The Advantages of the Modern Digital Radio Systems

A Brief Overview of DAB

DAB was designed in the late-1980s and the decisions for which technologies it would use were finalised in 1990. The most important technology as far as being up-to-date or not is concerned is undoubtedly the audio codec. The audio codec chosen for use on the DAB system was MPEG Audio Layer 2, or MP2 for short. MP2 is the less efficient 'cousin' of the famous MP3 audio codec, by which I mean that MP2 must use a higher bit rate than MP3 in order to achieve a given level of audio quality – MP2 must use 192 kbps (kilo bits per second, or thousand bits per second) to provide the same level of audio quality as 128 kbps MP3.

The MP2 audio codec is widely used, because it is used for the audio on TV channels on the DVB digital TV systems for satellite, cable and terrestrial. When used for TV channels, a bit rate of between 192 and 256 kbps is invariably used, and this provides a similar level of audio quality as can be found on FM radio with good reception.

The transmission technology used for DAB is called OFDM, which is a good technology, and is now used on many wireless digital systems, including terrestrial digital TV and wireless LAN systems. However, because DAB was designed in the late-1980s when microprocessor speeds were very slow compared to today, they opted to use a very simple version of OFDM in order to minimise the computational complexity. The downside of this is that the data capacity of each DAB multiplex is relatively low (1,152 kbps per DAB multiplex). More importantly the 'spectral-efficiency' (data capacity divided by the spectrum consumed) is very low by modern standards. The result of this very low spectral-efficiency is that DAB needs a huge amount of spectrum if it is to carry a lot of radio stations while providing these radio stations at a good level of audio quality. This inefficiency also makes DAB a very expensive system to use, because the high cost required to build and run a DAB multiplex and transmitter network can only be shared by a small number of radio stations – between 4 and 6 radio stations can be provided on each DAB multiplex if good audio quality is to be provided.

It is the fact that DAB requires such a large amount of spectrum and is so expensive to run that makes DAB a poor choice of system in comparison to the modern digital broadcast systems available today, such as DRM, DVB-H and DMB.

What the General Public Actually Wants from Digital Radio

When assessing the suitability of the technological aspects of candidate digital radio systems, it is easy to overlook what the general public actually wants from a new digital radio system. But in market research surveys, the general public are unequivocal in terms of what they are looking for from a digital radio system, and better audio quality is always cited as the most attractive feature.

Organisation	Year	Better Audio Quality	Extra Stations	Notes
WorldDAB Project	1997	29% 21%	11% 9%	Car drivers Home listeners
Ofcom, UK communications regulator	2004	63%	21%	Analogue-only listeners
Commercial Radio Australia	2004	75%	Unknown response	

Table 1. Percentage of people that want digital radio to provide better audio quality or extra stations in market research surveys

New digital-only radio stations do provide an incentive to consumers to ‘upgrade’ to digital radio, and they also provide broadcasters with an ‘excuse’ to advertise these new radio stations to drive demand. But it should never be forgotten that consumers *always* choose better audio quality as being the main advantage that digital radio provides.

The UK has not provided good audio quality, and has merely added extra stations. UK broadcasters try to suggest that following this route has been successful, and proves that it is the extra radio stations that drive DAB radio sales. This does not stand up to scrutiny. DAB radio sales in the UK are primarily a result of the huge amount of advertising for DAB on BBC TV and commercial radio. There have been 18 ‘very-high-impact’ DAB advertising campaigns on BBC TV so far, with a similar number of high-impact ad-campaigns on commercial radio. Each of these TV advertising campaigns would cost the equivalent of millions of pounds sterling if they were shown on commercial TV. Moreover, DAB is probably mentioned at least once per hour on all radio stations in station jingles. With such a huge amount of TV and radio advertising as this you can sell *anything*. It is wrong to think of DAB being a success in the UK without taking the level of advertising into consideration.

