.g. news and sport);
- wide functionality and flexibility in the use of radios (e.g. electronic programme guides, associated programme information, recording facilities, etc.);
- the ability to find different programmes easily (e.g. by automatic tuning) and
- a wide variety of radio channels

This report provides an overview of the conceivable distribution platforms that could be employed in the future to meet these targets. It must be noted that the primary focus is on terrestrial distribution. Other distribution mechanisms are addressed here to the extent necessary to put future opportunities for terrestrial distribution of radio in an appropriate context.

The RSPG has undertaken complementary work in this same area and its

study report - "The Future of Radio Broadcasting in Europe" - identifies needs, opportunities and possible ways forward". It is available at [URL] [ref1]. Supplementary information, including all the responses to the associated questionnaire which was circulated during this study, is also available [URL] [ref2].

THE CHANGING RADIO ENVIRONMENT

[summarise briefly what kind of services are currently being delivered as radio services, then discuss what services are likely to be expected in the future and what services are demanded by the customers such as linear programmes, non-linear programmes, multi-media content, etc.]

In the past people would typically sit down in their living room to listen to a radio programme as a dedicated activity. This has now become almost negligible. Today people listen while doing something else; working, doing homework, in the gym or travelling.

Most audiences listen to a limited number of radio stations which are all present on terrestrial platforms. Listening to Internet radio and continuing to listen with 'podcasting' is increasing in many European countries. This does not change the listening behaviour drastically; even on the Internet the majority of the listeners tune in to the most popular radio stations.

The Internet gradually changes the listener's behaviour. It offers today's audiences the possibility to influence what

information they get, as well as where and when they get it. They are now accustomed to being able to choose from a large selection of content, formats and channels, whether it be television, radio, printed media or the Internet. Young people listen to and use traditional media less and less, to the benefit of social media.

[add text on the need for revenue streams for digital radio]

Radio broadcasters are responding to the changing media environment by introducing thematic radio stations, multimedia content and sharply defined formats all of which serve specific audiences. This is only the beginning; radio must offer the possibility of further development to satisfy the changing needs of listeners.

The opportunity should be provided for new and existing content providers to increase and diversify the overall offer (e.g. using their archives, thematic channels, etc.) so that listeners can choose from a larger number of programmes and supplementary services. These might include surround sound, text, pictures and video. Content on demand or time shifting will need to be offered. All of this calls for digital production and distribution and may require a return channel.

Among all these changes it is likely that the 'listening-while-doing-something-else' character of radio will remain dominant in the foreseeable future. Also in the future it is likely that the majority of the audiences will still listen to a limited number of radio stations.

It is expected that broadcasters will continue to use terrestrial broadcasting platforms to serve the majority of their listeners; and these listeners will expect most of the extra functionality that the Internet offers. Only digital platforms will be capable of offering supplementary services like text, pictures, video and interactivity.

Besides the traditional terrestrial distribution of radio content a new distribution mechanism is currently emerging. Hence, broadcasters face two fundamental approaches to radio distribution with somewhat different characteristics, namely;

1) Broadcast

- Access to listeners is direct and not through a third party
- Strict regulation of content and access to distribution mechanisms
- One to many delivery - highly efficient for large audiences
- Free to air for the listener
- Access to spectrum is crucial
- Defined quality of service

2) Broadband

- Flexibility and interactivity
- Potential for worldwide coverage via the Internet
- Subscription needed for reception (Internet provider needed, not free to air)
- 'Gatekeeper' can exercise absolute control
- Best effort quality of service – dependant on traffic

Broadcasters are now operating in a hybrid environment producing and distributing content for conventional broadcasting distribution and for the internet. This presents challenges for the broadcaster and their regulators to:

- Keep radio simple for the user
- Keep down the costs of receivers
- Place constraints on standards choice
- Deal with technological replacement cycles faster than take-up rates and imposes certain requirements such as
 - Open standardisation
 - Assuring compatibility with CEPT and ITU spectrum regulation
 - System harmonisation

Furthermore broadcasters need to minimise technology license costs.

COVERAGE REQUIREMENT Considerations

In general terms, broadcasters target specific groups of listeners. These can be in a defined geographical area or be interested in a particular type of content. Within the target groups, broadcasters wish to serve as many people as possible with the greatest efficiency. Clearly, there are different needs when comparing national and regional services or public and commercial services.

Public broadcasters in Europe have to cover all, or large parts of, their national territory while commercial broadcasters are usually interested only in serving highly populated areas or traffic routes. There are also broadcasters who are serving areas which are significantly larger than their national territories. Furthermore, there is a large number of community broadcasters in Europe providing services in small areas like individual towns and cities.

Coverage requirements may differ between and within different countries. Broadcasting services are planned for fixed, portable outdoor / indoor or mobile (e.g. car) reception at different quality of service (QoS) levels. Even within a given country the target reception modes can be different in different parts of a country; portable indoor in big cities, mobile along the main traffic routes and fixed in rural areas, etc. Furthermore, geographic and topographic conditions – dense urban places, rural areas, mountainous or woody areas and the presence of large water spaces – are crucial. This is reflected in the way that broadcast networks are planned for different location probabilities in different areas.

