What's the difference between DVB-H and DAB — in the mobile environment?

Andreas Sieber and Chris Weck
IRT

The European digital terrestrial broadcast systems – DVB and DAB – have recently come into focus as a means of delivering streaming content to mobile, portable and even handheld receivers. But what are the pros and cons of using these broadcast systems in conjunction with cellular networks? This article explains it all.

Arising from the hype surrounding the Internet over the last ten years, there is increasing interest in offering multimedia services to mobiles. First, there was the big bang of selling frequencies for UMTS all over Europe, but it turned out that UMTS will not offer the huge bandwidth that modern streaming internet applications, such as TV, require. This means that, apart from point-to-point applications, there is an increasing requirement for point-to-multipoint, wireless, internet access technologies. Hence the terrestrial broadcast systems have recently come into focus, as a means of streaming multimedia content to mobile, portable and even handheld receivers.

There are three different technical solutions that could meet these requirements:

- **DAB**, adapted for multimedia delivery;
- **DVB-H**, the latest standard from DVB;
- **ISDB-T** from Japan, which will not be deployed in Europe.

History of the different systems

DAB

DAB was developed between 1988 and 1992. The system was primarily intended for audio broadcasting, although there is a provision for carrying data and multimedia services.

DAB services have already been launched in a number of countries, although the breakthrough has not been achieved in many countries up to now. There have been encouraging receiver sales in the UK – over 500,000 units had been sold by April 2004. It is predicted that over 1 million DAB receivers will have been sold in the UK by the end of 2004. In 2003, pre-Christmas sales of DAB portable receivers accounted for 85% of the overall UK DAB receiver market. In Germany, fewer DAB receivers have been sold than in the UK but the numbers are increasing steadily.

The DAB system, and especially the transmission network, was designed for outdoor reception at an antenna height of 1.5 m. Thus, DAB provides good coverage for in-car reception. However, there are concerns about indoor portable reception – which would require a significant increase in transmitter powers for planning purposes. At the first session of the ITU's Regional Radio Conference in June 2004 (RRC-04), a figure of 9 dB above the current planning levels (for outdoor mobile reception) was proposed for indoor portable reception. This compares with a figure of 15 dB suggested by NTL of the UK in a separate article published in this edition.

DVB-T

The terrestrial version of the DVB system was developed during the mid-1990s. It was primarily intended to use the terrestrial DVB system for portable and stationary reception using roof-top antennas. The design of the system was strongly influenced by the cost of the receiver implementation. To make the receivers cheaper, time interleaving – which would benefit mobile reception – was not implemented; instead, the same error correction as the satellite system, DVB-S, was used.

Today, the terrestrial system has already been launched in several countries. The numbers of DVB-T receivers sold are encouraging. In the Berlin area of Germany, up to 250,000 DVB-T receivers were sold in 2003, after the switchover from analogue to digital television. DVB-T for mobile and portable reception has been examined, and the receivers optimized, in different EU-funded projects such as ACTS-MOTIVATE (1998-99), MCP (2000-2001) and CONFLUENT (2002-2003). The use of (two-antenna) diversity receiver technology enables high-speed mobile reception of DVB-T, even in difficult situations.

DVB-H

During mobile testing of DVB-T, the question was raised whether DVB-T would also be suitable for other multimedia applications in the mobile environment. In particular, mobile phone manufacturers such as Nokia were interested in high data-rate applications over DVB-T, to provide mobile multimedia services. The motivation for this access technology was that TV is the last missing link in the value chain of the mobile phone business. Because it turned out rather early that DVB-T has some drawbacks for broadcasting to mobile phones, the idea of a dedicated standard for handhelds, based on DVB-T, was born. It is called DVB-H (DVB-Handhelds). The essential commercial requirements of DVB-H were found to be a battery-powered mobile terminal with a small screen. It should be able to receive multimedia services using a single antenna – in the portable, mobile and indoor environments.

Technical comparison of DAB and DVB-H

What are the differences between DAB and DVB-T/H?

In general the DAB and DVB-T/H transmission systems are based on the same modulation and coding technique, which is *Coded Orthogonal Frequency Division Multiplex* (COFDM). Any differences between them mainly exist in specific areas such as the carrier spacing, carrier modulation, FFT size etc.

