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Digital Radio Mondiale

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Digital Radio Mondiale (abbreviated **DRM**; *mondiale* being Italian and French for "worldwide") is a set of digital audio broadcasting technologies designed to work over the bands currently used for AM broadcasting, particularly shortwave. DRM can fit more channels than AM, at higher quality, into a given amount of bandwidth, using various MPEG-4 codecs.

Digital Radio Mondiale is also the name of the international non-profit consortium designing and implementing the platform. Radio France Internationale, TéléDiffusion de France, BBC World Service, Deutsche Welle, Voice of America, Telefunken (now Transradio) and Thomcast (now Technicolor SA) took part at the formation of the DRM consortium.

The principle of DRM is that bandwidth is the limited element, and computer processing power is cheap; modern CPU-intensive audio compression techniques enable more efficient use of available bandwidth, at the expense of processing resources.

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Features

DRM can deliver FM-comparable sound quality, but on frequencies below 30 MHz (long wave, medium wave and short wave), which allow for very-long-distance signal propagation. VHF is also under consideration, under the name "DRM+". DRM has been designed especially to use portions of older AM transmitter facilities such as antennas, avoiding major new investment. DRM is robust against the fading and interference which often plague conventional broadcasting on these frequency ranges.

The encoding and decoding can be performed with digital signal processing, so that a cheap embedded computer with a conventional transmitter and receiver can perform the rather complex encoding and decoding.

As a digital medium, DRM can transmit other data besides the audio channels (datacasting) — as well as RDS-type metadata or program-associated data as Digital Audio Broadcasting (DAB) does. Unlike most other DAB systems, DRM uses in-band on-channel (IBOC) technology and can operate in a hybrid mode called Single Channel Simulcast, simulcasting both analog signal and digital signal.

Status

The LW/MW/SW standard has been approved by the IEC, and the ITU has approved its use in most of the world. Approval for ITU region 2 (North and South America and the Pacific) is pending amendments to existing international agreements. The inaugural broadcast took place on June 16, 2003, in Geneva, Switzerland, at the ITU's annual World Radio Conference.

Current broadcasters include All India Radio, BBC World Service, Deutschlandradio, biteXpress, HCJB, Radio Canada International, Deutsche Welle, Radio Netherlands Worldwide, RTÉ Radio (RTÉ), Radio Exterior de España, RAI,[1] Kuwait Radio, Radio New Zealand International, Vatican Radio, Voice of Russia and Radio Romania International.[2]

Until now DRM receivers have typically used a personal computer. A few manufacturers are presently selling stand alone DRM receivers (Himalaya Electronics, Technisat, Morphy Richards, Starwaves, UniWave, Sarapulsky Radiozavod), which are mostly based upon the no longer available Radioscape RS500 module. The UniWave set is based upon the NewStar Electronics WR608 module. New modules are expected from NewStar Electronics (WR998), from Analog Devices, and others. Kenwood and Fraunhofer presented a prototype standalone receiver chip in September 2006.

Morphy Richards is mass producing DRM receivers, which are being promoted by the broadcaster Deutsche Welle.[3] The receivers cost under £169.99 in the UK (as of October 2008).[4] At the time of writing, Morphy Richards are only distributing these sets around Germany, Austria and the UK, but Europe-wide distribution is expected shortly, with grey market importers using German sourced radios to distribute

across Europe. UniWave has created a receiver called the Di-Wave 100, capable of receiving MOT Slideshow, pictures, and text (Journaline) streams. Support of low bitrate videos (Diveemo) is expected in an upcoming version of this receiver. It is not currently offered for sale.[5][6]

The British Broadcasting Corporation BBC has trialed the technology by broadcasting BBC Radio Devon in the Plymouth area. The trial (http://www.bbc.co.uk/devon/digitalmediumwave/faqs_feature.shtml) lasted for year (April 2007 - April 2008).[7] Digital Radio Mondiale is being considered by Ofcom for introduction in Britain in 2012 on the present AM medium wave band.[8]

RTE has also run single and multiple programme overnight tests during a similar period on the 252KHz LW transmitter in Trim, Co.Meath, Ireland which was upgraded to support DRM after Atlantic 252 closed.