Some broadcasters provide a single programme only while others offer a range of programmes. Some of the programmes may need to be delivered throughout a whole country to a high proportion of population (for a public service possibly more than 98%) while others can be confined to administrative, cultural or linguistic regions or even parts of them.

Aligning programme variety with geographical coverage is just one aspect of broadcaster's requirements. The ability to allocate transmission capacity for the delivery of particular programmes and enhanced services in a flexible manner is also a crucial freedom for broadcasters.

Finally, free-to-air distribution of radio programmes is essential for public service broadcasters as well as for commercial broadcasters in many countries.

General Aspects instructions

Depending on their requirements, broadcasters must identify those technologies that best suit their needs. The following questions should be considered when comparing different distribution platforms:

How well does the technology satisfy the needs of broadcasters and listeners?

What **functionality** can be expected?
(e.g. reception mode, mono, stereo, data services)

What **coverage** can be achieved?
(e.g. nationwide/regional/local)

What quality of service (**QoS**) can be achieved?

What is the **availability of equipment**, i.e. transmitters and receivers?

What **costs** will arise - for broadcasters and for listeners?

What **capacity** can be achieved? (e.g. bit rate per program, number of programmes in a multiplex, overall limits)

What **flexibility** is offered in terms of multiplex configuration, control over QoS parameters, the possibility to

increase the range of programmes and the development and implementation of new functions?
Specifically for terrestrial and satellite delivery there are additional issues to be taken into consideration:

Is the technology ready to be implemented?

Are the network **planning parameters** available/agreed?

Are the **compatibility criteria** established with other users of the same spectrum and in adjacent frequency bands?

How does the technology fit into the wider European context?

Does it comply with the **international agreements** and frequency plans?

Is it **standardised** in Europe?

Is there a wide **support** from broadcasters, manufacturers and regulators?

How does the technology utilise the available spectrum?

What **frequency band(s)** are available?

Are networks deployed in terms of MFN and/or SFN and what is the size of the networks, i.e. what is the **network topology**?

Broadcasters need to employ distribution mechanisms that meet their requirements for coverage, quality of service, variety of content offered and so on. In particular, distribution mechanisms need to be flexible to adapt to changing requirements. Moreover, distribution costs need to be predictable and under the control of broadcasters. Access to distribution platforms should not be hindered by 'gate-keepers' subject to non-broadcasting interests. These are the conditions and constraints against which the suitability of a given distribution platform has to be assessed.

Terrestrial Distribution

Terrestrial distribution of radio offers a combination of many positive characteristics for listeners and broadcasters:

- potential to provide universal coverage
- tailored coverage (local, regional, national)
- free to air services
- fixed, portable (indoor) and mobile reception
- receivers which are agile in frequency tuning and simple to use
- reliable as a channel of information, especially in crises and catastrophes
- an important medium for traffic information, shipping, mountain rescue, etc.
- audio quality and of multi-media information is independent of the number of simultaneous listeners

The following sections describe systems and spectrum issues for the terrestrial platform. Annex 1 attempts to address the key questions in section 4 with respect to terrestrial broadcasting distribution.

Terrestrial Radio Broadcasting Systems

[Elements of the broadcasting chain to be added – content provider, content aggregator network operator, listener etc.]

Analogue Radio Broadcasting Systems

AM and FM radio are currently the primary means to deliver conventional, ('linear'), audio content. Both can also be used to deliver additional services such as low bit rate radio text and traffic information. These systems have been in use for many years and their strengths and weaknesses are well known – see for example ECC Report 141] [ref3].

Digital Radio Broadcasting Systems

This report deals with four digital radio broadcasting systems:

Digital Radio Mondiale DRM: Digital system for long, medium and shortwave ('DRM30' broadcast configuration) and the VHF bands I, II (FM) and possibly III ('DRM+' broadcast configuration). It usually carries audio and multimedia programme(s) of a single broadcaster. Because of the advanced audio coding employed, it is possible to achieve greater audio quality than the analogue signal it replaces. In the AM bands it is possible to provide large scale coverage with few transmitters and to reach remote areas.

Digital Audio Broadcasting DAB (DAB Classic, DAB+ and DMB audio codecs): currently introduced in several countries in Europe and Asia. The DAB+ audio codec enables roughly twice the number of services per multiplex compared to the DAB Classic codec.

HD Radio: A propriatry standard developed in the USA which supports simultaneous operation of legacy analogue services (AM and FM), while allowing for gradual transition to digital services. Currently implemented in the USA, and considered in some other countries.

RAVIS : Digital terrestrial broadcasting system for VHF bands I and II. It is intended to deliver audio and multimedia (including video) content for fixed, portable and mobile reception through narrowband RF channels (100, 200, 250 kHz bandwidth). Russian Federation national standard under approval

[NOTE: a table should be developed that gives a quick overview about important features of the different systems, it should be put here Mike Hate]

[NOTE: put references where information on the systems can be found]

[NOTE RB: I think the next two sections do not belong here, the discussion about MFN/SFN is really of secondary importance for this document. It is addressed in the tables of Annex anyway. Therefore I propose to delete it. Furthermore, propose to use the subsection on spectrum as an introduction for Annex I and delete it here.]

