

## A Tour of Some Wireless and Mobile Communication Systems BROADCAST RADIO-Part 1

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### Analogue broadcasting

**AM**  
1906

**FM**  
~1955  
*(published: 1936)*



### The World of Broadcast Radio

- AM and FM are traditional technologies with which we are familiar.
- Radio networks are star shaped
- Typically there is a powerful radio transmitter covering a given area.
- Outside of coverage area no reception
- Radio receivers tend to be very cheap
- Fixed, portable and mobile receivers
- The transmissions are in one direction

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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
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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.

### Armstrong & FM

- Armstrong first got FM working in 1933. He showed it to Radio Corporation of America, who had most of his licenses, but they were unimpressed.
- RCA had at that point made vast investments in AM.
- All of their transmitters and all of the millions of radios that they had sold used it. Radios were now commodities, and sold **entirely based on price, not quality**.
- RCA told itself that consumers didn't care what the music sounded like from their radios, they just wanted to get it as cheaply as possible.
- They spent a couple of years evaluating the technique and then declined to license it.



Married on December 1, 1923, Howard and Marion Armstrong went to Palm Beach for their honeymoon. Here on the beach Howard tunes in the world's first "portable" radio, a wedding gift to his bride.

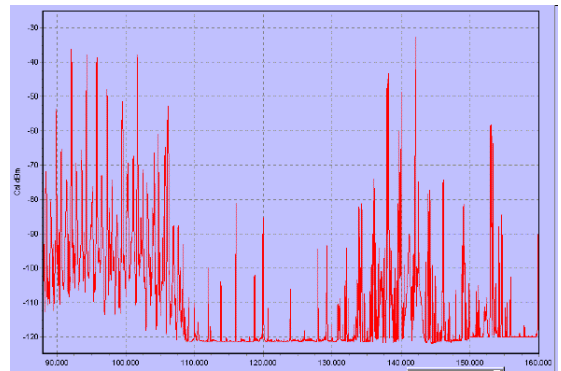
<http://world.std.com/~jlr/doom/armstrng.htm>

## Armstrong Invented FM Radio

- When he sought permission in 1935, however, to erect an experimental FM station to demonstrate the unusual qualities of his new radio system, he ran into a stone wall.
- The **Federal Communications Commission (FCC)** dismissed FM out of hand as "a visionary development," and denied him a permit.
- The standard radio networks operating on AM or amplitude modulation were equally indifferent. "Who needs a second method of broadcasting?" they said.
- It took Armstrong nearly five years to get his experimental station constructed, after threatening to take his invention to a foreign country.
- FM ended up being given spectrum by the FCC in the **44-50 MHz band**.

## example of politics at play

- In 1945 RCA and a block of other radio companies convinced the FCC to move the FM band from 44-50 MHz to **88-108 MHz**, where it is today.
- The nominal reason was to prevent "ionospheric disturbance", but no one was quite clear on what this was. The TV channel right above 50 MHz with its FM sound channel didn't seem to suffer from it.
- What it did do, though, was to immediately obsolete all the transmitters and receivers that had been built. To add insult to injury, the FCC also voted to severely limit FM's broadcasting power, and disallow radio relays from central stations to mountaintop antennas. Instead, the FM broadcasters had to send their material over AT&T's coax cables at exorbitant rates.
- The overall, and intended, result was to cripple FM broadcasting.



<http://www.gm4jji.co.uk/preamp/index.html>

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Frequency and Volume  
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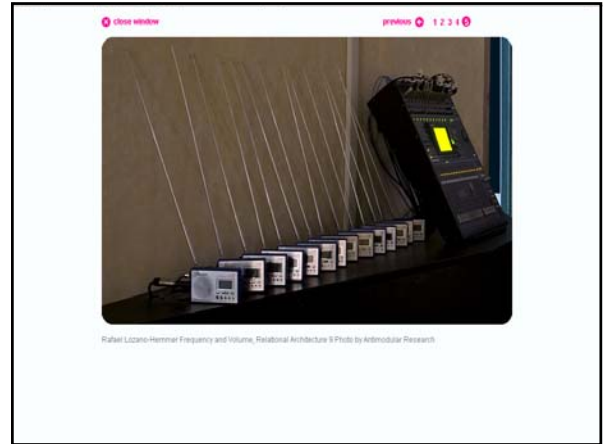
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#### Human rights group broadcast 'pirate' radio show in Beijing

- Updated Fri Aug 8, 2008 3:32pm AEST
- A human rights group has broken China's tight control of the media by broadcasting a radio show calling for freedom of expression in Beijing. At 8.08am local time, the Paris based group Reporters Without Borders began a twenty minute pirate broadcast on Beijing's airwaves. Using FM transmitters they broadcast a twenty minute show on FM radio denouncing China's censorship and control of the media and free expression. It's unknown how many people were able to listen to the program. **The press freedom group says it was the first radio station not controlled by the government to broadcast in China since the Communist Party took power in 1949.**

Wireless, not just broadcast radio can of course play this kind of role in general

#### DAB

- The latest trend in the world of radio broadcasting has been a move away from analogue to **digital radio**
- We talk about **DAB** now – digital audio broadcast
- The acronym DAB (Digital Audio Broadcasting) is synonymous with the **Eureka 147** standard.

