DAB+

The additional audio codec in DAB

WORLD DMB

Digital Multimedia Broadcasting

Radio • Mobile TV • Multimedia • Traffic Data

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Contents

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Why DAB+?

In the digital age, broadcasting standards need to balance the benefits of stability and innovation. Stability gives confidence to broadcasters, manufacturers and consumers. And yet, enhancing a standard to take advantage of technological innovation can offer new benefits and protect a standard's competitiveness in a rapidly changing market place. The international organisation responsible for the Eureka 147 standards, WorldDMB (formerly known as the WorldDAB Forum) has carefully monitored developments in audio coding. Although WorldDMB remains a strong advocate of stability, its Steering Board took the decision that the benefits of adding an additional highly efficient codec to Eureka 147's options were so significant that this innovation should be incorporated.

The benefits of DAB+ include:

- Latest MPEG-4 audio codec delivers exceptional performance efficiency
- More stations can be broadcast on a multiplex
- Greater station choice for consumers
- More efficient use of radio spectrum
- Lower transmission costs for digital stations
- New receivers backwards compatible with existing MPEG Audio Layer II broadcasts
- Current MPEG Audio Layer II services and consumers unaffected
- Compatible with existing scrolling text and multimedia services
- Robust audio delivery
- Optimised for live broadcast radio
- Broadcasters/regulators can select either standard MPEG Audio Layer II, or the additional audio coding, or both, to suit their country
- Fast re-tuning response time (low zapping delay)
- MPEG Surround is possible

Until now, DAB digital radio has always been broadcast using MPEG Audio Layer II coding. In the years since the DAB digital radio standard was first defined, more efficient coding schemes and algorithms have been devised. These allow audio with equivalent or better subjective quality to be broadcast at lower bit rates. Other broadcast technologies such as DVB-H (digital video broadcasting for handheld), DRM (Digital Radio Mondiale; i.e. digital long, medium and short wave) or MediaFLO use the audio coding MPEG-4 HE-AAC v2 and are able to carry multiple audio services in the digital capacity needed for a single radio service using MPEG Audio Layer II.

WorldDMB recently created a Task Force of its Technical Committee to develop the additional standard. After examining the options, DAB$^+$ using MPEG-4 HE-AAC v2 was adopted.

The significantly increased efficiency, which is discussed in more detail later in this document, offers benefits for Governments and Regulators (even better spectrum efficiency), broadcasters (lower costs per station) and consumers (a bigger choice of stations). It is designed to provide the same functionality of the current MPEG Audio Layer II radio services including service following (e.g. to the same service on another DAB ensemble or its FM simulcast), traffic announcements, PAD multimedia data (e.g. dynamic labels such as title artist information or news headlines; complementary graphics and images etc.).

In some countries where DAB digital radio has already been launched, broadcasters are committed to continuing to use MPEG Audio Layer II. However, in countries planning to launch digital radio the arguments in favour of launching with DAB$^+$ are compelling.

It is worth noting that this is not the first time HE-AAC v2 has been included in the Eureka 147 family of standards. Already, the DAB standards allow HE-AAC v2 audio as part of DMB multimedia services. DMB is designed for mobile television, and lacks some of the functionality required for a radio service. (A more detailed comparison can be found in chapter 4.)

To emphasise that DAB+ is intended for radio services (i.e., with streamed audio being the essential component), the following text uses the term “radio service” instead of the DAB term “audio service”.

Features of DAB+

DAB+ uses MPEG-4 High Efficiency AAC v2 profile (HE-AAC v2). This audio codec is the most efficient audio compression scheme available worldwide. It combines three technologies:

- The core audio codec AAC (Advanced Audio Coding).

- A bandwidth extension tool SBR (Spectral Band Replication), which enhances efficiency by using most of the available bit rate for the lower frequencies (low band) of the audio signal. The decoder generates the higher frequencies (high band) by analysing the low band and side information provided by the encoder. This side information needs considerably less bit rate than would be required to encode the high band with the core audio codec.

- Parametric stereo (PS): a mono down-mix and side information is encoded as opposed to a conventional stereo signal. The decoder reconstructs the stereo signal from the mono signal using the side information

HE-AAC v2 is a superset of the AAC core codec. This superset structure permits to use plain AAC for high bit rates, AAC and SBR (HE-AAC) for medium bit rates or AAC, SBR and PS (HE-AAC v2) for low bit rates. Therefore HE-AAC v2 provides the highest level of flexibility for the broadcaster. A detailed description of HE-AAC v2 is available on the EBU website[1]. An introduction to MPEG-4 is available on the MPEG Industry Forum website[2].

HE-AAC v2 provides the same perceived audio quality at about one third of the subchannel bit rate needed by MPEG Audio Layer II. The same audio coding is also used in DRM and DMB e.g. for television audio. Devices, which also include DMB or DRM can benefit from the fact that the audio coding for this range of technologies is essentially the same.

