

## A Tour of Some Wireless and Mobile Communication Systems BROADCAST RADIO – part 2

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review

yesterday we looked at DAB

1. What are the distinguishing technical features?
2. What are the wider social, political or economical issues related to DAB?



Before looking at DRM a reminder

- The lowest-frequency broadcasting band – **LF**, often known as the **long-wave band (LW)** – can provide extended coverage by ground wave from a single transmitter, and is thus very effective for **national coverage and beyond**.
- The long wavelength implies large transmitting-antenna structures, so this band is normally only used where a large coverage area is desired and can thereby justify the investment in the antenna.
- LW is popular in Europe especially, but is not available for broadcasting in the Americas.

MF or MW

- The medium-frequency (MF) or **medium-wave (MW)** band is available throughout the world and has a wide range of uses.
- Ground-wave propagation is slightly less effective at this frequency than at LF, but daytime coverage is still good.
- **One transmitter or a small network of a few transmitters can provide national coverage** (depending on the size of country) although the band is also used for local coverage with a single low power transmitter.

MF or MW

- At night (when absorption in the D layer of the ionosphere is reduced) sky-wave propagation occurs in addition to ground wave.
- This can be considered a hindrance or a help. The enhanced propagation can bring **interference**; e.g. a distant co-channel station unheard during the day becomes audible in the background of the wanted station.
- There can also be **self-interference** from the sky wave of the wanted station – this arrives later than the ground wave and thus causes interference as a form of multipath, resulting in fading or distorted sound.
- However, the enhanced propagation can also be exploited positively for **international broadcasting**, to places that the ground wave cannot reach.

## HF or SW

- The HF (or *short-wave*, SW) bands are mostly known for facilitating **international broadcasting, using sky wave**.
- Broadcasts can be targeted at distant countries with the advantage that there is no gatekeeper to obstruct, or other operator to charge for, the delivery of the service.
- Signals can even be sent halfway round the world, although most major broadcasters arrange to have transmitters somewhat nearer the target in order to improve reliability and give more choice of operating times and frequencies.

## HF or SW

- The lower-frequency end of the SW band is also used to provide national coverage of tropical or large countries (see *Appendices A and B*).
- Both applications rely on skywave propagation and thus depend on the **state of the ionosphere**, which **changes daily, yearly** and according to the 11-year sunspot cycle – with some random variations thrown in.
- For this reason, use of the HF band involves the broadcaster in changes of frequency during the day, and thus in the course of a broadcast unless broadcasting hours are short.
- In addition, uncertainties in forecasting, together with the fact that a large target country may require different modes of propagation in order to reach its various parts, mean that the use of two or more frequencies in parallel is common.

Extremely low frequency	ELF	3–30 Hz	Directly audible when converted to sound, communication with submarines
Super low frequency	SLF	30–300 Hz	Directly audible when converted to sound, AC power grids (50–60 Hz)
Ultra low frequency	ULF	300–3000 Hz	Directly audible when converted to sound, communication with mines
Very low frequency	VLF	3–30 kHz	Directly audible when converted to sound (below ca. 20 kHz; or <i>ultrasound</i> otherwise)
Low frequency	LF	30–300 kHz	<b>AM broadcasting</b> , navigational beacons
Medium frequency	MF	300–3000 kHz	Navigational beacons, <b>AM broadcasting</b> , maritime and aviation communication
High frequency	HF	3–30 MHz	Shortwave, amateur radio, citizens' band radio
Very high frequency	VHF	30–300 MHz	<b>FM broadcasting</b> , amateur radio, broadcast television, aviation
Ultra high frequency	UHF	300–3000 MHz	Broadcast television, amateur radio, mobile telephones, cordless telephones, wireless networking, remote keyless entry for automobiles, microwave ovens
Super high frequency	SHF	3–30 GHz	Wireless networking, satellite links, microwave links, satellite television, door openers
Extremely high frequency	EHF	30–300 GHz	Microwave data links, radio astronomy, remote sensing, advanced weapons systems, advanced security scanning

**Long wave, Medium wave and Short wave** can be used at times to refer to LF, MF and HF bands.

So?