# DAB

## frequencies set aside for DAB

- Band III: DAB – frequency band **174–240 MHz**
- L-Band: DAB – frequency band **1452–1492 MHz**

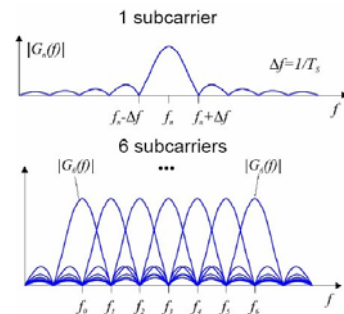
## What is DAB?

- DAB is a **digital radio** broadcasting system that through the application of **multiplexing** and **compression** combines multiple audio streams (and non-audio) together for transmission.
- Uses **MPEG** audio coding for compression
- Uses orthogonal frequency division multiplexing (**OFDM**) – which is robust in a **multipath** environment for transmission. [note: It was the first standard to include OFDM, which since then has become one of the most popular transmission schemes for modern wideband digital communication systems]
- When OFDM is used in conjunction with channel coding techniques, it is described as Coded Orthogonal Frequency Division Modulation (**COFDM**). This is what happens in a DAB system.
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## OFDM – orthogonal frequency division multiplexing



## COFDM for dealing with multipath

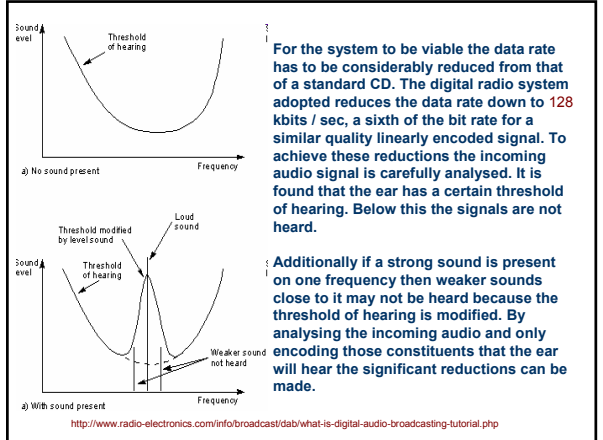


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## compression- MPEG

- MPEG -*Moving Picture Experts Group*
- The term refers to the family of digital video compression standards and file formats developed by the group.
- There are also MPEG standards for audio compression
- **MPEG-1 Audio Layer II** is actually the standard of interest for DAB
- DAB uses the MPEG Audio Layer II system to achieve a compression ratio of 7:1 without perceptible loss of quality. This system is modelled on the working of the human ear, and retains only the audible components of the sound.



## Note

- MPEG-1 uses Huffman coding at the end of process after the lossy coding part has taken place
- We saw something similar when we looked at MPEG-2 in class.

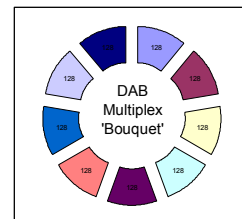
## multiplexing

- More than one programme of the radio station can be transmitted at the one time from a given transmitter
- Note if you listen to RTE 1 on FM they sometimes split into two simultaneous programmes but to get the parallel programme you have to tune to a different frequency (e.g. Religious Services)
- In DAB you use multiplexing to combine the different audio services
- DATA can be multiplexed as well

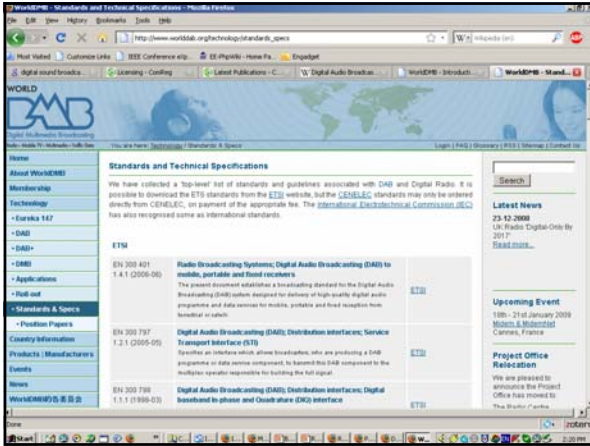
## multiplexing allows for data as well

- DAB can carry text and images as well as sound, and all receivers will be equipped to handle non-audio data.
- All but the smallest will be able to display at least two 16-character lines of text, allowing programme selection by name or programme type, and enabling broadcasters to transmit programme-associated data such as album title, song lyrics, or contact details.
- Additional services, such as traffic information and sports, weather or stock market news feeds, are possible. Transmission of full colour images possible.

