DVB-H – DVB goes Handheld

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Abstract

In DVB-H the "H" stands for handheld. DVB-H is the broadcast bearer for handheld terminals, building on DVB-T and is DVB's answer to the specific needs of hand-portable devices regarding enabling of low-power modes and adaptation to hand-held motion patterns (as opposed to vehicle mounted).

Hand-held terminals also imply a certain profile of user-interface and experience (screen-size, available keyboard etc.). This is addressed by a new class of services defined by the IP Datacast Forum (IPDC) and adopted by DVB to operate on top of DVB-H.

Both, the DVB-H broadcast bearer and the environment for IP Datacast (IPDC, www.ipdc-forum.org) services that DVB has built on top of DVB-H, will be presented in this article.

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1 DVB-H In The DVB Landscape

In the past two years, significant players in the industry have started concentrating resources on Mobile TV from multiple angles:

- Cellular operators have identified TV over 3G as an attractive service offer but have acknowledged the need for a true broadcast bearer associated to their network in order to sustain growth.
- Concurrently, broadcast network operators see in mobile TV the opportunity for growing their core business (i.e. deploy and densify broadcast networks) as most of the Digital Terrestrial TV deployments will finalize within the current decade.
- TV service providers contemplate mobile TV as a means to significant expand their subscriber basis by targeting the individuals additionally to the current cable and/or satellite household basis.
- Content providers have already been experiencing the attraction of 3G subscribers for exclusive content and are willing to increase the number of subscribers.

At the end of the day, there is a true demand that has been confirmed by multiple market studies and trials run all over the world.

Last but not least, industry players have to agree on technical specifications in order to avoid market fragmentation between different solutions. On the latter, DVB has made a major stem by approving in October 2005, after 18 months of intense work, version 1 of a set of specifications that describe how to make IP Datacast (IPDC) over DVB-H, in other words the essential components to deploy Mobile TV. DVB delivers a set of specification documents that cover use cases, architecture, PSI/SI signalling, content delivery protocols, electronic service guide, service purchase and protection.

2 DVB-H – How Broadcasting to Handheld Terminals Works Technically

Within the DVB broadcast bearers, DVB-H has a special role. It was created on top of DVB-T by adding technology to it in a compatible way. It is hence not a separate modulation system as could be suggested by its classification in the league of single-letter DVB acronyms (“DVB-X”). DVB-H is classified in this premier league, because it has a separate application domain and commercially stands equal with the other single-letter DVB systems like for instance DVB-S and DVB-T.

Technically there 2 dimensions to DVB-H: the transmission system and the protocol stacks.

2.1 The DVB-H Transmission System

The DVB-H transmission system is defined based on the existing DVB-T standard for fixed and in-car reception of digital TV. The main additional elements in the link layer are:

- 4 extensions from DVB-T:
  - addition of a 4K carrier OFDM mode to DVB-T
  - allocation of some of the thus far unused TPS bits in the DVB-T framing structure
  - addition of a 5-MHz channel bandwidth to be used in non-broadcast bands
  - addition of an in-depth OFDM symbol interleaver
- time slicing at the Transport Stream level
- additional forward error correction for Multiprotocol Encapsulation (MPE-FEC)

It should be emphasized that neither time slicing nor MPE-FEC technology elements, as they are implemented on the link layer, touch the DVB-T physical layer in any way. This means that the existing receivers for DVB-T are not disturbed by DVB-H signals; DVB-H is totally backward compatible to DVB-T. It is also important to notice that the payload of DVB-H are IP Datagrams or other network layer datagrams encapsulated into MPE sections.

The new 4K mode orthogonal frequency division multiplexing (OFDM) mode is adopted for trading off mobility and single-frequency network (SFN) cell size, allowing single-antenna reception in medium SFNs at very high speeds. This gives additional flexibility for the network design. 4K mode is an option for DVB-H complementing the 2K and 8K modes of DVB-T, which are also available. Also all DVB-T modulation formats (QPSK, 16QAM and 64QAM) with non-hierarchical or hierarchical modes, are possible to use for DVB-H.