Other Terrestrial Broadcasting Systems

Radio services can also be broadcast using digital terrestrial television networks. However, the current business models favour the use of DTT networks for TV services. This may constrain the use of these same networks also for radio broadcasting. Systems include:

DVB-T
DVB-T2
DVB-H and DVB-NGH
DVB-SH
MediaFLO

[NOTE: put references where information on the systems can be found]

Terrestrial Non-Broadcasting Systems

5.1.4.1 Mobile Internet Access

5.1.4.2 Multimedia Broadcast/Multicast Services (MBMS)

The Multimedia Broadcast/Multicast Services (MBMS) system has been specified by the third generation partner project (3GPP). The MBMS system represents a new advanced mode of operation in broadcasting networks providing both broadcasting and multicasting services based on any of these IMT family technologies. A new enhanced version of MBMS and the introduction on the LTE technology platform considerably increase the broadcasting system capacity.

5.1.4.3 Integrated Mobile Broadcast (IMB)

IMB is an updated standard for multicasting on cellular TDD signals, which was previously addressed by the MBMS standard. The IMB standard has received an agreement by GSM Association and 3GPP. IMB is part of 3GPP's Release 8 Standard, providing capabilities for Broadcast services, similar to the broadcast element of MBMS, in 3G TDD bands.

Complementary Distribution Mechanisms Platforms

Wired Distribution

Historically, Radio has been broadcast over wired infrastructure for a long time. Cable operators have distributed radio together with television in their offers.

5.2.1.1 Traditional Cable Distribution

Cable operators generally offer two services: broadcasting (radio and television) and telecommunications (voice, and internet). In Europe, cable operators should have agreements with broadcasters to distribute broadcast radio and TV content.

The service area is limited by the connexion in the home; mobility at home is made by home networking connected to the cable or wire distribution.

5.2.1.2 Fixed Internet Access

[NOTE: Concerns about net neutrality to be added.--> France/UK to provide a paragraph]

With the success of the Internet, radio broadcasters have provided their content through the Internet. This can be considered as a technical extension to wire or cable installations.

Internet radio terminals are dedicated equipment or a PC which allow programmes to be received everywhere in the World, including local radio stations which normally address a limited audience.

Projects for connecting radio and internet have been set up with the convergence between broadcasting sector and IP-delivered services. For example, the project RadioDNS is aiming at providing an efficient and seamless link between broadcast and IP platforms

Radio broadcasters have developed strategies of hybridisation of radio using delivery of content through different platforms. Internet is appropriate for an efficient interaction between the radio broadcaster and the audience. The broadcasters are studying standardisation and the Internet Media Device Alliance has announced the creation of guidelines for internet radio station metadata to define station identity and stream information for the specific station.

5.2.1.3 Next Generation Networks

Satellite Distribution

Sound can be broadcast by satellite and by hybrid or combined satellite and terrestrial systems. Satellite transmission is increasingly the main means of broadcast of services which to give full national coverage, compensating for limitations in national terrestrial spectrum or infrastructure availability.

ETSI standards provide information about the standardisation of Satellite Digital Radio (SDR) services. The systems use either broadcasting bands or mobile service bands to reach the users.

A broadcasting satellite service is possible in L Band while transmissions of multimedia over mobile satellite service use systems operating in S-Band.

Spectrum Issues

Regulatory Issues

[discuss the current regulatory framework under which radio services are currently provided in Europe; identify areas where modifications of the regulatory framework are needed and indicate what changes to which regulatory documents are required]

Regulation of spectrum usage for radio services has to ensure that regulatory conditions and measures reflect the needs of broadcasters, manufactures, and customers **AND OTHER USERS** according to market requirements.

Current Regulation Applicable to Terrestrial Radio Services

[add explanatory text for the tabletext?]There are a number of regional ITU Agreements together with CEPT regional Agreements which cover the broadcasting bands which are summarized in the table below.

[NOTE:; references need to be checked]

	LF/MF/HF	Band I	Band II	Band III	Band IV/V	L Band
Frequency Bands	<>30 MHz	47-68 MHz	87.5-108 MHz	174-230/240 MHz	470-790/862 MHz	1452-1492MHz
System	DRM HD Radio (MF only)	DRM RAVIS	DRM HD Radio RAVIS	DAB DVB-T DVB-T2/ NGH DVB-H DRM	DVB-T DVB-T2/ NGH DVB-H DVB-SH (terrestrial component) 3GPP	DAB MediaFlo DVB-T2/NGH DVB-H DVB-SH (terrestrial component)
Agreement	GE75 [4] (LF/MF only) ITU-R RR §12 for HF	ST61 [5]	GE84 [6]	GE06 [7] WI95revCO07 [?]	GE06 [7] [plus EC Decision on 800 MHzZ band] [8] ECC Decision	MA02revCO07 [?] and ECC Decision 0302 on satellite service [9]

Table 1: Title

Potential Modifications of the Regulatory Framework

LF / MF / HF

Band I

Band II

The introduction of digital systems in Band II would have to be considered on a case by case basis. The digital assignments should initially be inserted between existing analogue FM assignments and eventually on free FM assignments where possible. However, there is a need for some Rules of Procedure modification of in relation to the GE-8475 Agreement in order to take into account digital parameters.

