Broadcasting to Handhelds — an overview of systems and services

Chris Weck
Institut für Rundfunktechnik GmbH

Edgar Wilson
EBU Technical Department

This article stems from a study carried out by EBU Project Group B/BTH (Broadcasting to Handhelds) which has been examining the several system technology options. The group has also considered some service aspects, including business models and programme offers.

The results suggest that the first task for a broadcaster is to develop a clear understanding of the various roles in the "BTH value chain" that he might wish to play – from content production to the consumer. He must then develop the necessary synergies with partners in the future BTH world. This may subsequently have a direct influence on the choice of technical system, rather than making a selection on the basis of technical performance only. There will also be further fundamental considerations to take into account, such as spectrum availability.

Introduction

Getting live TV to a small battery-powered handheld device is quite a challenge. A number of competing technologies are positioning themselves to offer such a service in the coming year. Whilst the main novelty offered by Broadcasting to Handhelds (BTH) is likely to be perceived as "TV on a Mobile", many additional services will benefit from the growing functionality of digital broadcast technology. Radio has long been portable, but the new metadata extensions for programme selection and storage, and the rich multimedia which can be added to sound radio to enhance the whole "listening" experience, are beginning to move beyond simple possibility. Broadcasting to Handhelds can be a stand-alone receive-only service but can also make use of the functionality of mobile phones and broadcast receivers to enable truly interactive services.

Worldwide, a number of different technical systems have been designed to deliver broadcast content to handheld devices, leading to a high level of competition between them. All of the proposed systems which offer a truly "broadcast" approach – where a transmitter has a potentially unlimited number of simultaneous receivers – use multicarrier OFDM, the technology first exploited in broadcasting for DAB. The distinguishing features which differentiate the various technologies are in the details of (i) how many OFDM carriers are used, (ii) in what bandwidth, (iii) with which modulation and (iv) using which error protection coding. Whilst the variations in such technical details are important in establishing parameters which permit planning of the service capacity and coverage, the success of such services when offered to consumers will be dependent on many other factors. Currently broadcasters are seeking advice on which technology they should concentrate their resources on, and the timescale over which BTH services will be rolled out. The reality is that the technical performance of any of the proposed systems is more than likely to support the services which broadcasters wish to offer.

The business models for offering BTH services will not only rely on broadcasters; already many organizations are positioning themselves as members of the value chain from content to BTH consumer. Broadcasters have traditionally played a strong role in creating and delivering content to the consumer and must exploit their strengths in facing newcomers who will compete for this new business.

When a broadcaster considers providing BTH services, a number of questions will need to be addressed:

- Is the planned Broadcasting to Handhelds a telecommunication service, a broadcast service or a mixture of both?
- Who are the service providers, content aggregators and content creators?
- What business models are appropriate?
- Is close cooperation between the service, content and network providers needed?
- Who has the direct contact with the customer (content, service or network provider)?
- Is there already a promising end-to-end solution available on the market which meets the proposed business model, or must further commercial, technical and regulatory issues be solved to make BTH happen?

Without doubt, BTH can potentially offer many new opportunities to broadcasters, although it simultaneously brings great challenges. The results obtained from early surveys and the first field tests and commercial “friendly user” trials suggest that there is plenty of interest from consumers who would like to have access to multimedia content on a mobile-phone-sized device.

It is now becoming clear that even the latest third generation mobile phone networks have a very limited bandwidth capacity and they are unable to convey “rich media” to a large number of concurrent users. In general, broadcast networks are perfectly suited to providing the high required bitrates simultaneously to a mass of users with a high service reliability and excellent quality, all at a cost which is much less per user than the alternative use of a point-to-point telecom network for broadcast applications. Hence BTH may be the vehicle to best satisfy the expected customer demand.

Before broadcasters embark on launching BTH services in their countries, they must make some important strategic decisions on the services and content they wish to provide, on the spectrum to be cleared for the transmission, and on the business models they may wish to adopt. Close cooperation with regulatory authorities, mobile service providers, manufacturers and retailers will be necessary.