The bits in transmitter parameter signalling (TPS) have been upgraded to include two additional bits to indicate presence of DVB-H services and possible use of MPE-FEC to enhance and speed up the service discovery.

The addition to DVB-T physical layer is the 5-MHz channel bandwidth to be used in non-broadcast bands. This is of interest, e.g., in the United States, where a network at about 1.7 GHz is running using DVB-H with a 5-MHz channel.

A new way of using the symbol interleaver of DVB-T has been defined. For 2K and 4K modes, the operator may select, instead of native interleaver that interleaves the bits over one OFDM symbol, the option of an in-depth interleaver that interleaves the bits over four or two OFDM symbols, respectively. This approach brings the basic tolerance to impulse noise of these modes up to the level attainable with the 8K mode and also improves the robustness in mobile environment.

Time slicing (cf Figure 1 below) reduces the average power in the receiver front-end significantly by informing the receiver of the TS packet bursts in advance. The receiver can then turn off the most energy-intense system components – the RF front-end and the demodulator – during periods when only data the application is not interested in is transmitted. This yields energy savings up to about 90%-95%. Time slicing also enables smooth and seamless frequency handover when the user leaves one service area in order to enter a new cell during the off-times of the receiver. Use of time slicing is mandatory in

DVB-H. Time slicing is backwards compatible in that a DVB-T receiver will be able to decode time-sliced signals.

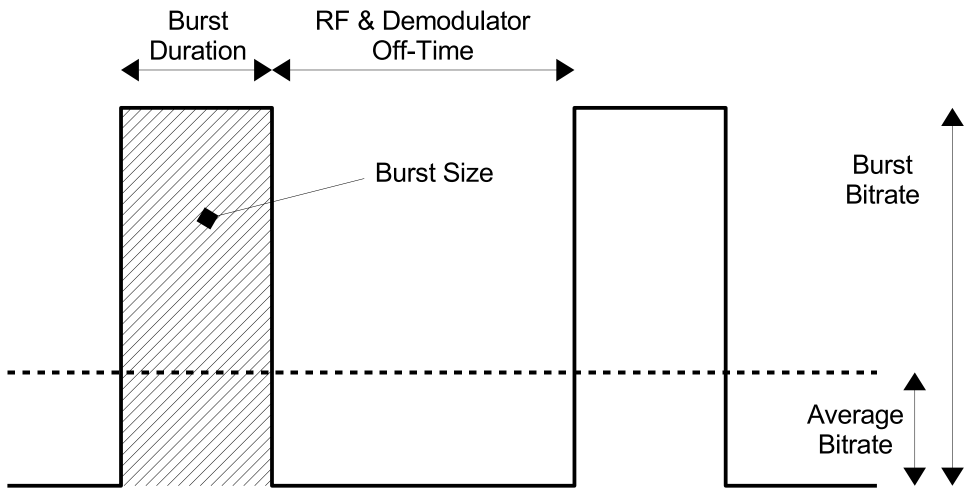

Figure 1: Principle of Time-Slicing [2]

The forward error correction for multiprotocol encapsulated data (MPE-FEC) gives an improvement in carrier-to-noise (C/N) performance and Doppler performance in mobile channels and, moreover, also improves tolerance to impulse interference. Use of MPE-FEC is optional for DVB-H. The mechanism interleaves Reed-Solomon (RS) parity byte tables with the application layer data. The data is organized in application data blocks of 191 columns and RS parity data blocks of 64 columns. The number of rows in the data blocks may be 256, 512, 768, or 1024.