International regulation

On 28 September 2006, the Australian spectrum regulator, the Australian Communications and Media Authority, announced that it had "placed an embargo on frequency bands potentially suitable for use by broadcasting services using Digital Radio Mondiale until spectrum planning can be completed" "those bands being "5950–6200, 7100–7300, 9500–9900, 11650–12050, 13600–13800, 15100–15600, 17550–17900, 21450–21850 and 25670–26100 kHz.[9]

DRM Plus

While the initial version of DRM covers the broadcasting bands below 30 MHz, the DRM consortium voted in March 2005 to begin the process of extending the system to the VHF bands up to 108 MHz.[10] DRM Plus (DRM+) will be the name of this technology.

On 31 August 2009, DRM+ has become an official broadcasting standard with the publication of the technical specification by the European Telecommunications Standards Institute; this is effectively a new release of the whole DRM spec with the additional mode permitting operation above 30 MHz up to 174 MHz. [11]

Wider bandwidth channels are used, which allows radio stations to use higher bit rates, thus providing higher audio quality. A 100 kHz DRM+ channel has sufficient capacity to carry one low-definition 0.7 megabit/s wide mobile TV channel: it would be feasible to distribute mobile TV over DRM+ rather than DMB or DVB-H.

DRM Plus is now successfully tested in Band III, and this gives the DRM system the widest frequency usage; it can be used in band I, II and III. It is possible that DRM+ can co exist with DAB in band III.[12]

Technique

Audio source coding

Useful bitrates for DRM range from 6.1 kbit/s (Mode D) to 34.8 kbit/s (Mode A) for a 10 kHz bandwidth (+/- 5 kHz around the central frequency). It is possible to achieve bit rates up to 72 kbit/s (Mode A) by using a standard 20 kHz (+/-10 kHz) wide channel.[13] (For comparison, pure digital HD Radio can broadcast 20 kbit/s using channels 10 kHz wide and up to 60 kbit/s using 20 kHz channels.)[14] Useful bitrate depends also on other parameters, such as:

- desired robustness to errors (error coding)
- power needed (modulation scheme)
- robustness in regard to propagation conditions (multipath propagation, doppler effect), etc.

DRM offers the possibility to use different audio coding system (source coding) depending on the bitrate:

- MPEG-4 HE-AAC (High Efficiency - Advanced Audio Coding). AAC is a perceptual coder suited for voice and music and the High Efficiency is an optional extension for reconstruction of high frequencies (SBR: spectral bandwidth replication) and stereo image (PS: Parametric Stereo). 24 kHz or 12 kHz sampling frequencies can be used for core AAC (no SBR) which correspond respectively to 48 kHz and 24 kHz when using SBR oversampling.
- MPEG-4 CELP which is a parametric coder suited for voice only (vocoder) but that is robust to errors and needs a small bit rate.
- MPEG-4 HVXC which is also a parametric coder for speech programs that uses an even smaller bitrate than CELP.

All codecs can optionally be combined with spectral band replication.

Broadcasters have some freedom of choice depending on the material they send. The most commonly used mode is HE-AAC (also called AAC+) that offers an acceptable audio quality somewhat comparable to FM broadcast.

Bandwidth

DRM broadcasting can be done using a choice of different bandwidths:

- 4.5 kHz. Gives the ability for the broadcaster to do a simulcast and use the lower-sideband area of a full 9 kHz channel for single sideband AM (designated H3E by the ITU), with a 4.5 kHz DRM signal occupying the area traditionally taken by the upper-sideband[15]. However the resulting bit rate and audio quality is not great. This would only apply to the region–1 (European) medium wave and long wave bands, or to the region–3 (Asian/Oceanian) medium wave band.
- 5 kHz. Gives the ability for the broadcaster to do a simulcast and use the lower-sideband area of a full 10 kHz channel for H3E single sideband AM, with a 5 kHz DRM signal occupying the area traditionally taken by the upper-sideband. However the resulting bit rate and audio quality is marginal (7.1—16.7 kbit/s for 5 kHz). This regime would apply to the AM band in region–2 and to the short wave bands the world over.
- 9 kHz. Occupies all the standard bandwidth of a region–1 long wave or medium wave broadcast channel so that the existing frequency plan can be reused. Also used for the region–3 medium wave band.
- 10 kHz. Occupies all the standard bandwidth of a region–2 AM or worldwide short wave broadcast channel (giving 14.8—34.8 kbit/s)

so the existing frequency plan can be reused.
- 18 kHz. Occupies an adjacent pair of region–1 long wave or medium wave channels or an adjacent pair of region–3 medium wave channels according to the existing frequency plan. This offers the possibility of offering better audio quality.
- 20 kHz. Occupies an adjacent pair of region–2 AM or worldwide short wave channels according to the existing frequency plan. This offers the possibility of offering better audio quality (giving 30.6—72 kbit/s).
- 100 kHz for DRM+. This bandwidth can be used in band I, II and III and DRM+ can transmit four different programs in this bandwidth.