The UK radio broadcasters also try to suggest that the promise of high audio quality hasn’t been a major factor in driving sales. This is false. The vast majority of DAB adverts do claim that the audio quality provided on DAB is better than on FM. In reality, not a single radio station on DAB in the UK provides audio quality as good as on FM! The BBC has received thousands of complaints about the audio quality of its radio stations on DAB, but because over 95% of all DAB receivers sold up to now are small portable radios, the majority of people accept the audio quality on DAB because the audio quality on these small kitchen-type radios does not really matter, and such small radios are incapable of reproducing good quality sound, and so mask the problems with the audio quality. But play DAB on any hi-fi system, car stereo or personal radio, and the problems with the audio quality are strikingly obvious.

The truth is that when consumers buy DAB they expect the audio quality to be better than on FM simply because DAB is a digital technology, and digital is always perceived to be better than analogue. DAB advertising merely re-inforces this mis-conception by making claims, such as that DAB provides "superb digital quality sound."

Improved quality plays a major role in the uptake of new technologies, with the perfect example being DVD players. Sales of DVD players took off primarily because of the significant improvement in picture and audio quality relative to VHS – despite the fact that DVD players couldn't even record. DVD players went on to become the fastest-selling consumer electronics product of all time.

Those that put forward the argument that quality isn't important will have their theory severely tested over the next few years when HDTV is launched. HDTV will be sold solely on the basis that it provides superior quality compared to standard-definition TV (SDTV), and the vast majority of channels that will be broadcast in HD format will be TV channels that viewers can already view in SD format. If these people are correct in saying that quality alone cannot sell a new technology, then HDTV will be a monumental failure. I predict that HDTV will be very popular in Europe.

DAB's Problem: Spectrum Scarcity & Number of Radio Stations

DAB can use two frequency bands: Band III (174 – 239 MHz) and L-band (1452 – 1490 MHz). However, it is extremely expensive to transmit DAB services in L-band due to the number of transmitters needed to cover a given area, as well as the high transmission powers required. As a result, most broadcasters prefer to transmit DAB in Band III. Unfortunately, a large majority of European countries use Band III for analogue TV, so there is very little spectrum available for DAB to use in this band.

Over the years, the FM band has become highly-utilized all over Europe, and a large number of FM and AM stations now have to be accommodated on whichever digital radio system is chosen. New digital-only radio stations will also need to be accommodated initially in order to provide an added incentive to consumers to make the switch to digital.

City	Approximate Number of FM Stations Available
Paris	50
Rome	80
Stockholm	37

Table 2. Number of FM stations available in some European cities

Overall, a large number of radio stations must be carried, and in most countries there is simply nowhere near enough available Band III spectrum to provide all of these radio stations while maintaining a high level of audio quality. L-band is a possible alternative, but as I have already mentioned, transmission in L-band is very expensive.

A perfect example of this problem is the UK: the UK already has seven Band III channels – significantly more Band III channels than almost all other European countries – and it is hoping to acquire five additional channels at the Regional Radio Conference in 2006. But even with all of these twelve Band III channels, Ofcom (the UK's communications regulator) recently announced that 31% of existing analogue radio stations will never be able to get onto DAB, and this is despite the radio stations already using very low bit rates in order to squeeze more stations on to the system. Overall, this means that 100 of the 326 analogue radio stations will not be able to get onto DAB, and using alternative technologies (including DRM and DVB-H) are now being looked into.

Also, one major factor that the UK has certainly overlooked in its planning of digital radio is the likely growth in the number of radio stations that will want to transmit in future. Drawing on digital TV as an example, the Sky Digital satellite TV platform in the UK started with 140 channels in 1998 and now there are 500 channels, with Ofcom licensing 156 new channels last year alone. The number of TV channels on Sky Digital is also predicted to grow at 10% per annum until 2010. If this 10% per annum growth-rate does materialise, then there will be over 800 channels on the Sky Digital system by 2010 – almost a six-fold increase from the number of channels initially!

Although there are obvious differences between digital TV and radio, it should be expected that after inception there would be a significant demand from broadcasters wishing to transmit new stations on a digital radio system. Therefore, allowance should be made for this eventuality.

The following table shows the MP2 bit rate required and the number of radio stations that can be fit onto a DAB multiplex for different levels of audio quality.

