# Digital Video Broadcasting Applications for Handhelds

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## INTRODUCTION

Following the success and wide adoption of the European Digital Video Broadcasting for Terrestrial (DVB-T) standard for digital terrestrial television, numerous coordinated research efforts on digital broadcast technology resulted in the recent standardization of Digital Video Broadcasting for Handeld Devices (DVB-H). The new specification aims at defining the physical and link-layer level of a digital broadcast network for Internet protocol (IP) datacasting services. At its core, DVB-H is based on DVB-T but it is more oriented in mobile and stationary reception by handheld devices. This article attempts a brief though thorough overview of the new technology, its technical aspects, and its new application perspectives.

## BACKGROUND

During the mid-1990s, the MPEG-2 Transport Stream (TS) (International Organization for Standardization [ISO], 1996) was accepted worldwide as baseband format for digital television networks. Its structure allows the transmission of encoded digital video and audio streams, along with IP data, organized in a statistical Time Division Multiplex (TDM). The need for an efficient physical layer arose, which would deliver the MPEG-2 TS to the end-user terminals via the "difficult" terrestrial channel.

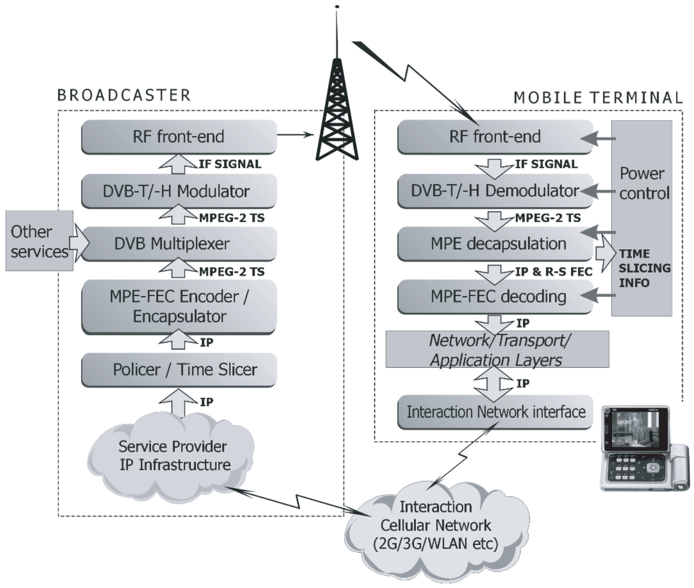
Several research efforts have been conducted around the world to optimize the physical layer for terrestrial digital television (DTV). North America adopted the ATSC A/53 system, developed by the Advanced Television Systems Committee (ATSC) in 1995, based on 8-VSB modulation. In Japan, the Association of Radio Industries and Businesses developed in 1998 the Integrated Services Digital Broadcasting-Terrestrial (ISDB-T) specification for the same purpose.

In Europe, DVB-T was standardized by the European Telecommunications Standards Institute (ETSI) in 1997 as a transmission system designed and optimized for terrestrial DTV configurations. Although it was initially designed for stationary use, DVB-T also presented an outstanding performance in mobile reception (Stare, 1998), where it outclassed ATSC (Wu, Pliszka, et al., 2000). To further support the perspective of mobile DTV, ETSI introduced in 2004 the DVB-H specification (*Digital Video Broadcasting (DVB); Transmission System for Handheld terminals (DVB-H),* 2004). DVB-H substantially comprises of a set of extensions to DVB-T which are oriented to handheld use. DVB-H inherits all the benefits of its predecessor and adds new, mobile-oriented features, focusing on IP datacasting and including better mobility and handover support, adaptive per-service error protection and power saving capabilities. At present, DVB-H is the dominant open standard in its field, and compliant systems are being deployed around the world, including Europe, the United States, and China. A strong competitor of DVB-H is Terrestrial Digital Multimedia Broadcasting (T-DMB), a standard developed in Korea and Japan, based on the European Digital Audio Broadcasting (DAB). A third player in the field of handheld DTV is Media Forward Link Only (MediaFLO), a U.S. proprietary technology developed by Qualcomm, which is gaining ground in North America.

The ETSI specification defines DVB-H as a "broadcast transmission system for datagrams." Like DVB-T, it specifies the physical and link layers, along with the service information. A DVB-H-compliant broadcast platform consists substantially of a DVB-T chain, including all the enhancements introduced by the new specification (Figure 1). Since a broadcast platform has no native support for interactivity, an IP-based cellular infrastructure (like WLAN, 2G/3G) can be employed complementarily to enable for fully interactive applications.

It must be clarified that most of the innovative features of DVB-H, as explained in the next section, are implemented on the link layer and do not affect the DVB-T physical layer. This allows the new technology to inherit all the benefits

*Figure 1. Block diagram of a DVB-H system*




of its predecessor, including flexible transmission schemes providing from 5 up to 32Mbps of capacity, excellent multi-path performance, due to the use of OFDM (Orthogonal Frequency Division Multiplexing), use of TV bands UHF using 8 MHz channels, and SFN-based operation.

In order to use the link-layer features of DVB-H, it is assumed that the useful payload to be conveyed consists of IP-datagrams (or other network layer datagrams) which are transmitted within the MPEG-2 TS, encapsulated according to the Multi Protocol Encapsulation (MPE) protocol. With this assumption, DVB-H becomes a totally IP-oriented system and does not support native MPEG-2 audiovisual streams. It is however feasible (although not recommended), that DVB-H services can coexist with traditional, DVB-T, MPEG-2-based DTV programs within the same multiplex.

## DVB-H TECHNICAL INNOVATIONS AND APPLICATION PERSPECTIVES

The new features of DVB-H were introduced taking into consideration three principal issues in mobile use: (1) handover/mobility, (2) varying signal reception conditions, and (3) limited battery time. DVB-H innovations can be summarized as follows:

*DVB-H innovations at physical layer (extensions to DVB-T)*

- **4K FFT Mode:** Native DVB-T operates at two modes (8K and 2K), referring to the number of carriers within the OFDM spectrum. 8K mode (6817 carriers) provides a longer symbol period, having a very good performance in large Single Frequency Networks (SFNs) due to better tolerance in long echoes. However, it is unsuitable for fast-moving receivers, since it is very vulnerable to Doppler shift, having relatively small intercarrier spacing. On the other hand, 2K mode (1705 carriers) provides improved Doppler performance but its behavior in SFN networks is poor. DVB-H introduces the 4K mode (3409 carriers) as a trade-off, combining good mobile reception with acceptable performance in small and medium SFNs.
- **Additional TPS Signalling:** Transmission Parameter Signalling (TPS) bits within the OFDM symbol carry additional DVB-H related information to enhance and speed up service discovery. TPS also carries cell-specific information, which assists the handover procedure in mobile receivers.
- **In-depth Symbol Interleaver:** The DVB-T symbol interleaver requires a certain buffer size both in the transmitter and the receiver. When switching from 8K mode to 4K or 2K, the buffer required for the process falls to ½ and ¼ respectively, since the size of the symbol (in bits) also decreases. DVB-H exploits the unused buffer by increasing the interleaving depth by a factor of 2 (4K) and 4 (2K), thus increasing tolerance to impulse interference.

*DVB-H innovations at link layer*

- **Time Slicing:** A basic issue in handheld operation is the limited battery time. This issue is of particular importance in terrestrial DVB reception, where the receiver/demodulator/demultiplexing/decapsulation chain consumes typically 1W. The time slicing fea-