- There are very good reasons to keep the AM bands for broadcasting purposes because of the types of coverage that they, uniquely, can provide.
- What is needed is a way to improve the audio quality, and indeed the whole listening experience (ease of use, supplementary information, presenting the choices available for easy selection ...)
- The way to achieve this is to apply digital processing techniques, just as has been done with other bands and other media.
- This has been done by the efforts of many organizations within the **Digital Radio Mondiale (DRM)** consortium

# DRM

## DRM

- The Digital Radio Mondiale (DRM) consortium was founded in **1998** representing broadcasters, academic institutions, and manufacturers.
- Its purpose is to develop a **non-proprietary** technical standard for the replacement of analogue AM (Amplitude Modulation) radio with digital radio, also called DRM. [Mondiale is the French word for world].
- International Telecommunications Union (ITU), International Electrotechnical Committee (IEC), and the European Telecommunications Standardisation Institute (ETSI) have all approved DRM broadcasts for frequencies **below 30 MHz**.

<http://www.drmmradio.co.uk/html/info.html>



## acknowledgement

- The following notes are partially taken from the website
- <http://www.drmmradio.co.uk/html/sfn.html>

## a little more

- DRM can be transmitted on **long wave, medium wave** and **short wave**.
- DRM uses the existing AM broadcast frequency bands and is designed to fit in with the existing AM broadcast band plan, based on signals of **9 kHz** or **10 kHz** bandwidth.
- It also has modes that can take advantage of wider bandwidths - **18 kHz** or **20 kHz**
- With DRM the audio quality is primarily determined by the **broadcast mode** and **spectrum occupancy** (i.e. radio bandwidth of the DRM signal). A given mode of broadcast, of which there are four, A, B, C and D, will be able to deal with different kinds of propagation effects. We will learn more about the modes in a little while.

## COFDM again!!!!

- The DRM radio signal consists of data transmitted using COFDM (Coded Orthogonal Frequency Division Multiplex).
- We looked at COFDM when we looked at DAB
- Recall that Digital Audio Broadcasting has 1536 carriers spaced 1 kHz apart.

## modes

DRM mode	propagation	data rate	error protection
A	minor fading	highest	lowest
B	as 'A' plus selective fading	middle	low
C	as 'B' plus severe fading	low	middle
D	as 'C' plus severe Doppler shift	lowest	highest

<http://www.drmmradio.co.uk/html/cofdm.html>

DRM mode	carrier spacing	number of carriers 9 kHz	number of carriers 10 kHz	number of carriers 18 kHz	number of carriers 20 kHz
A	41.66 Hz	204	228	412	460
B	46.88 Hz	182	206	366	410
C	68.18 Hz	*	138	*	280
D	107.14 Hz	*	88	*	178

\* mode not specified for long/medium wave broadcast.

### more info

- Mode A: Gaussian channel with very little multipath propagation and Doppler effect. This profile is suited for local or regional broadcasting. It is most likely to be used on **medium** and **long wave** using ground wave propagation for local broadcasts.
- B: multipath propagation channel. This mode is suited for medium range transmission. It is nowadays frequently used. It is the most common mode for single hop **short wave** broadcasts and most broadcasts within Europe use this mode. Night time or international **medium wave** broadcasts (via sky wave) may use Mode B instead of Mode A.
- C: similar to mode B, but with better robustness to Doppler (more carrier spacing). This mode is suited for long distance transmission. E.g. for long path multi-hop broadcasts on **short wave**. For example direct broadcasts from New Zealand or Australia being beamed into Europe.
- 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.

### compression

- It uses a better compression algorithm than DAB-**MPEG 4 HE AAC v2**
- DRM uses the HE AAC audio codec, which provides the same level of audio quality at **48 kbps** as the MP2 audio codec -- that DAB uses -- provides at 160kbps.
- Therefore, ignoring any other differences between the technologies, DRM can carry 160kbps / 48kbps = **3.33** times as many radio stations as DAB for the same total data capacity

### SFN again!!!!

- **Single Frequency Network**
- Using COFDM enables a Single Frequency Network (SFN) to be created where many transmitters are broadcasting on the same frequency and it does not matter if the individual transmitter coverage area overlaps.
- This is not possible with analogue transmissions as in areas that receive signals from different transmitters broadcasting on the same frequency there is considerable mutual interference. The analogue transmissions therefore have to be **synchronized**.