Audio Quality Level	Relation to FM-quality	MP2 Bit Rate kbps	Number of Radio Stations per DAB Multiplex
CD-quality	Better than FM	256	4
Very good quality	FM with good reception quality	224	5
Good quality	FM with average reception quality	192	6

Table 3. Relation between audio quality levels, bit rate and number of stations per DAB multiplex

Before looking at the consequences of the figures in the table above, extrapolating figures from a recent report into DAB in the UK, the total transmission costs across all services that a multiplex operator charges are £900,000 per annum for a local DAB multiplex transmitting in Band III.

Due to a DAB multiplex only being able to carry 4 CD-quality stations, there will be insufficient spectrum available even to carry existing FM radio stations, and the transmission cost per radio station would be £225,000 per annum. In comparison, it costs around £60,000 to run an FM transmitter with local coverage.

Lowering the audio quality to ‘good quality’ (192 kbps MP2), then DAB still requires a very large amount of spectrum to accommodate existing FM radio stations, and transmission cost per radio station on DAB is £150,000 per annum, which is still 150% more expensive than on FM. When the expansion in the number of radio stations wanting to transmit on digital radio is taken into consideration, however, again there will be insufficient spectrum available.

The only conclusions that you can come to for DAB are that:

- DAB effectively rules-out CD-quality radio due to the cost of transmission;
- it is even very unlikely that many radio stations would want to provide good audio quality due to the cost of transmission being 150% higher than transmitting an FM station;
- small radio stations will not be able to afford to transmit on DAB;
- there is insufficient spectrum to provide a large expansion in the number of radio stations while maintaining good audio quality;

The overall conclusion is that if the DAB system is used then low bit rates are virtually inevitable. Such low bit rates like are used in the UK provide low audio quality, and this is not what listeners actually want.

However, as will be explained in the following sections, the new digital broadcast systems, such as DRM and DVB-H, have solved DAB's problems of very high spectrum requirements and high cost of transmission. These new systems will allow a large expansion in the number of radio stations as well as allowing all of these stations to transmit at a very high level of audio quality.

New Technologies

Since DAB was designed in 1990, both audio coding and digital transmission technology underwent rapid advances. These rapid advances were due to a better understanding of the technologies, breakthroughs in research, along with the ever-increasing microprocessor speeds that allowed these advances to be capitalised on.

Audio Codecs

The MP2 and MP3 audio codecs were always seen by people in the audio coding industry as a first attempt at reduced bit rate audio coding, and just one year after these audio codecs were standardised by MPEG, development had started on a new codec that was meant to eventually replace MP3. This new audio codec became what is now the AAC (Advanced Audio Coding) codec, and it performs significantly better than both MP2 and MP3.

Then, in 1999, a new technology was developed by Coding Technologies called Spectral Band Replication (SBR), and when this technology was combined with existing audio codecs performance again improved significantly. The combination of SBR with AAC is called HE AAC (High Efficiency AAC), or alternatively by its trade name aacPlus (this is sometimes written AAC+) and is currently the most efficient audio codec in existence.

These increases in performance are best understood by looking at the bit rate required to provide a certain level of audio quality:

Audio Codec	Bit Rate Required to Provide Good Audio Quality kbps
MP2	192
MP3	128
AAC	96
HE AAC	64

Table 4. Bit rate required for good audio quality for different audio codecs

The relevance to digital radio systems of the above reductions in required bit rate is that for a given amount of spectrum, the newer more-efficient audio codecs can carry more radio stations than the older less-efficient codecs.

The following table shows which audio codecs the digital broadcast systems discussed in this document use:

System	Audio Codec
DAB	MP2
DMB	HE AAC / AAC
DVB-H	HE AAC / AAC
DRM	HE AAC / AAC

Table 5. Audio codecs that different systems use

Digital Transmission Schemes

The objective of a digital transmission scheme is to provide as high a data capacity as possible in the available bandwidth, while requiring as little transmission power as possible to provide robust reception.

To provide robust reception on mobile digital communication systems, error correction technology is used to correct bit errors that occur in transmission. Since DAB was designed, the strength of the error correction technology used on mobile digital systems has increased significantly due to the increase in speed of silicon chips which allow more complex error correction schemes to be used.

