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Digital Radio Mondiale (DRM); System Specification

EBU

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Foreword

This final draft ETSI Standard (ES) has been produced by Joint Technical Committee (JTC) Broadcast of the European Broadcasting Union (EBU), Comité Européen de Normalisation ELECtrotechnique (CENELEC) and the European Telecommunications Standards Institute (ETSI), and is now submitted for the ETSI standards Membership Approval Procedure.

NOTE: The EBU/ETSI JTC Broadcast was established in 1990 to co-ordinate the drafting of standards in the specific field of broadcasting and related fields. Since 1995 the JTC Broadcast became a tripartite body by including in the Memorandum of Understanding also CENELEC, which is responsible for the standardization of radio and television receivers. The EBU is a professional association of broadcasting organizations whose work includes the co-ordination of its members' activities in the technical, legal, programme-making and programme-exchange domains. The EBU has active members in about 60 countries in the European broadcasting area; its headquarters is in Geneva.

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Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Introduction

The frequency bands used for broadcasting below 30 MHz are:

- Low Frequency (LF) band: from 148,5 kHz to 283,5 kHz, in ITU Region 1 [i.3] only;
- Medium Frequency (MF) band: from 526,5 kHz to 1 606,5 kHz, in ITU Regions 1 [i.3] and 3 [i.3] and from 525 kHz to 1 705 kHz in ITU Region 2 [i.3];
- High Frequency (HF) band: a set of individual broadcasting bands in the frequency range 2,3 MHz to 27 MHz, generally available on a Worldwide basis.

These bands offer unique propagation capabilities that permit the achievement of:

- large coverage areas, whose size and location may be dependent upon the time of day, season of the year or period in the (approximately) 11 year sunspot cycle;
- portable and mobile reception with relatively little impairment caused by the environment surrounding the receiver.

There is thus a desire to continue broadcasting in these bands, perhaps especially in the case of international broadcasting where the HF bands offer the only reception possibilities which do not also involve the use of local repeater stations.

However, broadcasting services in these bands:

- use analogue techniques;
- are subject to limited quality;
- are subject to considerable interference as a result of the long-distance propagation mechanisms which prevail in this part of the frequency spectrum and the large number of users.

As a direct result of the above considerations, there is a desire to effect a transfer to digital transmission and reception techniques in order to provide the increase in quality which is needed to retain listeners who, increasingly, have a wide variety of other programme reception media possibilities, usually already offering higher quality and reliability.

In order to meet the need for a digital transmission system suitable for use in all of the bands below 30 MHz, the Digital Radio Mondiale (DRM) consortium was formed in early 1998. The DRM consortium is a non-profit making body which seeks to develop and promote the use of the DRM system worldwide. Its members include broadcasters, network providers, receiver and transmitter manufacturers and research institutes. More information is available from their website (http://www.drm.org/).

In March 2005, the DRM Consortium voted at its General Assembly to embark on extending the capability of the DRM system to provide digital radio services at higher transmission frequencies. This range includes:

- 47 MHz to 68 MHz (Band I) allocated to analogue television broadcasting;
- 65,8 MHz to 74 MHz (OIRT FM band);
- 76 MHz to 90 MHz (Japanese FM band);
- 87,5 MHz to 107,9 MHz (Band II) allocated to FM radio broadcasting;
- 174 MHz to 240 MHz (Band III) allocated to digital broadcasting.

This extension completes the family of digital standards for radio broadcasting.

1 Scope

The present document gives the specification for the Digital Radio Mondiale (DRM) system for digital transmissions in the broadcasting bands below 300 MHz.

With respect to the previous published version, the present document adds loudness metadata provision and removes certain options from coding parameters for xHE-AAC audio.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

[1] ISO/IEC 14496-3: "Information technology - Coding of audio-visual objects - Part 3: Audio".

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

[3] ISO/IEC 10646: "Information technology -- Universal Coded Character Set (UCS)".

[4] ISO 639-2: "Codes for the representation of names of languages - Part 2: Alpha-3 code".

[5] ISO 3166 (all parts): "Codes for the representation of names of countries and their subdivisions".

[6] ISO/IEC 8859-1: "Information technology - 8-bit single-byte coded graphic character sets - Part 1: Latin alphabet No. 1".

[7] ETSI TS 101 968: "Digital Radio Mondiale (DRM); Data applications directory".

[8] ISO/IEC 23003-4: "Information technology - MPEG audio technologies - Part 4: Dynamic Range Control".

[9] ISO/IEC 23003-1: "Information technology - MPEG audio technologies - Part 1: MPEG Surround".

[10] ISO/IEC 23003-3: "Information technology - MPEG audio technologies - Part 3: Unified speech and audio coding".

[11] ETSI TS 126 290: "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; 5G; Audio codec processing functions; Extended Adaptive Multi-Rate - Wideband (AMR-WB+) codec; Transcoding functions (3GPP TS 26.290)".

