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Testing of DVB-H systems

The new standard DVB-H

The modulation of DVB-H supports a reliable wireless transmission of digitised information with a high bit rate. Originally designed for the replacement of analogue television also data of any kind can be radiated.
The DVB-T standard has been extended towards DVB-H, the extension for mobile reception on handheld devices. The focus is the implementation of data services used on mobile receivers, such as mobile phones, smart phones and PDAs. These extensions are widely compatible with the DVB-T core system. They are related to higher system layers of such digital terrestrial video broadcasting systems.

With DVB-H a first seamless architecture used for data services will be created based on the Internet Protocol (IP). DVB-H addresses the transmission of very high compressed video streams. The new video compression standards like H.264/AVC are used here. DVB-H is enriched by approaches to deliver files, pictures and the cooperation with return channels based on mobile phone systems (GSM, UMTS).
Additionally DVB-H defines features for a high reliability if transmission errors were occured and especially to save the battery power of small handheld devices.

The standardization of DVB-H is an ongoing successful process. Still in 2004 a first release of the working documents and standards is expected. First field trials are started already in summer 2004. In 2005 and beginning of 2006 first commercially available end user devices will be available. The main focus in Europe is to launch such networks and to offer DVB-H services during the soccer world championship.

For the development of the DVB-H networks, the end user devices and the installation and monitoring of mobile data services request dedicated analysis and monitoring solutions. These demand DVB-H specific test functions, implemented on DVB-T measurement equipment.

The DVB-H extensions

The approach of DVB-H (EN 302 304, DVB TM 2977) is to reused the physical layers of DVB-T systems (ETS 300 744) and to stay compatible. The following extension were defined for the terrestrial transmission layer:

- 4k mode:
  Additionally to the 2k and 8k FFT mode a type 4k is incorporated: Therefore a further symbol rate is created as compromise between high data rates, mobile reception and low power consumption. For the signalling of this new mode the purpose of available TPS bits (S38, S39) were extended.
- TPS extension:
  Still unused TPS bits (S49, S50) are used in order to announce if in higher layers of the system Time Slicing or Forward Error Correction is applicable.
- Cell_Id:
  The cell identification in DVB-H networks is now mandatory to transmit.
- In-Depth-Interleaver:
  The buffer for the OFDM interleaver of the 8k mode is used in 2k and 4k mode as additional In-Depth-Interleaver in order to manage 2 or 4 OFDM frames.

- 5 MHz:
  The spectral bandwidth 6, 7 and 8 MHz are extended by a 5 MHz spectrum. Especially the reuse of free wireless communication channels, e.g. mobile phone channels, allows the installation of DVB-H systems outside broadcasting channels (VHF, UHF), e.g. used in L band).

The fundamental new functions of a DVB-H system are related to a better error correction and therefore the consideration of a higher sensitivity of wireless mobile data transmission. Besides the current DVB-T Forward Error Correction (FEC) mechanism (Viterbi, Interleaving, Reed-Solomon) the data is additionally secured by the Multi Protocol Encapsulation FEC.

