Digital video broadcasting module

DVB AND MPEG

h.shirazi@qmul.ac.uk

Dr Hamid Shirazi

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Week3: Day-1

Advantage of DTV over Analogue TV

It has several advantages over the traditional analogue TV.

- The most significant one is that digital channels take up less bandwidth space
- It also provides movie-quality picture and CD-quality sound along with a variety of other enhancements.
- It is possible to apply compression methods:
    - about five digital programs can be broadcast via an analogue channel.
    - It results in significant frequency saving and wider choice of programs therefore digital broadcasters can provide more digital channels in the same space.
- In addition, it can also provide a High-Definition digital service or other services, such as multimedia or interactive services.
- Enhanced user experience:
    - an electronic program guide (EPG) allows easier orientation between digital programs;
    - Moreover, additional information can be obtained for the programs. If the television set has a bilateral channel, the Internet service can be received.

DVB Systems

pan-European platform, known as DVB, was established in 1993.
Its aim was to create standards and to disperse it world-wide. DVB standards were evolved in order to specify the transmission and encoding technology of digital broadcasting in different platforms:

- Satellite – DVB-S
    - Channel characteristics: electro- magnetic disorders, such as lightning, the rapid change in the ionosphere properties
    - Viterbi error-correcting code and QPSK (modulating 4 different phases of a reference signal)
- Cable – DVB-C
    - Channel characteristics: Signal travels only in one route
    - QAM (chanding amplitude and phase of carrier waves)
    - Channel coding
- Terrestrial – DVB-T
    - OFDM (multi-carrier modulation scheme using orthogonally spaced sub-carriers modulated e.g. QAM)
    - Concatenated channel coding
- Mobile – DVB-H
    - adapts the successful DVB-T system for digital terrestrial television to the specific requirements of handheld, battery-powered receivers

Baseband Processing for DVB

- In DVB project, it was decided that by all members that for source coding of audio and video signals, as well as multiplexing of the different signals, the standards developed by the Moving Pictures Experts Group, MPEG-2, should be used.
    - The reason for this decision was the fact that MPEG-2 promised to become a solution that could be accepted world-wide, a promise that has since been fulfilled. This, in turn, will make it possible to use **affordable integrated circuits** from various manufacturers, especially in the decoders.
- MPEG-2 is a set of generic standards.
    - It is not possible to just use the existing standards documents and start a DVB service or build IRDs.
    - Instead, subsets need to be defined in the form of implementation **guidelines** for the specific services to be realized.
    - Currently, the DVB Project has defined such guidelines for multiprogram television services with different image quality levels from limited-definition TV (LDTV) via standard-definition TV (SDTV) to enhanced-definition TV (EDTV) and high-definition TV (HDTV).
- Usefulness of selecting one of the **scalable profiles** described in the MPEG- 2 documentation:
    - One of the applications of scalability is embedding SDTV image content in HDTV data streams (spatial scalability).
    - This enables a broadcaster to transmit only **one video signal** which may be decoded by an SDTV decoder in order to display an SDTV image and by an HDTV decoder in order to display an HDTV image.
    - Based on the results of this research the DVB Project made the decision to **ignore spatial scalability** and instead introduce the concept of **simulcasting**.

For simulcasting

same video signal is transmitted twice within one transport stream, namely as an SDTV signal and as an HDTV signal.

It was found that at a given cumulative data rate for both signals the **quality** of the SDTV and HDTV images is better than when using the same data rate to transmit a scalable signal

MPEG Standards

MPEG = Moving Pictures Expert Group

MPEG-1	MPEG-2	MPEG-4	MPEG-7	MPEG-21
Part1: systems ISO/IEC11172-1 "PES layer"	Part1: systems ISO/IEC13818-1 "Transportation"	Part1: systems ISO/IEC14496	Metadata, XML based ISO/IEC15938 "Multimedia Content Description Interface"	additional "tools" ISO/IEC21000
Part2: video ISO/IEC11172-2	Part2: video ISO/IEC13818-2	Part2: video ISO/IEC14496-2		
Part3: audio ISO/IEC11172-3	Part3: audio ISO/IEC13818-3	Part3: audio (AAC) ISO/IEC14496-3		
	Part6: DSM-CC ISO/IEC13818-6	Part10: video (AVC, H.264) ISO/14496-10		
	Part7: AAC ISO/IEC13818-7			

Audio and Video coding (brief)

- The description of the data signal structure will begin with uncompressed A/V signals
- SDTV raw signal will have a date rate of 270 Mbit/s
    - The video signals are compressed to about 1 Mbit/s in MPEG-1 and to about 2 - 7 Mbit/s in MPEG-2. The video data rate can be constant or variable (statistical multiplex).
- Digital stereo audio signal (CD quality) will have a data rate of 1.5 Mbit/s
    - The audio signals have a data rate of about 100 - 400 kbit/s (mostly 192 kbit/s) after compression – audio data rate is always constant and a multiple of 8 kbit/s

Figure 4 illustrates the audio and video raw signals.