[12] IEC 62106: "Radio Data System (RDS) - VHF/FM sound broadcasting in the frequency range from 64,0 MHz to 108,0 MHz".

[13] ETSI TS 102 386: "Digital Radio Mondiale (DRM); AM signalling system (AMSS)".

[14] ETSI TS 103 176: "Digital Audio Broadcasting (DAB); Rules of implementation; Service information features".

[15] ETSI TS 102 980: "Digital Audio Broadcasting (DAB); Dynamic Label Plus (DL Plus); Application specification".

[16] ETSI TS 103 771: "Digital Radio Mondiale (DRM); Regional profiles".

[17] Unicode® standard.

[18] Unicode® bidirectional algorithm, UAX#9.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] Recommendation ITU-R BS.1615: "Planning parameters" for digital sound broadcasting at frequencies below 30 MHz".

[i.2] Recommendation ITU-R BS.1660: "Technical basis for planning of terrestrial digital sound broadcasting in the VHF band".

[i.3] ITU Radio Regulations.

[i.4] Recommendation ITU-R BS.1770-4: "Algorithms to measure audio programme loudness and true-peak audio level".

3 Definition of terms, symbols, abbreviations and conventions

3.1 Terms

For the purposes of the present document, the following terms apply:

cell: sine wave portion of duration T_s, transmitted with a given amplitude and phase and corresponding to a carrier position

NOTE: Each OFDM symbol is the sum of K such sine wave portions equally spaced in frequency.

energy dispersal: operation involving deterministic selective complementing of bits in the logical frame, intended to reduce the possibility that systematic patterns result in unwanted regularity in the transmitted signal

Fast Access Channel (FAC): channel of the multiplex data stream which contains the information that is necessary to find services and begin to decode the multiplex

kbit/s: kilo bits per second (1 000 bits per second)

logical frame: data contained in one stream during 400 ms or 100 ms

Main Service Channel (MSC): channel of the multiplex data stream which occupies the major part of the transmission frame and which carries all the digital audio services, together with possible supporting and additional data services

mod: modulo operator

NOTE: (x mod y) = z, where y > 0, such that x = qy + z, q is an integer and $0 \leq z < y$.

multiplex frame: logical frames from all streams form a multiplex frame

NOTE: It is the relevant basis for coding and interleaving.

OFDM symbol: transmitted signal for that portion of time when the modulating amplitude and phase state is held constant on each of the equally-spaced carriers in the signal

reserved for future addition (rfa): bits with this designation are set to zero

NOTE: Receivers need not decode these bits.

reserved for future use (rfu): bits with this designation are set to zero

NOTE: Receivers need to check these bits in order to determine the valid status of the other fields in the same scope.

Service Description Channel (SDC): channel of the multiplex data stream which gives information to decode the services included in the multiplex

NOTE: The SDC also provides additional information to enable a receiver to find alternative sources of the same data.

Single Frequency Network (SFN): network of transmitters sharing the same radio frequency to achieve a large area coverage

transmission frame: number of consecutive OFDM symbols, whereby the first OFDM symbol contains the time reference cells

transmission super frame: set of consecutive transmission frames, whereby the first OFDM symbols contain the SDC block

UEP profile: combination of protection levels and lengths of higher protected parts for unequal error protection

3.2 Symbols

For the purposes of the present document, the following symbols apply:

$E[\ ]$	expectation value of the expression in brackets
f_R	reference frequency of the emitted signal
K	number of active carriers in the OFDM symbol
K_{max}	carrier index of the upper active carrier in the OFDM signal
K_{min}	carrier index of the lower active carrier in the OFDM signal
L_{MUX}	number of input bits per multiplex frame for the multilevel encoding
N_{MUX}	number of MSC cells (QAM symbols) per multiplex frame
T	elementary time period, equal to $83^{1/3}$ µs (1/12 kHz)
T_f	duration of the transmission frame
T_g	duration of the guard interval
T_s	duration of an OFDM symbol
T_{sf}	duration of the transmission super-frame built from the set of transmission frames
T_u	duration of the useful (orthogonal) part of an OFDM symbol, excluding the guard interval
$X*$	complex conjugate of value X
$\lceil\ \rceil$	round towards plus infinity
$\lfloor\ \rfloor$	round towards minus infinity