This increase in the strength of error correction technology allows higher data rates to be transmitted in the same amount of bandwidth, which increases the spectral-efficiency. As can be seen in the following table, the spectral-efficiency of the modern systems has increased a great deal since DAB was designed in the late-1980s.

System	Spectral-Efficiency kbps/kHz
DAB	0.674
DMB	0.93
DVB-H	1.24
DRM	1.91

Table 6. Spectral-efficiency of the digital systems

Overall Performance of Modern Digital Radio Systems versus DAB

The overall performance of a digital radio system combines the efficiency of the audio codec with the spectral-efficiency of the transmission system. This results in the amount of spectrum required to carry a radio station at a given level of audio quality.

System	Spectrum Required for a Good Audio Quality Radio Station kHz	Performance Relative to DAB
DAB	285	1.0
DMB	71	4.0
DVB-H	52	5.5
DRM	33	8.6

Table 7. Overall performance of modern digital systems relative to DAB

The above table clearly shows the massive improvement in performance since DAB was designed, with DRM requiring almost 9 times less spectrum as DAB requires to carry one good audio quality radio station.

Transmission Costs per Radio Station

Because of the higher efficiency of the modern digital broadcast systems, the transmission costs per radio station are far lower than the costs when DAB is used. This is most easily explained by comparing DAB with DVB-H: By using one of the lower data capacity modes for a DVB-H multiplex, the total transmitter powers required will be very similar to those required for a DAB multiplex. This means that the overall cost of building and running the multiplex will also be very similar for both DVB-H and DAB. However, the DVB-H multiplex can carry 68 radio stations with a good audio quality, whereas the DAB multiplex can only carry 6 with the same level of audio quality. Therefore, because the multiplex infrastructure and running costs are almost the same for both systems, the cost can be spread across 68 radio stations for DVB-H, but it is only spread across 6 radio stations for DAB. Obviously the transmission cost per radio station with DVB-H will be about eleven-times lower than the cost per station when DAB is used. Or using the cost of transmitting a CD-quality radio station on DAB of £225,000, on DVB-H it would only cost £20,000 per annum – three-times cheaper than transmitting on FM!

DRM is a slightly different case because DRM radio stations only use very low transmitter powers and very narrow bandwidths. This means that there are two extremes:

1. a large number of radio stations share the same higher-power transmitter and multiplexer hardware;
2. one radio station uses its own DRM hardware and a very-low-power transmitter;

Scenario 1 is the same as the situation for DVB-H where the transmission costs are spread over a very large number of radio stations, so the transmission costs are very low compared to DAB.

Scenario 2 allows the use of a very-low-power transmitter and avoids the data stream having to be sent to a multiplex operator's offices to be multiplexed with data streams from other radio stations, which means simpler digital hardware. Mainly because of the very low power of the transmitter, the transmission costs for this scenario are also far lower than for DAB.

Modern Digital Radio Systems

DRM

DRM has become the most attractive of the modern digital radio systems for a number of reasons. It has only become attractive, however, since it was announced in March 2005 that it would be extended to work at frequencies up to 120 MHz. Once the work on the extension is complete (the work is expected to finish in 2007), the system will be called DRM Plus. Currently, DRM can only work at frequencies up to 30 MHz, because it was originally meant to replace LW, MW and SW analogue radio. DRM currently only uses narrow bandwidth channels, and although it can carry good audio quality radio stations (the current maximum bit rate is 72 kbps using the HE AAC audio codec), up until recently it has mainly only been used for very-long-distance international radio station transmissions which use very-low bit rates, and the audio quality is poor. However, there is a great deal of interest in DRM at the moment, and attention seems to be moving towards testing the system for local radio stations where higher capacity transmission modes can be used. DRM is also perfectly suited to national and regional radio broadcasting.

Once DRM has been extended it will use wider channels, which will allow it to carry high bit rate and high audio quality radio stations. Additionally, the Chairman of the DRM Consortium, Peter Senger, said in a recent interview that once DRM has been extended it might carry Dolby Surround Sound 5.1 channels.

