DVB-H Technology: Perspectives and Applications

Professor PhD Kalman Fazekas
Short summary of plenary talk

I. INTRODUCTION

The digitization of traditional broadcast systems has made significant progress in recent years. During the development of DVB, three different transmission methods were developed: DVB-S (Satellite), DVB-C (Cable) and DVB-T (Terrestrial). In DVB-T, digital television is broadcast terrestrially in 6, 7 or 8 MHz-wide radio channels in a gapped frequency band of about 47 MHz to 862 MHz at net data rates of either approximately 15 Mbit/s or 22 Mbit/s.

The mobile radio networks are networks in which contents bi-directional (point-to-point) connections are possible at relatively low data rates. The broadcasting networks are unidirectional networks in which contents are distributed point-to-multipoint jointly to a large number of parties at relatively high data rates.

DVB-H is principally a transmission system allowing reception of broadcast information on single antenna handheld mobile device. DVB-H stands for "Digital Video Broadcasting for Handheld mobile terminals" and is an attempt at convergence between mobile radio networks and broadcasting networks. DVB-H represents a convergence between GSM/UMTS and DVB. The GSM/UMTS mobile radio network is used as the interactive channel via which high-rate services such as, e.g. video streaming (H.264/MPEG4, AVC) are requested which are then transmitted either via the mobile radio network (UMTS) or are remapped onto the DVB-H network. In DVB-H, a DVB-T network is virtually used physically, with some modifications of the DVB-T standard. DVB-H includes a new transmission mode in the DVB-T physical layer using a 4096 FFT size: the 4k mode. The proposed 4k mode is also architecturally/hardware compatible with existing DVB-T infrastructure, requiring only minor changes in the modulator and the demodulator.

DVB-H technology is designed to use the digital terrestrial TV broadcast communications to deliver multimedia services to mobiles. It can use the same spectrum slots used by digital TV. The DVB technology for handhelds has been designed to meet almost all the objectives of delivering a TV service to handhelds, which include:
● Broadcast service reaching potentially unlimited users;

● Delivery of sufficiently large transmitted power so that the mobiles can work even within buildings;
● Conservation of battery power used in receiving the TV service of choice;
● Use of the terrestrial broadcast spectrum, which is being rendered free as a result of the digitalization of TV networks;
● Robust coding and error correction to provide to highly variable signal strength conditions encountered in the handheld environment;
● Minimum infrastructure to roll out the TV services for mobiles.

DVB-H can use the same infrastructure as DVB-T. A DVB-H service can deliver 20–40 channels or more (depending on the bit rate) or up to 11 Mbps (typical) in one DVB-H multiplex, which can reach millions of viewers, being in a broadcast mode.

The following are the options for configuring a DVB-H system:
● Bandwidth modes of 5, 6, 7, and 8MHz
● COFDM carrier modes 2K, 4K, 8K and
● Modulation formats of 4QAM, 16QAM, and 64QAM

DVB-H was standardized by the DVB and the ETSI under EN 302 304 in November 2004. Due to the evolving nature of the technology, there are new versions of the basic specifications that take into account the latest developments. The technology has been validated in a number of trials, including Helsinki, Pittsburgh, Oxford, Barcelona, and Berlin. DVB-H is based on open standards and is compatible with DVB-T. It follows the IP datacast model and the entire network is end-to end.

The commercial requirements of the system were determined by the DVB Project in 2002:
▪ DVB-H shall offer broadcast services for portable and mobile usage, including audio and video streaming with acceptable quality. The data-rates in practice have to be sufficient for this purpose. For the DVB-H system, a useful data-rate of up to 10 Mbit/s per channel is possible. Transmission channels will mostly be allocated in the regular UHF broadcasting band. VHF Band III may be used alternatively. Non-broadcast frequencies should be useable also.
▪ The typical user environment of a DVB-H handheld terminal is very similar to the mobile

radio environment. Therefore DVB-H needs to have the potential for similar geographic coverage. The term handheld terminal includes multimedia mobile phones with colour displays as well as personal digital assistants (PDAs) and pocket PC types of equipment. All these kinds of devices have a number of features in common: small dimensions, light weight, and battery operation. These properties are a precondition for mobile usage but also imply several restrictions on the transmission system. The terminal devices require an external power supply in most cases and have to be operated with a limited power budget. Low power consumption is necessary to obtain reasonable usage and standby cycles.