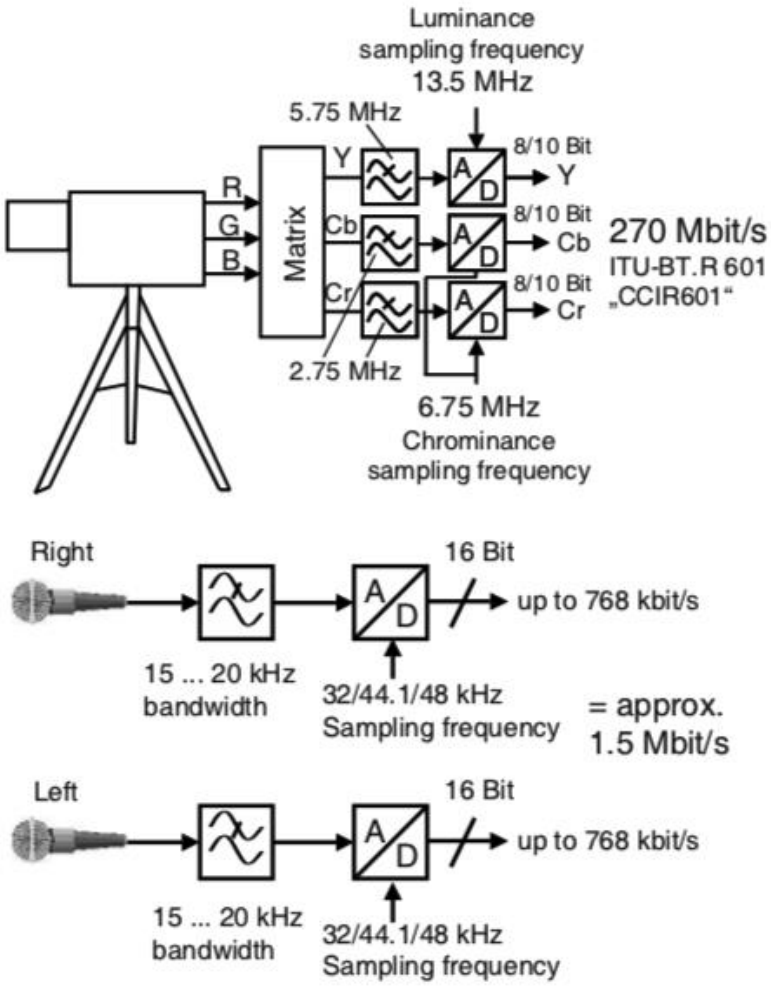


Figure 1: video and audio data signals

MPEG data stream – Elementary Streams

- Elemntary streams (ES):
  - The compressed video and audio signals in MPEG are called “elementary streams”, ES in brief.
  - There are thus video streams, audio streams and, quite generally, data streams, the latter containing any type of compressed or uncompressed data.
  - Immediately after having been compressed (i.e. encoded), all the elementary streams are divided into variable-length packets, both in MPEG-1 and in MPEG-2 as depicted in Figure 2.

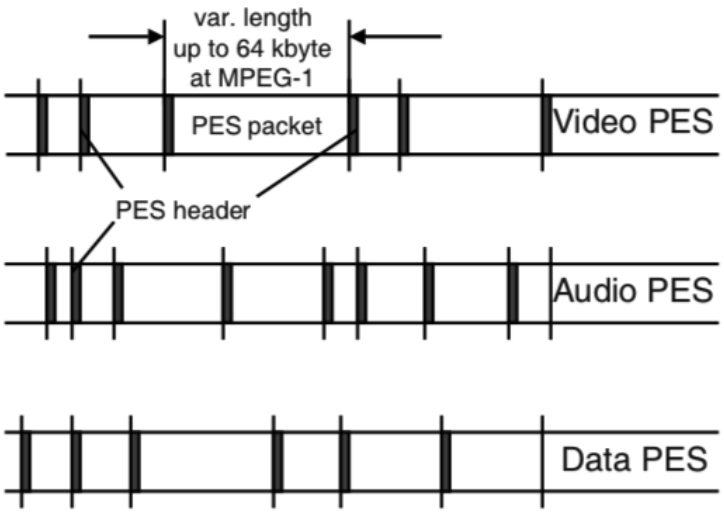


Figure 2: MPEG Elementary Streams

Variable length containers:

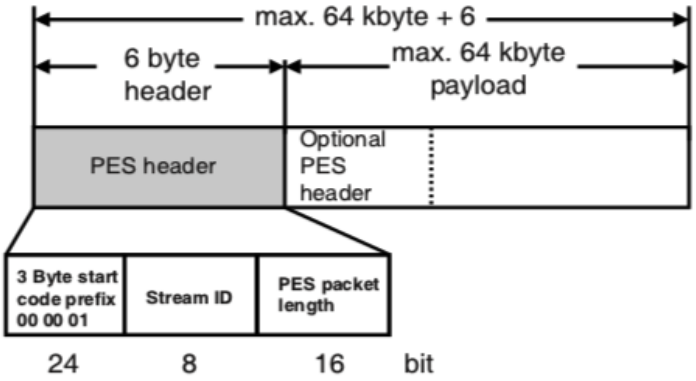
it is possible to have sometimes more and sometimes less compression depending on the instantaneous video and audio content, hence variable- length containers are needed in the data signal. These containers carry one or more compressed frames in the case of the video signal and one or more compressed audio signal segments in the case of the audio signal.