Abbreviations

16-QAM	16-state Quadrature Amplitude Modulation
AVC	(MPEG-4) Advanced Video Coding
C/N	Carrier-to-Noise ratio
COFDM	Coded Orthogonal Frequency Division Multiplex
DAB	Digital Audio Broadcasting (Eureka-147)
DQPSK	Differential Quadrature (Quaternary) Phase-Shift Keying
DVB	Digital Video Broadcasting
DVB-H	DVB - Handheld
DVB-S	DVB - Satellite
DVB-T	DVB - Terrestrial
FEC	Forward Error Correction
FFT	Fast Fourier Transform
GMSK	Gaussian Minimum Shift Keying
GSM	Global System for Mobile communications
IP	Internet Protocol
ISDB-T	Integrated Services Digital Broadcasting – Terrestrial
ISP	Internet Service Provider
MPE	(DVB) MultiProtocol Encapsulation
QPSK	Quadrature (Quaternary) Phase-Shift Keying
R-S	Reed-Solomon
SFN	Single-Frequency Network
UHF	Ultra High Frequency
UMTS	Universal Mobile Telecommunication System

FFT size

DAB can apply 256, 512, 1k and 2k FFT in a 1.5 MHz channel. DVB-H, on the other hand, can apply 2k, 4k and 8k FFT in channels with a bandwidth of 5, 6, 7 or 8 MHz.

Time slicing

Time slicing in DVB-H is a new power-saving mechanism at the receiver side. If the receiver could be switched off in those time intervals where the service is not transmitted, then battery power could be saved. Time slicing in DVB-H means that the data is transmitted in bursts that can be scaled from a few milliseconds to some seconds. The technique is based on a service-related trade-off between the following two questions: *what data rate is required for the service and how much battery power should be saved at the receiver side?*

DAB also transmits its data in bursts. This “data burst” is part of a frame in DAB which lasts 24 ms followed by a null symbol.

Time interleaving

There is no time interleaving in DVB-H, because the DVB-T standard did not provide for this: DVB-T was not designed for high-speed mobile reception.

DAB was designed from the very beginning for mobile reception. Time interleaving solves fading problems in mobile reception conditions with only one antenna. The time interleaving distributes burst errors over a larger timescale so that the FEC is able to correct the errors. In mobile reception it is more likely that burst errors occur than single errors. Time interleaving in DAB works over 16 “data bursts”. One data burst lasts 24 ms so that time interleaving works over 384ms.

Unequal Error Protection (UEP)

Unequal Error Protection means that bits of higher importance for the decoding process are protected better than bits of lower importance.

DAB supports UEP. This means that the bits are protected according to their importance for the decoding process. This is very important for mobile and portable reception because, in general, hostile reception conditions cannot be avoided. Therefore, the service behaviour in bad reception conditions is the key question. With UEP, the failure characteristic can be optimized with respect to objective or subjective quality-of-service aspects, by designing different error protection classes in relation to the protection of the main service.