▪ Mobility is an additional requirement, meaning that access to services shall be possible not only at almost all indoor and outdoor locations but also while moving in a vehicle at high speed. Also, the handover between adjacent DVB-H radio cells shall happen invisibly when moving over larger distances. However, fast varying channels are very error-prone. The situation is worsened by the fact that antennas built into handheld devices have limited dimensions and cannot be pointed at the transmitter if the terminal is in motion. A multi-antenna diversity approach is mostly impossible because of space limitations. Moreover, interference can result from GSM mobile radio signals transmitted and received within the same device. As a result, accessing a downstream of several Mbit/s with handheld terminals is a very demanding task.

▪ Finally, the new system needs to be similar to the existing DVB-T system in order to enable the re-use of the same transmission equipment.

Digital video broadcasting using terrestrial transmission is a widely used technology with over 50 countries already having terrestrial transmissions in digital mode. Even in countries in which use analog TV transmission, digital terrestrial transmission is rapidly being introduced and is replacing the analog terrestrial transmissions. In the process, spectrum is being freed up, as a single DVB-T multiplex can carry six to eight channels, which were earlier occupying one frequency slot each. An extension of these services to mobile devices has therefore been considered the most workable option by suitable modifications to the DVB-T recommendations, which have led to the DVB-handheld recommendations. DVB-T services are not directly suitable to mobile devices, as the standards for DVB-T have been formulated for fixed receivers with relatively large roof-mounted antennas and no limitations on receiver battery power. These factors make the straight reception of DVB-T in a mobile environment, characterized by much lower signal strengths, mobility, and fading,

unsuitable. The DVB-H standard, which addresses these factors through suitable enhancements to the specifications, becomes an ideal medium for mobile TV delivery.

The other factor that tilts the scale toward DVB-H is that the 3G-based mobile TV services, which are common in nature, are not scalable for mass delivery. They have limitations in using the frequency spectrum and network resources to deliver multiple-channel broadcast television to large number of simultaneous users. To an extent these are being addressed by multicast services such as MBMS. However, pure broadcast television independent of the cellular network frequencies has very significant advantages.

The existing technology of digital audio broadcasting (DAB) is similarly not ideally suited, due to the narrow transmission bandwidths possible and the need for spectrum and protocols for reliable multimedia delivery. The DMB system is an extension of the DAB standards that provides additional features for mobile multimedia. DVB-H, which is based on IP layer and IP datacasting of content packets, is a technology that has an advantage over DMB in this regard.

II. DVB-H SYSTEM

DVB-H (Digital Video Broadcasting Handheld) is the best mobile broadcast delivery system currently available, for the following main reasons: An approved standard since November 2004 for handheld equipment by ETSI (European Telecommunications Institute) with a high adoption rate worldwide. It benefits from existing DVB-T infrastructure components, which reduces initial investments. It provides the best user experience in the mobile environment, with an energy-saving handset that is only on 10-25% of the time, program guide, soft loss-free handover and in-building coverage. It offers an excellent-quality picture and audio quality when required. In DVB-H the quality of the stream can be modified flexibly to the content thus enabling optimization of audiovisual quality against number of content channels for maximum income gains. Battery consumption is reduced by up to 90% due to time-slicing technology when compared to non-time sliced technologies. Efficient use of bandwidth enables up to 55 mobile channels plus scalability. It is accessible by viewers of approximately 300 million mobile users since 2006. DVB-H broadcasts audio and visual contents while 3G streaming receives the contents via the communication network. The services are balancing as they are based on different technologies and don't interfere with each other. DVB-H is a one-to-many technology with low power consumption and high mobility that can be received with DVB-H-enabled phones. Program

contents and guides are offered by providers while consumers select the channel they want to watch. A one-to-one technology, 3G streaming emphasizes video one demand that lets consumers actively choose the programs they want. DVB-H offers smoother and clearer TV picture than 3G streaming.