MPEG data stream – Packetised Elementary Stream (PES)

- Packetised elementary streams (PES):
  - Elementary streams are dividied in packets called PES and each packet will have size of up to 64 kbytes.
  - Each PES consists of a short header and payload.
    - **Header** will have a 16bit *indicator* for the max. 64 kbytes
    - **Payload** contains either compressed audio/video streams or a pure data stream.
  - ❖ In case the video packets are longer than 64 kbytes, *indicator* will be 0 and decoder should use other mechanism to find the end of the packet e.g. start code.

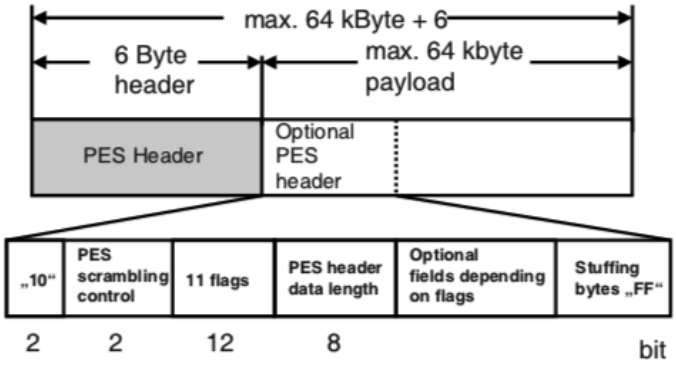
PES packet structure and PES header structure

- Start cord prefix (3 byte) = 000001
- Stream ID to indicate type of ES (video, audio, data)
- Packet length (2 bytes) if set to 0 decoder can use start code to find PES packet limits



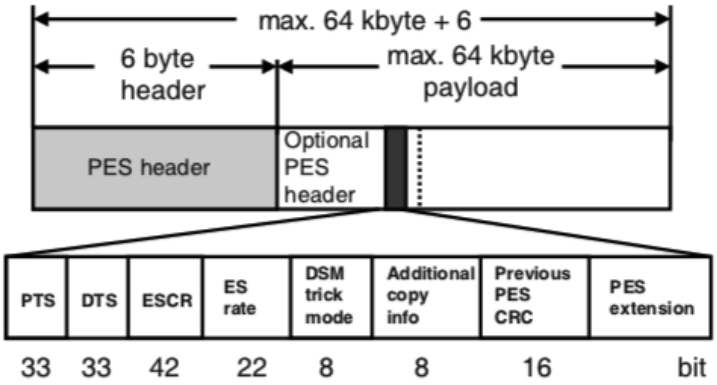
Optional PES header in payload structure

- Controlled by 11 flags in total of 12 bits
- PES header data length shows total size of header



Optional fields inside optional PES header

- Presentation time stamp (PTS) and Decoding time stamp (DTS) are used for synchronization of audio and video



Multiplexing MPEG-2 Transport Streams

- A **program** can contain video and audio, only audio (audio broadcast) or only data, and the structure is thus flexible and can also change during the trans- mission.
    - E.g. Formula 1 transmission with a number of camera angles (track, spectators, car, helicopter) and presented in different languages.
- All the multiplexed data streams of all the programs are then multiplexed again and combined to form a complete data stream which is called an "**MPEG-2 transport stream**"
    - An MPEG-2 transport stream contains the 188-byte-long transport stream packets of all programs with all their video, audio and data signals.
- Depending on the data rates, packets of one or the other elementary streams will occur more or less frequently in the MPEG-2 transport stream.
- For each program there is one MPEG encoder which encodes all elementary streams, generates a PES structure and then packetizes these PES packets into transport stream packets.
- The data rate for each program is usually approx. 2 - 7 Mbit/s but the aggregate data rate for video, audio and data can be constant or vary in accordance with the program content at the time. This is then called "**statistical multiplex**".

    ❖ The transport streams of all the programs are then combined in a multiplexed MPEG-2 data stream to form one overall transport stream (Figure 3) which can then have a data rate of up to about 40 Mbit/s.

- There are often up to 6, 8 or 10 or even 20 programs in one transport stream. The data rates can vary during the transmission but the overall data rate has to remain constant.