Technological solutions for BTH

Two particular technical approaches ***DVB-H*** and ***T-DMB*** have already been developed and are ready for market exploitation within Europe.

DVB-H is based on IP encapsulation over the MPEG-2 Transport Stream over the physical layers of DVB-T. T-DMB, on the other hand, is based on the physical layers of DAB, applying the same MPEG-2 Transport Stream interface as with DVB. Some other solutions for DAB-based systems are in development or under study [1], as is the MBMS (Multimedia Broadcast Multicast Service)

1. DAB variants may use ***IP over Enhanced Packet Mode*** or ***IP over MPEG-2 TS over Enhanced Stream Mode*** (using the MPEG-TS interface of DMB). All the various options of IP over DAB are currently under study in the German DxB project.

variant of the 3G telecom system. Each has the potential to find applications in Europe, depending on various constraints in a given service area. In most situations, one system may be preferable to another, taking into account considerations such as business model viability, availability of spectrum, cost of the distribution network, availability and cost of the consumer terminals, and the legacy of systems already in use.

DVB-H and T-DMB are technically similar at the lower physical layer since both use the transmission technique COFDM (Coded Orthogonal Frequency Division Multiplexing). More commonality could possibly be found by developing a common protocol stack, leading to a simplified implementation in common chipsets. Such a "combined DxB approach" with DVB-T-based and DAB-based physical layers could ultimately lead to significant economies of scale and lower consumer costs.

The combined approach would also allow broadcasters to "create once, distribute in many ways" with content or applications transmitted via either DVB- or DAB-based systems. To this end, common media formats, common protocol layers, common metadata sets and common middleware formats would need to be developed for use in both systems, taking into account a need for scaling due to different transmission capacity capabilities, and providing for backwards compatibility with any existing deployments of the different systems.

The current developments in DVB-H and T-DMB are presently marked by a significant differentiation at the physical access level including the lower layers, and the support functions required to build a complete system such as middleware, codec formats, ESG metadata, and delivery protocols. The present evidence suggests that the protagonists of the two systems will not delay the roll out of the first services, simply to seek greater commonality.

Comparison of transmission costs

Since both DVB-H and T-DMB are based on the COFDM transmission process, in theory they should have comparable transmission power requirements per audio or video service. The potential increase in the spectrum efficiency of DVB-T/H using say, 16-QAM, requires a simultaneous

Abbreviations

16-QAM	16-state Quadrature Amplitude Modulation
API	Application Programming Interface
BTH	Broadcasting To Handhelds
CBMS	(DVB) Convergence of Broadcast and Mobile Services
CIF	Common Intermediate Format
COFDM	Coded Orthogonal Frequency Division Multiplex
D-QPSK	Differential – QPSK
DAB	Digital Audio Broadcasting (Eureka-147)
DMB	Digital Multimedia Broadcasting
DVB	Digital Video Broadcasting
DVB-H	DVB - Handheld
DVB-T	DVB - Terrestrial
DxB	Combination of DAB and DVB-T/DVB-H
EPM	(DAB) Enhanced Packet Mode
ESG	Event Schedule Guide
ETI	(DAB) Ensemble Transport Interface
FEC	Forward Error Correction
GSM	Global System for Mobile communications
IP	Internet Protocol
IRT	*Institut für Rundfunktechnik GmbH* (German broadcast engineering research centre)
MBMS	Multimedia Broadcast Multicast Service
MPE	(DVB) MultiProtocol Encapsulation
MPEG	Moving Picture Experts Group
MPEG-TS	MPEG – Transport Stream
MSC	(DAB) Main Service Channel
OFDM	Orthogonal Frequency Division Multiplex
PMR	Private Mobile Radio services
PMT	(MPEG) Programme Map Table
PSB	Public Service Broadcasting
QPSK	Quadrature (Quaternary) Phase-Shift Keying
RF	Radio-Frequency
RPC	Reference Planning Configuration
RRC	Regional Radiocommunication Conference
RS	Reed Solomon
SFN	Single-Frequency Network
SMS	Short Message Service
SP	Service Provider
T-DAB	Terrestrial - DAB
T-DMB	Terrestrial - DMB
UHF	Ultra High Frequency
VGA	Video Graphics Array
VHF	Very High Frequency

increase in transmitter power compared with T-DAB/DMB, while reducing the spectrum efficiency with a third error-protection mechanism lowers the required transmitter power correspondingly.

