DVB-H Time Slicing

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Abstract

DVB-H (Digital Video Broadcasting) is a digital transmission standard developed by the international DVB-Project. It was standardised in 2004 and enables small battery powered handheld devices to receive IP data services such as low definition TV services. The DVB-H standard is derived from the DVB-T standard which is used to broadcast TV services in Europe. DVB-H cares especially about the needs of battery powered devices. The concept of time slicing enables the receiver to be periodically switched off and to reduce the power consumption by up to 90%. This report shows the technical differences between DVB-H and DVB-T and informs how time slicing works.

Keywords: DVB-H, Time Slicing, Handover, Energy Saving

1 Introduction

Digital Video Broadcasting (DVB) is an open standard for digital television. There are a number of methods to transmit the DVB signal including by satellite (DVB-S, DVB-S2 and DVB-SH), cable (DVB-C), terrestrial television (DVB-T), terrestrial television for handhelds (DVB-H) and by microwave (DVB-MT). With a transmission rate of 20 Mbit/s in a 6 MHz bandwidth channel one high definition television (HDTV) or 3-4 standard definition television programs can be broadcasted to fixed locations. HDTV provides a resolution of up to 1920 x 1080 pixel while the resolution of SDTV is up to 768 x 576 pixel.

With DVB-H, multimedia services like TV can be received with handheld devices, mobile phones and PDAs. This report is structured as follows: Section 2 gives an overview about DVB-T. Section 3 provides information about the differences between DVB-H and DVB-T, the time slicing concept and handovers. The conclusion is presented in Section 4.

2 DVB-T

DVB-T is the terrestrial mode of DVB and the common standard for digital television in Europe and Australia. The maximum data rate is 20 Mbit/s. There are up to four programs per channel. Each program gets an average data rate of 3.5 Mbit/s. In comparison an analogue TV program is transmitted at a rate of 3 to 5 Mbit/s and DVDs use a data rate of up to 9.8 Mbit/s. The programs are sent over different channels as MPEG-2 streams. Other codecs are possible as well.

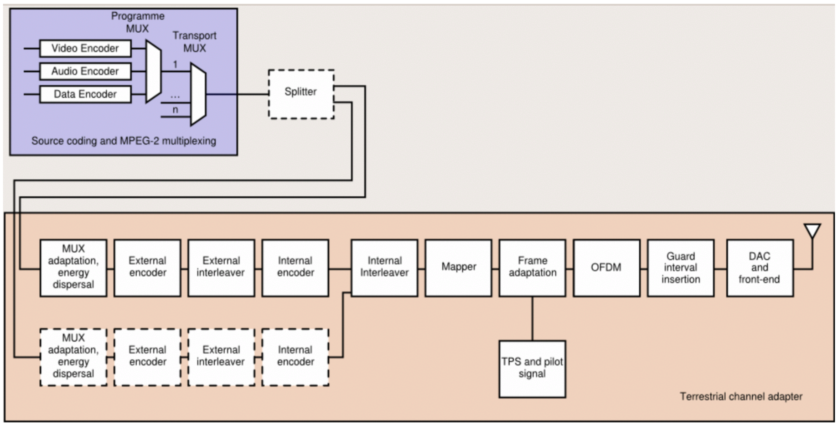

Figure 1: DVB-T transmission system

As shown in figure 1 Video, audio and data streams are compressed and multiplexed together into a Program Stream (PS). Several PSs are multiplexed together into a MPEG-2 Transport Stream (TS). The TS is received by Set Top Boxes. The range of the transmitted data is between 5 and 32 Mbit/s. The Splitter allows transmitting two different TSs. This can be, e.g. a standard definition SDTV and a high definition HDTV signal on the same carrier. A MPEG-2 TS contains a sequence of data packets each with a fixed length of 188 bytes. The external encoder applies a first level of error correction to the data stream. The transmitted data is rearranged using conventional interleaving.