### the opposite to SFN

- In the UK commercial rock music station Virgin Radio has **13 transmitters** on 1215 kHz ranging from a few hundred watts to a powerful 200 kW (five at 100 kW) that provide the main coverage. To achieve national coverage requires additional transmitters to cover areas where reception of the main frequency is poor or non-existent.
- 1197 kHz - ten transmitters (200 watts to 2 kW).
- 1233 kHz - five transmitters (100 watts to 500 watts).
- 1242 kHz - four transmitters (500 watts to 2 kW).
- 1260 kHz - two transmitters (500 watts and 1 kW).

### the opposite to SFN

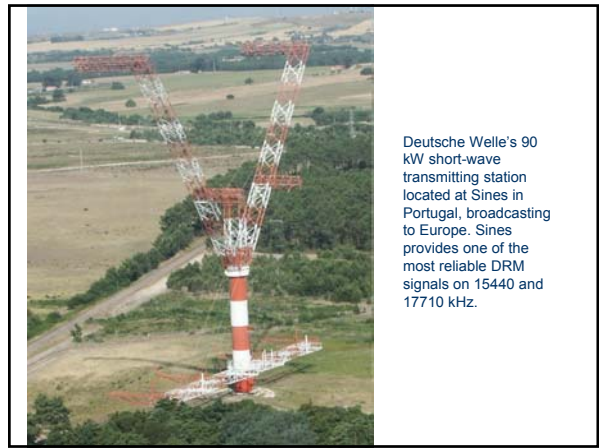
- Another example of a synchronised network is commercial radio station talkSPORT (the station's name describes the format). To get national coverage talkSPORT requires -
- 1053 kHz - twelve transmitters
- 1071 kHz - two 1 kW transmitters.
- 1089 kHz - seven transmitters (including two 400 kW).
- 1107 kHz - six transmitters (500 watt to 2 kW).

### the opposite of SFN

- Consequently these two stations require a total of **nine frequencies** and **61 AM transmitters** to provide national coverage and in some areas reception is possible on more than one frequency. This makes any analogue synchronised network wasteful in terms of spectrum usage and the number of transmitters needed.
- DRM only requires **one frequency** and **as many transmitters** as needed to achieve any desired broadcast area. This makes DRM much more efficient in terms of radio spectrum use.
- Unfortunately Virgin Radio and talkSPORT also broadcast on the 'Digital 1 Network' national DAB multiplex, so there is little incentive for them to switch from AM to DRM as they are already 'digital'.

Live Broadcast Schedule - DRM4 - Mozilla Firefox

Time	Group	Site	Power	Programme	Language	Site		
0000-0070	daily	1431	ND	Carthage	0.05	MC1	English	Sydney101
0000-0200	daily	1371	ND	Baselena	1.00	DRM Huber	German	Stomberg101
0000-2400	daily	1398	ND	AUS-1039	3	ABC	English	Wollongong_101
0000-2400	daily	1008	ND	Prox	1	Economic Ch.	Chinese	Shanya_101
0000-2400	daily	243	ND	Denmark	0.2	Tvst	Danish	Falsholm101
0000-2400	daily	993	ND	France	1	DRM test	French	Vallbona_101
0000-2400	daily	19778	ND	France	0.5	TDF Radio	French	Remous
0000-2400	daily	99000	ND	France	0.55	TDF	French	Remous
0000-2400	daily	789	ND	SP	1	DRM test	German	Budap
0000-2400	daily	955	ND	Spain	1.0	SLF	German	Lecht_101
0000-2400	daily	909	ND	Spain	0.5	DRM test	German	Lecht101
0000-2400	daily	14003	ND	Spain	1	DRM test	German	Lecht_101_101
0000-2400	daily	1393	ND	SP	1.0	WDR 2 klassik	German	Lampertshaus
0000-2400	daily	24076	ND	Spain	0.5	DRM test	German	Hilgheim
0000-2400	daily	24000	ND	Spain	0.5	DRM test	German	Hilgheim
0000-2400	daily	25095	ND	London	0.5	DRM - Premier Radio	English	Capital_Radio
0000-2400	daily	693	ND	Italy	30	RAD tests	Italian	Milano
0000-2400	daily	894	ND	Italy	25	RAD	Italian	Lecht_Rainbow
0000-2400	daily	24033	ND	Italy	0.5	Radio Maria	Italian	Acquafredda
0000-2400	daily	25740	ND	Spain	0.05	Radio Roma	Italian	Milano
0000-2400	daily	24063	ND	Roma	0.5	RAD test	Italian	Lecht_101
0000-1234	daily	13781	45	East Asia	95	DRM	French	Remous101