Working alongside the German broadcaster Hessische Rundfunk, the IRT has carried out sample calculations for DVB-H and T-DMB coverage. The existing DVB-T transmitter network was taken as a basis for potential DVB-H coverage (using 16-QAM), while the present T-DAB network was used to indicate potential T-DMB coverage. In the latter case, an increase in power of 9 dB was assumed over that required by the technical specifications for T-DAB networks.

The results of the coverage analysis *(Table 1)* show that probable coverage is rather similar for both systems. In the case of DVB-H, this is around 50%, and in the case of T-DMB around 60%. Although the findings here marginally favour T-DMB, this is unlikely to be the deciding factor in future considerations. Indeed, a comparison of the parameters that are collated in *Table 1* confirms that the required transmission power per service is more or less the same with both DMB and DVB-H. If the outputs of all transmitters in the DVB-H and T-DMB transmitter network are added together, it becomes clear that the total transmitter network power in the case of DVB-H is around ten times higher than that of the T-DMB network. At the same time, the data rate is nine times higher in the case of DVB-H.

Table 1
Findings of IRT/Hessische Rundfunk coverage analysis

Transmitter network	Number of transmitters	Total transmitter power	Total data rate	Population served in [%] (portable indoor)
DVB-H	12	550 kW	9.9 Mbit/s	47.7
T-DMB	9	57 kW	1.1 Mbit/s	59.2
Difference		Approx. 10 x	Approx. 9 x	

Comparison of transmission efficiency

The costs of transmission in principle rise as a function of the data rate and the required transmission power. Hence, in the case of DVB-H with 10 times the data rate of T-DMB, the costs of one multiplex would be expected to be about 10 times higher than for T-DMB. In a practical network, however, the cost curve may not increase linearly with the power and the data rate, because costs will also depend on possible synergy effects achieved in the distribution network and the precise transmitter set-up and, therefore, a factor less than 10 could be achieved. In any case, the major remaining difference between DVB-H and T-DMB is in the spectrum bandwidth and the ratio of the total data rate available from one multiplex. Using a single large multiplex, rather than several small multiplexes, will be efficient where a high number of services are being transmitted. Conversely, where only a small number of services are to be transmitted, the use of one or just a few small multiplexes would be more efficient than using one large multiplex. From a technical analysis carried out by TDF in France, it was concluded that T-DMB is more convenient where less than ten services are to be transmitted, and DVB-H is more efficient where more than ten services are to be transmitted.

A further analysis of the economics of the two technical approaches is given in Daniel Skiöld's article in this edition of the Technical Review: An economic analysis of DAB and DVB-H.

Network structures and coverage targets

The use made of television and radio services implies different requirements for reception. Taking the example of Germany, the public service broadcasters are currently planning for 90 to 95% TV coverage with directional antenna reception when DVB-T is fully rolled out. This corresponds to around 70% portable outdoor and around 50% portable indoor reception. Where handheld terminals