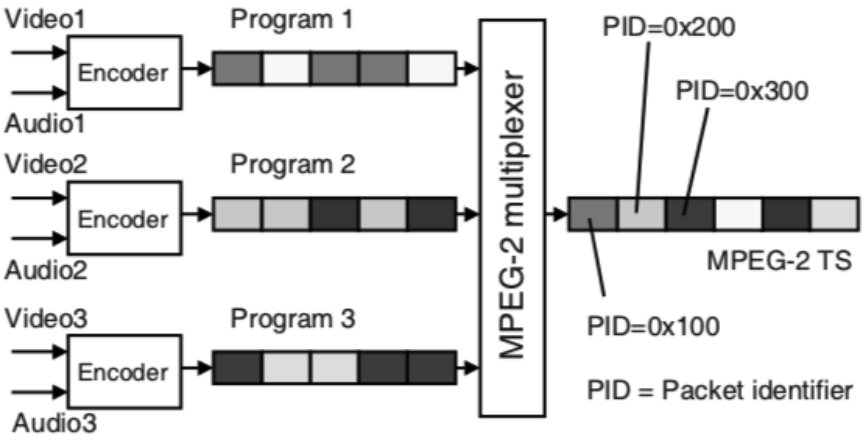


Figure 3: Multiplexed MPEG-2 transport stream packerts

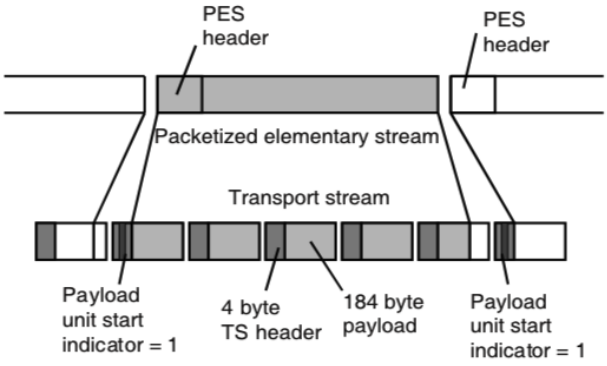
MPEG Transport Streams (TS)

- This "Packetized Elementary Stream" (PES) with its relatively long packet structures is not, however, suitable for transmission and especially not for broadcasting a number of programs in one **multiplexed** data signal. To this end, the long PES packets are additionally divided into smaller packets of constant-length.
- In MPEG-2, the objective has been to assemble **up to 6, 10 or even 20** independent TV or radio programs to form one common multiplexed MPEG-2 data signal.
- This data signal is then transmitted via satellite, cable or terrestrial transmission links.

From the PES packets, 184-byte-long pieces are taken and to these another 4-byte-long header is added making up 188-byte-long packets called "transport stream packets" which are then multiplexed.

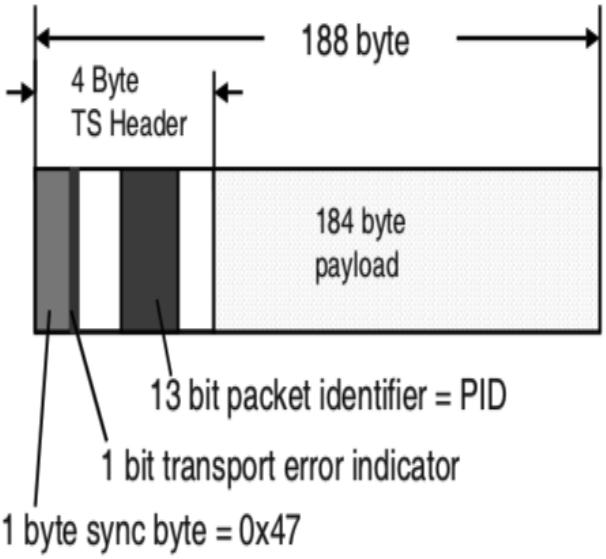
- To be able to determine the current structure of the transport stream during the decoding, the transport stream also carries lists describing the structure, so-called "**tables**".

Forming MPEG-2 transport stream packets



MPEG-2 transport stream packet structure

- Header (4 bytes)
  - Sync byte using constant spacing of 188 bytes in TS and value of 0x47 – after receieving 5 TS, sync is repeated in decoder
  - PID and tables shows which ES or content payload is.
  - Error indicator set by de-modulator to 1, if error can't be corrected. Reed-Solomon is used in DVB -C/S/T to correct up to 8 errors. 16 bytes Checksum is added to 188 bytes TS.
- Payload (184 bytes)



MPEG Service Information (SI)

- Service Information (SI) is a necessary ingredient of all future digital services.
- The term service information stands for a set the information tables that will be transmitted together with the programmes.
- The data included in the tables are - among other things – meant to enable automatic configuration of a receiver and to help establish the user interface of future DVB receivers.
- A comprehensive list of program type descriptors is provided, as is a table called a parental guide. This will inform parents about the suitability of programs for certain age groups and will enable them to block the viewing of unsuitable ones.
- Several additional technical solutions were found to complete the list of baseband processing functionalities required by today's broadcast services.
- The incorporation of teletext services or the generation and embedding of subtitles and of all kinds of stationary graphical elements such as logos need to be mentioned as examples.

The service information tables contain information about each **specific program**, the **bouquet of programs** of a specific broadcaster, the current **event** within the program, and so on.