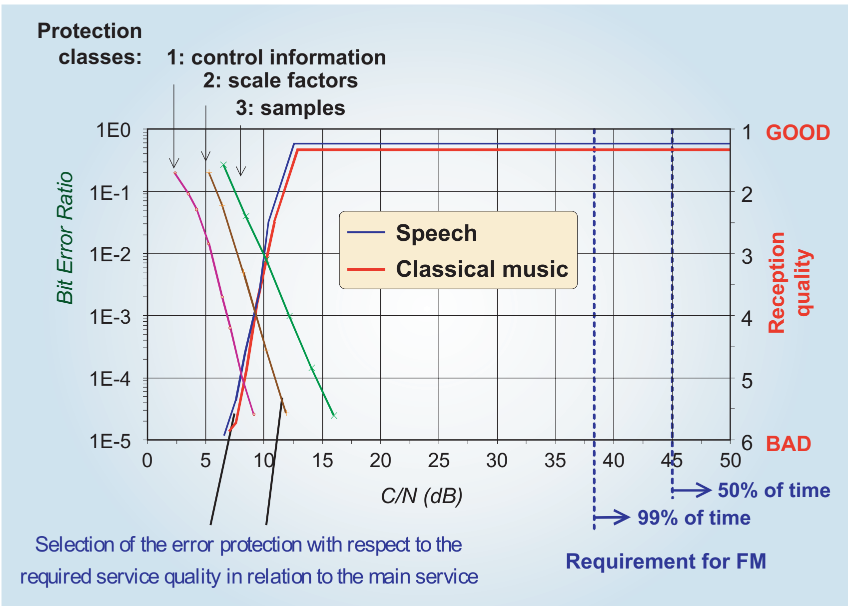


Figure 1
Unequal Error Protection in DAB, for audio content

DVB-T/H has no provision for UEP. This means that errors which occur and damage certain important information (e.g. the control information) are only protected like the less significant bits. For the user, it may not matter if less significant bits are destroyed but he/she will be most concerned if significant synchronization is lost.

Multi Protocol Encapsulation – Forward Error Correction (MPE-FEC)

Multi Protocol Encapsulation, combined with an additional Forward Error Correction (FEC), in DVB-H is used to improve the mobile reception with only one antenna. But this error protection only works within one time slice. Errors in transmission usually occur not as single errors but as burst errors. So if the time slice is disturbed too much, the service drops out, not only for the duration of the time slice but also during the time up until the next time slice is transmitted. MPE-FEC is an additional FEC at the higher protocol layer and can correct residual errors on lower layers, but only to a certain extent. So DVB-H has no individual protection for its significant bits.

Further laboratory tests and field trails are scheduled to investigate the reception performance of DVB-H with one antenna, both with and without MPE-FEC. DVB-H uses IP as the transport layer and on top of that there is MPE-FEC and Advanced Video Coding (AVC).

DAB doesn't use MPE-FEC, as this is just an additional error-protection mechanism on a higher transport layer. It would be no problem to use MPE-FEC, or a similar error protection system, in DAB as well.

The WorldDAB consortium is currently considering an extension of the DAB standard which would include a DVB-H-like error protection scheme based on MPE-FEC, or one based on the R-S coding of the MPEG-2 transport streams as used in the DVB-T and DVB-S standards.

Scalability

A DAB multiplex is based on 864 capacity units which can be combined to fit to any data rate required by the service. One capacity unit therefore limits the minimum size of a service data rate. Depending on the chosen error protection, this is in the order of 1.3 kbit/s: for data services, a multiple of 8 kbit/s is usually used.

DVB-H offers services which can be scaled from 0 - 10 Mbit/s. It only depends on the size of the time slice.

Which system achieves the requirements?

For various reasons, DAB fits better to the technical requirements of mobile terminals, if a data rate of 300 kbit/s or less is used per service. For example, there is lower effort needed on the multiplex. Four to six programmes could be transmitted via DAB whereas there are 30 or more programmes requiring to be multiplexed in DVB-H. This huge number of programmes is more difficult to handle, especially if every content provider is keen on managing his own multiplex. DAB has a simpler demodulation technique using *Differential Quadrature Phase-Shift Keying* (DQPSK). With this demodulation technique, there is a complexity reduction on the receiver side. DAB needs only 5 - 20% of the power of DVB-T at the receiver side, whereas DVB-H consumes about 33% of the power of DVB-T. The power reduction greatly depends on the service data rate.

Because of the lower bandwidth of DAB compared to DVB-H, DAB transmitter networks need much less power than DVB-H transmitter networks. The transmitted power of a DVB-H network is at least the same as for DVB-T. DAB can provide a high network spectrum efficiency by using large SFNs. Furthermore, the frequency resources can be used very efficiently due to individual spectrum planning for each service operator. The channel bandwidth of DAB is 1.5 MHz. This fits, for example, three times within a UMTS channel (5 MHz). Today, there is very little usage of L-band for DAB audio services and there is still spectrum available for DAB multiplexes in this band.

Free choice? Other aspects of DVB-H and DAB

Coexistence of DVB-T and DVB-H

Usually broadcasters distribute their programmes by setting up a multiplex to combine different programmes in one transport stream of a DVB-T transmitter network. The transmitter network usually consists of high-power transmitters in order to reach a large coverage area.