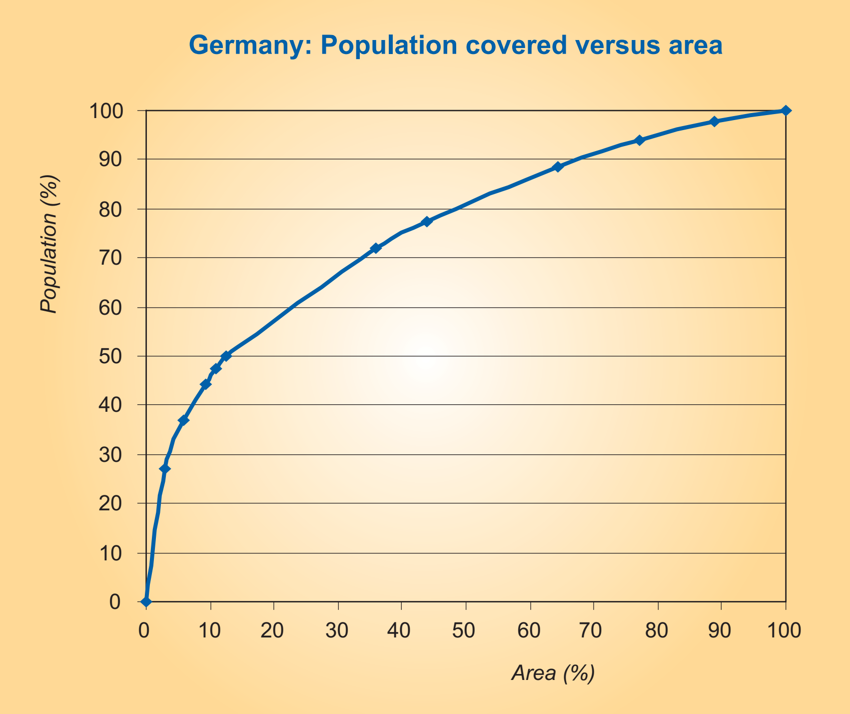

Figure 1
Population covered as a function of area covered. The total population in 2002 was 82.5 million for an area of 350 thousand square km

are concerned, the coverage probability diminishes to 40 to 45%, owing to the low antenna gain.

However, radio service planning must normally reach even higher coverage. In principle, it should be possible to receive radio in every kitchen and every bathroom, as well as when travelling anywhere by car. This means that, in the future, digital radio must have probable coverage of more than 99% for mobile listening, and a figure almost as high for portable indoor listening.

These differing requirements result, in practical terms, in two separable but complementary coverage targets: The target for DVB-T portable indoor reception could be in densely populated areas, whilst the target for portable indoor T-DAB radio reception could be for the rest of the country. Similarly there could be two complementary options for the transmission of mobile broadcast services. These would involve either broadcasting DVB-H as a piggy-back system on DVB-T, or broadcasting DMB piggy-backed on the DAB digital radio system.

As can be expected, network costs for mobile broadcast services rise in proportion to the area they cover. An analysis of population density in Germany is useful when comparing network costs in densely and less densely populated areas.

Fig. 1 shows the population reached as a function of the area covered. It can be seen that coverage of around 10% of Germany's surface area would be sufficient to reach almost 50% of the population. To reach the other half on the population, however, coverage would have to be extended to the other 90% of the country, in other words to double the number of population served, the coverage area has to be ten times larger, meaning that the network costs would also be ten times higher. The densely-populated areas in Germany are marked in blue on the map shown in *Fig. 2*.

This means that mobile broadcast services can be offered in densely-populated areas five times more cheaply per user, than in the rest of the country. For a service provider, this means that the financial benefit is five times higher in densely-populated areas than if it were providing the same service to the same number of customers in less densely-populated areas.

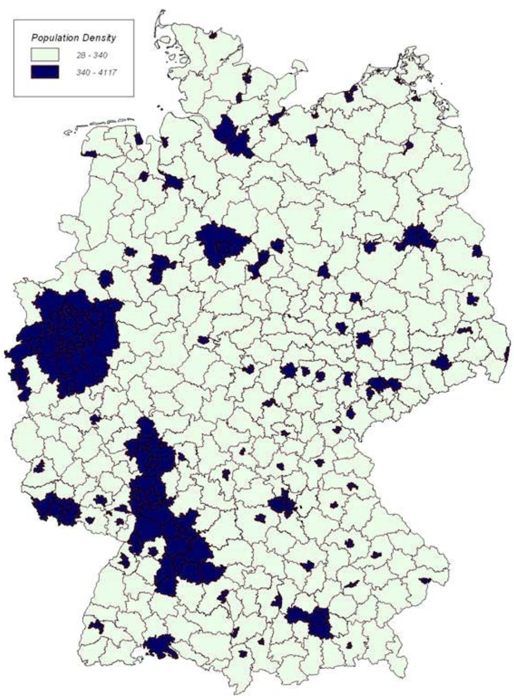

Figure 2
The areas in Germany in which 50% of the population live (blue) account for only some 10 % of the country's surface area