Some definitions and abbreviations

Bouquet	A collection of services marketed as a single entity
broadcaster (SERVICE Provider)	An organization which assembles a sequence of events or programmes to be delivered to the viewer based upon a schedule
component (ELEMENTARY Stream)	One or more entities which together make up an event, e.g. video, audio, teletext
Conditional Access (CA) system	A system to control subscriber access to services, programmes and events e.g. Videoguard, Eurocrypt
delivery system	The physical medium by which one or more multiplexes are transmitted e.g. satellite system, wide- band coaxial cable, fibre optics, terrestrial channel of one emitting point
Entitlement Management Messages (EMM)	Are private Conditional Access information which specify the authorization levels or the services of specific decoders. They may be addressed to individual decoder or groups of decoders
Event	A grouping of elementary broadcast data streams with a defined start and end time belonging to a common service, e.g. first half of a football match, News Flash, first part of an entertainment show
MPEG-2	Refers to the standard ISO/IEC 13818. Systems coding is defined in part 1. Video coding is defined in part 2. Audio coding is defined in part 3
Multiplex	A stream of all the digital data carrying one or more services within a single physical channel
Network	A collection of MPEG-2 Transport Stream (TS) multiplexes transmitted on a single delivery system, e.g. all digital channels on a specific cable system
original_network_id	A unique identifier of a network
Programme	A concatenation of one or more events under the control of a broadcaster e.g. news show, entertainment show

DVB service delivery model

The relationship of some of these definitions are illustrated in Figure 4.

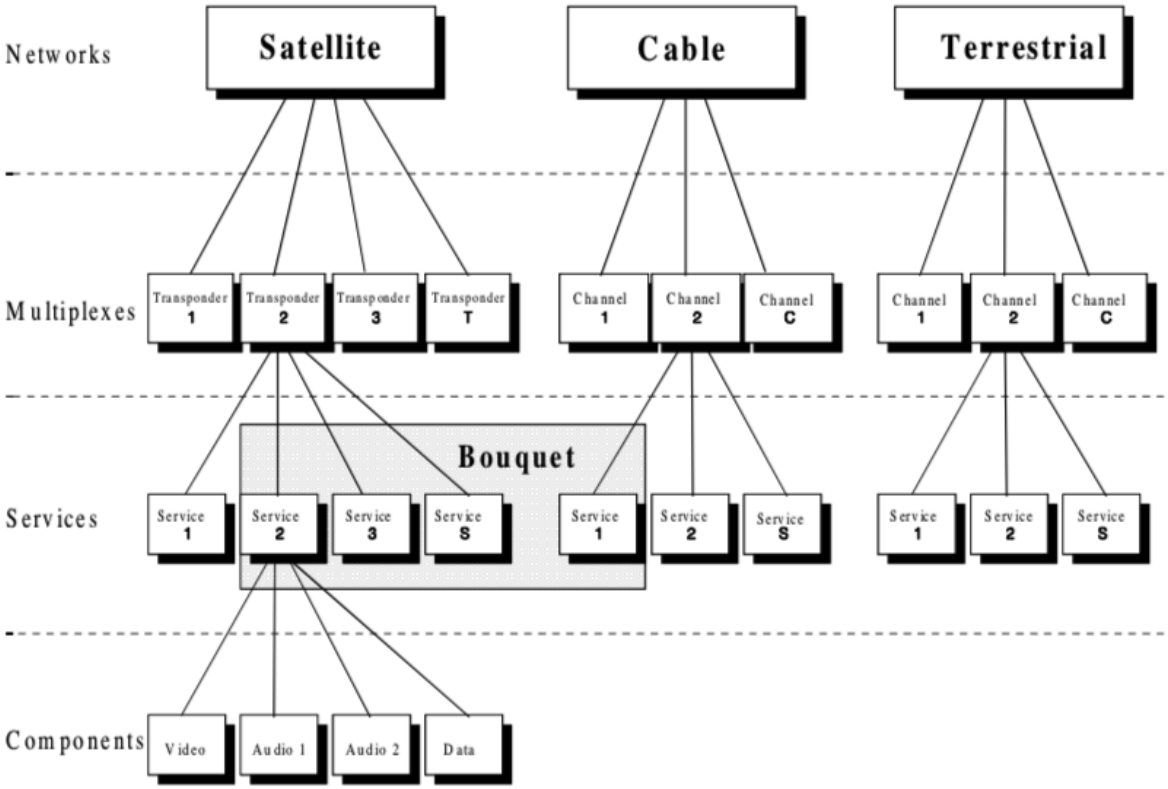


Figure 4: DVB service delivery model

Service Information (SI) in DVB

- Service Information (SI) data forms a part of DVB bitstreams:
    - in order that the user can be provided with information to assist in selection of services and/or events within the bitstream,
    - and so that the Integrated Receiver Decoder (IRD) can automatically configure itself for the selected service.
    - SI data for automatic configuration is mostly specified within ISO/IEC 13818-1 as Program Specific Information (PSI).
- In addition, more data can be used as complements to PSI to aid automatic tuning of IRDs, and additional information intended for display to the user. The manner of presentation of the information is not specified in the standard, and IRD manufacturers have freedom to choose appropriate presentation methods.
- It is expected that Electronic Programme Guides (EPGs) will be a feature of Digital TV transmissions.
    - The definition of an EPG is outside the scope of SI specification, but the data contained within the SI may be used as the basis for an EPG.

