DAB Digital Radio Broadcasting

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DAB Digital Radio

DAB Digital Radio, which is also known as digital audio broadcasting, is an entirely new system for broadcasting and receiving radio stations. As the name indicates signals are broadcast in a digital format to enable CD quality to be achieved. People who have heard DAB digital radio have commented on the significantly better sound quality and "presence" of the new radio system. Also it does not suffer from the multipath effects often experienced on FM transmissions and as the system uses what it known as a single frequency network (SFN) there is no retuning required when moving from one coverage area to the next.

In addition to this many new services can be carried on these digital radio transmissions enabling the new system to be compatible with the 21st century. The digital radio signal carries data alongside the audio, and this enables text and images to be transmitted alongside the audio to enhance the listening experience. In this way it is possible to transmit the title of a track, and a picture of the artist whilst the some music is being transmitted. It is also possible to have news scrolling across the bottom of the screen used on the radio.

DAB digital radio is now well established in many countries around the world from the UK and Europe to Canada, Australia and many other countries. Wit the facilities that digital radio offers it is now being accepted and listeners are switching to these new digital radio transmissions in the areas where they are available.

How DAB digital radio works

To produce a digital system that operates satisfactorily under the conditions required for digital radio a large amount of work was undertaken in the development stages. Some existing digital techniques were investigated but it was realised these had significant limitations for this application. One of the major problems was that many receivers would use non-directional antennas and as a result they would pick up reflected signals. These would be delayed sufficiently for the data to become corrupted. Additionally the bandwidth required to accommodate a full stereo signal would need to be reduced to ensure efficient use of the spectrum. The technical standards for digital radio were developed under the auspices of the European Eureka Project 147. This consortium consisted of manufacturers, broadcasters research bodies and network operators.

There are two main areas of the system that are of interest in digital radio: namely the modulation system and the audio digital encoding and compression system.

The encoding and compression system is of paramount importance. For the system to be viable the data rate has to be considerably reduced from that of a standard CD. The digital radio system adopted reduces the data rate down to 128 kbits / sec, a sixth of the bit rate for a similar quality linearly encoded signal. To achieve these reductions the incoming audio signal is carefully analysed. It is found that the ear has a certain threshold of hearing. Below this the signals are not heard. Additionally if a strong sound is present on one frequency then weaker sounds close to it may not be heard because the threshold of hearing is modified. By analysing the incoming audio and only encoding those constituents that the ear will hear the significant reductions can be made. Further reductions in data rate can be achieved by reducing the audio bandwidth. This is implemented on some channels such as those used only for speech.

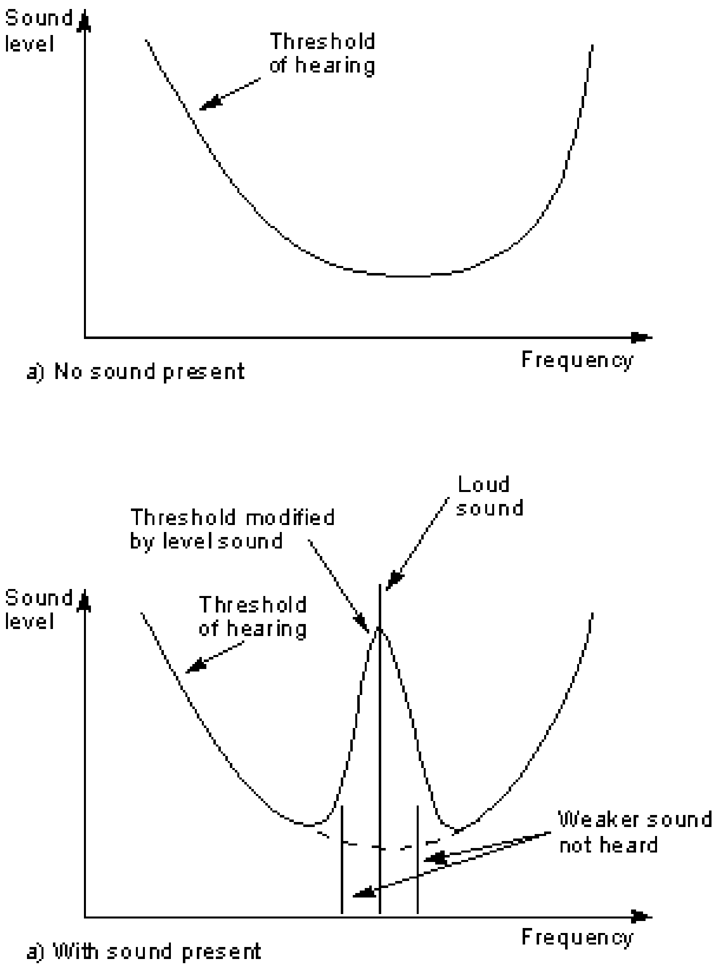


Fig. 1 The threshold of hearing of the human ear.