Band III

Band III is the only frequency band that provides the opportunity for rapid introduction of core digital radio services in most of Europe using the terrestrial broadcasting systems described in this document. However, any Band III usage would need to comply with the GE06 framework.

If the use of different systems is to be foreseen in Band III appropriate spectrum rasters must be defined together with the necessary sharing criteria. Where other frequency bands are to be used for the introduction of digital radio, coexistence of different systems should be allowed through appropriate spectrum rasters and sharing criteria.

[Question – is there sufficient spectrum to meet all digital radio needs in Band III?]

Band IV/V

L-Band

[Relevant Market Developments]

Aligned Digital receiver profiles by WorldDMB and DRM Consortium

Minimum standards for digital receivers.

IMDA - Internet Media Device Alliance have defined a basic receiver profile for internet radios.

Radio DNS

European Digital Radio Forum (DRM Consortium, World DMB, IMD Alliance, Radio DNS) It is noted that further work is required in other areas such as

[NOTE: text required under each bullet point]

Aligned digital receiver profiles by WorldDMB and DRM Consortium

Minimum technical performance standards for digital receivers.

IMDA - Internet Media Device Alliance

have defined a basic receiver profile for internet radios.

Radio DNS

European Digital Radio Forum (DRM Consortium, World DMB, IMD Alliance, Radio DNS)

Regulation in European Countries

Impact on car industry

Time Frame

Time frame for the development of various systems?

Regulation in European Countries.

Impact on car industry?

Equipment Licensing Issues

DAB and DRM

The DAB and DRM system share the same licensing models.

Both systems are openly standardized and their specifications are freely and **completely** available for all to implement encoder/transmitter and receiver equipment; there is no undisclosed or restricted intellectual property (IP) owned by individual companies and organizations. Broadcasters and receiver manufacturers can rely on the current as well as future availability of concurrent and independent implementations.

As with all modern standards, both the DAB and DRM systems include IP license cost, to grant revenue from commercial equipment sales to those who originally developed the technology. This cost is taken care of by manufacturers and thus invisible to broadcasters and operators of transmitter equipment and receiver buyers. All license costs are handled in the form of a one-time payment; there are no running IP royalties for broadcasters and transmitter operators independent of the number of services deployed or system features. License pools have been set up to offer a convenient and reliable one-stop license handling for manufacturers.

HD Radio

iBiquity licenses its IP to the HD Radio™ community. iBiquity has committed to the National Radio Systems Committee, the Federal Communications Commission and the International Telecommunication Union that it will license its technology on reasonable and nondiscriminatory terms.

iBiquity licenses manufacturers of transmission equipment the right to copy iBiquity's HD Radio software in their equipment and the right to manufacture equipment that incorporates iBiquity's patents and other IP. In return, iBiquity receives a one time per unit license fee.

In the United States, iBiquity separately licenses broadcasters to use its IP to transmit a digital signal. The license includes the right to provide a main channel simulcast of analog programming, additional multicast channels and datacasting services. Broadcasters pay iBiquity a one time fee for the main channel simulcast and annual fees for multicasting and datacasting services.

Outside the United States, the license to transmission equipment manufacturers includes the right for broadcasters to offer main channel simulcasting of analog, multicasting and program associated data; all broadcaster license fees for these services are included in the purchase price of the transmission equipment, and are valid for the life of the products. International broadcasters do not pay any license fees to iBiquity for these services and there are no recurring fees. Broadcasters interested in offering datacasting services would require a separate license with iBiquity and would be required to pay a separate license fee for that service.

iBiquity also licenses semiconductor and receiver manufacturers. iBiquity licenses semiconductor manufacturers the right to manufacture and sell products that include iBiquity IP in return for recurring royalties. iBiquity separately licenses receiver manufacturers to use iBiquity's intellectual property in receiver devices. Receiver manufacturers pay a separate royalty for those rights.

Next Steps

Conclusions

title

Introduction

Several frequency bands are used for radio broadcasting. These frequency bands have different characteristics that make them suitable for different types of radio service. As a general rule, wide area coverage is easier to achieve in the lower frequency bands but the capacity of these bands is restricted. Higher frequency bands have greater capacity but it is more difficult and costly to provide coverage over a wide area.

Some radio systems can only operate in one frequency band whereas others are flexible and can operate in several frequency bands. Furthermore, some systems require several programmes to be combined in a multiplex while others are more suitable for broadcasting single programs.

[Explanation for the figure]

Importance of frequency for radio broadcasting

LF / MF / HF Bands (148.5 kHz - 30 MHz)

The LF, MF and HF frequency bands between 148.5 kHz and 30 MHz are traditionally used for analogue AM broadcasting. Advanced systems that could be introduced into these bands are DRM and HD Radio AM. The LF and MF bands are primarily used for domestic broadcasting and the HF bands for international broadcasting. Due to changing propagation conditions during the day the coverage in these bands is variable. This can be tolerated by listeners of analogue services but requires extra care in planning digital services to ensure that listeners do not lose their reception.