DVB-H overcomes two key limitations of the DVB-T standard when used for handheld devices it lowers battery power consumption and improves robustness in the very difficult reception environments of indoor and outdoor portable use in devices with built-in antennas. DVB-H can be used alongside mobile telephone technology and thus benefit from access to a mobile telecom network as well as a broadcast network. The fact that the DVB-H platforms can be used and share the infrastructure with DVB-T makes it necessary to take into account of DVB-H standards, potential service scenarios, and licensing processes. The first trial of DVB-H service was in 2005 with Finnish Mobile TV running the first pilot for DVB-H for 500 users with Nokia 7710 receivers. The initial package included three television and three radio channels. In the United Kingdom a pilot project was conducted by NTL Broadcast and O2 (a mobile operator). In The Netherlands as well, the trials were successful using the network operator Nozema.

Trials have also been conducted in France, Spain, and other European countries. Crown Castle in the United States is launching the Modeo DVB-H service. Commercial DVB-H services have also been launched in Europe where Operator 3 in Italy launched its DVB-H network coinciding with the FIFA World Cup 2006, with services being offered in Rome and Milan. Commercial DVB-H license has also been granted in Finland to Digital, by which commercial trials have also been completed. A number of countries are expected to come out with DVB-H commercial networks soon.

However, the growth of DVB-H in individual countries is dependent on the release of spectrum from the DVB-T and analog bands when the analog transmissions are stopped. This could take as long as until 2012.
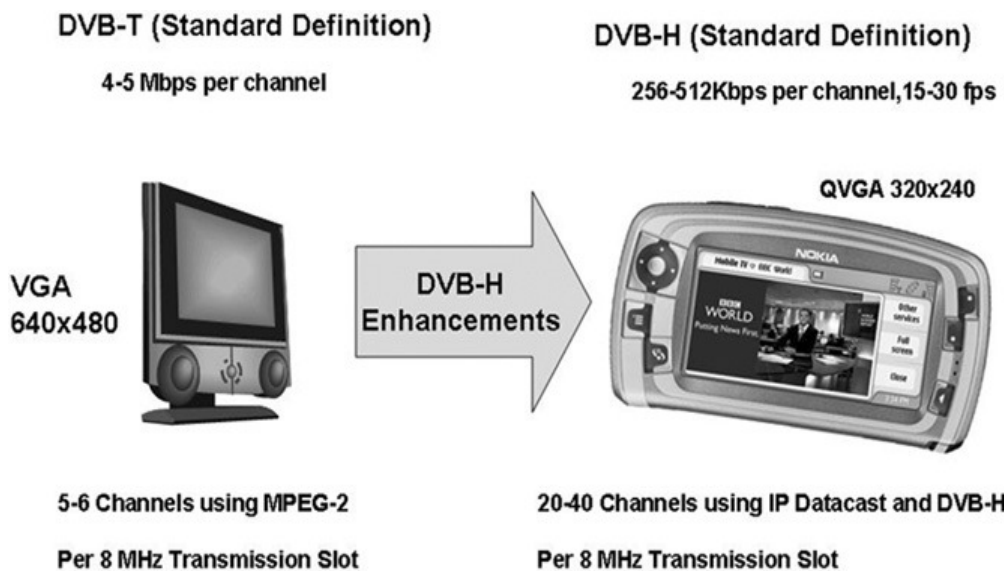

Figure 1. Comparison between DVB-T – DVB-H.

DVB-H is based on IP based transport. Video is typically carried using MPEG-4/AVC (H.264) coding of video signals, which can provide a QCIF coding at 384 kbps or less. Even a CIF video can be coded at sub 1 Mbps by using H.264 encoders. These encoders can work on real-time TV signals and provide MPEG-4/AVC-encoded output in IP format.