The conceptual structure of DVB-H user equipment is shown in Figure 2 below. It includes a DVB-H receiver (a DVB-T demodulator, a time-slicing module, and an optional MPE-FEC module) and a DVB-H terminal. The DVB-T demodulator recovers the MPEG-2 transport stream (TS) packets from the received DVB-T RF signal. It offers three transmission modes: 8K, 4K, and 2K with the corresponding signalling. The time-slicing module controls the receiver to decode the wanted service and shut off during the other service bits. It aims to reduce receiver power consumption while also enabling a smooth and seamless frequency handover. The MPE-FEC module, provided by DVB-H, offers in addition to the error correction in the physical layer transmission, a complementary FEC function that allows the receiver to cope with particularly difficult reception situations.

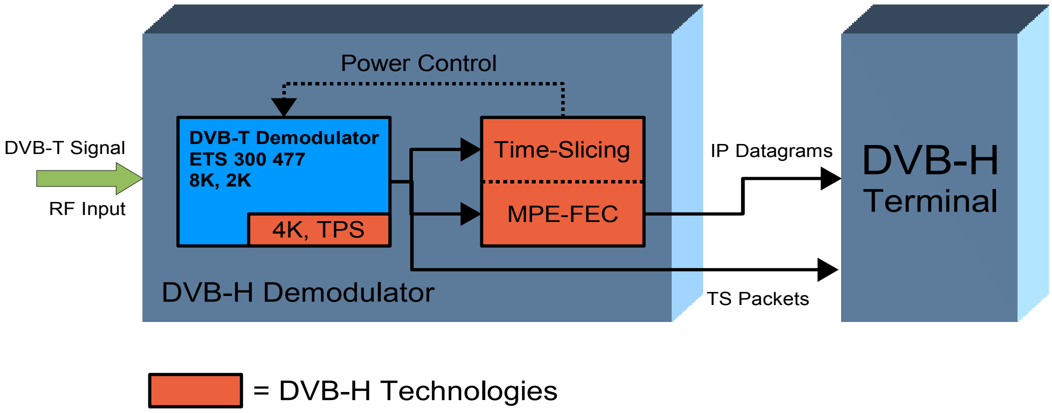

Illustration 2: Conceptual Structure of a DVB-H Receiver [2]

2.2 *The Protocol Stacks Associated with DVB-H*

In the previous section we have described what the transmission system of DVB-H is and strictly speaking the term "DVB-H" comprises no more than this transmission system. Practically however, a transmission system is always created for a specific use. In the case of DVB-H that was the delivery of multimedia services to handheld, battery-powered terminals combining terrestrial broadcast with 2G and 3G mobile networks. Hence DVB has set out to complement the DVB-H specification with a set of specifications that cover use cases, architecture, PSI/SI signaling, content delivery protocols, electronic service guide, service purchase and protection. These specifications were and are developed by the DVB TM Ad-Hoc group on the convergence of broacast and mobile services (DVB TM-CBMS). The CBMS architecture document identifies several reference points and interfaces, but the just published first versions of the specifications focuse on:

- What will be delivered over DVB-H (audio, video, subtitles, files),
- How it will be delivered (real-time streaming, file push),
- How it is described (electronic service guide),
- How it is protected.

In version 1 of the specifications, most of the key principles for IP Datacast over DVB-H are fully defined and the related protocols are fully specified (cf. Figure 3 below). Among those principles, as much as possible of the service and signalling elements are carried on top of the IP layer in order to enable the reuse of the IP Datacast framework on other bearers. The expectations around these specifications have been such that number of companies demonstrated pre-version 1 implementations during the IFA and IBC trade-shows in September 2005. The next steps in the technical work within DVB will include as a starting point the preparation of implementation guidelines for each of the specification documents available, with objective to guide implementation in the early days of Mobile TV using IP Datacast over DVB-H.