From an economic viewpoint, then, there is no reason to offer mobile broadcast services outside the major conurbations – at least not until the markets in these areas are saturated. There must be another, non-financial reason to extend coverage to less densely-populated areas. Here, mandatory coverage requirements for public service radio, laid down on the basis of social policy, will have a part to play.

Given the very high costs of providing coverage to less densely-populated areas, it is likely that the range of mobile broadcast services available in the major towns and conurbations will be much higher than in the countryside which will be able to enjoy only a basic level of provision with a minimum number of services. A comparison of the T-DMB and DVB-H systems reveals that, with the same network costs, almost 100% of the population can be reached with T-DMB, while DVB-H is able to reach almost 50% of the population – albeit with ten times the number of services.

Since intelligent service offerings which exploit the memory capacities of the user's terminal can be used to increase the "virtual" number of mobile broadcast service elements that the customer can receive, the parallel broadcast of a large number of services to the whole of the country is neither cost- nor frequency-spectrum-efficient in the long term.

In summary, DVB-H would be the system of choice if the objective is to reach as many people as possible with a wide range of services at low transmission cost within densely-populated areas. T-DMB would enable wider coverage with intelligent mobile broadcast services at a reasonable cost, similar to that for digital radio.

Services, applications and content

The development of solutions for broadcast to mobile and portable consumer devices is an opportunity for the provision of new free-to-air services, as well as for new subscription and pay-per-view services.

Broadcasters have already diversified their activities beyond their core competence in television and radio broadcasting by developing Internet and broadband services successfully. Broadcasting to mobile and portable devices is a further possibility for widening their offer and maintaining their connection with their customers. There are early indications that some broadcasters are remodelling themselves as "delivery method agnostic" content providers.

Bearing in mind the need to rationalize investment, diversification to other distribution media and personal consumption contexts should not mean reinventing broadcasting. If some adaptation is required, it should be minimized – and maximum interoperability between the different platforms should be maintained.

To be successful, new services have to take into account the typical characteristics of the receiving device as well as the typical user environment. There are two possible types of handheld device – the stand-alone multimedia receiver with access to broadcast networks and the convergent media/communication device providing, in addition, access to a mobile communication network.

Truly "handheld" devices are likely to have relatively small screen sizes from around 5 cm up to perhaps 12 cm diagonal, like typical mobile phones, PDAs and portable DVD players. Even the smallest of these will feature sharp pixel resolution, with the larger ones offering VGA (640 x 480) resolution. Early experience suggests that CIF (352 x 288) resolution at bitrates around 200 kbit/s can give a useful viewing experience, even permitting the reading of Teletext-sized captions.

The typical user may be on the move and he may use his handheld for watching media in short sections during otherwise inactive moments (e.g. when waiting for an appointment, and in public transportation, …). The receiving conditions at such times will be very different from normal TV viewing, and usage will take place against much higher background noise levels and distracting activities. However, the handheld receiver is likely to be a personal device and it remains to be seen whether there may be times at home or work when the user will simply want to use his personal TV set for individual viewing. Some content will have to be adapted if the audience for such a new type of viewing behaviour develops.

Business models

There are perhaps four main business models in traditional broadcasting: (i) the free-to-air model, financed by a licence fee; (ii) the commercial free-to-air model, financed by advertising; (iii) the subscription Pay-TV model, and (iv) the on-demand model with pay-per-view. There may also be combinations of these models (e.g. a subscription-based service with commercials).