LF/MF/HF Bands	Analogue AM	DRM (DRM30 configuration)	HD Radio AM (hybrid A/D, MF Band only)
functionality	<ul style="list-style-type: none"> - fixed, portable (indoor and outdoor), mobile reception - mono 	<ul style="list-style-type: none"> - fixed, portable (indoor and outdoor), mobile reception - mono, stereo (surround sound e.g. in double channels) - full range of standardized multimedia and data services (DAB compatible): advanced text, images, EPG, traffic, individual B2B data, etc. - emergency alert/warning with receiver re-tuning, audio and (multi-lingual) text information 	<ul style="list-style-type: none"> - stereo; simulcast - every device category, anywhere
coverage	community, local, regional, nationwide, international	- community/local (26 MHz, low-power MF), regional, nationwide, international	Similar to analogue AM
QoS	<ul style="list-style-type: none"> - low audio quality - graceful degradation 	<ul style="list-style-type: none"> - FM like audio quality or better, undisturbed - soft fade-out/fade-in of audio - seamless switching DRM-DRM, DRM-FM, DRM-AM, DRM-DAB supported 	<ul style="list-style-type: none"> - FM-like quality; graceful degradation; - blending between analogue and digital
availability of equipment	good, both receivers and transmitters	<ul style="list-style-type: none"> - good on transmitter site - initial receivers in the market - dedicated chipsets being developed to enable mass-market receivers 	Broadly available over 6 years for 10 kHz bandwidth

costs	<ul style="list-style-type: none"> - high transmission costs - most common receivers are inexpensive 	<ul style="list-style-type: none"> - medium transmission cost for high-power transmitters (e.g. international coverage), lower than analog - existing transmitters and infrastructure can often be upgraded to digital - free open source implementations available both on transmitter and receiver side 	<ul style="list-style-type: none"> - Low broadcasting operating costs - Receivers at all levels; higher than analogue
capacity	one audio service per channel	<ul style="list-style-type: none"> - up to 4 audio services per channel - up to 35 kbps for European single channels, up to 72 kbps for double channels - low-bitrate data services like advanced text and TMC 	2 audio services; data services
flexibility	limited	<ul style="list-style-type: none"> - flexible bitrate assignment for each service (audio/data) - fits with existing channel spacing; single (9 and 10 kHz), double, half channels - flexible trade-off between capacity and signal robustness - existing analog broadcasts can be accompanied by digital signal for transition period 	flexible
planning parameters	Recommendation ITU-R BS.560-4 [9]	<ul style="list-style-type: none"> - ETSI ES 201 980 [10] - ITU-R Rec BS. 1615 [11], ITU RR §12 [12]– - ITU-R Resolution 543 (WARC03) [13] 	<ul style="list-style-type: none"> - NRSC-5B [14] - US: FCC part 47 [15] - ITU-R Rec. BS.1615 [11](for 10kHz only)
compatibility criteria with other systems	- yes, internationally agreed within ITU	ITU-R BS 1514-1 [16]	
international agreements	ITU GE75 Agreement	-ITU-R BS 1514-1[16] ITU-R - CCRR 20 [17]	Not included in ITU-R CCRR 20 [11]
standardized in Europe	ITU Recommendations	ETSI ES 201 980 [10]	ITU-R Rec. BS.1514-1 [16]
support	- yes, worldwide	yes, worldwide	USA (all entities)
other frequency band(s)	none	VHF bands above 30 MHz	none

network topology	MFN, synchronisation	SFN, synchronous MFN, non-synchronous MFN	MFN, SFN (not tested according to ITU-R Rec BS.165156 [11])
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Table 2: Title

Band I (47 – 68 MHz)

Band I, the frequency range between 47 – 68 MHz is **mainly used by analogue television**, and it is not planned for digital TV. In a few European countries this band is also used for FM services (so called OIRT FM band from 66 to 73 MHz). However, most of these countries have ceased using Band I for FM broadcasting services. Consequently, digital terrestrial broadcasting systems such as DRM (using the 'DRM+' configuration) and RAVIS could be introduced in Band I. At the present time, no regulatory framework exists for the introduction of digital terrestrial broadcasting systems and in some countries there are other services in operation in Band I.

Services in this band are particularly subject to long distance interference (Sporadic E) at certain times of the year and therefore Band I is more suitable for the provision of local services where the wanted signal can be relatively high.

[NOTE: HD Radio to be included]

Band I	Analogue FM	DRM (DRM+ configuration)	RAVIS
functionality	<ul style="list-style-type: none"> - fixed, portable (indoor and outdoor), mobile reception - mono / stereo - audio only 	<ul style="list-style-type: none"> - fixed, portable (indoor and outdoor), mobile reception - mono, stereo, surround sound - full range of standardized multimedia and data services (DAB compatible) advanced text, images, EPG, traffic, individual B2B data, etc. - emergency alert/warning with receiver re-tuning, audio and (multi-lingual) text information 	<ul style="list-style-type: none"> - fixed, portable (indoor and outdoor), mobile reception - a number of programmes (multiplex) in one channel - each programme may contain audio, video, text, static images and other multimedia information - mono / stereo / multichannel audio
coverage	community, local, regional, nationwide	community, local, regional, nationwide	- community, local, regional, nationwide
QoS	<ul style="list-style-type: none"> - good audio quality for fixed reception - graceful degradation - independent of demand 	<ul style="list-style-type: none"> - very good and undisturbed audio quality (up to CD like) - soft fade-out/fade-in of audio - seamless switching DRM-DRM, DRM-FM, DRM-AM, DRM-DAB supported - independent of demand 	<ul style="list-style-type: none"> - good audio quality for any type of reception - non-graceful degradation - independent of demand