Other systems using AAC:

- iPOD
- DRM (Digital Radio Mondiale)
- 3GPP / 3GPP2
- T-DMB
- S-DMB (Korea)
- MediaFLO
- ISDB (Integrated Services Digital Broadcasting; Japan)
- DVB-H
- XM Satellite Radio (USA)
- HD Radio (USA)

All the functionality available for MPEG Audio Layer II services is also available for DAB+: service following (e.g. to FM or other DAB ensembles), traffic announcements, PAD multimedia (dynamic labels such as title artist information or news headlines; still images such as weather charts, images and other multimedia content.), service language and programme type information (e.g. Classical Music, Rock Music, Sport) etc.

MPEG Audio Layer II and HE-AAC v2 radio services can coexist in one ensemble. However, legacy receivers might list HE-AAC v2 radio services even though they will not be able to decode them.

The geographical coverage area of radio services using HE-AAC v2 is slightly larger than that for radio services using MPEG Audio Layer II. The multimedia information carried in PAD of an HE-AAC v2 radio service is much better protected against transmission errors than PAD data of a radio service using MPEG Audio Layer II.

An important design criterion for DAB+ was a short "zapping" delay. Both the time it takes to switch from one radio service to another station on the same DAB ensemble as well as the time it takes to tune to a radio service on another DAB ensemble was minimized.

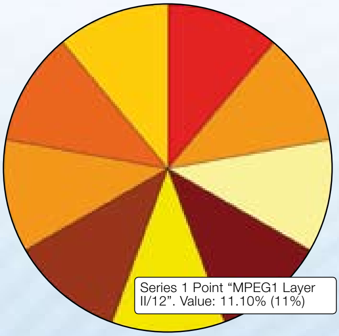
Currently all DAB radio services are mono or stereo. However, DAB+ also provides the means to broadcast surround sound in a backwards compatible way. Using MPEG Surround it is possible to broadcast a stereo signal together with surround side information (e.g. 5 kbps side information). Standard stereo radios will ignore this side information and decode the stereo signal. MPEG Surround receivers will evaluate the side information and reproduce surround sound. So at a comparatively low additional bit rate, the broadcaster can increase the audio experience on surround sound receivers, and still provide high quality sound to all other radios.

[1] EBU Tech review: MPEG-4 HE-AAC v2 – audio coding for today's digital media world (2006)
http://www.ebu.ch/en/technical/trev/trev_305-moser.pdf

[2] An MPEGIF White Paper: Understanding MPEG-4: Technologies, Advantages, and Markets
http://www.m4if.org/public/documents/vault/MPEG4WhitePaperV2a.zip

Possible scenarios with DAB+

The following figures show how the bit rate of a DAB ensemble may be assigned to:

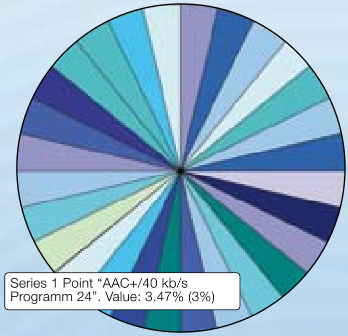


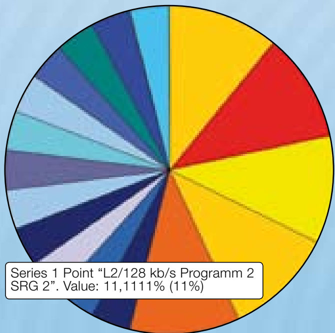
Multiplex with MPEG Audio Layer II (DAB)

9 radio services using MPEG Audio Layer II at 128 kbps

Multiplex with HE-AAC v2 (DAB+)

28 radio services using HE-AAC v2 at 40 kbps and 1 audio service using HE-AAC v2 at 32 kbps.





Multiplex with MPEG Audio Layer II and HE-AAC v2 (DAB and DAB+)

5 radio services using MPEG Audio Layer II at 128 kbps and 12 radio services using HE-AAC v2 at 40 kbps and 1 radio service using HE-AAC v2 at 32 kbps

A 40 kbps subchannel with HE-AAC v2 provides a similar audio quality (even slightly better in most cases) as MPEG Audio Layer II at 128 kbps.

Comparison of DAB$^+$ and DMB for radio services

DMB is based on MPEG audio/video standards and is adapted to DAB. In addition to audio and video, it is also possible to provide additional multimedia information. DMB is designed and optimised for mobile television, but it is not recommend for radio services.