The value chain for BTH services – from content production to the user – features a number of different roles such as:

- Content provider for individual programmes;
- Content provider for complete scheduled programme channels;
- Content aggregators;
- Broadcast network operators;
- Multiplex operator;
- Mobile telecom network operators.

These roles can be combined in many different ways and one organization may undertake several roles. Below are several examples of possible business models that might be used for BTH services in the future. The list is not intended to be comprehensive nor is the numbering of the models meant to represent an order of preference or priority.

Model 0: Broadcaster-led approach with free-to-air broadcasting and consumer manufacturers offering products on the open market

- The broadcaster (content provider) manages the end-user relationship.
- BTH reception-only and combined TV/mobile phone products are offered to consumers. Such combined products are not necessarily “converged” in terms of API or protocol support.
- The broadcaster (content provider) and broadcast network operator establish the BTH service together.
- No specific requirement for the mobile telecom operator relationship, except for “traditional” SMS and phone call interactivity.
- Branding is based on the existing broadcaster’s channel branding, but with the emphasis on portable services (simulcast streams or specially-produced material).
- The revenue comes from traditional sources (licence fee / advertising) on the basis of a new-found public audience for personal TV on the move.

Model 1: Independent BTH service provider approach

- The BTH operator manages the end-user relationship.
- A dedicated BTH service provider is established and made responsible for spectrum usage and content aggregation.
- A complete package is offered to the consumer by one service provider.

Model 2: Mobile telecom operator on his own – without broadcaster

- The mobile telecom operator manages the end-user relationship.
- The content is sourced from third parties, such as Internet service providers, portal owners, commercials.

Model 3: Broadcaster-led approach with mobile telecom operator

- The broadcaster manages the end-user relationship.
- The broadcaster is paid by the user, the mobile telecom network provider or by advertising revenue.
- Consumers may need to make payment to more than one service provider for different services.

Model 4: Mobile telecom operator-led approach with broadcaster

- The mobile telecom operator manages the end-user relationship.
- The mobile telecom operator has to purchase spectrum and/or has to pay for the transmission capacity within the broadcast network.
- The mobile telecom operator has to purchase content from the broadcaster or the broadcast network operator.
- General marketing is carried out by the mobile telecom operator.
- The broadcaster is responsible for marketing the revenue-generating programmes.
- The revenue is shared.
- Branding for the broadcaster may not be possible.

Model 5: Mobile telecom operator-led approach

- The mobile telecom operator is responsible for the whole value chain.
- The broadcasters provide DVB-H data capacity within their networks.
- The mobile telecom operator has a dominant role.
- There is only minor involvement of the broadcaster.
- The content can be sourced from broadcasters and third parties/Internet portals etc.

Model 6: Mobile telecom operator-led approach with broadcast network operator

- The mobile phone operators are Service Providers (SPs) and have the end-user relationships (billing, marketing, customer service etc).
- The SPs subsidise BTH terminals which are typically in the form of mobile phones.
- The SPs buy content rights from content providers and/or content aggregators.
- The SPs may offer PSB content providers some free capacity (similar to the satellite situation in some countries).
- The SPs buy network capacity from the broadcast network operator.
- Typically, several SPs (mobile telecom operators) offer BTH services in competition.

Model 7: Content aggregator-led approach

- One or more content aggregators buy all the capacity on a BTH network from the broadcast network operator.
- The content aggregator buys content rights from content providers to fill capacity.
- The mobile phone operators are SPs and maintain the end-user relationships (billing, marketing, customer service etc).
- The SPs buy the right to offer a particular set of broadcast services to end-users from one or more content aggregators.
- Typically, only one BTH network is offered (but there could be competing networks).

- Typically, several SPs (mobile telecom operators) offer BTH services, in competition, on a single BTH network.

Technical aspects of BTH systems

The technology which has been developed for BTH services has been well described in the literature, including recent editions of ***EBU Technical Review***. *Table 2* on the next page illustrates typical features of some of the DVB- and DAB-based options, in comparison with the original DVB-T and DAB systems.