It is also possible to use DVB-H within an existing DVB-T transmitter network: the multiplex operator has to reserve a certain data rate in the multiplex to transmit DVB-H services. This data rate has always to be reserved for DVB-H services.

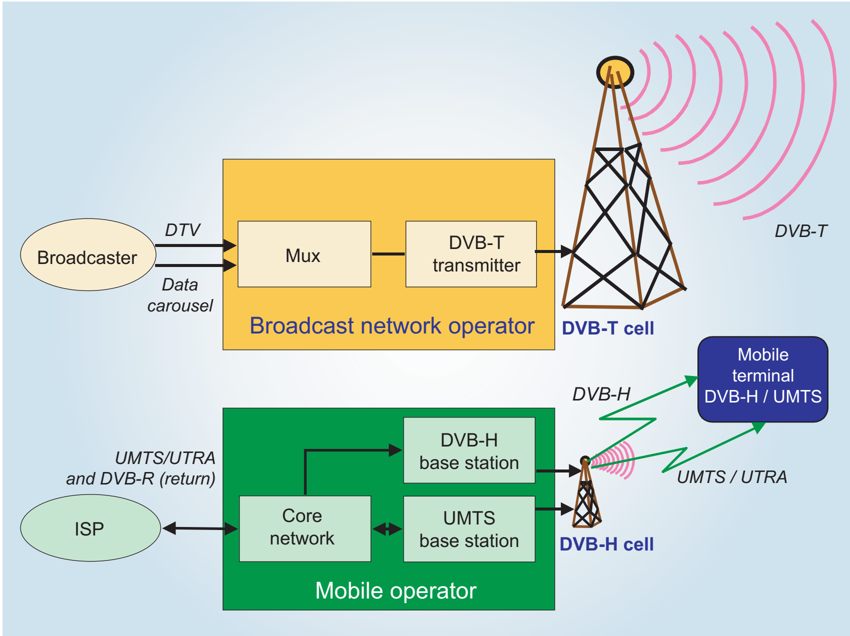


Figure 2
Co-siting of DVB-H and UMTS

The more likely scenario for using DVB-H would be to extend the existing UMTS networks with a broadband downlink channel for multimedia content delivery using Internet Protocol. An Internet Service Provider (ISP) could deliver IP content through a core network to either UMTS or DVB-H base stations which could be co-sited at the same physical location *(see Fig. 2)*.

Multiplexing issues

DVB-H can offer more than 30 TV programmes for small displays using 16-QAM modulation. If a more robust mode is used, there are still half the number of programmes in one multiplex. This is preferable for a (vertical) business model where one multiplex operator, who may be independent of the content provider, is responsible for the whole service. It supports a monopolistic market model, if only one DVB-H multiplex is available. The service can easily be changed by the multiplex operator.

DAB offers 4 - 6 TV programmes for small displays, and there is more flexibility when different services and network operators are involved. In DAB it is easier to set up individual networks for different broadcasters. This access offers a more horizontal market model, because there can be more independent content providers and multiplex operators.

Nationwide single-frequency networks

In principle, nationwide networks are possible for both DVB-H and DAB but, because of the reduced sensitivity to self-interference, DAB allows for one large SFN. This is very spectrum efficient. In comparison, with DVB-T/H in 16-QAM mode, the maximum size of an SFN is about 200 km.

Future work to harmonize DAB and DVB-H

Cooperation has started between DVB-H and WorldDAB, aimed at answering the following questions:

- Is there a standard similar to DVB-H but on the basis of DAB that would be useful or possible?
- Would an end-user device catering for both standards be easy to implement?

- What is missing in DAB in order to provide data or video transmission?

There is already some flexibility in each system to harmonize DAB and DVB-H. For example, DAB can use the MPE-FEC of DVB-H. Another possibility may be at the higher-level layers such as video coding (MPEG-4, H.264) and the transport layer (use of IP). What is really needed is a common interface definition between IP-Datacast / DVB-H services and the physical layer of DAB.

