An overview of the MPEG-2 Transport Stream in Digital Video Broadcasting

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Abstract

This paper provides an overview of the transport mechanism of MPEG-2 as used as a part of the Digital Video Broadcasting standards. It is written as part of the Multimedia Systems course at Luleå University of Technology as well as a first insight into the BRaIN project's main carrier technology focused upon. The paper will first present an overview of the broadcasting transport protocols using the MPEG-2 TS data link layer, provide a general description of the transport stream packets and finally review some characteristics of MPEG-2 TS data flow within DVB receivers.

Keywords: wireless communication, digital video broadcasting, mobility, MPEG2-TS.

Introduction

MPEG-2 has been adopted as the standard encoding and delivery of digital television programs and broadcasting. While MPEG-1 defined how to store a file for local retrieval, MPEG-2 defined both local storage and stream transport. Although not specifying how the encoding, multiplexing and decoding are to be performed, it defines a data format as a Program Stream or a Transport Stream, respectively for error-free mediums and for error-prone environments such as Digital Video Broadcasting over wireless links. In fact, the scope of the MPEG-2 TS is broadcast over cable, over the air and over satellite links.

As we seek to combine the use of DVB as an IP carrier together with other carrier technology within projects such as CDT/BRaIN [7], it is therefore of importance to understand the characteristics of MPEG-2 Transport Streams as well as DVB technology to identify those aspects that needs further attention.

Overview of broadcasting transport protocols

Figure 1 shows the transport protocols as found in a digital broadcasting system. As focus is given towards using DVB as an IP transport, the case of MPEG-4 media over RTP/UDP/IP is represented as an example.

Of particular interest, besides the MPEG-2 TS itself, is the MPEG-2 Sections, the Digital Storage Media Command and Control (DSM-CC Sections). The DSM-CC allows different protocols to be used together or individually as support to the transport of multimedia services, thus enabling data piping and carousel services [2].

The MPEG-2 Transport Stream Syntax

One of the objectives of the MPEG-2 TS was to design a transport stream suitable for error-prone links offering no support for the carriage of structured data. It therefore uses small sized packets and provides many features found in data link layers, such as packet identification (PID), synchronization (Synch byte), timing (clock references and timestamps), multiplexing and sequencing information (CC field). An MPEG-2 TS may contain multiple programs though its multiplexing facility.

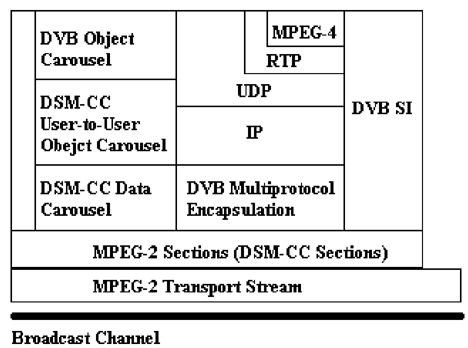

Figure 1: Broadcast transport protocols, with MPEG-4 over RTP/UDP/IP

The presence of data link layer functionality combined with transport layer functionality makes this multimedia transport specific for raw mediums, as this functionality is readily found in other networks. Therefore its use in IP networks is far from optimal due to this duplicated functionality, making it an inefficient transport protocol.

On the other end, although it was originally meant as an MPEG-2 audio and video transport for digital television, MPEG-2 TS is also suitable for IP transport.

The MPEG-2 TS packet

The transport stream is composed of time-multiplexed packets from different streams [3]. The MPEG-2 packet is

Header (4 bytes)	Optional variable length adaptation field	Payload (184 bytes)

Figure 2: The MPEG-2 TS packet

a 188 bytes packet, consisting of a 4 bytes header leaving 184 bytes for payload, as shown in figure 2. The small packet length is more suited for high error mediums as the errors thus affects less data, although the header represents a higher overhead for such a packet size.

The header, as shown in figure 3, contains a Sync byte used for random access to the stream. It also contains a Program ID (PID), which allows for the identification of all packets belonging to the same data stream, or alternatively it provides a mean for multiplexing data streams within transport streams. It may be viewed as the equivalent of the port number field in UDP packets. Finally, the Continuity Counter field (CC) may be viewed as the equivalent of the RTP sequence number. It is incremented by one for each packet belonging to the same PID therefore allowing for the detection of missing packets [3].

Sync byte	PID	CC

Figure 3: MPEG-2 TS header

The adaptation field, which is optional, may be used to convey a program clock reference (PCR) to help synchronization of the playback at the receiving end.