Service Information (SI) description

- ISO/IEC 13818 specifies SI which is referred to as PSI.
- The PSI data provides information to enable automatic configuration of the receiver to demultiplex and decode the various streams of programs within the multiplex.
- The PSI data is structured as four types of table. The tables are transmitted in sections.

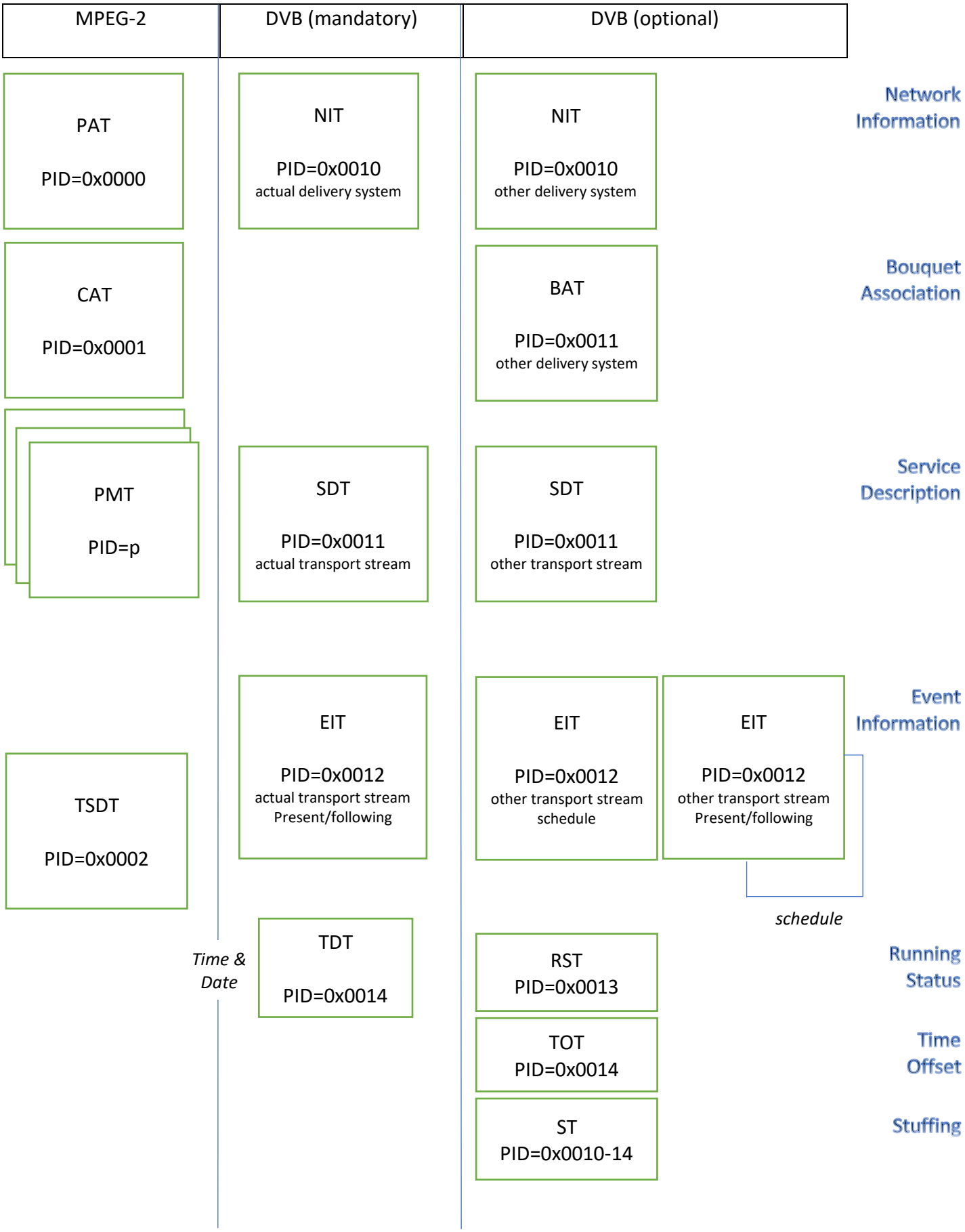
Programme Association Table (PAT)	Conditional Access Table (CAT)	Programme Map Table (PMT)	Network Information Table (NIT)
for each service in the multiplex, the PAT indicates the location (the Packet Identifier (PID) values of the Transport Stream (TS) packets of the corresponding Program Map Table (PMT). It also gives the location of the Network Information Table (NIT).	CAT provides information on the CA systems used in the multiplex; the information is private (will be explained later) and dependent on the CA system, but includes the location of the EMM stream, when applicable.	PMT identifies and indicates the locations of the streams that make up each service, and the location of the **Program Clock Reference** fields for a service.	NIT is intended to provide information about the physical network. The syntax and semantics of the NIT are defined in EN 300 468.