As it is based on IP transport, DVB-H can support video and audio coding other than MPEG-4/AVC. Fundamentally as an IP transport, it ultimately can support any AV stream type. In addition to MPEG-4, Microsoft VC-1 coding format is set out in the DVB-H standards. The resolution and frame size can be selected by the service provider to meet the bit rate objectives. The data is then transmitted by using an IP datacast (Fig. 2).

In a typical DVB-H environment a number of TV and audio services may be encoded by multiple encoders. All these encoders are connected by an IP switch to an IP encapsulator, which then combines all the video and audio services as well as the PSI and SI signals and EPG data into IP frames. The IP encapsulator also provides for channel data to be

organized into time slices so that the receiver can remain active only during the times for which the data for the actively selected channel is expected to be on air (Fig. 3)

The IP encapsulator also provides a more advanced forward error correction code, which can deliver reliable signals in typical mobile environments. The data rate at the output of an IP encapsulator under

DVB-H will in general be dependent on the modulation type used as well as the bandwidth available. Typically a DVB-H multiplex would be 11 Mbps of data, which when modulated could generate a carrier, e.g. 7–8 MHz. This compares with a 21-Mbps multiplex for DVB-T service in the VHF band.
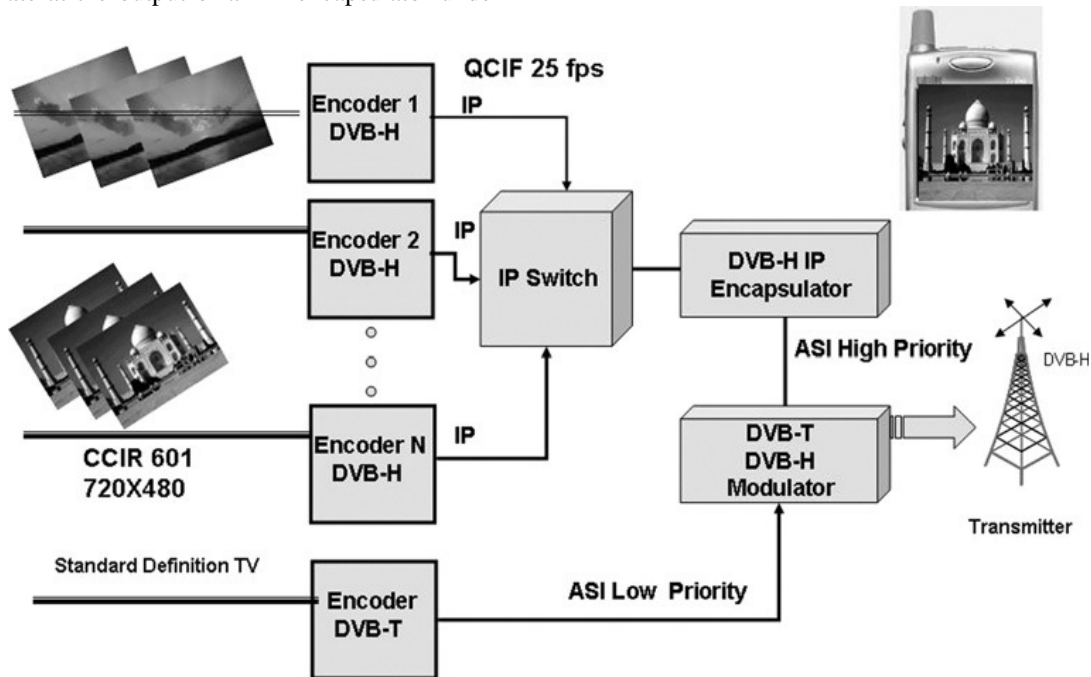

Figure 2. A DVB-H Mobile TV Transmission System.