The following table shows the predicted data capacities for the new wider channels with typical error protection levels (error correction code rate of 0.6):

Channel Bandwidth kHz	Capacity using 16-QAM kbps	Capacity using 64-QAM kbps
50	99	143
100	198	285

Table 8. DRM channel bandwidths and multiplex capacities after extension to work at frequencies up to 120 MHz

It will therefore be straightforward to provide CD-quality radio stations using 128 kbps AAC in just 50 kHz of bandwidth.

System	Audio Codec	Bit Rate Required for CD-quality kbps	Bandwidth Required for a CD-quality Radio Station kHz
DAB	MP2	256	428
DRM	AAC	128	50

Table 9. Bandwidth required for a CD-quality radio station

DRM can fit 8 CD-quality stations into the same amount of bandwidth that DAB would require to carry just one CD-quality station, and there's room left over for another 20 kHz DRM channel as well. This would obviously benefit listeners because of the amount of choice and range of genres that could be made available on DRM. It would also benefit a country's government because radio would consume far less spectrum than if DAB were used, thus it would free-up more spectrum for other applications, which could potentially be lucrative if that spectrum was auctioned-off.

The level of transmitter power required has a large effect on the cost of the transmitter network. Transmitter powers are highly dependent on both the frequency and bandwidth of the transmitted signal – the lower the frequency and the narrower the bandwidth the lower the required transmitter power will be. Just taking these two factors into account, the transmitter powers required for a DRM signal to cover the same area as a DAB multiplex can be as much as 20 to 25 dB lower. This equates to a reduction in power by a factor of 100 to 316, respectively. This clearly shows why transmitters for DRM will be far cheaper than for DAB.

Because of the low transmission costs, the barriers to entry are lowered for new radio stations wishing to transmit on digital radio. This will encourage new radio stations to launch, as well as making existing, smaller stations more profitable and/or strengthen their financial viability.

Radio waves also propagate over longer distances at lower frequencies, which is beneficial for national and regional broadcasters that have to provide reception over large coverage areas.

Because DRM uses far narrower channel bandwidth than DAB or DVB-H, this makes it far more flexible for frequency / multiplex planning purposes. This is especially the case for small radio stations serving a small coverage area. With DAB, small stations have to be carried along with a number of other stations over a relatively large coverage area (e.g. coverage of a city or region) to make the multiplex financially viable. It is wasteful of bandwidth, power and money for such small local radio stations to be transmitted on expensive DAB multiplexes over such large coverage areas when a single, low-power DRM transmitter could specifically target the required small coverage area.

There will also be occasions where there is an insufficient number of radio stations to fill a DAB multiplex. DAB is unsuited to this scenario because the economics of DAB rely on as many radio stations using the multiplex as possible to share the cost of transmission (unfortunately, this has the negative consequence that it encourages broadcasters to use low bit rates to save money, as has happened in the UK). When the multiplex is, say, half-full, then the cost of transmission on DAB has to be shared amongst these fewer radio stations, and the transmission cost per radio station would be double that of a full multiplex. This situation does not occur with DRM, because each station can be transmitted individually. Furthermore, if DAB were used in this scenario the full 1.75 MHz DAB multiplex bandwidth would be consumed, whereas with DRM, if there are only three radio stations each using 50 kHz channels, then the DRM stations would consume less than a tenth of the bandwidth that DAB requires.

DRM is the only system that is well-suited to carrying radio stations which require nation-wide coverage right down to those with the smallest coverage areas – the wider the bandwidth of the multiplex the less suitable it is to carry small-coverage-area radio stations, and vice versa.

Numerous combined DRM/DAB portable radios and DRM car stereos were demonstrated at the IFA consumer electronics fair in Berlin in September 2005. Some of these products are expected to be in the shops for the run-up to Christmas, and more receivers will be launched in 2006. The main breakthrough for DRM receivers has been the launch of a dual DRM/DAB receiver module developed by Radioscape in the UK, which enables low-cost DRM receivers to be produced for the first time.

Despite it being a new standard, DRM is already being transmitted in 30 different countries and in all six continents. Once it has been extended to 120 MHz it is likely to become a very successful global standard due to the benefits already described.