Additional DVB information (tables)

- PAT, CAT, and PMT of the PSI give information only for the multiplex in which they are contained (the actual multiplex).
- The additional information can also provide information on services and events carried by **different multiplexes, and even on other networks**. This data is structured as nine **tables**:

Bouquet Association Table (BAT)	provides information regarding bouquets. As well as giving the name of the bouquet, it provides a list of services for each bouquet.
ServiceDescriptionTable (SDT)	contains data describing the services in the system e.g. names of services, the service provider, etc.
EventInformationTable (EIT)	contains data concerning events or programmes such as event name, start time, duration, etc. The use of different descriptors allows the transmission of different kinds of event information e.g. for different service types.
RunningStatusTable (RST)	gives the status of an event (running/not running). The RST updates this information and allows timely automatic switching to events.
TimeandDateTable (TDT)	gives information relating to the present time and date. This information is given in a separate table due to the frequent updating of this information.
TimeOffsetTable (TOT)	gives information relating to the present time and date and local time offset. This information is given in a separate table due to the frequent updating of the time information.
StuffingTable (ST)	is used to invalidate existing sections, for example at delivery system boundaries.
SelectionInformationTable (SIT)	is used only in "partial" (i.e. recorded) bitstreams. It carries a summary of the SI information required to describe the streams in the partial bitstream.
DiscontinuityInformationTable (DIT)	is used only in "partial" (i.e. recorded) bitstreams. It is inserted where the SI information in the partial bitstream may be discontinuous.

General organisation of SI



Structure of SI tables

- SI and MPEG-2 PSI tables shall be segmented into one or more sections before being inserted into TS packets.
- The tables, when transmitted shall not be scrambled, with the exception of the EIT, which may be scrambled if required
    - If a scrambling method operating over TS packets is used, it may be necessary to use a stuffing mechanism to fill from the end of a section to the end of a packet so that any transitions between scrambled and unscrambled data occur at packet boundaries.
    - In order to identify the CA streams which control the descrambling of the EIT data, a scrambled EIT schedule table shall be identified in the PSI.
    - Service_id value 0xFFFF is allocated to identifying a scrambled EIT, and the program map section for this service shall describe the EIT as a private stream and shall include one or more CA_descriptors which give the PID values and optionally, other private data to identify the associated CA streams.
    - Service_id value 0xFFFF shall not be used for any other service.

Table explanation

<table>
<tr><td>Table_id</td><td>Identifies to which section the table belongs. List of values:
<table>
<tr><th>Table</th><th>PID value</th></tr>
<tr><td>PAT</td><td>0x0000</td></tr>
<tr><td>CAT</td><td>0x0001</td></tr>
<tr><td>TSDT</td><td>0x0002</td></tr>
<tr><td>reserved</td><td>0x0003 to 0x000F</td></tr>
<tr><td>NIT, ST</td><td>0x0010</td></tr>
<tr><td>SDT, BAT, ST</td><td>0x0011</td></tr>
<tr><td>EIT, ST</td><td>0x0012</td></tr>
<tr><td>RST, ST</td><td>0x0013</td></tr>
<tr><td>TDT, TOT, ST</td><td>0x0014</td></tr>
<tr><td>network synchronization</td><td>0x0015</td></tr>
<tr><td>reserved for future use</td><td>0x0016 to 0x001D</td></tr>
<tr><td>DIT</td><td>0x001E</td></tr>
<tr><td>SIT</td><td>0x001F</td></tr>
</table></td></tr>
<tr><td>Table_id_extension</td><td>Identifies the sub-table:
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0x00</td><td>program_association_section</td></tr>
<tr><td>0x01</td><td>conditional_access_section</td></tr>
<tr><td>0x02</td><td>program_map_section</td></tr>
<tr><td>0x03</td><td>transport_stream_description_section</td></tr>
<tr><td>0x04 to 0x3F</td><td>reserved</td></tr>
<tr><td>0x40</td><td>network_information_section - actual_network</td></tr>
<tr><td>0x41</td><td>network_information_section - other_network</td></tr>
<tr><td>0x42</td><td>service_description_section - actual_transport_stream</td></tr>
<tr><td>0x43 to 0x45</td><td>reserved for future use</td></tr>
<tr><td>0x46</td><td>service_description_section - other_transport_stream</td></tr>
<tr><td>0x47 to 0x49</td><td>reserved for future use</td></tr>
<tr><td>0x4A</td><td>bouquet_association_section</td></tr>
<tr><td>0x4B to 0x4D</td><td>reserved for future use</td></tr>
<tr><td>0x4E</td><td>event_information_section - actual_transport_stream, present/following</td></tr>
<tr><td>0x4F</td><td>event_information_section - other_transport_stream, present/following</td></tr>
<tr><td>0x50 to 0x5F</td><td>event_information_section - actual_transport_stream, schedule</td></tr>
<tr><td>0x60 to 0x6F</td><td>event_information_section - other_transport_stream, schedule</td></tr>
<tr><td>0x70</td><td>time_date_section</td></tr>
<tr><td>0x71</td><td>running_status_section</td></tr>
<tr><td>0x72</td><td>stuffing_section</td></tr>
<tr><td>0x73</td><td>time_offset_section</td></tr>
<tr><td>0x74 to 0x7D</td><td>reserved for future use</td></tr>
<tr><td>0x7E</td><td>discontinuity_information_section</td></tr>
<tr><td>0x7F</td><td>selection_information_section</td></tr>
<tr><td>0x80 to 0xFE</td><td>user defined</td></tr>
<tr><td>0xFF</td><td>reserved</td></tr>
</table></td></tr>
<tr><td>Section_number</td><td>allows the sections of a particular sub_table to be reassembled in their original order by the decoder.
Recommenation: sections are transmitted in numerical order, unless it is desired to transmit some sections of the sub_table more frequently than others, e.g. due to random access considerations.</td></tr>
<tr><td>Version_number</td><td>When characteristics of the TS described in the SI change (e.g. new events start, different composition of elementary streams for a given service), then new SI data shall be sent containing the updated information.
A new version of the SI data is signalled by sending a sub_table with the same identifiers as the previous sub_table containing the relevant data, but with the next value of version_number.</td></tr>
<tr><td>Current_next_indicator</td><td>Each section shall be numbered as valid "now" (current), or as valid in the immediate future (next).
This allows the transmission of a future version of the SI in advance of the change, giving the decoder the opportunity to prepare for the change.
There is however, no requirement to transmit the next version of a section in advance, but if it is transmitted, then it shall be the next correct version of that section.</td></tr>
</table>