The output of the Mapper (complex symbols) are grouped in the Frame Adaption into blocks of constant length. A frame is generated out of 68 blocks and a superframe is built out of 4 frames. Pilot signal and TPS (Transmission Parameter Signalling) signals are inserted in each block. Pilot signals are used for synchronisation and equalisation. TPS are used to send parameters and to identify the transmission cell. The sequence of blocks are modulated with the orthogonal frequency-division multiplexing (OFDM) technique in 2K, 4K or 8K mode. The Guard interval, a method to ensure that transmissions do not interfere each other, is inserted to extend every OFDM block by copying the end of each block to the front to reduce receiver complexity. The DAC (digital analog converter) transforms the digital signal into an analog and then modulated to radio frequency (VHF, UHF). Each DVB-T channel is 6, 7 or 8 MHz wide. Similar techniques are used to decode the signal at the receiver in the opposite order.

3 DVB-H

DVB-H brings multimedia services over digital terrestrial broadcasting networks to handheld devices. It is derived from DVB-T, a standard for fixed terminals. Handheld devices require different technologies for the transmission system in order to save battery power. The transmission system is frequently turned off to reduce the average power consumption. On the link layer time slicing reduces the average power consumption and enables smooth and seamless handovers.

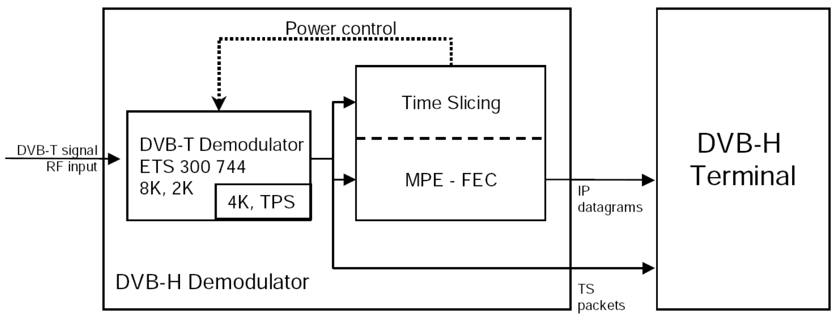

Figure 2: Conceptional Structure

Forward error correction for multiprotocol encapsulated data (MPE-FEC) improves

Carrier-to noise ratio (C/N) performance and Doppler performance. The C/N is ratio of the signal power to the noise power corrupting the signal of a modulated signal. The Doppler Effect is the change in frequency and wavelength when moving relative to the source of the waves. In order to move seamless from one transmission cell to another, the reception of DVB-H services may not be interrupted.

The conceptual structure of a DVB-H receiver as seen in Figure 2 includes a demodulator and a terminal. The DVB-H demodulator consists of DVB-T demodulator, a time slicing module and an optional MPE-FEC module. The DVB-T demodulator decodes the received MPEG-2 stream. Three transmission modes are provided: 8K, 4K and 2K. The 4K mode is the standard for DVB-H. The time slicing module reduces the power consumption and enables smooth and seamless handovers when moving from one transmission cell to another. DVB-H transmits IP-based services. traditional MPEG-2 services and time sliced DVB-H services are multiplexed together and broadcasted. The handheld device decodes only the IP-based services.

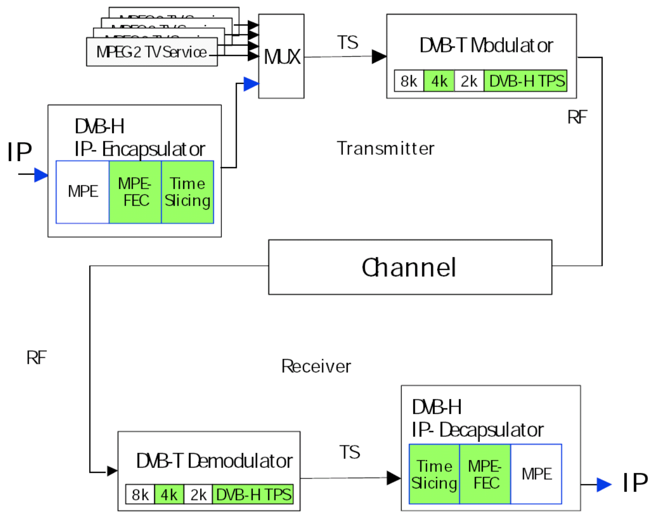

Figure 3: DVB-H description

Figure 3 shows traditional MPEG-2 services and time-sliced DVB-H services together on the same multiplex. The handheld device decodes only IP-based services. The fields marked in green are new to DVB-H.