Finally, the payload contains the audio or video data as Packetized Elementary Streams (PES) or the MPEG-2 table section. A table section specify necessary information about the program conveyed in the stream, such as audio and video PIDs for a program or the PID of some other associated program data. A table may be fragmented over many packets, and is covered by a CRC field to detect any residual errors during transmission.

PES Packet structure

The packet length of the PES is variable and contains a header and a payload called PES data. The PES header includes the packet start-code prefix, the stream identifier, the PES packet length, an optional PES header and a variable amount of stuffing bytes (FF).

Prefix 3 bytes	Str_id 1 byte	Length 2 bytes	PES header (opt)	FF (opt) (var)	PES data (var)

Figure 4: PES packet data bytes

Figure 5 shows how the multiplexing of PES packets results in the MPEG-2 TS, from the video and audio encoders.

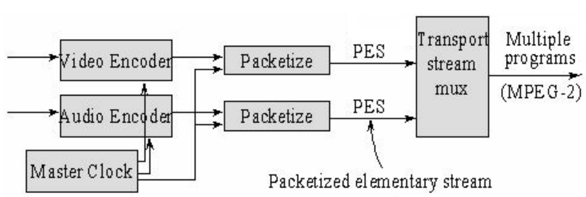

Figure 5: Multiplexing of MPEG-2 program streams

MPEG-2 TS receivers in DVB systems

As shown in figure 6, a DVB receiver will demultiplex the MPEG-2 transport stream typically consisting of audio and video - handled directly by their respective decoders - and possibly some data as well as applet-like programs, handed over to system memory for further processing.

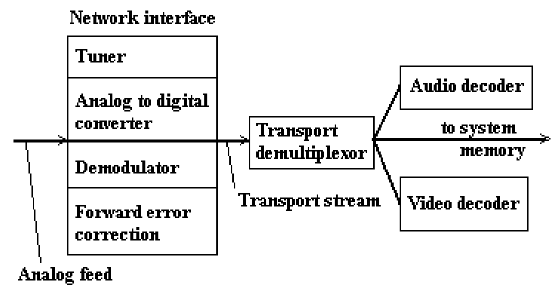

Figure 6: Data flow in a DVB receiver

Figure 7 shows an example of the possible scenarios of the transport of MPEG-4 multimedia stream within a DVB system. The data can either be sent directly from the MPEG-2 TS through the MPEG-4 decoders using transport layer information provided by the transport stream, or alternatively be sent through an IP stack as regular IP traffic before being handled by the MPEG-4 decoders. As one objective might be to use MPEG-TS as an IP bitstream, impact of overhead in terms of capacity and processing power may need to be considered in further work.

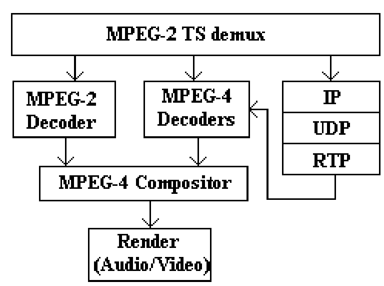

Figure 7: Transport of MPEG-4 streams over MPEG-2 TS

These scenarios for the transport of high quality multimedia may need further investigation, and may extend to the comparison between transfer of multimedia over DVB as IP data or within MPEG2 TS encapsulation.

Further work

The technical challenges of establishing an architecture combining MPEG-2 TS together with other wireless delivery technology in a flexible wireless IP transport network are non-trivial.

As the characteristics of wireless connections [6] shows numerous disadvantages such as high-error rates, connection degradation leading to frequent disconnections and potentially handovers in general, this being combined with different characteristics such as amount of FEC used, unequal quality of service, coverage area, handovers, presence of feedback channel and different spectrum capacity, it is of interest to provide an overview of the technologies addressed within such an architecture as the first step towards identifying these challenges.

DVB, together with MPEG-2 TS, being one of those wireless carriers considered for such a platform, raises another topic of interest which will be the elaboration of a QoS model based of the characteristics of all wireless carriers considered.

References

[1] MPEG-4 Applications, K. Diepold, ISO/IEC, July 1998.
[2] DVB-MHP presentation, Patrik Molander, Teracom, June 2000
[3] Design of an MPEG-2 transport demultiplexor core, R.E. Anderson, E.M. Foster, IBM, 1999
[4] MPEG-2 Transport over ATM Networks, Tryfonas, Varma, IEEE Communications, 1999.
[5] Multimedia Systems, Standards and Networks, Puri, Chen, Marcel Dekker, 1st Ed., 2000.
[6] The challenges of Mobile Computing, Forman, Zahorjan, University of Washington, 1994
[7] BRaIN project proposal, Pelletier, Ahmadi, Centre for Distance-spanning Technology, 2001