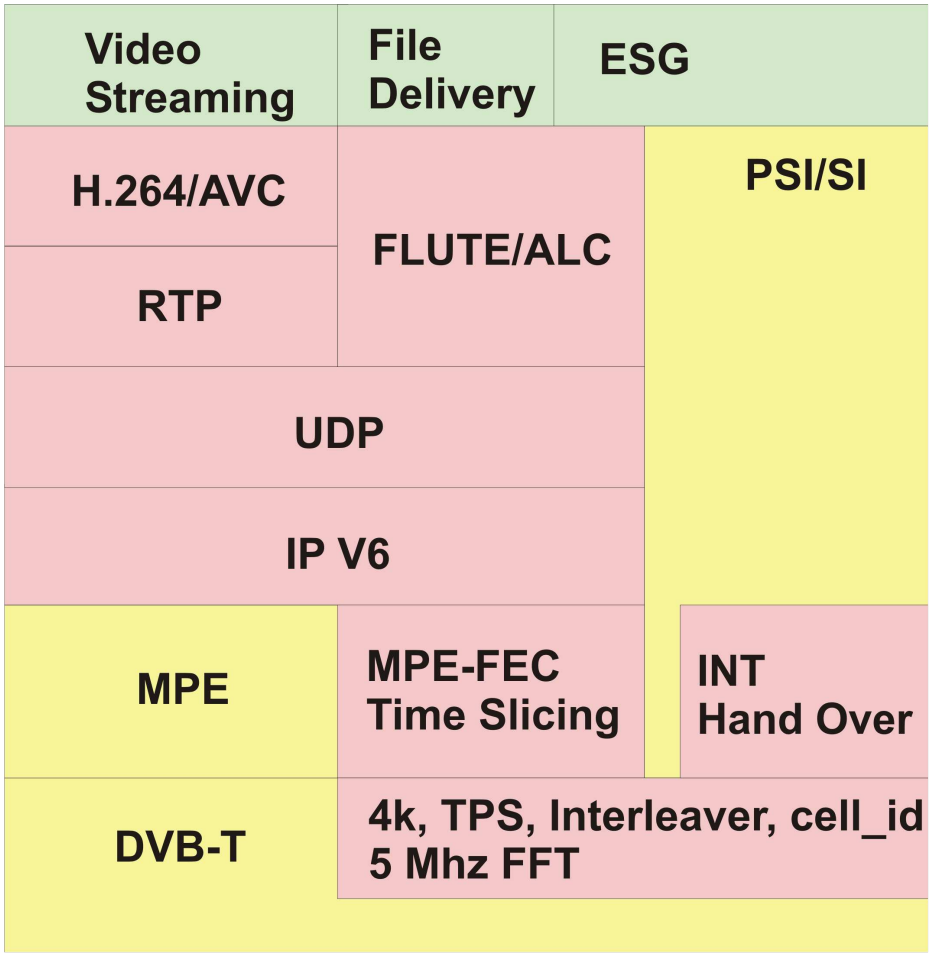

Figure 1: Function blocks and extensions of DVB-H

The integration of Time Slicing (figure 2) is an effective approach in order to reduce the power consumption of a DVB-H front end chips by at least 80%. A main feature of the Time Slicing is – instead to transmit the data continuously like in TV services – the insertion of the data as packets and bursts, similar to time slots in communication systems.

On the transport layer (DSM/CC and MPE, ISO/IEC 13818-6) the following extensions were defined:

- Time Slicing:
  the block oriented radiation (bursts) of parallel data services. Therefore the front end can be switched-off temporarily in order to increase the battery life time. Additionally, during the break in the data transmission while waiting for the next data burst the neighbour DVB-H cells can be scanned in order to select the best reception condition or to be prepared for a handover.

- MPE-FEC:
  An additional Reed-Solomon code (RS 255,191) for the IP data is added. With it the signal to noise ratio (SNR) can be improved by 7 to 8 dB. Furthermore a better Doppler shift (21 – 58 Hz) results. This allows to move faster during reception (about 250 km/h with 16QAM, channel frequency 200 MHz, 8k mode, code rate 2/3 and 13,27 Mbit/s transmission rate).
- Virtual Time Interleaver:
  In order to reduce bursty errors on transmission links the MPE-FEC data is scrambled with a Time Interleaver.

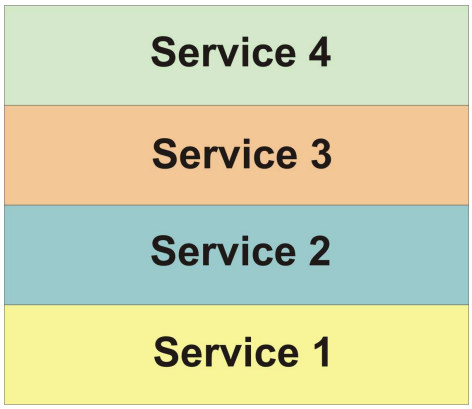

Figure 2: DVB-H Time Slicing

The transmitted DVB-H data services demand the announcement and signalling: what is available, where to find the service etc. Also the seamless reception of services during a movement within different cells (handover, roaming) require appropriate extensions.