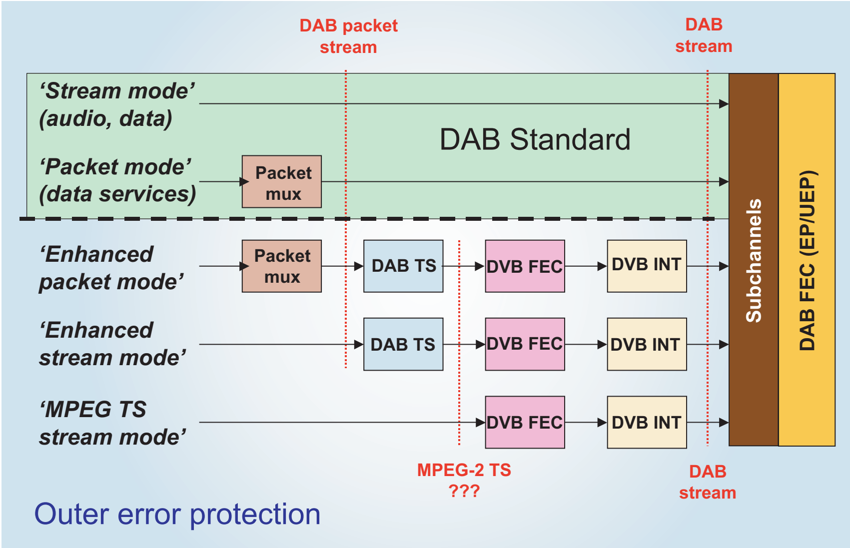


Figure 3
Data transfer with DAB and additional error protection

So the question currently being discussed in various project groups is: "*What is needed in DAB to provide DVB-H services to the mobile user*".

Some of the objectives are:

- definition of the outer error protection;
- unification of media formats for media services;
- definition of a common interface between the DAB physical layer and DVB-H services.

In DAB there already exists a stream mode for audio and data delivery. Also a "packet mode" exists for data services. Under discussion is an "enhanced packet and stream mode" and a stream mode for the MPEG transport stream *(see Fig. 3)*.

Fading and impulsive noise in mobile reception

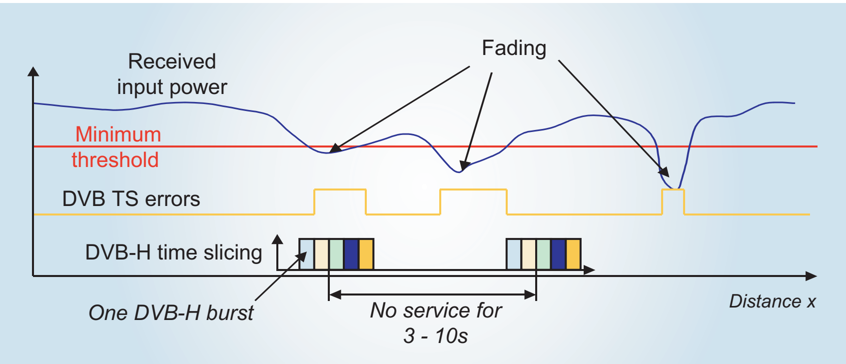


Figure 4
Fading and impulsive noise distortions in DVB-H

Fading means the loss of received power at the antenna while moving around. This sudden loss can happen through echoes, driving in tunnels and through distortions caused by engine ignition, GSM phones etc. These distortions are merged here under the term "impulsive noise".

If the received input power decreases below the minimum threshold, Transport Stream errors occur because the HF signal cannot be decoded any longer. If the time slice of a service is transmitted during the period when the error occurs, the service drops out until the subsequent time slice is received correctly.

Power consumption of DVB-H at the receiver site

Fig. 5 shows the diminishing power consumption of DVB-T front-ends over time *(Source: Nokia)*, for handheld devices under full operation (excluding baseband decoding and other processing power).

According to Texas Instruments (May 2004), DVB-T needs about 1.2 W whereas DAB needs 400 mW.

Over the next few years, DVB-T will still consume more power for just the front-end decoding than DAB will for the whole receiver.