## typical configuration

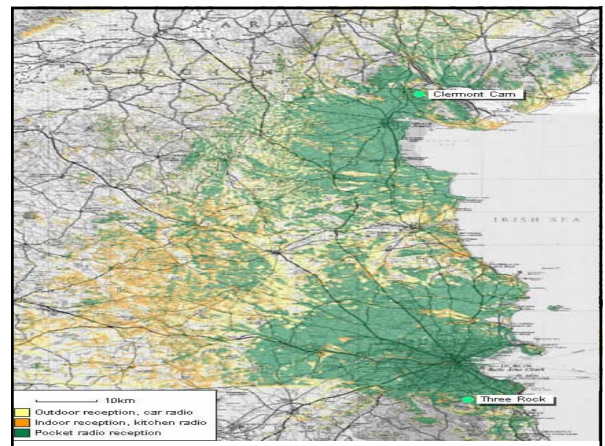
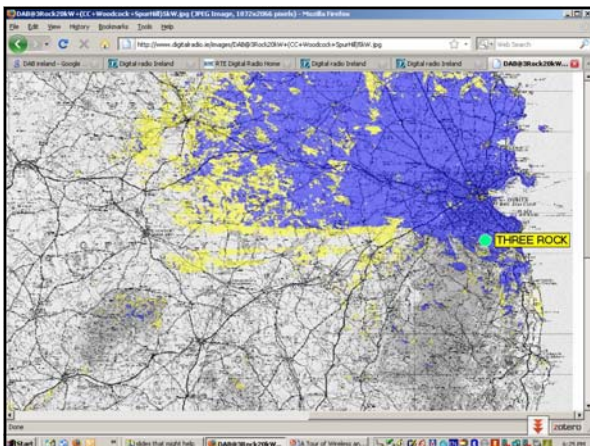
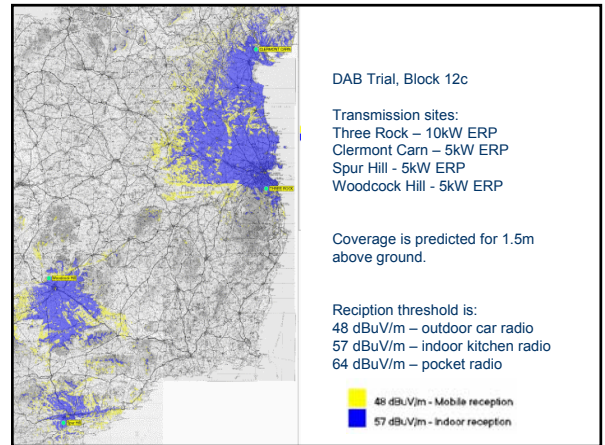


DAB stereo audio at 128kbps  
up to 9 services per multiplex



## The Story with RTE

- RTÉ has indicated to the Department of Communications that it will have a DAB network covering the South East corridor, making DAB accessible to 52% of the population, by the end of 2010.
- The terrestrial DAB frequencies set aside for Ireland seem to be at 174-223 and 223-230 MHz.



## Mixed signals on digital radio

Saturday, March 22nd, 2008 **JOHN COLLINS IRISH TIMES 21/03/2008**

- RTÉ WILL **cease broadcasting on medium wave (MW)** next Monday just as it expands its digital radio service to cover almost half the population. This week the State broadcaster extended its trial of digital radio technology to Cork and Limerick, making it available to 44 per cent of the population.
- Based on the Digital Audio Broadcasting (DAB) standard, the trial broadcasts **include seven new RTÉ digital radio services** including a children's radio service and a dedicated news headline channel, as well as content from commercial broadcasters.
- However, some industry observers have wondered if the State broadcaster is backing the right technology, particularly in light of its statutory obligation to broadcast to the Irish abroad. Brian Greene, a digital media consultant, says **"killing MW to fund DAB is a crazy move by RTÉ" because DAB has a short range while MW can be picked up by listeners in the UK.**

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some DAB recordings

- For its part, RTÉ maintains that its services are **available on the Sky Digital platform and over the web**. According to JP Coakley, RTÉ Radio's head of operations, the broadcaster will save €1.5 million in annual running costs by shutting down MW, **of which €1 million relates to electricity costs**. Coakley says the MW infrastructure had "an immediate need to inject circa €2.4 million in capital as the installation is reaching the end of its natural life". The savings will not just fund DAB but a number of online projects, improvements to FM broadcasting and additional programming resources, according to Coakley. "That said, national DAB has to stand as a separate business and rationale - it's about an industry moving together to provide the next generation of radio to the listener, rather than just what RTÉ can fund on its own," says Coakley.
- The replacement that RTÉ is proposing for MW is **long wave (LW)**.