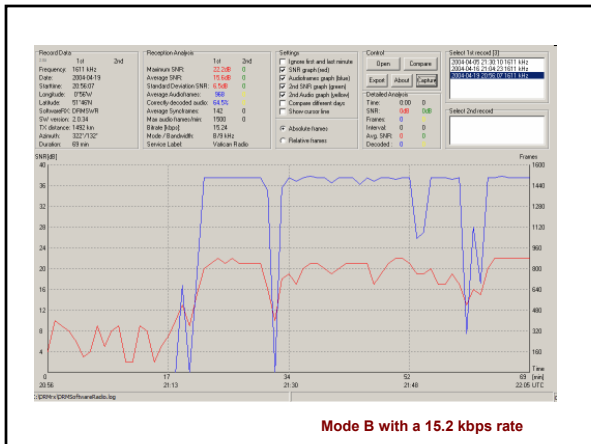
Deutsche Welle's 90 kW short-wave transmitting station located at Sines in Portugal, broadcasting to Europe. Sines provides one of the most reliable DRM signals on 15440 and 17710 kHz.



General view of the Santa Maria di Galeria transmitter site (Vatican Radio).

some measurements

- The following slide has some measurements of the signals from the Vatican Radio taken in the UK.
- The Vatican radio broadcasts on **1611 kHz** using their medium wave transmitter at Santa Maria di Galeria as shown in the previous slide.
- The red trace on the following slide is of interest. It shows the Signal-to-Noise ratio (SNR).



a few points

- These broadcasts are receivable here in the UK as no radio stations use this frequency within the UK.
- As can be seen from the time axis reception is not possible before 21:15 UTC (22:15 local time),
- This could mean that the entire path must be in total darkness before the conditions are suitable for skywave transmission
- The radio path is about 1500 km from Rome to the UK.



[http://www.digitalradiotech.co.uk/2008/12/internet\\_radio\\_explosive\\_growth.php](http://www.digitalradiotech.co.uk/2008/12/internet_radio_explosive_growth.php)

Internet radio saw spectacular growth over the period from May to October 2008, with live streaming, on-demand and personalised radio stations all seeing the equivalent of over 100% annual growth in listeners, and over 4 million listened to Internet radio via live streaming or on-demand or the first time.

[http://www.digitalradiotech.co.uk/2008/12/internet\\_radio\\_explosive\\_growth.php](http://www.digitalradiotech.co.uk/2008/12/internet_radio_explosive_growth.php)

Type of listening	Listeners Oct 07 MIDAS1 report millions	Listeners Apr/May 08 MIDAS2 report millions	Listeners Oct 08 MIDAS3 report millions	Growth Apr/May 08 - Oct 08	Equivalent annual growth Apr/May 08 - Oct 08	Annual growth Oct 07 - Oct 08
Internet radio (ever listened)	12.0	14.5	16.1	11%	26%	34%
Internet radio (listen every week)	8.1	9.4	11.6	23%	58%	43%
Live streaming (ever)	9.0	10.9	15.0	38%	101%	67%
On demand (ever)	7.6	9.3	13.5	45%	125%	78%
Podcast listeners (ever)	4.3	6.0	7.2	20%	49%	67%
Personalised radio (e.g. last.fm)	1.6	2.1	2.9	38%	102%	81%

[http://www.digitalradiotech.co.uk/2008/12/internet\\_radio\\_explosive\\_growth.php](http://www.digitalradiotech.co.uk/2008/12/internet_radio_explosive_growth.php)

Unfortunately, the BBC is so incredibly biased towards DAB that their TV ad campaigns have almost exclusively featured DAB up to now: there have been 21 ad campaigns for DAB; 1 ad campaign for radio via digital TV; and a big fat zero ad campaigns for Internet radio. This is despite the fact that the BBC is supposed to be 'platform-neutral', which means that they're supposed to promote the different platforms that carry digital radio on an equal basis.

**itrips!**