availability of equipment	limited, both receivers and transmitters	<ul style="list-style-type: none"> - limited for Band I transmitters and receivers - good for DRM transmitter enhancements - 	- mass production of receivers is planned in 2011
costs	<ul style="list-style-type: none"> - medium distribution costs - most common receivers are inexpensive, available on a limited scale 	<ul style="list-style-type: none"> - medium transmission cost, lower than analog - existing transmitters and infrastructure can often be upgraded to digital - free open source implementations available both on transmitter and receiver side 	<ul style="list-style-type: none"> - medium distribution costs - production of different receivers is planned, including inexpensive with FM receiving capability
capacity	- one audio service per channel	<ul style="list-style-type: none"> - up to 4 audio services per channel - up to 186 kbps net capacity 	<ul style="list-style-type: none"> - from 80 to 900 kbps in one channel - from 2 to more than 20 stereo audio programmes in multiplex
flexibility	limited	<ul style="list-style-type: none"> - flexible bitrate assignment for each service (audio/data) - fits with existing channel spacing: 96 kHz channel bandwidth - flexible trade-off between capacity and signal robustness - co-location above or below analog transmission, or independently located (seamless receiver switching in any case) - existing analog broadcasts can be accompanied by digital signal for transition period 	<ul style="list-style-type: none"> - audio, video and other multimedia services - controlled quantity and quality of services in each programme
planning parameters	ITU ST61 Agreement [5]		
compatibility criteria with other systems	ITU ST61 Agreement [5]		
international agreements	ITU ST61 Agreement [5]		
standardized in Europe	ITU Recommendations	ETSI ES 201 980 [10]	Russian Federation national standard under approval

support	decreasing number of broadcasters, manufacturers, regulators	successful trials in France by association of private broadcasters	broadcasters, manufacturers, regulators in Russian Federation
other frequency band(s)	Band II	LF/MF/HF, VHF Bands II and III	Band II
network topology	MFN, near SFN under certain conditions	SFN, synchronous MFN, non-synchronous MFN	both SFN and MFN

Table 3: Title

Band II (87.5 – 108 MHz)

Band II, the frequency range between 87.5 and 108 MHz is exclusively used by FM broadcasting. DRM (using the 'DRM+' configuration), HD-Radio and RAVIS are candidate systems for use in Band II in Europe.

[NOTE: HD Radio to be updated]

Band II	Analogue FM	DRM (DRM+ configuration)	HD Radio	RAVIS
functionality	<ul style="list-style-type: none"> - fixed, portable (indoor and outdoor), mobile reception - mono / stereo - audio / RDS - TPEG 	<ul style="list-style-type: none"> - fixed, portable (indoor and outdoor), mobile reception - mono, stereo, surround sound - full range of standardized multimedia and data services (DAB compatible) advanced text, images, EPG, traffic, individual B2B data, etc. - emergency alert/warning with receiver re-tuning, audio and (multi-lingual) text information 	<ul style="list-style-type: none"> - every device category; anywhere - stereo audio services; multicast - several data services (traffic, weather, EPG, etc) - services for audience with impairments - emergency alert 	<ul style="list-style-type: none"> - fixed, portable (indoor and outdoor), mobile reception - a number of programmes (multiplex) in one channel - each programme may contain audio, video, text, static images and other multimedia information - mono / stereo / multichannel audio
coverage	community, local, regional, nationwide	community, local, regional, nationwide	similar to analogue	- community, local, regional, nationwide

QoS	<ul style="list-style-type: none"> - good audio quality for fixed reception 	<ul style="list-style-type: none"> - very good and undisturbed audio quality (up to CD like) - soft fade-out/fade-in of audio 	<ul style="list-style-type: none"> - good quality; graceful degradation; 	<ul style="list-style-type: none"> - good audio quality for any type of reception - non-graceful degradation
	<ul style="list-style-type: none"> - graceful degradation - independent of demand 	<ul style="list-style-type: none"> - seamless switching DRM-DRM, DRM-FM, DRM-AM, DRM-DAB supported - independent of demand 	<ul style="list-style-type: none"> - blending between analogue and digital 	<ul style="list-style-type: none"> - independent of demand
availability of equipment	<ul style="list-style-type: none"> - excellent, both receivers and transmitters - growth in the mobile phone market 	<ul style="list-style-type: none"> - good for DRM transmitters - initial receivers available - dedicated chipsets being developed to enable mass-market receivers 	<ul style="list-style-type: none"> Broadly available over 6 years 	<ul style="list-style-type: none"> - mass production of receivers is planned in 2011
costs	<ul style="list-style-type: none"> - medium distribution costs - most common receivers are inexpensive, wide range is available 	<ul style="list-style-type: none"> - medium to low transmission cost, lower than analog - existing transmitter infrastructure can often be upgraded to digital - free open source implementations available both on transmitter and receiver side 	<ul style="list-style-type: none"> - low broadcasting operating costs - receivers at all levels; higher than analogue 	<ul style="list-style-type: none"> - medium distribution costs - production of different receivers is planned, including inexpensive with FM receiving capability
capacity	<ul style="list-style-type: none"> - one audio service per channel - the whole bund allows up to 25 programmes at any location, at some locations more 	<ul style="list-style-type: none"> - up to 4 audio services per channel - up to 186 kbps net capacity 	<ul style="list-style-type: none"> - initially 8 audio services per channel - initially 96 to 144 kbps 	<ul style="list-style-type: none"> - from 80 to 900 kbps in one channel - from 2 to more than 20 stereo audio programmes in multiplex