In a typical DVB-H environment a number of TV and audio services may be encoded by multiple encoders. All these encoders are connected by an IP switch to an IP encapsulator, which then combines all the video and audio services as well as the PSI and SI signals and EPG data into IP frames. The IP encapsulator also provides for channel data to be organized into time slices so that the receiver can remain active only during the times for which the data for the actively selected channel is expected to be on air.

The IP encapsulator also provides a more advanced forward error correction code, which can deliver reliable signals in typical mobile environments. The data rate at the output of an IP encapsulator under DVB-H will in general be dependent on the modulation type used as well as the bandwidth available. Typically a DVB-H multiplex would be 11 Mbps of data, which when modulated could generate a carrier, e.g. 7–8 MHz. This compares with a 21-Mbps multiplex for DVB-T service in the VHF band. The effectively lower transmission rate for DVB-H is due to a higher level of forward error correction applied to make the transmissions more robust for the handheld environment. The output of

the IP encapsulator, which is in ASI format, is then modulated by a COFDM modulator with 4K (or 8K) carriers. The COFDM modulation provides the necessary flexibility against selective fading and other propagation conditions. The DVB-T standard provides for 2K or 8K carriers in the COFDM modulation. The 4K mode was intended to be use in the DVB-H as 2K carriers would not give sufficient protection against frequency-selective fading and also provide for a smaller cell size due to the guard interval requirement for single frequency networks (SFNs).

At the same time the 8K carrier mode has the carriers placed too close in frequency for the Doppler shifts to be significant for moving receivers. Hence the new mode of 4K carriers has been incorporated as part of the DVB-H standards. The 4K mode provides a better solution between the cell size and the Doppler effects due to motion.

A 4K symbol interlever is also used in the modulation process. However, it should be recognized that the carrier mode actually used would depend on the frequency band employed, i.e. UHF band or L-band. The modulation used for each of the carriers can be with QPSK, 16QAM, or

64QAM. The DVB-H standard provides for COFDM modulation, which is suitable for ASFNs. The system uses GPS based time clocks and time stamping to ensure that all the transmitters in a given area can operate maintaining time synchronisation, which is needed for SFNs. This also implies that repeaters can be used in the coverage area at the same frequency and these repeaters serve to add to the signal strength that is received at the mobile.

III. DVB-SH STANDARD

The DVB-SH standard provides a universal coverage by combining a Satellite Component (SC) and a Complementary Ground Component (CGC) in a comparative mode, the SC ensures geographical global coverage, while the CGC provides cellular-type coverage. All types of environment (outdoor, indoor) can then be served, either using the SC from its first day to service, and/or the CGC that is to be progressively deployed building on the success of DVB-H. A typical DVB-SH system is based on a hybrid architecture combining a Satellite Component and, where necessary, a CGC consisting of terrestrial repeaters fed by a broadcast distribution network of various kinds (DVB-S2, fiber, xDSL, etc.

IV. APPLICATIONS

One of the clear benefits of DVB-H is the possibility of delivering real-time services for vast audiences in a certain area. Mobile TV and multimedia services are important owing to the flat or declining average revenue per user curves generated from voice services alone.
The main types of applications are:
- Video on demand (VOD)
- Video clips
- Live TV
- Games
- Audio downloads
- SMS and MMS
- Etc.

V. CONCLUSION

DVB-H is largely based on the successful DVB-T specification for digital terrestrial television, adding to it a number of features designed to take account of the limited battery life of small handheld devices, and the particular environments in which such receivers must operate.
As with DVB-H, the DVB-SH specification is also designed for the delivery of audio, video and data services to hanheld devices.

The DVB-H technology is the latest development within the set of DVB transmission standards.

VI. 6. REFERENCES

Walter Fischer, Digital Video and Audio Broadcasting Technology, Springer-Verlag, 2008
P. Ntorzis, DVB-H Technology, Thesis work, 2009
http://www.dvb-h.org/technology.htm
http://www.ebu.ch/en/technical/trev/trev301-dvb-h.pdf
M. Kornfeld, U. Reimers, DVB-H – the emerging standard for mobile data Communication, EBU Technical Review, Jan. 2005