4 Time Slicing

The disadvantage of the DVB-T system is that the whole data stream has to be decoded to have access to the TV channel. The main problem of the handheld devices is the limited battery lifetime. Time Slicing is used in DVB-H to reduce the power consumption of the device. It also provides support for seamless service handover. Time Slicing is based on time division multiplexing (TDM). The idea is to send data in bursts using a higher bit rate compared to the bit rate of traditional streaming systems. Within the current burst the next time (delta t) is indicated to the receiver.

Between the bursts the receiver is idle and no data is received. If a constant lower bitrate is required, the received bursts may be buffered. However, the transmitter is never shut off. Between the bursts the receiver may monitor neighbouring cells. This information is used for a handover decision. The burst bitrate should be at least 10 times higher than the constant bit rate. A duty cycle of 10% results in 90% power saving.

Time-Slicing enables the receiver to monitor neighbouring cells for the same service between the bursts. During the Off-time the handheld device may switch from the current transport stream to the next one in the neighbouring cell without interrupting the service. The handover mechanism and the time slicing for seamless handover is explained more detailed in section 4.4 and section 4.5

4.1 MPE-FEC

The MultiProtocol Encapsulation-Forward Error Correction (MPE-FEC) improves the C/N- and Doppler performance and increases the tolerance to impulse interference. An additional level of error correction at the MPE layer adds parity information of the datagram to a separate MPE-FEC section. Though the parity overhead is 25%, error-free datagrams can be received after decoding even under bad reception conditions.

4.2 Delta-t Method

The delta-t method signals the time from the current burst to start of the next burst. The delta-t timing information is relative to the current burst. Therefore no synchronisation of the clocks between transmitter and receiver is needed. The burst duration, burst bitrate and off-time may vary. The delta-t parameter is transmitted in the header of each MPE section. Even under very bad reception conditions the delta-t information about the next burst can be accessed and power saving provided. The delta-t method

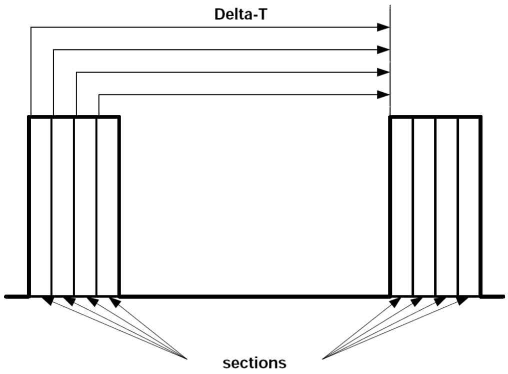

Figure 4: MPE section

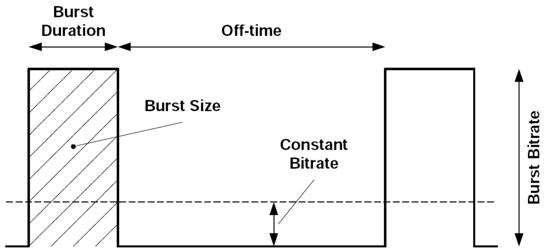

Figure 5: Burst Parameters

is insensitive to any constant delay. However jitter influences the delta-t accuracy. Jitter is an unwanted variation of the interval between successive bursts. For time slicing a delta-t jitter of 10 ms is acceptable because delta-t itself has a resolution of 10ms.

4.3 Burst Size and Off-time

A Receiver has to buffer the receiving data in its memory. The data is processed between the bursts. The available memory of the device must be larger than the Burst Size. The Burst Size is the number of Network Layer bits within a burst. The Burst Bitrate is the bitrate used during transmission of a time sliced burst. Constant bitrate is the average bitrate when time slicing is not used. The Burst Duration is the time from the beginning to the end of a burst. The Off-time is the time between the bursts. During this time no packets are transmitted or received for the relevant stream.