flexibility	limited	- flexible bitrate assignment for each service (audio/data)	flexible	- audio, video and other multimedia services
		- fits with existing channel spacing: 96 kHz channel bandwidth - flexible trade-off between capacity and signal robustness - co-location above or below analog transmission, or independently located (seamless receiver switching in any case) - existing analog broadcasts can be accompanied by digital signal for transition period		- controlled quantity and quality of services in each programme
planning parameters	Recommendation ITU-R BS.412-9		- NRSC-5B [14] - US: FCC part 47 [15]	
compatibility criteria with other systems	Recommendation ITU-R SM.1009-1 (compatibility with aeronautical services above 108 MHz)			
international agreements	ITU GE84 Agreement			
standardized in Europe	Recommendation ITU-R BS.704	ETSI ES 201 980 [10]	- ITU-R Rec. BS. 1114-6 [16] - ETSI TR draft (in progress)	Russian Federation national standard under approval
support	broadcasters, manufactures, regulators	successful trials in Germany	- USA: all entities - worldwide: several manufacturers, numerous broadcasters and regulators	broadcasters, manufacturers, regulators in Russian Federation
other frequency band(s)	76-87.5 MHz in some countries	LF/MF/HF, VHF Bands I and III		Band I

network topology	MFN, near SFN under certain conditions	SFN, synchronous MFN, non-synchronous MFN	MFN and SFN	both SFN and MFN
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Table 4: Title

Band III (174 – 230 MHz)

NOTE: DRM+ to be included here]

Band III, the frequency range between 174 and 230 MHz is used for analogue television and DAB. Under GE06 it is planned for DAB and DVB-T services. Band III is the primary spectrum range for the introduction of radio broadcasting using the DAB platform carrying a mix of DAB Classic, DAB+ and DMB-Audio based audio services per DAB multiplex. The DAB platform as the dedicated radio broadcasting system deliver radio content in terms of several programs bundled to generate a single multiplex which is transmitted within the intended bandwidth of 1.75 MHz. Clearly, broadcasters who are not in a position to fill an entire multiplex will need to share a multiplex with others.

DRM (DRM+ configuration) is not yet included in this section of this document as it is not currently standardized for use in Band III. After a modification of the DRM ETSI standard that includes VHF band III DRM+ will be added.

DRM and DAB share the same modulation scheme, audio codecs and data applications, and are fully interoperable from a listener's perspective. By providing an automatic two-way service linking. DAB and DRM signals can be complimentary. DAB provides an efficient multiplex solution for multiple broadcasters sharing the same coverage area, while DRM is suitable for individual broadcasters like community stations or single local/regional services.

Band III	DAB
functionality	<ul style="list-style-type: none"> - fixed, portable (indoor and outdoor), mobile reception - mono / stereo, surround sound - full range of standardized multimedia and data services (DRM compatible): advanced text, images, EPG, traffic, individual B2B data, etc. - emergency alert/warning with receiver re-tuning, audio and (multi-lingual) text information
coverage	community, local, regional, nationwide
QoS	<ul style="list-style-type: none"> - very good audio quality (up to CD like) - non-graceful degradation - automatic switching DAB-DAB, DAB-FM, DAB-AM, DAB-DRM supported - independent of demand
availability of equipment	<ul style="list-style-type: none"> - more than 1000 different DAB receiver models commercially available - more than 30 million DAB receivers sold worldwide - encoder and transmitter equipment widely available

costs	<ul style="list-style-type: none"> - receivers at affordable levels and falling - medium distribution costs, particularly if a DAB multiplex is shared by many programmes using the DAB+ audio encoding
capacity	<ul style="list-style-type: none"> - depending on protection level (e.g. p13: ca. 1184 kbps) - number of audio services depends on audio quality desired and coding used; typically it ranges between 6 for (DAB) and 20 for (DAB+) stereo services per multiplex. For DMB-radio up to 10 radio services in addition to other services, in the multiplex.
flexibility	<ul style="list-style-type: none"> - audio services and/or additional data services - adjustable quality of each programme (data rate) - flexible trade-off between capacity and signal robustness
planning parameters	<ul style="list-style-type: none"> - ITU GE06 Agreement [7] - Handhelds: EBU-TECH 3317 [18]
compatibility criteria with other systems	ITU GE06 Agreement [7]
international agreements	ITU GE06 Agreement [7]
standardized in Europe	ETSI EN 300 401 [19]
support	broadcasters, manufacturers, regulators
other frequency band (s)	L-Band
network topology	<ul style="list-style-type: none"> - SFN - MFN possible

Table 4: Title

L-Band (1452 - 1479.5 MHz)

L Band, the frequency band 1452 and 1479.5 MHz has been planned for T-DAB. However, when compared with Band III the wave propagation conditions are more challenging from a network planning point of view. As a consequence, one of the main issues with L-band is the need for denser networks to achieve comparable coverage.