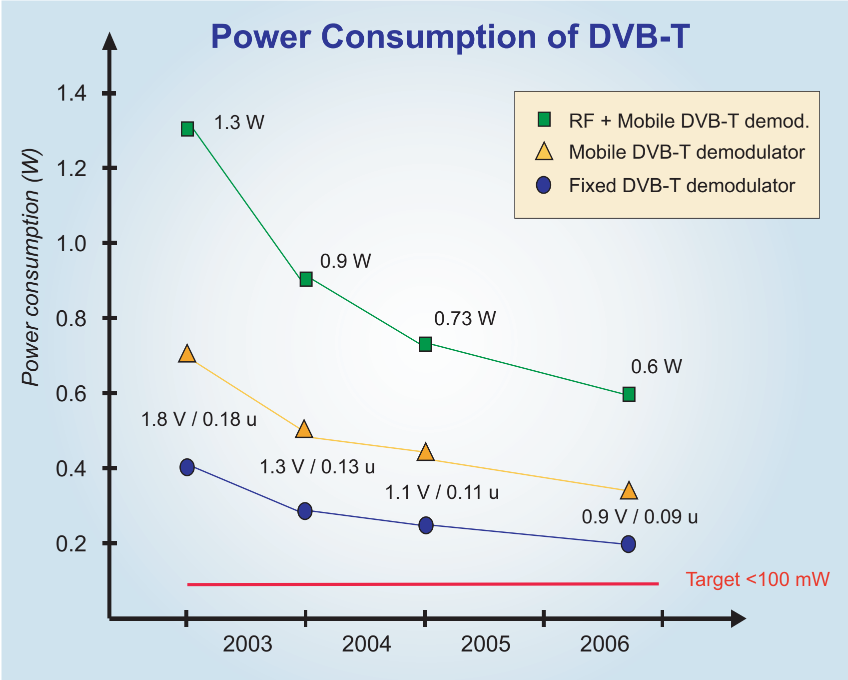


Figure 5
Power consumption of DVB-T front-ends over the next few years
(Source: NOKIA)

Frequency options and the situation in Europe

Band III and L-band are in use for DAB. VHF Band III is used for audio broadcasting services in large regional or nationwide areas. Terrestrial L-band (1452 - 1477 MHz) could become available for DAB services to handheld devices.

For DVB-H there is a very difficult frequency situation in several European countries, notably Germany, where UHF is still heavily in use for analogue television. While migrating from analogue to digital transmissions, even fewer channels may be available due to the need for simulcasting of analogue and DVB-T services. In central European countries such as Germany, there will be no significant digital dividend when compared to, for example, the UK, Sweden and France. It will also depend on the planning choices made for providing portable indoor reception.

Transmitter power needed for a DVB-H service

There are widely differing coverage requirements for indoor, portable and mobile reception. *Table 1* shows the different sensitivity requirements of GSM, DVB-T/H and DAB. It also indicates what power is needed at the receiver side to decode the service.

Table 1
Sensitivity comparison between GSM, DVB-H and DAB

	GSM	**DVB-T/H**	**DVB-T/H**	**DAB**
Frequency range	**D-Net (900 MHz)/ E-Net (1800 MHz)**	**VHF (174 - 230 MHz)/ UHF (470 - 838 MHz)**	**VHF (174 - 230 MHz)/ UHF (470 - 838 MHz)**	**VHF (174–230 MHz)/ L-band (1452 - 1477 MHz)**
Modulation	**GMSK**	**16QAM**	**QPSK**	**DQPSK**
Thermal noise (dBm/Hz)	-174	-174	-174	-174
Bandwith (dBHz)	54.3	68.8	68.8	61.76
Noise figure (dB)	10	7	7	6
System requirements (dB) C/N or E_c/N_o	8	22	15	15
Sensitivity (dBm)	-101.7	-76.2	-83.2	-91.24
DELTA (dB)	**0**	**25.5**	**18.5**	**10.5**

With reference to the bottom row of *Table 1*, it can been seen that DVB-H / QPSK has to radiate 8 dB (18.5 – 10.5) more power than DAB for the same service, while DVB-H / 16-QAM needs 15 dB (25.5 – 10.5) more radiated power than DAB.