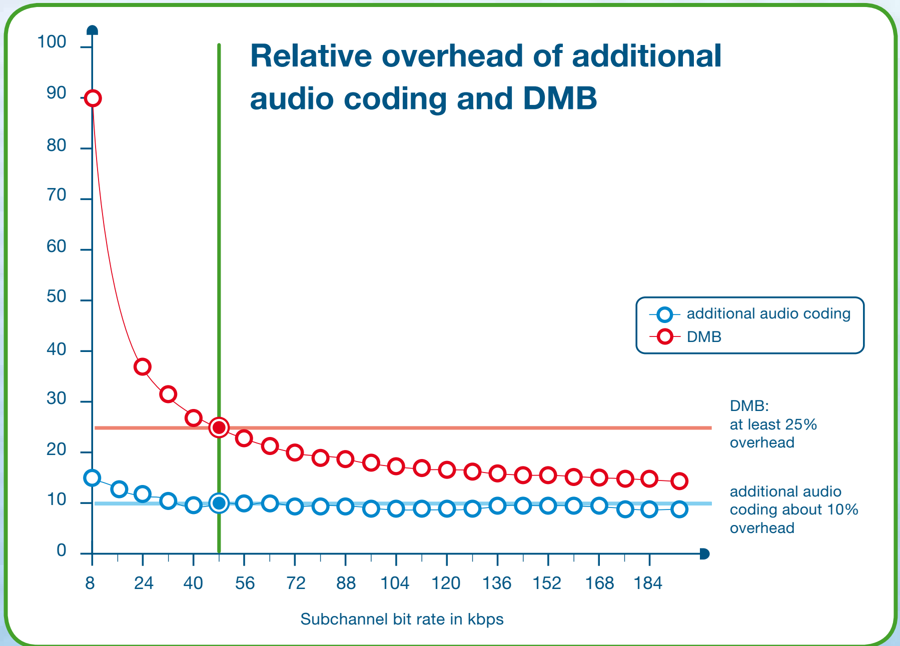
One consideration is that DMB is missing some features which are expected for radio services e.g. PAD, DLS, service following etc.

Also, since DMB is based on MPEG audio/video standards it inherits some of the overhead needed to manage and synchronize audio and video (and possibly also multimedia) streams. This overhead is relatively low for the high bit rates that would be used for a mobile television channel, but the overhead becomes significant for the low bit rates that would be used for a radio service.

In contrast, DAB$^+$ is optimised for radio services (including PAD information) and thus has a much lower overhead (see figure).

At the moment (beginning of 2007), most DMB receivers also expect a video component before they start decoding the audio. However in the future, devices may no longer have this restriction. Therefore, in addition to the audio, at the moment it would be necessary to provide a video component (picture radio) at a high enough frame rate when using DMB. A low frame rate causes a high delay when tuning to the service.

All the functionality available for DAB services is also available for DAB$^+$, but it is not available for DMB (it is not needed for a mobile television service): services following (e.g., to FM, AM, DRM or another DAB radio service), traffic announcements, PAD multimedia (dynamic labels such as title artist information or news headlines; still images such as weather charts or CD covers, etc.), service language and programme type information etc.



This figure shows a comparison of the relative overhead (used for error correction and transport protocol) of additional audio coding (assuming no PAD information) and DMB (PAD information not possible) in case of a radio service.

The resistance to transmission errors of both systems is similar, since they are based on comparable error correction schemes.

Performance of DAB+

During the standardisation process, field tests were conducted in the UK and Australia. They showed that the geographical coverage area of radio services using HE-AAC v2 is slightly larger than that for radio services using MPEG Audio Layer II.

Audio services using HE-AAC v2 performed about 2-3 dB better at the threshold of audibility. This means that in some areas close to the coverage area where MPEG Audio Layer II services already showed audible artefacts, HE-AAC v2 radio services showed no audible artefacts.

The error behaviour of MPEG Audio Layer II is different to that of HE-AAC v2.

With MPEG Audio Layer II, the weaker the DAB signal gets, the more audible artefacts can be heard.

HE-AAC v2 produces no audible artefacts, but when the signal gets too weak, an increased number of audio frames will be lost and this causes short periods of silence (fade-out and fade-in). Test listeners preferred this error behaviour. Compared to radio services using MPEG Audio Layer II, radio services using HE-AAC v2 will fail later (they can cope with a slightly lower DAB signal quality), but the margin from error free reception to loss of reception is smaller.

To determine the audio quality at low bitrates, listening tests were performed by the EBU (European Broadcasting Union) in 2003. For stereophonic audio, the listening tests show that at an audio bit rate of 48 kbps, HE-AAC offers good to excellent quality, at an audio bit rate of 64 kbps it offers excellent quality.

At the time of these tests, HE-AAC v2 was not yet available. The PS (parametric stereo) tool, which was added after the EBU tests were completed, significantly increases the perceived audio quality at lower bit rates.

It should be noted that the bit rates cited from these listening tests are pure audio bit rates and not DAB subchannel bit rates. In order to carry audio in a DAB multiplex using the new specification a 10% overhead should be taken into account.

Audio comparison tests performed in Australia in 2005 confirmed that HE-AAC v2 provides similar perceived audio quality at about one third of the subchannel bit rate needed by MPEG Audio Layer II.

Broadcasters will want to make further tests before taking operational decisions about the appropriate bit rate for a particular service.

Status of standardization

The standard specifying the additional audio coding was submitted to ETSI in December 2006. The timetable was for the standard to be published in April 2007.

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