Spectrum availability for BTH services

The spectrum availability for BTH services varies across Europe due to the very different geographical, cultural or spectrum policy situations.

Countries or areas separated by sea or mountains can take advantage of these geographical factors to increase their spectrum availability, although sea can also be a disadvantage due to warm water propagation effects. In areas with a very dense concentration of state boundaries or different cultural regions within states, especially in the central part of Europe, less spectrum is generally available as the frequencies have to be equitably shared over the different areas. In addition, some countries reserve a part of the spectrum for other primary services, including the military and private mobile radio services (PMR), making less spectrum available for BTH.

Currently, the RRC-04/06 process is well under way and the service requirements which the national administrations are requesting for the final all-digital frequency plan are now known. The requirements registered by European countries vary from seven to twelve or more DVB-T coverages, and from three to seven or more T-DAB coverages. This gives some indication of the high demand on available spectrum, and it remains to be seen whether all of these requirements can be fulfilled by the planning process.

The first session of the RRC in 2004 agreed on the planning parameters and criteria for T-DAB and DVB-T. For T-DAB planning, two reception modes were defined: mobile and portable indoor antenna reception. For the DVB-T standard, three modes were defined: fixed roof-top, mobile and portable (outdoor or indoor) antenna reception.

However, the Report from the first session of the RRC does not specify planning criteria for DVB-H, since they were unknown at the time (May 2004). It is possible, however, to make input requirements for DVB-H by specifying a DVB-T system variant and other planning parameters, or by specifying a given Reference Planning Configuration (RPC). This DVB-T requirement can be used for a DVB-H service – if it does not create more interference than would the specified DVB-T service, and if it does not claim more protection.

A major limitation of handheld reception is the antenna size. Whether for reasons of fashion or practical convenience, the use of very small antenna sizes implies very low antenna gains and hence requires very high field-strength values, beyond those required for DVB-T portable indoor reception.

If one country wishes to implement DVB-H networks, the best option may be to plan at the RRC for so-called RPC3 because it is the configuration which allows for the transmission of higher field strength values. When the planning parameters for DVB-H have been defined, if the required field strengths turn out as expected to be higher than the ones of RPC3, then the use of very dense networks will be necessary to respect the interference conditions established at the RRC. However, such networks will probably be required anyway to get the required indoor coverage. Alternative infrastructure concepts are under study, such as a dense network of low-power, low-antenna-height transmitting stations in an SFN configuration that provides high field strengths in the wanted coverage area, rather like today's GSM telecoms networks.

Table 2
Comparison of typical features of the various technologies

		DVB-T	DVB-H		DAB	DMB	DxB	
Basic features								
Main reception target		Portable, mobile	Mobile		Mobile	Mobile	Mobile	
Receiver power saving facility		No	Yes		Yes	Yes	Yes	
Supported services	Audio	✓	✓		✓	✓	✓	
	Video	✓	✓		×	✓	✓	
	Data	✓	✓		✓	✓	✓	
	IP based	✓	✓		×	note [a]	✓	
	IP return over channel	✓	✓		✓	✓	✓	
Bearer, Physical Layer		DVB-T	DVB-T		DAB	DAB	DAB	
Transport Stream		MPEG-2 TS	IP over MPEG-2 TS		DAB/ETI	MPEG-2 TS DAB/ETI	IP over MPEG- TS DAB/ETI	IP over EPM
RF and Data Rate Features								
Spectrum Allocation (RF bands)		VHF Band III, UHF	UHF[b]		VHF Band III, L-Band	VHF Band III	VHF Band III, L-Band	
Bandwidth (MHz)		7.61[c]	7.61[d]		1.53	1.53	1.53	
Modulation Scheme		16-QAM	16-QAM		D-QPSK	D-QPSK	D-QPSK	
Inner Forward Error Correction		1/2	1/2	1/2	1/2	1/2	1/2	1/2
Guard Interval		1/8	1/8	1/8	1/4	1/4	1/4	1/4
Outer Forward Error Correction		RS (188,204)	RS (188,204)	RS (188,204)	-	RS (188,204)	RS (188, 204)	RS (188, 204)
Additional Parameters (indicative values)			No MPE-FEC	MPE-FEC =3/4			IP over MPEG-TS[e]	IP over EPM[f]
TS data rate (DVB-T/H) or MSC data rate (DAB/DMB/DxB) (Mbit/s)		11.06	11.06	11.06	1.18[g]	1.15	1.15	1.15
Data Rate for services where only IP is used[h] (Mbit/s)		10.7	10.7	8.00	1.15	~1.0	~1.0	1.0
Possibility to share multiplex or transmitter network with:		DVB-H	DVB-T		DMB/DxB	DAB/DxB	DAB/DMB	
Content and Programme Descriptors								
Programme Guide		MPEG2-TS	CBMS[i]		DAB	DAB	CBMS or DAB	
Ancillary programme elements for one video service		PMT	CBMS		DAB	MPEG-4 MPEG-7	CBMS, DAB or MPEG-7 under consideration	