Conclusions

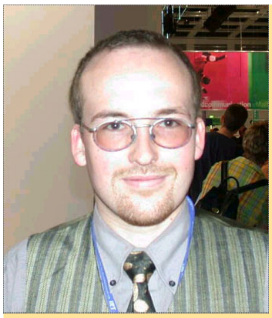
Arguments for DAB

DAB was designed for mobile reception with one antenna, right from the very beginning of the standardization process:

- The data rate is scalable for small displays up to 1.2 Mbit/s (1.5 Mbit/s at lower error-protection levels);
- A DAB transmitter network is cheaper to build than a DVB-H network;
- There is spectrum available in L-band, where multiplexes could be used to provide multimedia services;
- DAB is robust against impulsive noise, due to its time-interleaving feature;
- Lower transmitter power is needed for DAB compared to DVB-H;
- DAB is driven by the broadcasters, whether for audio or multimedia services.

Why do companies push DVB-H?

DVB-H is currently the focus of the mobile phone manufacturers and operators. Many players in this sector want to take advantage of the DVB-T success story. As DVB-H can be deployed simply by using the current DVB-T infrastructure, they see it as a way of greatly enhancing the data rate that can be provided when compared with just UMTS alone. But DVB-H has low mobile performance



After his graduation in Telecommunications Engineering at the Technical University of Munich in 1997, **Andreas Sieber** joined the Neurological Section of the University Hospital in Munich to work on the development of technical devices and measurements. After nearly two years of experience in this field, he joined the IRT in Munich in 1999, starting his career as a research engineer in the Broadcasting Transmission Systems section. In the past years much of his work has been concerned with DVB-T stationary and mobile reception, including noise and interference considerations for DVB-T and DAB. His special interest is the convergence of UMTS and broadcasting services, whose scope also includes GSM/GPRS. He is member of the DVB-UMTS and DVB-H groups.

Mr Sieber has undertaken a number of field trials, notably within the EU project MOSQUITO, and carried out QoS measurement campaigns on local SFN networks. He has worked on the convergence aspects of DVB-T and UMTS technology within the EU projects CISMUNDUS and CONFLUENT. Currently he is involved in evaluating the DVB-H Standard within the EU project INSTINCT.

In 1986, **Chris Weck** joined the Institut für Rundfunktechnik (IRT) in Munich (which is the research and development institute of the public broadcasters in Germany, Austria and Switzerland). For many years, he worked in the section "Digital Broadcasting Transmission Systems", where he contributed to numerous national and international projects in the area of digital transmission systems (e.g. specification of the DAB and DVB-T systems), broadcast service quality and coverage issues, as well as hybrid broadcast and mobile networks.

Since 2000, Dr Weck has been the general manager of the division "Programme Distribution" and is co-ordinating various IRT projects dealing with broadcasting transmission systems, wave propagation, network issues and frequency management.

when using just one antenna. Also, DVB-H needs more transmitter power compared to DAB for providing content to small-sized displays.

Summary

- DAB was designed for mobile reception;
- DVB-H is based on the physical layer of DVB-T which was originally designed for portable and fixed reception using a rooftop antenna;
- DAB is better suited for mobile terminals, provided a data rate of 300 kbit/s is used for each service;
- DVB-H offers higher data rates, but at the expense of higher transmitter power and lower flexibility;
- There are efforts currently to enhance DAB for DVB-H services.
- DVB-H services in the UHF band is not an option in all European countries, due to the difficult spectrum situation.

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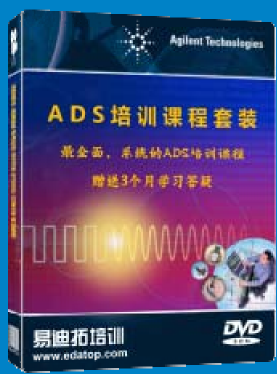

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我们的课程优势：

※ 成立于 2004 年，10 多年丰富的行业经验，

※ 一直致力并专注于微波射频和天线设计工程师的培养，更了解该行业对人才的要求

※ 经验丰富的一线资深工程师讲授，结合实际工程案例，直观、实用、易学

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