DAB proponents try to slur DRM due to its narrow bandwidth channels, which they claim can produce reception problems. However, as I have already mentioned, after it has been extended, the channel bandwidths will be far wider than they are now. It also seems to have escaped the DAB proponents' attention that the most successful digital mobile communication system of all time is the GSM mobile phone system, and that also uses narrow bandwidth channels. Moreover, DRM actually uses more advanced technology than GSM and is therefore even better equipped to deal with narrow bandwidth channels. FM also uses narrow bandwidth channels as well, and although FM reception isn't always perfect it is a great deal better than DAB proponents would like to have us all believe. Moreover, problems with FM reception are far more likely to be due to insufficient signal strength than any bandwidth-related problems.

Once it has been extended, DRM will be an excellent system, using state-of-the-art technology throughout. It is the best-suited system for digital radio use out of all the prospective systems discussed in this document. It is suited to all coverage area sizes; it can easily provide very high audio quality in very little spectrum; it is flexible for frequency planning; it is very cheap to transmit per radio station in all scenarios; low-cost receivers will be available by Christmas 2005, and DRM Plus receivers will be available for it as soon as the extension is complete. DRM Plus could offer Dolby Surround Sound, which would provide a unique selling point for it over and above what DAB claims to provide.

Any country considering using DAB should seriously consider why they want to use DAB when DRM is vastly superior to it. Whichever system a country chooses to use is a very-long-term commitment, because unlike TV systems, radio systems have historically been in-use for decades. Choosing the inferior system for very-short-term reasons, such as the current greater availability of DAB receivers, is a very shortsighted view to take, because DAB brings with it some major disadvantages, which are all solved by using DRM.

DVB-H

DVB-H can be transmitted alongside terrestrial digital TV channels in a DVB-T multiplex. However, DVB-T multiplexes usually use high data capacity transmission modes and are planned for rooftop aerial reception, whereas DVB-H must cater for ground level, high-speed mobile reception as well as indoor reception. Consequently, DVB-T multiplexes tend not to be suitably configured for carrying DVB-H services. Instead, it is envisaged that DVB-H services will typically run on purpose-built multiplexes for DVB-H services alone.

Proponents of DAB usually try to mis-represent DVB-H by using the most pessimistic transmission parameters to make the transmitter powers look far higher than are actually necessary, which then makes DVB-H multiplexes look as if they are very expensive to build and run. I’ve seen this on a number of occasions and it is highly dishonest, because it is designed to mis-lead non-technical people. I have included the mis-representations that DAB proponents use in the Appendix at the end of this document.

DVB-H can use 5, 6, 7 or 8 MHz-wide channel bandwidths. However, because of the way Band III frequencies are planned internationally, only the 5 and 7 MHz bandwidth channels are appropriate for digital radio use, because they fit into three and four 1.75 MHz Band III channels, respectively.

The following tables show the number of good audio quality radio stations that can be carried in 5 MHz and 7 MHz DVB-H multiplexes for the different DVB-H transmission modes. For comparison purposes, the number of stations a DAB multiplex can carry are given.

System	Modulation	Code Rate	Bandwidth (MHz)	Number of Good Audio Quality Radio Stations per Multiplex	Number of DAB Multiplexes Required to Provide Equivalent No. of Stations	DAB Bandwidth Required to Provide Equivalent No. of Stations (MHz)
DAB	QPSK	1/2	1.75	6	-	-
DVB-H	QPSK	2/3	5	48	8	14
DVB-H	16-QAM	1/2	5	72	12	21
DVB-H	16-QAM	2/3	5	97	17	30

NOTE – Code rate for DAB is the overall code rate, and the MPE-FEC outer-layer of FEC coding is used for DVB-H

Table 10. Number of DAB multiplexes and bandwidth required to provide equivalent number of stations as a 5 MHz DVB-H multiplex

System	Modulation	Code Rate	Bandwidth (MHz)	Number of Good Audio Quality Radio Stations per Multiplex	Number of DAB Multiplexes Required to Provide Equivalent No. of Stations	DAB Bandwidth Required to Provide Equivalent No. of Stations (MHz)
DAB	QPSK	1/2	1.75	6	-	-
DVB-H	QPSK	2/3	7	68	12	21
DVB-H	16-QAM	1/2	7	102	17	30
DVB-H	16-QAM	2/3	7	136	23	40