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AAC	Advanced Audio Coding
ACELP	Algebraic Code Excited Linear Prediction
AF	Audio Frequency
AFS	Alternative Frequency Switching
AM	Amplitude Modulation
AMR-WB	Adaptive Multi-Rate WideBand
AMSS	Amplitude Modulation Signalling System
AWGN	Additive White Gaussian Noise
BER	Bit Error Rate
CA	Conditional Access
CC	Country Codes
CCIR	Comité Consultatif International des Radio-communications
CI	Continuity Index
CIRAF	Conferencia Internacional de Radiodifusión por Altas Frecuencias
C/N	Carrier to Noise
CRC	Cyclic Redundancy Check
DAB	Digital Audio Broadcasting
dBFS	deciBels Full Scale
DC	Direct Current
DL	Dynamic Label
DRM	Digital Radio Mondiale
DSB	Double SideBand
ECC	Extended Country Code
EEP	Equal Error Protection
EP	Error Protection
ER	Error Robust
EW	East West
FAC	Fast Access Channel
FEC	Forward Error Correction
FIG	Fast Information Group
FM	Frequency Modulation
HCR	Huffman Codeword Reordering
HE-AAC	High Efficiency AAC
HF	High Frequency
HFCC	High Frequency Coordination Committee
ID	Identification
IdLQ	Identifier List Qualifier
IFFT	Inverse Fast Fourier Transform
ILS	International Linkage Set
ISO	International Organization for Standardization
LA	Linkage Actuator
LF	Low Frequency
LKFS	Loudness, K-weighted, relative to nominal Full Scale
LOS	Line-Of-Sight
LRI	Left-to-Right Isolate
LSb	Least Significant bit
LSN	Linkage Set Number
LTO	Local Time Offset
LTR	Left-To-Right
MDCT	Modified Discrete Cosine Transform
MDI	Multiplex Distribution Interface
MF	Medium Frequency
MJD	Modified Julian Date
MPEG	Moving Picture Experts Group
MPS	MPEG Surround
MSb	Most Significant bit
MSC	Main Service Channel

MW	Medium Wave
NS	North South
OFDM	Orthogonal Frequency Division Multiplexing
OIRT	Organization Internationale de Radiodiffusion et de Télévision
PDI	Pop-Directional-Isolate
PDS	Power Density Spectrum
PI	Programme Identifier
PNS	Perceptual Noise Substitution
PPI	Padded Packet Indicator
PRBS	Pseudo-Random Binary Sequence
PS	Parametric Stereo
QAM	Quadrature Amplitude Modulation
QMF	Quadrature Mirror Filter
RDS	Radio Data System
RF	Radio Frequency
rfa	reserved for future addition
rfu	reserved for future use
RLI	Right-to-Left Isolate
RM	Robustness Mode
RS	Reed-Solomon
RTL	Right-To-Left
RVLC	Reversible Variable Length Coding
SAC	Spatial Audio Coding
SBR	Spectral Band Replication
SDC	Service Description Channel
SFN	Single Frequency Network
SI	Side Information
SId	Service Identifier
SNR	Signal to Noise Ratio
SSB	Single SideBand
SW	Short Wave
TCX	Transform Coded eXcitation
TES	Temporal Envelope Shaping
TNS	Temporal Noise Shaping
TSD	Transient Steering Decorrelator
UEP	Unequal Error Protection
uimsbf	unsigned integer most significant bit first
UK	United Kingdom
US	United States
USAC	Unified Speech and Audio Coding
UTC	Co-ordinated Universal Time
UTF	Unicode Transformation Format
VCB11	Virtual Codebooks for Codebook 11
VHF	Very High Frequency
VSB	Vestigial SideBand
WSSUS	Wide Sense Stationary Uncorrelated Scattering model
xHE-AAC	eXtended HE-AAC
XOR	eXclusive OR

3.4 Conventions

Unless otherwise stated, the following convention, regarding the order of bits within each step of processing is used:

- in figures, the bit shown in the left hand position is considered to be first;
- in tables, the bit shown in the left hand position is considered to be first;
- in numerical fields, the Most Significant bit (MSb) is considered to be first and denoted by the higher number. For example, the MSb of a single byte is denoted "b7" and the Least Significant bit (LSb) is denoted "b0";
- in vectors (mathematical expressions), the bit with the lowest index is considered to be first.

4 General characteristics

4.1 System overview

The DRM system is designed to be used at any frequency below 300 MHz, with variable channelization constraints and propagation conditions throughout these bands. In order to satisfy these operating constraints, different transmission modes are available. A transmission mode is defined by transmission parameters classified in two types:

- signal bandwidth related parameters;
- transmission efficiency related parameters.

The first type of parameters defines the total amount of frequency bandwidth for one transmission. Efficiency related parameters allow a trade-off between capacity (useful bit rate) and ruggedness to noise, multipath and Doppler.

4.2 System architecture

This clause gives a general presentation of the system architecture, based on the synoptic diagram of figure 1, which gives reference to the clauses defining the individual parts of the system.

Figure 1 describes the general flow of different classes of information (audio, data, etc.) and does not differentiate between different services that may be conveyed within one or more classes of information. A detailed description on the distribution of services onto those classes can be found in clause 6.