ELEC 691X/498X – Broadcast Signal Transmission Winter 2018

Instructor: DR. Reza Soleymani, Office: EV-5.125, Telephone: 848-2424 ext.: 4103.

Office Hours: Wednesday, Thursday, 14:00 – 15:00

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In this lecture we cover the following topics:

- MPEG Transport Stream MPEG-TS).
- Program Association Table (PAT).
- Program Map Table (PMT).

Reference:

- https://en.wikipedia.org/wiki/MPEG_transport_stream

- http://www.etsi.org/deliver/etsi_ts/102400_102499/10247001/01.02.01_60/ts_10247001v010201p.pdf

Lecture 6:
MPEG-Transport Stream

- We have so far learnt about how to compress the video and audio. We have also learnt about how we can transmit the compressed video as bit stream over the air or other media (modulation). We will later learn more about transmission aspects, e.g., error control coding, What we have not yet talked much about is how a receiver such as set top box or receiver embedded in our television set (or a DVD or Blu-ray player) puts back these bits together before attempting to decode the video and passing it through some interface such as HDMI or VGA to the screen.

- MPEG transport stream (MPEG-TS, MTS or TS) is used in broadcast systems such as DVB, ATSC and IPTV. It is used for transmission and storage of audio, video, and Program and System Information Protocol (PSIP) data. Transport Stream is specified in MPEG-2 Part 1, Systems (formally known as ISO/IEC standard 13818-1 or ITU-T Rec. H.222.0).
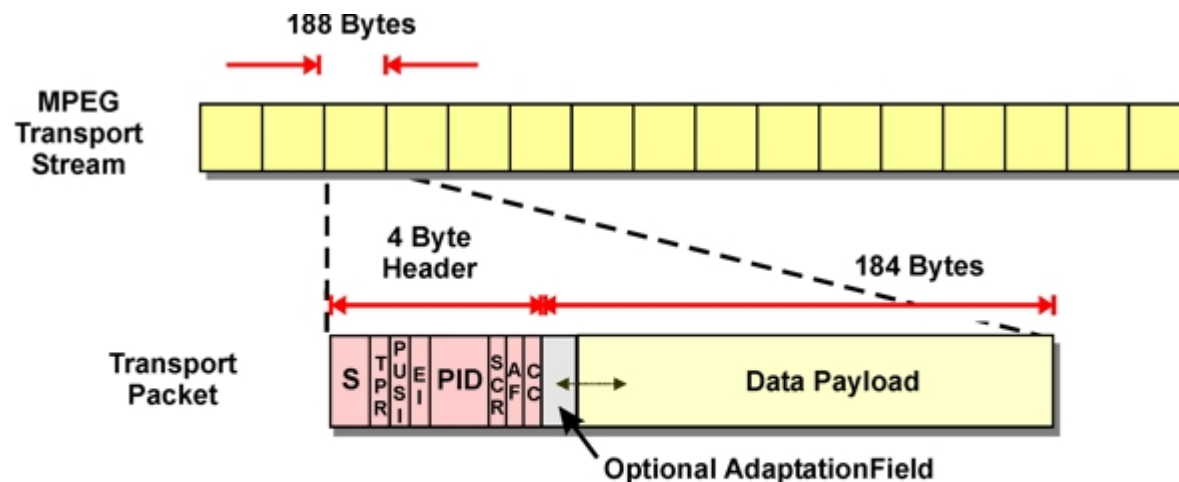
Lecture 6:
MPEG-Transport Stream

- Transport stream specifies a container* that encapsulates packetized elementary streams, with error correction and stream synchronization features for maintaining transmission integrity when the signal is degraded.

- Transport streams differ from the similarly named program streams in several important ways: program streams are designed for reasonably reliable media, such as discs (like DVDs), while transport streams are designed for less reliable transmission, namely terrestrial or satellite broadcast. Further, a transport stream may carry multiple programs.

- Like OSI protocol stack, Transport Stream has different layers. It specifies what programs are in the stream, what each program consists of (video, audio and data), etc.

* A container or wrapper format is a metafile format whose specification describes how different elements of data and metadata coexist in a computer file.

Lecture 6:
MPEG-Transport Stream

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- A packet is the basic unit of data in a transport stream. It starts with a sync byte and a header. Additional optional transport fields may follow. The rest of the packet consists of payload. Packets are 188 bytes. An extra 16 bytes may be added for error correction making it 204 bytes long.