As seen in Figure 6, an increasing Burst Bitrate increases also the power saving. Increasing the Burst Bitrate from 1 Mbps to 2 Mbps increases the Power Saving from 60% to 78% for a Constant Bitrate of 350 kbps. However, increasing the Burst Bitrate from 7 Mbps to 14 Mbps has only small effect on the Power Saving (91% to 93%).

4.4 Handover

When the reception quality of DVB-H devices becomes too low, a handover to another frequency may be required. The receiver scans for possible alternative signals providing better quality. Time slicing enables the receiver to monitor neighbouring cells during Off-time. The bursts of IP streams can be synchronised in a way that the receiver can

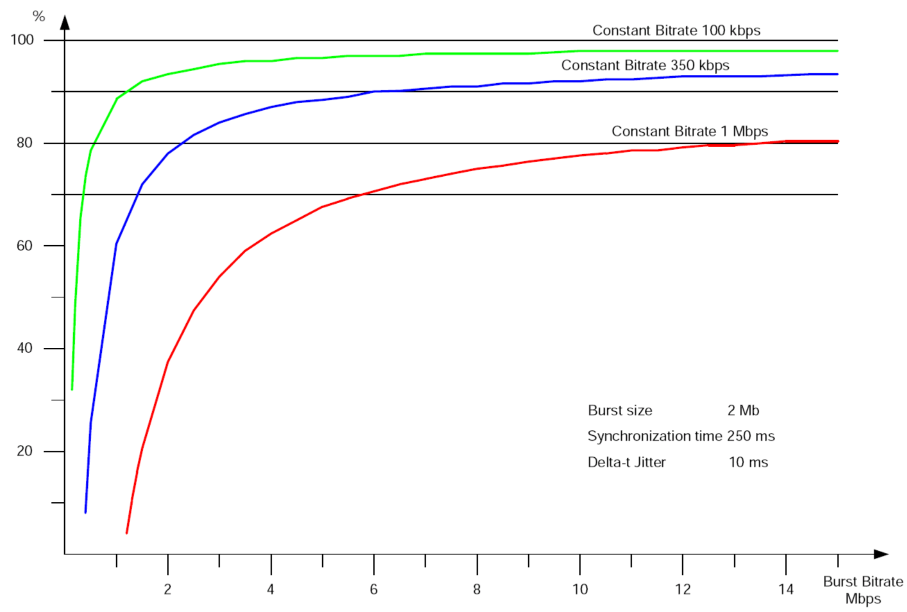

Figure 6: Power Saving

switch to the neighbouring cell and continue receiving the IP stream without interruption. The time required to check the signal strength on a single frequency takes less than 20 ms.

To select a new frequency some mechanisms may be:

- signal scan
- use of Network Information Table (NIT)
- use of Transmission Parameter Signalling (TPS) and NIT
- use of IP/MAC Notification Table (INT) for IP based services

4.4.1 Signal scan

A signal scan is necessary when the device has no information about existing DVB-H signals and networks. When the receiver is started the first time, or it was shut off and then moved a long distance, the receiver scans the whole transmission band or tests single known frequencies.

4.4.2 Use of Network Information Table

When the signal strength becomes to low the receiver may test other frequencies given in the NIT for the current multiplex. It then tries to synchronise on this frequency.

4.4.3 Cell identification with TPS and NIT

The receiver uses the the cell identification and the Time Slicing indicator transmitted in the Transmission Parameter Signalling (TPS), information on frequencies for different cells and information of the coverage of the cells. The last two pieces of information are provided in the Network Information Table (NIT). The receiver locates neighbouring cells by comparing their locations.

4.4.4 Use of INT tables

To improve the above mechanism information found in IP streams can be used. Two IP streams carry the same content when the source and destination IP address are identical, if IP streams are associated with the same IP platform and when the destination IP address is not in a unicast range.