Modulation

The modulation used for DRM is COFDM (Coded Orthogonal Frequency Division Multiplexing), where every carrier is modulated with QAM (Quadrature Amplitude Modulation) with a selectable error coding.

The choice of transmission parameters depends on signal robustness wanted and propagation conditions. Transmission signal is affected by noise, interference, multipath wave propagation and Doppler effect.

It is possible to choose among several error coding schemes and several modulation patterns: 64-QAM, 16-QAM and 4-QAM. OFDM modulation has some parameters that must be adjusted depending on propagation conditions. This is the carrier spacing which will determine the robustness against Doppler effect (which cause frequencies offsets, spread: Doppler spread) and OFDM guard interval which determine robustness against multipath propagation (which cause delay offsets, spread: delay spread). The DRM consortium has determined four different profiles corresponding to typical propagation conditions:

- A: Gaussian channel with very little multipath propagation and Doppler effect. This profile is suited for local or regional broadcasting.
- B: multipath propagation channel. This mode is suited for medium range transmission. It is nowadays frequently used.
- C: similar to mode B, but with better robustness to Doppler (more carrier spacing). This mode is suited for long distance transmission.
- D: similar to mode B, but with a resistance to large delay spread and Doppler spread. This case exists with adverse propagation conditions on very long distance transmissions. The useful bit rate for this profile is decreased.

The trade-off between these profiles stands between robustness, resistance in regards to propagation conditions and useful bit rates for the service. This table presents some values depending on these profiles. The more the carrier spacing is the more the system is resistant to Doppler effect (Doppler spread). The more the guard interval is the more the system is resistant to long multipath propagation (delay spread).

The resulting low-bit rate digital information is modulated using COFDM. It can run in simulcast mode by switching between DRM and AM, and it is also prepared for linking to other alternatives (e.g. DAB or FM services).

DRM has been tested successfully on shortwave, mediumwave (with 9 as well as 10 kHz channel spacing) and longwave.

Mode	OFDM Carrier spacing (Hz)	Number of carriers				Symbol length (ms)	Guard interval length (ms)	Nb symbols per frame
		9 kHz	10 kHz	18 kHz	20 kHz			
A	41.66	204	228	412	460	26.66	2.66	15
B	46.88	182	206	366	410	26.66	5.33	15
C	68.18	-	138	-	280	20.00	5.33	20
D	107.14	-	88	-	178	16.66	7.33	24

There is also a lower bandwidth two-way communication version of DRM as a replacement for SSB communications on HF[16] - note that it is NOT compatible with the official DRM specification. It may be possible in some future time for the 4.5 kHz bandwidth DRM version used by the Amateur Radio community to be merged with the existing DRM specification.

The Dream software will receive the commercial versions and also limited transmission mode using the FAAC AAC encoder.

Error coding

Error coding can be chosen to be more or less robust.

This table shows an example of useful bitrates depending on protection classes

- OFDM propagation profiles (A or B)
- carrier modulation (16QAM or 64QAM)
- and channel bandwidth (9 or 10 kHz)

Bitrates, kbit/s

Protection class	A (9 kHz)	B (9 kHz)	B (10 kHz)		C (10 kHz)		D (10 kHz)	
	64-QAM	16-QAM	16-QAM	64-QAM	16-QAM	64-QAM	16-QAM	64-QAM
0	19.6	7.6	8.7	17.4	6.8	13.7	4.5	9.1
1	23.5	10.2	11.6	20.9	9.1	16.4	6.0	10.9
2	27.8	-	-	24.7	-	19.4	-	12.9
3	30.8	-	-	27.4	-	21.5	-	14.3

The lower the protection class the higher the level of error correction.

See also

- AMSS AM signalling system
- Digital Audio Broadcasting (DAB)
- Digital Multimedia Broadcasting (DMB)
- Digital Radio Oceane (DRO)
- DVB-H (Digital Video Broadcasting - Handhelds)
- DVB-T (Digital Video Broadcasting - Terrestrial)
- ETSI Satellite Digital Radio (SDR)
- HD Radio, American system for digital radio
- ISDB-Tsb, Japanese system for digital radio.