188 Bytes

MPEG Transport Stream

4 Byte Header   184 Bytes

Transport Packet   S | TPR | PUSI | EI | PID | SCR | AF | CC | Data Payload

Optional AdaptationField

S - Sync
TPR - Transport Priority
PUSI - Payload Start
EI - Error Indicator

PID - Packet Identifier (stream ID)
SCR - Scrambling Control
AF - Adaptation Field
CC - Continuity Check Index

Lecture 6:
MPEG-Transport Stream

- **Program Identifier (PID):** Each table or elementary stream in a transport stream is identified by a 13-bit packet identifier (PID). A demultiplexer extracts elementary streams from the transport stream in part by looking for packets identified by the same PID. Examples of PID:

Decimal	Hex	Description
0	0x0000	Program Association Table (PAT): a directory listing of all Program Map Tables
1	0x0001	Conditional Access Table (CAT)
2	0x0002	Transport Stream Description Table contains descriptors relating to the overall transport stream
3	0x0003	Control Information Table containing control streams used by Program Map Tables
8188-8190	0x1FFC-0x1FFE	May be assigned as needed to Program Map Tables, elementary streams and other data tables
8191	0x1FFF	Null Packet (used for fixed bandwidth padding)

Lecture 6:
MPEG-TS: Programs

Programs

- Transport stream has a concept of programs. Each single program is described by a Program Map Table (PMT) which has a unique PID, and the elementary streams associated with that program have PIDs listed in the PMT.

Example: A transport stream used in digital television might contain three programs, to represent three television channels. Suppose each channel consists of one video stream, one or two audio streams, and any necessary metadata. A receiver wishing to decode a particular "channel" merely has to decode the payloads of each PID associated with its program. It can discard the contents of all other PIDs. A transport stream with more than one program is referred to as MPTS - Multi Program Transport Stream. A single program transport stream is referred to as SPTS - Single Program

Programs Specific Information (PSI)

- There are 4 PSI tables: Program Association (PAT), Program Map (PMT), Conditional Access (CAT), and Network Information (NIT). The MPEG-2 specification does not specify the format of the CAT and NIT.

Program Association Table (PAT)

- PAT stands for Program Association Table. It lists all programs available in the transport stream. Each of the listed programs is identified by a 16-bit value called program number. Each of the programs listed in PAT has an associated value of PID for its Program Map Table (PMT). The value 0x0000 of program number is reserved to specify the PID where to look for Network Information Table (NIT). If such a program is not present in PAT the default PID value (0x0010) shall be used for NIT. TS Packets containing PAT information always have PID 0x0000.

Lecture 6:
MPEG-TS: Programs

- **Program Map Tables (PMTs)** contain information about programs. For each program, there is one PMT. While the MPEG-2 standard permits more than one PMT section to be transmitted on a single PID (Single Transport stream PID contains PMT information of more than one program), most MPEG-2 "users" such as ATSC and SCTE require each PMT to be transmitted on a separate PID that is not used for any other packets. The PMTs provide information on each program present in the transport stream, including the program number, and list the elementary streams that comprise the described MPEG-2 program. There are also locations for optional descriptors that describe the entire MPEG-2 program, as well as an optional descriptor for each elementary stream. Each elementary stream is labeled with a stream type value.

- **Conditional Access Table (CAT)** provides information about the conditional access method used on this network and where the relevant streams can be found. This table is used when the scrambling is performed at the MPEG Transport Stream level.

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Program Clock Reference (PCR)

- To enable a decoder to present synchronized content, such as audio tracks matching the associated video, at least once each 100 ms a Program Clock Reference, or PCR is transmitted in the adaptation field of an MPEG-2 transport stream packet. The PID with the PCR for an MPEG-2 program is identified by the pcr pid value in the associated Program Map Table. The value of the PCR, when properly used, is employed to generate a system timing_clock in the decoder. The STC or System Time Clock decoder, when properly implemented, provides a highly accurate time base that is used to synchronize audio and video elementary streams. Timing in MPEG2 references this clock. For example, the presentation time stamp (PTS) is intended to be relative to the PCR. The first 33 bits are based on a 90 kHz clock. The last 9 are based on a 27 MHz clock. The maximum jitter permitted for the PCR is +/- 500 ns.

Lecture 6:
MPEG-TS: Null Packets

Null Packets

- Some transmission schemes, such as those in ATSC and DVB, impose strict constant bitrate requirements on the transport stream. In order to ensure that the stream maintains a constant bitrate, a Multiplexer may need to insert some additional packets. The PID 0x1FFF is reserved for this purpose. The payload of null packets may not contain any data at all, and the receiver is expected to ignore its contents.