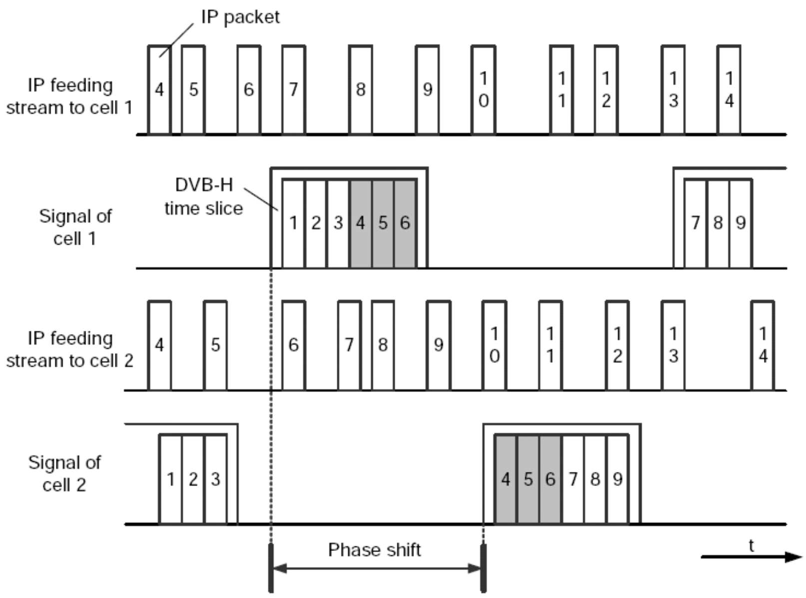

Figure 7: Phase shift

4.5 Time slice synchronisation for seamless handover

When a handheld device moves from one DVB-H cell to the next, the current service should be received in the new cell without interruption. The new cell is supposed to provide the same service with identical content. Network cells have to be designed in a way that time slices of the corresponding services are synchronised, otherwise handovers may not be possible. IP network delay and packet jitter may be different for neighbouring cells. The time slices of the two transmitters sent out at the same time may have different content and can cause packet loss during handover. Therefore, a static phase shift may be done in the two network cells. The phase shift should be large enough to enable synchronisation to the new stream. Figure 7 shows the principle.

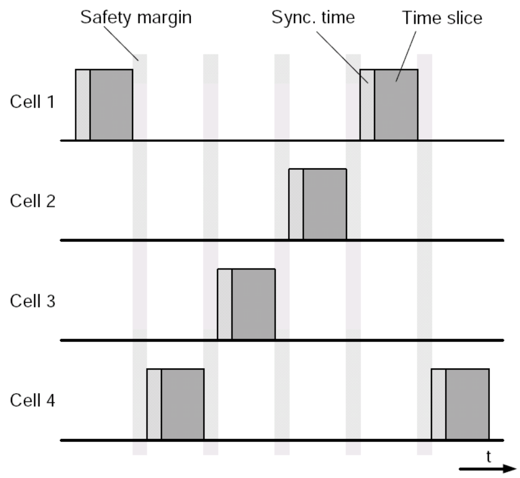

Figure 8: Phase shift for four cells

Where more than two cells come together more than two different phase shifts are necessary. Figure 8 shows how time slices have to be phase shifted for four neighbouring cells to allow a seamless handover. The terminal needs some time to synchronise with the signal of the new cell before it can start to receive the service. A safety margin is added additionally to handle any time slice jitter.

5 Conclusion

In this report the main differences between DVB-T and DVB-H have been presented. Time Slicing based on TDM is one of the characteristics of DVB-H. The power consumption for receiving multimedia data is decreased by 90%. The data is received in bursts so that the receiver remains inactive when no bursts are received. Time-Slicing uses the delta-t method to indicate the beginning of the next burst. No synchronisation between transmitter and receiver is needed. DVB-H channels require less bandwidth as traditional TV channels. Therefore it is possible to transmit more TV channels within a multiplexed DVB-H stream than in a multiplexed DVB-T stream.

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