The signalling in DVB-H systems were completed by:

- INT table:
- The IP Notification Table (INT) is used as directory of the active and transmitted IP data services.
- Additional SI tables:
  New tables are integrated in the transport stream, used for the transmission of the data as well as the separate insertion of the supplementary MPE-FEC data blocks (EN 300 468).
- Handover:
  Based on the existing tables, which are very important now in DVB-H, and additional information (e.g. INT, SDT, NIT), the end user device can make use seamlessly of data services provided by different networks, especially during movement and handover.

As important transmission protocol for the data IP (Internet Protocol) is used, other protocols are possible. Therefore a seamless integration with different technologies coming from the IT, Internet world and other mobile communication protocols is supported.

Instead of the MPEG-2 video encoding new and more efficient encoding algorithms are intended to be used (H.264/AVC). These standards provide videos with a decreased bandwidth by similar picture quality. The adaptation to small displays used in PDAs and smart phones (CIF resolution) is addressed. With a DVB-H total transmission capability of 10 to 15 Mbit/s up to 30 parallel video streams are possible. The video bandwidth of a single program can be delivered with a bandwidth of about 384 Kbit/s with a good quality.

On the higher layer of a DVB-H systems the following extensions and components are used:

- IP V6:
  The use of the state-of-the-art IP protocol provides an increased number of end system addresses. Additionally the encryption of data (IPSec) is supported by IP V6.
- H.264/AVC:
  The new video compression standard H.264 or Advanced Video Codec AVC is used to encode the video and audio streams instead of MPEG-2.
- FLUTE/ALC:
  For the transmission of files a carousell based approach is used (File Delivery over Unidirectional Transport Environment / Asynchronous Layered Coding).
- I_MT:
  The cooperation of data servers, end user devices and interfaces used for the return channels is standardized by the Interface of Mobile Terminal (I_MT).

Analysis of DVB-H systems

For the installation and launch of mobile data services based on DVB-H as well as the reliable operation of such networks specific and new analysis and testing functions are needed.

The main aspects are such questions like:

- Are the DVB-H networks compliant to the standards ?
- Which data services with what quality parameters are transmitted ?
- Which type of errors and what error ratios occur during the reception of DVB-H ?
- Are data services seamlessly and error-free able to be received ?
- Is the parallel operation of MPEG-2 TV together with DVB-H services guaranteed ?

A DVB-H analyser reuses functions of a solution to install and check DVB-T networks, e.g. to see the constellation, the spectrum etc. Such basic functions addressing the wireless radiation are:

- The analysis and display of the TPS information (constellation, bandwidth, code rate, guard interval), extended by the DVB-H TPS bits
- Display of the spectrum and the channel mask, but also for the 5 MHz channels
- MER, BER and CSI measurements
- C/N and signal level measurements

Additional, new functions, especially for DVB-H, could be:

- Analysis of the Time Slicing: correctness, relation between Burst Size, Off Time and the use of bandwidth (figure 3)
- Check of the MPE-FEC and the calculation of error rates, BER measurement and consideration of the QEFIP values (1x10exp3, figure 4)
- Analysis of the additional signalling tables, especially with focus on correct and complete signalling of services and if handover is potentially possible.