NOTE – Code rate for DAB is the overall code rate, and the MPE-FEC outer-layer of FEC coding is used for DVB-H

Table 11. Number of DAB multiplexes and bandwidth required to provide equivalent number of stations as a 7 MHz DVB-H multiplex

The above tables show the number of DAB multiplexes and the DAB bandwidth required to provide the same number of radio stations as a single DVB-H multiplex can carry. In all cases, if DAB were used then a large number of multiplexes are required to carry the same number of stations as a single DVB-H multiplex. Each one of these DAB multiplexes requires a separate transmitter network and digital multiplexer hardware. Using the example of the 7 MHz DVB-H multiplex using 16-QAM with a code rate of 1/2: there would need to be 17 DAB transmitter networks and 17 digital multiplexers, whereas the DVB-H multiplex requires just one transmitter network and one digital multiplexer. The individual transmitters for the DVB-H multiplex would need to use a higher power than for each of the DAB transmitters, but overall, the single DVB-H multiplex would cost a *tiny* fraction of the cost of 17 DAB multiplexes. Therefore, and this applies for all DVB-H transmission modes and for both 5 and 7 MHz channel bandwidths, DVB-H is *far* cheaper to transmit per radio station than DAB is.

And because the number of DAB multiplexes increases as the capacity of the DVB-H multiplexes increases, so does the amount of bandwidth that DAB requires. Using the same DVB-H mode as in the previous example, DAB requires 30 MHz of spectrum compared to DVB-H only requiring 7 MHz. It should be clear from previous sections that spectrum is a scarce resource, and it should not be squandered by using spectrally inefficient technologies.

DVB-H also has the advantage of extendability, in that if new stations want to start transmitting then a higher capacity mode can be used to accommodate these new services. Moving from lower to higher capacity transmission modes will cost extra money, but it would not require extra spectrum. With DAB, if more radio stations want to transmit then more spectrum and more multiplexes are required.

Because of the wide bandwidth channels that it uses, DVB-H is most suitable for national SFN (single-frequency networks) or large coverage area multiplexes. DVB-H is not suitable for local or small-area multiplexes because it would consume a lot of spectrum, and it is unlikely that the multiplex could be filled. Again, DRM is the best-suited system for this kind of coverage.

One drawback of DVB-H is that there are currently no receivers available because it is a new standard. However, DVB-H will be included in mobile phones, which sell in very high volumes (600 million units globally last year). This will result in DVB-H receiver chips having a very low unit cost, which will enable low cost radio receivers to be produced.

DMB / DAB with the HE AAC Audio Codec

DMB is actually transmitted over a DAB transmitter network, and is really just DAB with the ability to use the HE AAC audio codec and stronger error correction. It therefore allows broadcasters that have already built DAB transmitter networks to continue to exploit this infrastructrure, but in a more efficient way, because more radio stations can be carried on each multiplex. Because each multiplex can carry more radio stations, less new multiplexes would need to be built, thus saving capital investment, running costs and spectrum.

To convert a DAB multiplex to a DMB multiplex all that is needed are new HE AAC audio encoders plus a DMB processor for each station. The figure below shows how DMB services interface with the DAB system.

To the DAB system, DMB services appear to be data services, and a DAB receiver simply passes the DMB stream on to the DMB receiver.