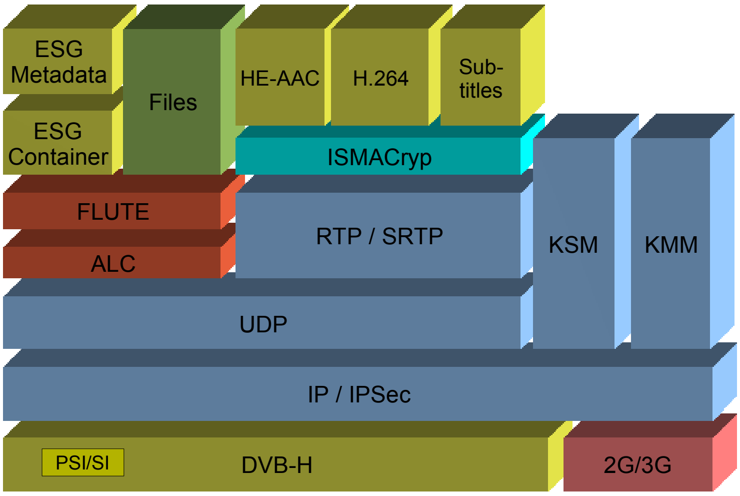

Figure 3: IP Datacast over DVB-H Protocol Stack Architecture (indicative) [1]

3 IPDC Services - How Broadcasting to Handheld Terminals Works Commercially

Mobile phone ownership and usage are still growing dramatically on a global basis. There are now around 2 billion paying customers. And increasingly, consumers are using their mobile phones for multimedia – not just for communication, but also for entertainment (with streamed video, music and games), and for news and information services. Being able to watch your favourite TV show, tune into news as it happens, or catch the latest sports events – all on your mobile phone – indoors, outdoors, or even while travelling – Mobile TV is easy to understand and has obvious uses, so already there is genuine consumer interest. Nokia estimates suggest that around 20% of active mobile phone users are highly interested in acquiring the service and prepared to pay a realistic charge for it – around 10 to 12 EUR a month.

Because there is no theoretical limit to the number of people who can receive content broadcast within a coverage area, digital broadcasting is a highly cost-effective way to reach a large audience. When combined with Internet Protocol Datacasting (IPDC), digital broadcasting enables mobile phone users to receive a wide selection of top quality TV services over a DVB-H network. IPDC enables a set of commercially attractive bonuses:

- Efficient use of both, broadcast and mobile network bandwidth enables up to 55 mobile channels plus scalability.
- It is supported by publicly available air interface specifications helping to drive device interoperability and market development.
- Its security includes end-to-end control of stream encryption, generation of decryption keys and delivery of keys to consumers in a billing-integrated way

In terms of applications, IP Datacast integrates the one-to-many broadcast service with an interactive return channel provided by the Mobile Network Operator (cf. Figure 4 below).

As well as offering viewers the opportunity to interact with programming (e.g. by voting), it can be used to order products and services, or send viewers to a web site or other digital content. IP Datacast also links with the billing and e-commerce systems of the Mobile Network Operator, and provides the Interactive User Guide (IUG). The IUG moves viewers seamlessly from one broadcast channel to another, and between the broadcast environment and the Mobile Network Operators' cellular services.

Figure 4: Integrating Broadcast with Interactive [3]

The content offered by broadcasters, aggregators and content providers will be transmitted via the broadcast network operators' infrastructures direct to consumers' handsets. Mobile network operators' networks will be used as a return path to effect billing and audience measurement services via e-commerce systems. In most of the current trials, the business model is based on subscription payment, but other payment methods are being tested as well. Some trials include free, premium and pay-per-view services, all of which will provide new customers and revenue streams.