References

1. **^** The experimentation on DRM (http://www.raiway.rai.it/index.php?lang=EN&cat=94)
2. **^** http://www.drm.org/for-listeners/live-broadcast-schedule/
3. **^** article: DRM radios available internationally for less than 200 € (http://www.dw-world.de/dw/article/0,2144,2173460,00.html)
4. **^** http://www.igear.com/product_details.php?item_id=1478&
5. **^** http://www.drm.org/uploads/media/20090327-New_DRM_receiver_unveiled_and_reiterated_support_for_DRM_from_EBU_ABU_01.pdf
6. **^** http://www.universal-radio.com/catalog/portable/0023.html
7. **^** http://www.bbc.co.uk/devon/content/articles/2009/05/11/digital_medium_wave_report_feature.shtml Digital medium wave trial report (BBC)
8. **^** http://www.ofcom.org.uk/consult/condocs/futureradio/ The Future of Radio (Ofcom, 2007)
9. **^** article: ACMA embargoes spectrum to plan for Digital Radio Mondiale (http://www.acma.gov.au /ACMAINTER.852114:STANDARD::pc=PC_100801)
10. **^** DRM+ Presentation (http://www.drm.org/fileadmin/media/downloads/drmplus_presentation_v1_5_.pdf) , DRM.org, accessed 2009-02-02
11. **^** ETSI ES 201 980 V3.1.1
12. **^** Symposium about the DRM+ field trial in VHF band III (http://www.drm-radio-kl.eu/symposium2010/symposium2010en.htm)
13. **^** "Broadcasters' User Manual" (http://www.drm.org/pdfs/Broadcast_Manual.pdf) (PDF; 4.5 MB). EBU. p. 19. http://www.drm.org /pdfs/Broadcast_Manual.pdf.
14. **^** The Structure and Generation of Robust Waveforms for AM In-Band On-Channel Digital Broadcasting (http://www.ibiquity.com/i/pdfs /Waveforms_AM.pdf) PDF
15. **^** "See section 5: "DRM/AM single channel simulcast"" (http://www.etsi.org/deliver/etsi_ts/102500_102599/102509/01.01.01_60 /ts_102509v010101p.pdf) . http://www.etsi.org/deliver/etsi_ts/102500_102599/102509/01.01.01_60/ts_102509v010101p.pdf.
16. **^** WinDRM (http://n1su.com/windrm/) - software for Audio and Fast Data over HF SSB

External links

DRM in general

- Digital Radio Mondiale (DRM) - official homepage (http://www.drm.org/)
- DRM Info with transmitter pictures (http://www.drmradio.co.uk/)
- Map of DRM capable transmitter sites worldwide with frequency schedule etc. (http://maps.hirschler.net/tx_site.html)
- DRM - progress on the receiver front (http://www.ebu.ch/trev_293-jackson.pdf)
- How to receive DRM on the long-, medium- and shortwave bands (http://www.drmradio.dk)
- Long-range DRM Digital Radio - introductory leaflet (http://www.drmradio.dk/Leaflet.pdf)
- A Listeners' Guide to Digital AM (DRM) (http://www.radionetherlands.nl/features/media/dossiers/drm.html)
- DRM Patent Licensing (http://www.vialicensing.com/licensing/DRM_index.cfm)
- DRM - Digital Radio Mondiale - Digital AM radio below 30 MHz (http://www.aoruk.com/drm.htm)
- UK Digital Radio News (http://www.digitalradiotech.co.uk/)
- DRM Digital Radio - A broadcasters view of the future (http://www.deutsches-drm-forum.de/IFA_Symp_BBC.pdf)

DRM broadcast transmitter manufacturers

- TRANSRADIO, Germany - DRM Signal Generator DRM DMOD2 and DRM Transmitters (http://www.broadcast-transradio.com/html/drm.html)
- THOMSON Broadcast & Multimedia AG, Switzerland/France - DRM Transmitters on MF and HF, DRM Encoder/Multiplexer/Modulator/Measurement Receivers (http://www.thomsongrassvalley.com/products_disttrans/index_radio_transmission.html)
- Nautel, Canada - DRM transmitters (http://www.nautel.com/DRM.aspx)
- RFmondial, Germany - DRM/DRM+ Modulator/Monitoring/Test Receivers (http://www.rfmondial.com)
- RIZ Transmitters Co., Croatia - DRM Transmitters on MW, SW, HF, DRM Encoder/Multiplexer/Modulator (http://www.riz.hr/drm/drm.html)
- Continental Electronics, Dallas, Texas, USA, Transmitters for DRM (http://www.contelec.com/sw_index.html)