L-Band	DAB
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functionality	<ul style="list-style-type: none"> - fixed, portable (indoor and outdoor), mobile reception - mono / stereo, surround sound - full range of standardized multimedia and data services (DRM compatible): advanced text, images, EPG, traffic, individual B2B data, etc. - emergency alert/warning with receiver re-tuning, audio and (multi-lingual) text information
coverage	<ul style="list-style-type: none"> - suitable for community and local coverage - regional and nationwide coverage possible but difficult to achieve
QoS	<ul style="list-style-type: none"> - very good audio quality (up to CD like) - non-graceful degradation - automatic switching DAB-DAB, DAB-FM, DAB-AM, DAB-DRM supported - independent of demand
availability of equipment	<ul style="list-style-type: none"> - receiver choice more limited compared to Band III
costs	<ul style="list-style-type: none"> - receivers at affordable levels and falling - high distribution costs - costs of building a network are significantly higher than for Band III
capacity	<ul style="list-style-type: none"> - depending on protection level (e.g. p13: ca. 1184 kbps) - number of audio services depends on audio quality desired and coding used; typically it ranges between 6 stereo services per multiplex; and up to 20 stereo services for a DAB+ multiplex; for DMB-radio, up to 10 services per multiplex
flexibility	<ul style="list-style-type: none"> - audio services and/or additional data services - adjustable quality of each programme (data rate) - flexible trade-off between capacity and signal robustness
planning parameters	<ul style="list-style-type: none"> - CEPT MA02revCO07 Special Arrangement [8] - Handhelds: EBU-TECH 3317 [18]
compatibility criteria with other systems	CEPT MA02revCO07 Special Arrangement [8]
international agreements	CEPT MA02revCO07 Special Arrangement [8]

standardized in Europe	ETSI EN300 401 [19]
support	limited support from broadcasters, manufacturers and regulators
other frequency band(s)	Band III
network topology	- SFN, MFN - large SFNs difficult to implement

Table 5: Title

TITLE

Roll-out of digital radio based on the Eureka 147 family of standards, audio coding and receiver sales

Regular services:

Europe

United Kingdom - DAB - 12 million receivers sold

Denmark - DAB - 2 million receivers sold

Switzerland - DAB and DAB+ - 450.000 receivers sold

Norway - DAB - 290.000 receivers sold

Malta - DAB+

Outside Europe

South Korea - DAB and T-DMB - 20 million receivers sold

Australia - DAB+ - 110.000 receivers sold

Hong Kong

Singapore

Taiwan

Countries planning launch of digital radio

Europe

Italy - DAB+ and DMB-A

France - DMB-A

Germany - DAB+

Czech Republic - DAB+

Sweden - DAB+

Hungary - DAB+

Outside Europe

Malaysia - T-DMB

List of references

[ref1]

[ref2]

ECC Report 141: Future possibilities for the digitalisation of band II (87.5-108 MHz)

GE75: GE75 Agreement, Geneva 1975 (www.itu.int)

ST61: **ST61** Agreement, revised Geneva 2006 (www.itu.int)

GE84: **GE84** Agreement, Geneva 1984 (www.itu.int)

GE06: **GE06** Agreement, Geneva 2006 (www.itu.int)

EC Decision 2010/267/EC MA02revCO07: MA02revCO07 Special Arrangement

Recommendation ITU-R BS.560-4: Radio-frequency protection ratios in LF, MF and HF broadcasting

ETSI ES 201 980: Digital Radio Mondiale (DRM);System Specification

Recommendation ITU-R BS.1615 : "Planning parameters" for digital sound broadcasting at frequencies below 30 MHz

ITU RR: Radio Regulations (www.itu.int)

ITU-R Resolution 543 (WRC03): Provisional RF protection ratio values for analogue and digitally modulated emissions in the HF broadcasting service

NRSC-5B: NRSC-5 Standard and Reference Documents

FCC part 4: Disruptions to, Communications

Recommendation ITU-R BS 1514-1: System for digital sound broadcasting in the broadcasting bands below 30 MHz

ITU-R -CCRR 20: Special study, under No. 13.15 of the Radio Regulations, in relation to the Regional Agreements GE75, RJ81 and RJ88

EBU-TECH 3317: Planning parameters for hand held reception. Concerning the use of DVB-H and T-DMB in Bands III, IV, V and the 1.5 GHz band

ETSI EN 300 401: Radio Broadcasting Systems;Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers

MA02revCO07: MA02revCO07 Special Arrangement

ECC Decision ECC/DEC/(09)03