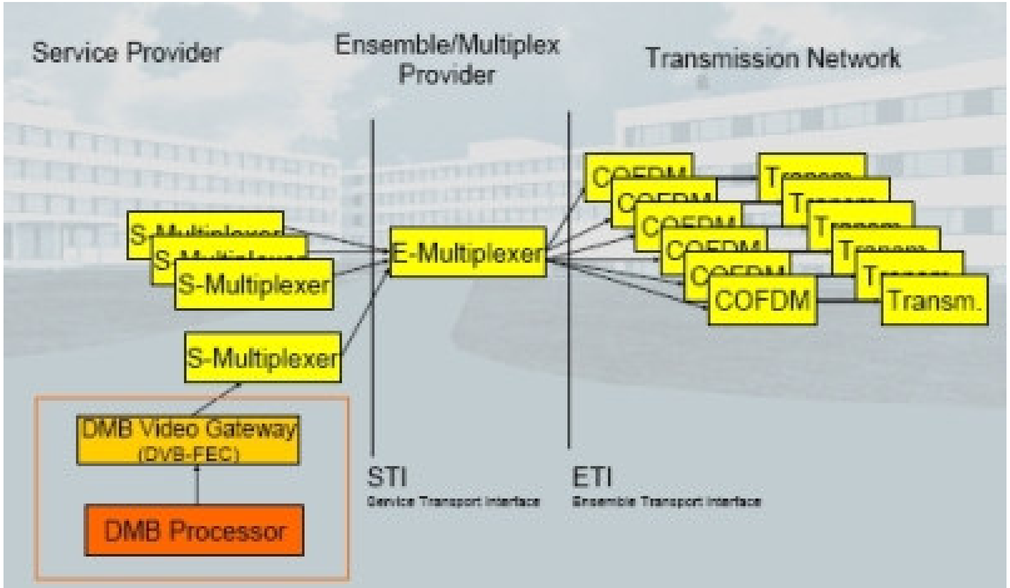

Figure 1. Interface of DMB services to the DAB system

The DMB processors and audio codecs are small, one-off purchases, and because the alternative is building numerous new DAB multiplexes then the savings in infrastructure and running costs are large.

The Chairman of the WorldDAB Technical Committee recently said in a presentation in Taiwan that DAB was "paving the way for new audio codecs, e.g. HE AAC". Such a change would allow DAB to be effectively identical to DMB, because DMB's additional error correction has already been specified for DAB-use. However, the vast majority of the improvement in performance of DMB relative to DAB is due to DMB adopting the HE AAC codec, and merely using DAB with the new error correction does not provide a major increase in performance.

Because DMB is transmitted over a DAB network it uses identical 1.75 MHz channel bandwidths. It is therefore neither better nor worse in terms of its flexibility for frequency / multiplex planning.

Like DVB-H, there are currently no DMB receivers available suitable for digital radio use. But DMB receiver chips are also expected to be included in mobile phones, so the same argument applies for DMB as it does for DVB-H in this regard.

Appendix

The following points show how DAB proponents mis-represent the required DVB-H transmitter powers, and consequently mis-represent the total cost of implementing a DVB-H multiplex:

- they assume DVB-H uses a transmission frequency is 600 MHz or higher frequencies instead of 200 MHz (9.5 dB extra power required for DVB-H)
- they use figures from the DVB-H Implementation Guidelines which are for very short integrated mobile phone antennas, whereas they use full-size antennas for DAB (approximately 11 dB extra power required for DVB-H)
- they use SNR (signal to noise ratio) values for video reception, when audio doesn't require such high SNR values (extra 3 – 4 dB power required for DVB-H)

Overall, with an extra 24 dB of transmitter power, that equates to transmitter power figures that are inflated by a factor of 251!

They also conveniently fail to mention that the 8 MHz-wide, high-capacity transmission-mode DVB-H multiplexes they use for their figures can carry 155 radio stations at good audio quality, whereas DAB can only carry 6 good audio quailty radio stations in a multiplex. So, not only do they inflate the transmitter power figures by a factor of about 251, they even fail to mention that the DVB-H multiplex can carry 26-times as many radio stations at the same level of audio quality as DAB can.

In reality, no country needs to carry 155 radio stations on one multiplex; DVB-H can be used in Band III; for a radio system you wouldn't use tiny mobile phone antennas for radios; and radio carries audio, so SNR values for video are inappropriate. When all of these differences are factored-in, then for almost identical capital cost multiplexes, a relatively low-capacity 7 MHz DVB-H multiplex can carry 68 radio stations whereas DAB can carry just 6 radio stations on a multiplex at the same level of audio quality. Therefore, the transmission costs per radio station are 11-times lower than for DAB. DAB proponents completely distort these figures in order to suggest that DVB-H is actually more expensive to run than DAB. The fact that DAB proponents have to go to the extent of distorting figures for competing systems shows that they have to hide the gross inefficiencies of the DAB system in order to justify the use of the 15-year-old DAB system.