The other key to the operation of digital radio is the modulation system. Called Coded Orthogonal Frequency Division Multiplex (COFDM) it is a form of spread spectrum modulation that provides the robustness required to prevent reflections and other forms of interference from disrupting reception.

The system uses about 1500 individual carriers that fill around 1.5 MHz of spectrum. The carriers are spaced very close to one another. Interference between the carriers is prevented by making the individual signals orthogonal to each other. This is done by spacing each one by a frequency equal to the data rate being carried. In this way the nulls in the modulation sidebands fall at the position where the next carrier is located. The audio data is then spread across the carriers so that each carrier takes only a small proportion of the data rate. This has the advantage that if interference is encountered in one area then sufficient data is received to reconstitute the required signal. Guard bands are also introduced at the beginning of each symbol, and the combined effect is such that the system is immune to delays consistent with signals 60 km further away than the primary source.

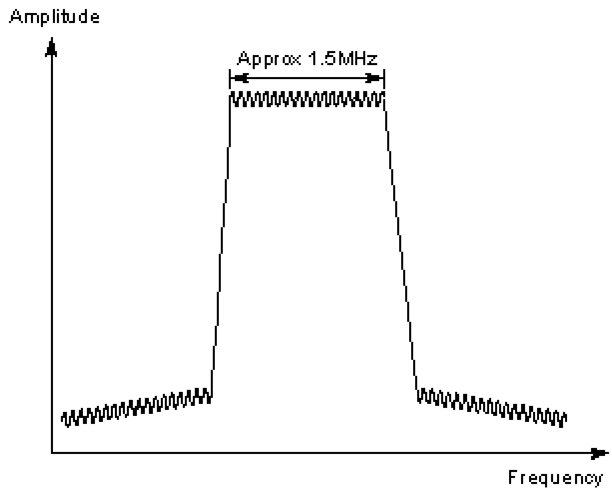


Fig. 2 Spectrum of a Digital Radio Signal

With this level of immunity, the system can operate with other digital radio transmitters operating on the same frequency without any ill effects. This means that it is possible to set up a system where all the transmitters for a network operate on the same frequency. This means that it is possible to set up single frequency networks throughout an area in which a common "multiplex" is used. Even though it may appear that this is a recipe for poorer reception caused by several transmitters using the same frequency, the opposite is actually true. It is found that out of area signals tend to augment the required signal. It also means that small areas of poor coverage can have a small transmitter on exactly the same frequency filling in the hole and further improving reception in adjacent areas.

A further advantage of this digital radio system is that it requires less power than the more traditional transmitters. For example those that carry the main BBC FM networks from the main transmitting sites like Wrotham in the South East of England run at powers of around 100 kW for each of the four main services that are transmitted. The cost of the electricity alone is a significant factor in the BBC's running costs and the power reductions will bring huge savings, not to mention the environmental benefits.

DAB band allocations

In the UK a spectrum allocation between 217.5 and 230 MHz has been reserved for digital radio transmissions. This gives a total of seven blocks of 1.55 MHz, each able to carry a multiplex of services. In other countries as well spectrum is being made available. Within Europe spectrum is being made available either in Band III as in the UK or in L band between 1452 and 1467 MHz. The upper part of the band between 1467 and 1492 will be reserved for satellite delivery of digital radio.

DAB radio equipment

One of the main problems with the initial launch of digital radio was the availability of the equipment. A large investment had been required from the equipment manufacturers. The heavy reliance on digital signal processing techniques meant large development programmes were needed to develop the equipment. There were also problems with the fact that the early implementations required high current levels. These solutions would not have been suitable for portable receivers, and for in car and home applications heat dissipation was a problem. Furthermore the multi-chip solutions made the equipment large and bulky as well as making the manufacturing costs high.

Manufacturers soon solved the problem. Specific chip sets for DAB were developed and these enabled costs to be reduced dramatically from the initial ones that were seen so that DAB is no where near as high as it was when compared to FM receivers.
Many people now comment on the significant enhancements that DAB digital radio brings. One typical example was when a friend walked into a shop and noticed the music playing had an increased presence. He assumed it must be DAB, and this was confirmed when he asked. Others have noticed the seamless performance when in a car. None of the intermittent hissing when travelling through a marginal area between the two transmitters.
Accordingly DAB digital radio is now the broadcasting medium for the 21st Century.

Although it may appear that comparatively few channels are available, each multiplex is able to carry many stations. If high quality audio is required then fewer stations can be accommodated. However it is often possible to accommodate around four or five high quality broadcasts along with several lower quality ones. In addition to this data can also be carried.