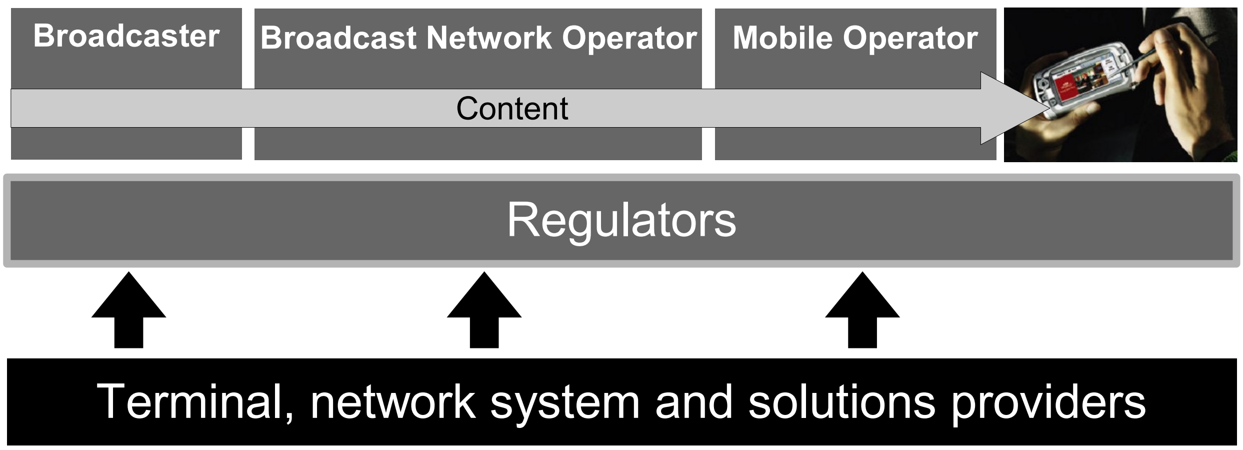

Figure 5: IP Datacast Business System [3]

4 Conclusion

The DVB-H standard, while in no way changing the current digital TV business models for fixed reception, does provide new business possibilities for a variety of players from broadcast and cellular operators to chip and equipment manufacturers. The standard has proven performance in laboratory and field tests where the additional error correction and virtual interleaver technologies have shown their efficiency. The power saving achieved by time slicing makes digital broadcast reception in handheld terminals a practical reality.

The new system, complemented by IPDC service models, has been well received by various operators, both broadcast and telecom. Several pilot networks are running in various parts of the world and commercialization in the form of chips and user terminals is nderway by several manufacturers.

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6 About the Authors

Alexander Adolf received a Dipl.-Ing. (FH) degree in Data and Information Technology from the Georg-Simon Ohm University of Applied Sciences in Nuremberg (Germany) in 1995. After developing GSM terminals for Nortel, he entered the digital media industry in 1996 and joined BetaResearch as a Senior Software Developer. For BetaResearch, he helped in the commercial launch and operation of Premiere, the first digital pay-TV operator in the German speaking countries. In 1997, he joined the DVB TM-GBS technical experts group, which he is chairing since 2000. Since 2001 he is with Micronas and heading the team for middleware and application software stacks. Mr. Adolf is a member of the Association of Engineers in Germany (VDI).

Georges Martinez graduated from « Ecole Supérieure d'Ingénieurs en Electrotechnique et Electronique » in 1990. From 1991 to 1995, he was with Philips Research Labs in France. He was involved in the study and specification of low-complexity base-band algorithms for digital video broadcast over cable (DVB-C) and terrestrial (DVB-T). From 1995 to 1997, he was with Philips Semiconductors as architect and design project leader for the cable digital IC's. He joined Motorola Labs in 1997 where he first addressed 3G Radio Resource Management and Layer 2/3 aspects while UMTS was starting. Between 1999 and 2004, he led the Composite Radio Systems team whose charter was the development and validation of advanced system architectures for hybrid networks, including broadcast and cellular bearers. Since 2005, he is leading the Motorola Mobile Devices Technology Office in Paris, focusing on mobile broadcast and multimedia. On behalf of Motorola, he has been very active in the development of broadcast/cellular concepts within the DVB since these activities started. Currently, he is chairing the DVB-CBMS ad-hoc group. Georges Martinez has published 13+ papers and holds more than 10 patents.