

## DAB+ attributes

DAB+ uses MPEG-4 High Efficiency AAC v2 profile (HE-AAC v2). This audio codec is the most efficient audio compression scheme available worldwide and allows for up to three times as many services per multiplex as the original DAB: A 40 kbps sub channel with HE-AAC v2 provides a similar audio quality (even slightly better in most cases) as MPEG Audio Layer II at 128 kbps.

HE-AAC v2 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: 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<sup>1</sup>. An introduction to MPEG-4 is available on the MPEG Industry Forum website: <http://www.oipf.tv/mpegif>

HE-AAC v2 provides the same perceived audio quality at about one third of the sub channel bit rate needed by MPEG Audio Layer II.

Other systems using AAC include:

- 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)

## **DAB+ functionalities**

All the functionalities available for MPEG Audio Layer II services are 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.

## **Short Zapping Delay**

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.

## **Surround Sound**

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.

## **The performance of DAB+ in field tests**

During the standardisation process, field tests were conducted in the UK and Australia. They gave a number of interesting results:

- 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 artifacts, HE-AAC v2 radio services showed no audible artifacts.

- The error behavior 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 artifacts can be heard. HE-AAC v2 produces no audible artifacts, 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 behavior. 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, but it can safely be assumed that its performance will be similar to or even better than that of HE-AAC.

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 sub channel 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 sub channel 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.