DAB CHANNEL	FREQUENCY MHZ
5A	174.928
5B	176.640
5C	178.352
5D	180.064
6A	181.936
6B	183.648
6C	185.360
6D	187.072
7A	188.928
7B	190.640
7C	192.352
7D	194.064
8A	195.936
8B	197.648
8C	199.360
8D	201.072
9A	202.928
9B	204.640
9C	206.352
9D	208.064
10A	209.936
10B	211.648
10C	213.360

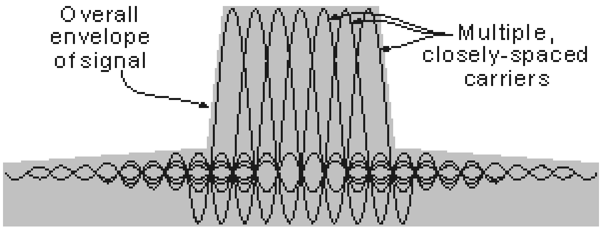
DAB CHANNEL	FREQUENCY MHZ
10D	215.072
11A	216.928
11B	218.640
11C	220.352
11D	222.064
12A	223.936
12B	225.648
12C	227.360
12D	229.072
13A	230.748
13B	232.496
13C	234.208
13D	235.776
13E	237.448
13F	239.200

In view of the different broadcasting platforms that could be used account needs to be taken of this. Eureka 147 allows for broadcasts both from terrestrial transmitters and from satellite based transmitters. For DMB both platforms are possible, but in view of the differing platforms and transmission requirements there would need to be some modifications between the two systems. For terrestrial based transmissions a flavour of the system designated as T-DMB (Terrestrial Digital Multimedia Broadcasting) is used, whereas for satellite broadcasting S-DMB (Satellite Digital Multimedia Broadcasting) is used.

Broadcasting DMB and DAB
Image courtesy RadioScape

DMB RF signal characteristics

Like many other broadcasting systems, DMB and DAB use a form of transmission known as Orthogonal Frequency Division Multiplex (OFDM). This has been adopted because of its high data capacity and suitability for applications such as broadcasting. It also offers a high resilience to interference, can tolerate multi-path effects and is able to offer the possibility of a single frequency network, SFN.



OFDM Spectrum

Note on OFDM:

Orthogonal Frequency Division Multiplex (OFDM) is a form of transmission that uses a large number of close spaced carriers that are modulated with low rate data. Normally these signals would be expected to interfere with each other, but by making the signals orthogonal to each other there is no mutual interference. The data to be transmitted is split across all the carriers to give resilience against selective fading from multi-path effects..

Click on the link for an **OFDM tutorial**

DMB format

The transmissions for the form of DMB being deployed in many countries occupy approximately 1.5 MHz bandwidth and for the VHF broadcasts the transmission contains 1536 Carriers. However it is possible to use a variety of modes:

- **2K mode** 1536 carriers
- **1K mode** 768 carriers
- **0.5K mode** 384 carriers
- **0.25K mode** 192 carriers

Frequency allocations

It would be possible to utilise the DAB transmission system within the UK for DMB, however much of the capacity has been taken up, although some reserve capacity has been retained for future data transmissions of which DMB could be part.

A more likely solution for DMB is to use frequencies within the L-Band DAB allocation (1452 - 1467.5 MHz). This might be possible in some countries where the use of this broadcasting allocation could be used for this purpose with little legislation.
Using a new band it will not only be possible to use smaller antennas, an important element for mobile phones and PDAs, but it will also be possible to tailor the transmission to accommodate the Doppler shifts likely to be encountered by small mobile devices. This can be achieved by reducing the number of carriers. Despite the carrier number reduction, the maximum data rate of 1.152 Mbps is still retained. The drawback of using the L band frequencies is that they would require a much higher density of transmitters to provide the required coverage.

Battery consumption

One of the major requirements for any mobile video system such as DMB is that it shall not place a major load on the battery of the handheld device. With user expectations requiring that battery life shall be several days between recharges, this is a major consideration. While battery technology is improving, and IC technology has enabled current consumption of chips to be reduced, the basic technology can also play its part.
DMB is also ideally suited to the delivery of material to handheld devices. DAB inherently includes a technique known as time slicing by using an effectively using a Time Division Multiplexing delivery method. In this way the receiver is only switched on when it is required, thereby saving battery power.

Summary

It remains to be seen whether DMB or DVB-H will be the major standard that is adopted for mobile video. Some indicate that both schemes may be used in different countries around the world Accordingly many chip manufacturers who are addressing this market are catering for both schemes and developing systems that will be able to switch between the variety of bands that will be used around the globe.
In addition to this DMB trials are well advanced, particularly in Korea where it appears DMB will be adopted. For other countries, it remains to be seen what happens.