Digital Audio Broadcasting

BBC RADIO

Introducing DAB

Radio broadcasting was first demonstrated in 1895 when the Italian engineer Marconi sent 'wireless' signals a few hundred yards. Despite developments along the way, his basic method is still in use around the world

Digital Audio Broadcasting – DAB – is the most fundamental advance in radio technology since those days. It gives listeners interference-free reception of high quality sound, easy-to-use radios, and the potential for wider listening choice through many additional stations and services.

DAB will revolutionise radio in much the same way that the CD changed the record industry. The 78 rpm record provided a recording that although intelligible was of low quality, and could be easily damaged; the LP marked an improvement in quality, but still the record was prone to scratching and damage, and it wasn't until the arrival of the totally new technology, the CD, that high quality sound and robustness were achieved

In a similar way in radio terms, AM (Amplitude Modulation) broadcasts on Medium Wave and Long Wave, provides a basic service, but is very prone to interference and fading. The introduction of FM (Frequency Modulation) on VHF gave the possibility of high quality hi-fi sound, but only works properly to fixed tuners at home fitted with a roof-top aerial: in the car or on portable receivers FM reception may suffer from interference.

DAB provides high quality, interference-free reception for home radios, car radios and personal radios, with only a small non-directional whip aerial.

The BBC is the first broadcaster in the world to begin a full DAB radio service, which starts in the London area in September 1995. By 1998 some 60% of the UK population (including the major trunk-road network) will be able to receive the BBC National DAB signal, but it will take several more years before the whole of the UK will be covered. Existing AM and FM broadcasting will continue for many years, but eventually DAB will replace AM and FM broadcasts, in the same way that the CD is gradually superseding the LP and analogue tape.

Why DAB is Necessary

Although FM broadcasting is capable of providing an excellent quality sound, it can do so only in perfect reception conditions, which in reality can only be obtained in a fixed location where the radio is fed from an outside aerial accurately aligned to have an unobstructed signal from the transmitter. In practice then it is difficult to achieve optimum reception, especially on a portable receiver or in a car.

The main problem is that signals from the FM transmitter 'bounce' off the sides of buildings, trees and household objects. These 'reflected' signals mix with the direct signal from the transmitter received by the radio and may cause interference. As you move about the room, or the car travels, different patterns of interference are caused, and the listener is subjected to bursts of loud and soft noises, audio disturbances, and 'fluttering' of the signal.

Because a radio can only receive one signal at a time from one transmitter, without causing interference, transmitters in adjacent areas need to be on different frequencies to prevent an overlap of signals. For example, to cover the UK with Radio 4 on FM about 200 transmitters are used, and 40 different frequencies required. When motoring, the radio constantly has to be retuned, either manually, or automatically on FM using the Radio Data System – RDS.

As several different frequencies need to be used to provide wide coverage for a network, each takes up a large part of the available radio broadcasting frequency spectrum. This severely restricts the total number of different stations possible, and the UK together with much of the rest of the world, has run out of room for new and additional stations.

How DAB Developed

DAB is the result of a standard devised and developed by a group of European broadcasters and consumer electronics industries and their research institutes, including the BBC's Research & Development Department. The European project group is collectively known as Eureka 147 – part of a wider European communications and technologies initiative.

Since 1987, Eureka 147 has developed DAB to provide a reliable, multi-service digital sound broadcasting system for reception by mobile, portable and fixed receivers, using a simple rod aerial. It is a rugged, and yet a highly spectrum efficient sound and

data broadcasting system that can be used in any usual broadcasting band and on terrestrial (land-based transmitters), satellite or cable networks.

How DAB Works

DAB works by combining well-established digital audio techniques with two totally new technologies allowing signals to be broadcast efficiently in terms of spectrum and robustness.

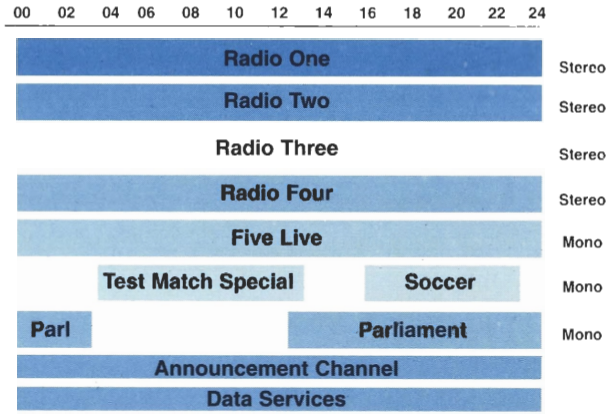
It is widely appreciated that if sound is recorded in a digital manner, as a series of 'ones' and 'noughts' rather than as an analogue signal, it is possible to reproduce the sound accurately and without degradation. Unfortunately, the amount of information obtained by digitising the sound is so vast that it would require too much radio spectrum to broadcast in this manner.

The first of the new technologies used to achieve spectrum efficiency in DAB is a system called MUSICAM. This reduces the amount of information required to broadcast by discarding unnecessary information, for example sounds which are not perceived by the listener, which currently would be masked by other, louder, sounds.

The new technology which ensures that a signal can be received reliably and robustly, even in an environment prone to interference, is the technique used for the actual broadcast – called COFDM, Coded Orthogonal Frequency Division Multiplex. This process transmits the signal, not on a single frequency, but on 1,536 different carriers in a precise mathematical relationship. The MUSICAM sound signals components are split amongst these carriers, and also split over a short period of time.