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- <http://www.briangreene.com/bhq/2008/03/>
- This person has a blog that comments on RTE and its DAB system

but- sound quality???

The reason why they're using insufficient bit rate levels is due to DAB using the inefficient MP2 audio codec, which needs to be used at bit rate levels of at least 192 kbps to provide good audio quality -- FM provides an audio quality which is equivalent to 192 - 224 kbps MP2. Unfortunately, 98% of all of the stereo stations on DAB in the UK are using a bit rate level of 128 kbps, hence the audio quality is poor.

SOURCE:

[http://www.digitalradiotech.co.uk/dab/incompetent\\_adoption\\_of\\_dab.htm](http://www.digitalradiotech.co.uk/dab/incompetent_adoption_of_dab.htm)

So?

1. **Improved end-user features (can contain non audio information)**
2. **Reception quality**
3. **More stations (because it is more spectrally efficient)**
4. **Variable bandwidth**
5. **Less pirate interference**

But?

1. Implementation choices leading to Sound quality issues
2. Currently limited coverage
3. Expense of the receivers
4. Expense of the system as more transmitters required (though overall have read comments on electricity savings)
5. More power needed for the receiver (hence batteries do not last as long)
6. Compatibility – we have not looked at new DAB standards, DAB+ – the scene is not so settled



## AM has been turned off by RTE

- 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

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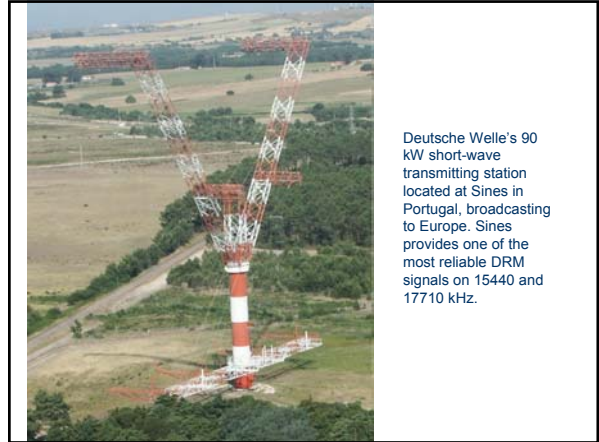
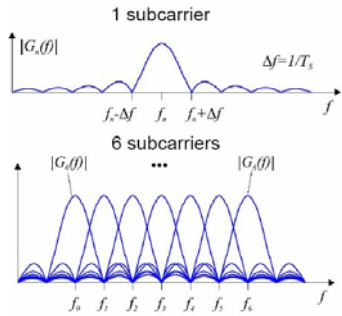
## DRM

- 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].

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

The screenshot shows the homepage of the Digital Radio Mondiale (DRM) website. The header features the DRM logo and the text "DIGITAL radio mondiale a Unique Global Solution". Below this, there is a "News" section with several articles dated 12.01.09, 15.12.08, and 10.12.08. The main content area is divided into four columns: "DRM: The System", "For Listeners", "For Broadcasters", and "For Manufacturers". Each column contains a small image and a brief description of the DRM system and its benefits. The "For Listeners" column mentions that DRM has near-PM sound quality plus the ease of use that comes from digital transmissions. The "For Broadcasters" column notes that with digital radio, broadcasters are enjoying increased interactivity and connectivity with listeners. The "For Manufacturers" column states that the market for digital radio is huge and DRM offers manufacturers the opportunity to embrace the huge untapped market.

reminder- OFDM



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.



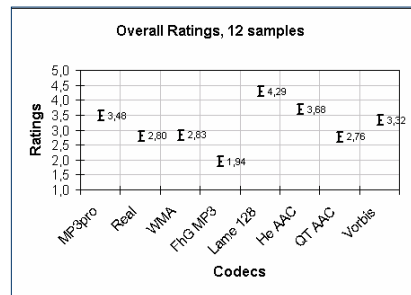
General view of the Santa Maria di Galeria transmitter site (Vatican Radio).

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

testing

- A **codec listening test** is a scientific study designed to compare two or more lossy audio codecs, usually with respect to perceived fidelity and/or compression efficiency.
- Most tests take the form of a double-blind comparison.



<http://www.rjamorim.com/test/64test/results.html>

### drm audio samples

- <http://www.drm.org/for-listeners/watch-hear-drm/listen-to-drm-audio-samples-drm-field-tests/>
- <http://irishcitizensradio.com/>
- Interesting website