DRM software

- DRM Software Radio (http://www.drmrx.org) developed by the Fraunhofer IIS (http://www.iis.fraunhofer.de)
- Dream DRM Receiver - An open source software radio published by the University Darmstadt (Germany) (http://www.tu-darmstadt.de)
- HamDream (http://www.qslnet.de/member/hb9tlk/) A modified DREAM receiver supporting 2.5 kHz bandwidth.
- Diorama (http://nt.eit.uni-kl.de/static/diorama/index.html) DRM receiver. An open source DRM receiver written in MATLAB by the Institute of Telecommunications (http://nt.eit.uni-kl.de/) of the University Kaiserslautern (Germany) (http://www.uni-kl.de/))
- Spark (http://www.drm-sender.de) A DRM software transmitter developed by the University of Applied Sciences Kaiserslautern (Germany) (http://www.fh-kl.de/index.php?id=178)
- WinDRM (http://n1su.com/windrm/) DRM software for amateur radio users.

DRM radio techniques

- DRM Software Radio product (http://www.drmrx.org/)
- DRM Receiver Modifications (http://www.drmrx.org/receiver_mods.html)
- "bird-nest" DRM receiver (http://www.drmrx.org/mods/Simple_fixed_channel_DRM-v2.pdf)
- Dream - an open-source software DRM Receiver (http://drm.sourceforge.net)
- How to receive DRM: A practical guide (http://www.drmradio.dk)
- Spark (http://www.drm-sender.de) , a DRM signal generator (transmitter) software, University of Applied Sciences-Kaiserslautern Germany (http://www.fh-kl.de/index.php?id=178)

DRM's COFDM

- "The how and why of COFDM" (http://www.ebu.ch/en/technical/trev/trev_278-stott.pdf) Jonathan Stott. EBU: *EBU Technical Review (http://www.ebu.ch/en/technical/trev/trev_home.html)* 278 (winter 1998).
- Explaining some of the magic of COFDM, J H Stott (BBC) (http://www.bbc.co.uk/rd/pubs/papers/paper_15/paper_15.html) : "COFDM is particularly well matched to these applications, since it is very tolerant of the effects of multipath."
- Coded Orthogonal Frequency Division Multiplexing (COFDM) (http://www.digitalradiotech.co.uk/cofdm.htm)
- All About OFDM from SSS Online and Pegasus Technologies (http://www.sss-mag.com/ofdm.html)
- OFDM, VOFDM, COFDM, Orthogonal Frequency Division Multiplexing: tutorials (http://www.palowireless.com/ofdm/tutorials.asp)
- OFDM, VOFDM, COFDM, Orthogonal Frequency Division Multiplexing: resources (http://www.palowireless.com/ofdm/resources.asp)
- COFDM/8-VSB Controversy Archive & Links (http://www.digitaltelevision.com/cofdm/)

See also

- Digital Radio Mondiale - Consortium Agreement (http://www.drm.org/fileadmin/media/downloads/lac_063.pdf)
- ETSI Standards 302 245, 201 980, 102 821, 102 820, 102 759, 102 668, 102 509, 102 386, 102 371,102 358, 102 349, 101 980, 101 968 freely available at ETSI Publications Download Area (http://pda.etsi.org/pda/queryform.asp)
- ETSI Standard: Digital Radio Mondiale (DRM); XML Specification for DAB Electronic Programme Guide (EPG), ETSI TS 102 818 V1.3.1 (2006-02) (http://webapp.etsi.org/action/PU/20060228/ts_102818v010301p.pdf)
- "Planning parameters" for digital sound broadcasting at frequencies below 30 MHz, ITU-R Recommendation BS.1615, (Question ITU-R 223/10) (payment required) (http://www.itu.int/rec/R-REC-BS.1615-0-200306-I/en)
- DRM consortium website (http://www.drm.org)
- (http://tech.ebu.ch/digitalradio) EBU Technical department overview of the DRM family: DRM/DRM+
- J.Stott: DRM — key technical features (http://www.ebu.ch/en/technical/trev/trev_286-stott.pdf) , article in the EBU technical review
- ES 201 980 V3.1.1 (2009-08) (http://pda.etsi.org/exchangefolder/es_201980v030101p.pdf) PDF (1.7 MB); direct download of the DRM standard

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- Digital Broadcasting (http://www.dmoz.org/Science/Technology/Television/Digital_Broadcasting/) at the Open Directory Project

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