Such a DVB-H analyser is supplemented by functions like:

- analysis and display of IP connections (addresses, used higher protocols) and the specific data rates
- Information about data encryption and security (IPSec), Digital Rights Management (DRM)
- Decoding and display of video sequences coded with H.263 or H.264/AVC
- Reception of data and statistics about FLUTE/ALC, e.g. error rates, cycle counters
- Analysis of the Electronic Program Guide, check of the XML and SDP files needed to make use of the service

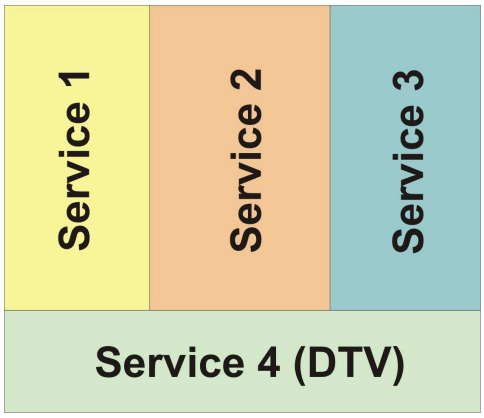

Figure 3: Parameter of the Time Slicing

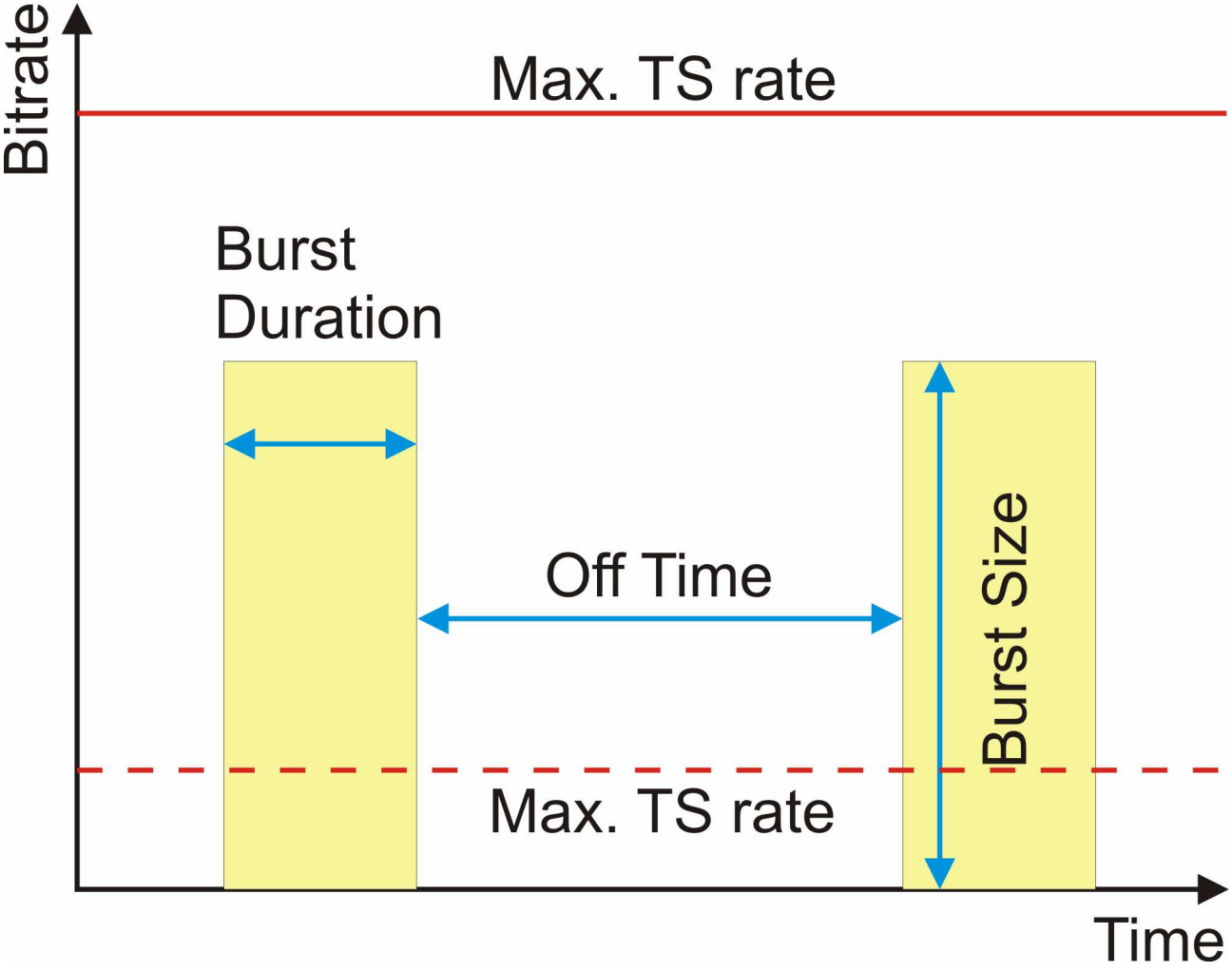

Figure 4: Improved parameters based on MPE-FEC

DVB-H is reusing the technology of DVB-T in order to provide cost-effective broadcast-orientated data services. Services where data has to be delivered to a wide audience and a large group of users simultaneously are only and even possible effectively just based on a broadcast system itself.

But DVB-H will also offer services based on subscriptions and fees (pay service). Therefore further monitoring and testing functions are reasonable:

- Analysis and checks of the subscriber management
- analysis of the behaviour of DVB-H networks in terms of a very high dynamic allocation, service requests, activation and release of data connections and services (service oriented statistics and information)
- Collection of information for billing and accounting (accounting ticket) for a valid and fair charging of service providers and users
- Creation of monitoring and reference receptions sites for an online analysis of the transmission quality, problems, also with capabilities to control processes and parameters on the transmission side
- Extended measurement of the coverage and mobile reception using parameters like speed of movement, e.g. used to validate DVB-H systems across railway tracks or motorways.

Summary