The way these carriers are arranged and the signal component parts distributed on the carriers is very precise. It is designed so that a receiver is able to recombine the individual parts and restore the original signal even if reception has been affected by interference and some of the transmission lost entirely. Provided that a component part of the signal has been received at least once, the receiver can make use of it. Reflected signals which plague FM reception, actually benefit the CODFM technique as they provide yet another opportunity for the radio to receive the signal. Importantly therefore, using the same frequencies for each service from all transmitters is advantageous to the process, so only a single frequency network is required across the whole of the UK and no retuning is necessary by the receiver in moving from one area to another

An example of BBC Network DAB Services



The DAB Signal

The DAB signal has a large capacity, enough to carry not just one radio service, but several. In addition to audio, the features that are part of RDS are also transmitted: display of the name of the service, a code allowing selection of listening according to type of programme required, information in text form about the services available, and local travel information. These will all be part of the BBC's initial DAB service, with more features being added in future years.

This whole package of DAB is referred to as a DAB ensemble, and in the the UK there will eventually be several ensembles. One will be for BBC National Radio, and one for Independent National Radio, with others allocated for Local & Regional Radio.

The ensemble is simply a large number of bits (about 2,300,000) which are used for carrying audio, data, and as part of the transmission process itself to provide protection against transmission errors. Of these, about 1,200,000 bits are available for carrying audio and data, split amongst the different radio services. The number of bits available for each is variable, the more bits allocated, the higher the quality possible.

This variability, or re-configuration is very useful and solves a major problem faced by the BBC with conventional broadcasting.

At present, the BBC broadcasts five national networks, Radio's 1-4 in stereo on FM and Radio 5 Live in mono on AM. But listeners have many other requirements of the BBC – for instance, important Parliamentary debates, Test Match Specials, other major sporting events, or special programmes. In order to meet such needs, 'normal' programmes are taken off, or postponed and these additional services substituted.

Some people are annoyed that their regular programmes are not available, but equally many listeners look forward to ball-by-ball commentary of cricket matches

The re-configuration of the ensemble allows the BBC to satisfy both groups of listeners. By adjusting the number of bits used by each network, enough bits are obtained to add an additional service and extend listening choice. There is a slight reduction in the quality of the regular services, but no-one misses out on their favourite programme entirely.

DAB Services in the United Kingdom

In the United Kingdom, the Government Authorities have allocated frequency spectrum for DAB between 217.5-230 MHz

This spectrum is part of broadcasting band III formerly used for 405 lines, VHF television. Within this spectrum there is room for seven DAB ensembles, which have been allocated for use both by the BBC and Independent broadcasting. One has been allocated to BBC National Radio Services, and one is earmarked for Independent National Radio; these two ensembles will eventually cover the UK. The remaining five ensembles are intended to provide BBC and Independent Local & Regional Radio. They will be arranged so that each area, in addition to the national services, will receive one ensemble carrying up to six local/regional stations. In the main metropolitan areas two local ensembles should be available, providing up to twelve local/regional services.

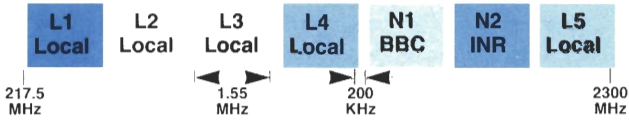
The BBC National Radio DAB Service

The BBC launches its national Network DAB ensemble in September 1995. This will carry the familiar radio stations, Radio 1, Radio 2, Radio 3 and Radio 4 in stereo, and Radio 5 Live, in mono. The capacity within the ensemble will allow the BBC to offer some additional services. These may include extended coverage of proceedings from parliament, and more coverage of live events, particularly sport.

Each service will be supported by the text and programme type features.

To provide a DAB service the BBC needs to install new equipment at its transmitter sites across the country. The first five to be equipped will cover the Greater London area, at least as far out as the M25, and provide DAB to nearly 20% of the UK's population. By equipping a further 22 transmitters, the BBC will cover major towns and cities, the interconnecting motorway and trunk road network, and 60% of the population, by 1998.

DAB – Allocation of UK Spectrum



DAB Receivers

DAB is an entirely new technology, so existing radios will not be able to benefit from the service and new radios will be required. The first DAB receivers on the market are expected to be home tuners and car radios, with manufacturers eventually producing portable radios and personal stereos as well.

DAB hi-fi tuners may be added as part of an existing stack system, while DAB receivers in the car are likely to be interfaced to either a new, or existing FM-RDS radio. The link with RDS is important, as when travelling out of a DAB-served area listening will need to be maintained by the radio reverting to FM

Linking a DAB car receiver to FM-RDS, will also allow DAB listeners to benefit from the RDS Travel service broadcast by BBC Local Radio stations, until they too are available on DAB.

Early DAB radios will be expensive However, in line with all significant technological developments, prices will fall rapidly as more and more DAB receivers are sold, and manufacturers are able to benefit from large scale production

BBC DAB Project Team includes:

Project Director: David Witherow, formerly Deputy Managing Director, BBC World Service

Manager: Mark Saunders, who will also continue to manage the BBC's Radio Data System

Research & Development: Paul Ratliff, Chairman, DAB System Standardisation Group Eureka 147 Project

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