a. Not implemented, but currently under development.

b. For return channel compatibility with GSM, UHF Channels 21 to 49 are said to be preferred. In addition to UHF, L-Band may be a possibility in some countries including the UK.

c. Bandwidth used in VHF Band III is 6.66 MHz.

d. DVB-H may also occupy bandwidths of 6.66 MHz, 5.71 MHz or 4.76 MHz.

e. MPE-FEC could be used.

f. MPE-FEC could be used.

g. Un-equal error protection.

h. Approximate figures assuming an IP packet length of 1 kbyte, and with no multiplexing data or SI overhead.

i. CBMS refers to the work programme in DVB including commonality with OMA/BCAST for the General Service Guide.

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.

Edgar Wilson joined the EBU Technical Department in 1988 as a specialist in data broadcasting technology, having worked on many digital TV research projects with the IBA (Independent Broadcasting Authority) in the UK. One of his immediate tasks with the EBU was to assist in the first public demonstrations of DAB to an ITU Conference in Geneva. He was the EBU representative in the early work on digital television broadcasting with the EU RACE project R2082 dTTb and, from the commencement of the DVB Project in 1993, he was secretary to the Terrestrial Commercial Module which captured the service requirements for what became the DVB-T standard. He was Head of the DVB Project Office until the end of 1997, and participated from the start in DigiTAG (the Digital Terrestrial Television Action Group) as Project Manager. DigiTAG continues to encourage the implementation of services on the DVB terrestrial platform and, in 2005, published an influential DVB-H Handbook.

Mr Wilson's present EBU work is with the BMC (Broadcast Systems Management Committee) and its project groups on Broadcasting to Handhelds (B/BTH) and Maintenance of Single Frequency Networks (B/SFM).

Conclusions

Traditional broadcasting is changing as digital broadcasting and interactivity are rapidly being introduced and new players are entering the market. This means more programmes, more competition and new distribution platforms.

In the area of broadcasting to handhelds, several technical solutions are under development – based on different transmission systems and using different frequency resources. Several business applications and concepts, based on various realizations of converging networks and terminals, have resulted.

There is unlikely to be a totally right or wrong way to deal with broadcasting to handhelds in a given country. However, a broadcaster should be aware of the many options that these services may offer and should be ready to develop a concept for the roles he wants to play in the BTH world. This will depend on the investment already made in infrastructure, the present roles and branding of the broadcaster and on future investment in BTH technology. Costs are critical and the future perspective and aspirations of the broadcaster should be a key aspect in this consideration.

As different BTH systems are rolled out around the world, all players have to be aware that this is not a totally new "green-field" opportunity for earning money but a form of convergence between broadcasting and mobile telecoms systems. This implies that BTH may tend to affect the traditional services of broadcasters and telecoms operators, and there will therefore be gains and losses on both sides. The best chance for BTH success is therefore to develop business models and alliances across the various elements of the value chain to help to create as many winners as possible. Without this, it is quite probable that the BTH concept will never reach its potential.