DVB-H provides additionally new functions and features to DVB-T. A test system for DVB-H will be an extension and improvement of a DVB-T test device and analyser. Besides the already used measurement guidelines for DVB-T (TR 101 290) additional parameters of higher layers have to be checked and validated in DVB-H networks.
Based on the focus of mobile data reception a portable measurement device for a robust field usage is needed, perhaps with capabilities for outdoor applications.

A solution to support field trials, the installation and operation of DVB-H networks and for the continuous development of the terrestrial broadcasting standards with a high flexibility for adaptation of measurement approaches is needed.
Such a solution is based on available components for DVB-T reception and measurement extended by additional features and functions to check the higher layers of DVB-H systems.

Abbreviations

ALC	Asynchronous Layered Coding
AVC	Advanced Video Coding
BER	Bit Error Ratio
CIF	Common Intermediate Format
DRM	Digital Rights Management
DSM-CC	Digital Storage Media - Command and Control
DVB	Digital Video Broadcasting
DVB-H	Digital Video Broadcasting - Handheld
DVB-T	Digital Video Broadcasting - Terrestrial
EN	European Normative
FEC	Forward Error Correction
FLUTE	File Delivery over Unidirectional Transport Environment
GSM	Global System for Mobile communication
I_MT	Interface of Mobile Terminal
INT	IP/MAC Notification Table
IP	Internet Protocol
IPSec	IP Security
MER	Modulation Error Ratio
ISO	International Standardization Organisation
MPE	Multi-Protocol Encapsulation
MPEG	Motion Picture Expert Group
NIT	Network Information Table
QEFIP	Quasi Error Free on IP level

OFDM	Orthogonal Frequency Division Multiplexing
QAM	Quadratur Amplitude Modulation
RS	Reed Solomon
SDP	Service Description Protocol
SDT	Service Description Table
SNR	Signal to Noise Ratio
TM	Technical Module
TPS	Transport Parameter Signalling
TV	Television
UMTS	Universal Mobile Telecommunication System
XML	eXtendable Mark-up Language