Example: Network Informatin Table (NIT)

- The NIT conveys information relating to the physical organization of the multiplexes/TSs carried via a given network, and the characteristics of the network itself.
- The combination of **original_network_id** and **transport_stream_id** allow each TS to be uniquely identified throughout the ETS application area.
- Networks are assigned individual **network_id** values, which serve as unique identification codes for networks, more information in ETR 162[1].
- In the case that the NIT is transmitted on the network on which the TS was originated, the network_id and the original_network_id shall take the same value.
    - Guidelines for the processing of SI at transitions between delivery media boundaries, e.g. from satellite to cable or SMATV systems, can be found in ETR 211[2].
- IRDs may be able to store the NIT information in non-volatile memory in order to minimize the access time when switching between channels ("**channel hopping**").
- The **NIT shall be segmented into network_information_sections** as shown in **Figure 5**.
    - Any sections forming part of an NIT shall be transmitted in TS packets with a **PID value of 0x0010**.
    - Any sections of the NIT which describe the **actual network** (that is, the network of which the TS containing the NIT is a part) shall have the **table_id value 0x40** with the network_id field taking the value assigned to the actual network in ETR 162.
    - Any sections of an NIT which refer to a **network other than the actual network** shall take a **table_id value of 0x41** and the network_id shall take the value allocated to the other network in ETR 162.

Syntax	No. of bits	Identifier
network_information_section(){		
table_id	8	uimsbf
section_syntax_indicator	1	bslbf
reserved_future_use	1	bslbf
reserved	2	bslbf
section_length	12	uimsbf
network_id	16	uimsbf
reserved	2	bslbf
version_number	5	uimsbf
current_next_indicator	1	bslbf
section_number	8	uimsbf
last_section_number	8	uimsbf
reserved_future_use	4	bslbf
network_descriptors_length	12	uimsbf
for(i=0;i<N;i++){		
descriptor()		
}		
reserved_future_use	4	bslbf
transport_stream_loop_length	12	uimsbf
for(i=0;i<N;i++){		
transport_stream_id	16	uimsbf
original_network_id	16	uimsbf
reserved_future_use	4	bslbf
transport_descriptors_length	12	uimsbf
for(j=0;j<N;j++){		
descriptor()		
}		
}		
CRC_32	32	rpchof
}		

Figure 5: Network Information section

[1] ETR 162: "Digital Video Broadcasting (DVB); Allocation of Service Information (SI) codes for DVB systems".
[2] ETR 211: "Digital Video Broadcasting (DVB); Guidelines on implementation and usage of Service Information (SI)".

Example: Bouquet Association Table (BAT)

- The BAT provides information regarding bouquets.
- A **bouquet** is a collection of services, which may traverse the boundary of a network.
- The BAT shall be segmented into **bouquet_association_sections** using the syntax of table below.
- Any sections forming part of a BAT shall be transmitted in TS packets with a **PID value of 0x0011**.
- The sections of a BAT sub_table describing a particular bouquet shall have the bouquet_id field taking the value assigned to the bouquet described in ETR 162. All BAT sections shall take **a table_id value of 0x4A**.

Syntax	No. of bits	Identifier
bouquet_association_section(){		
table_id	8	uimsbf
section_syntax_indicator	1	bslbf
reserved_future_use	1	bslbf
reserved	2	bslbf
section_length	12	uimsbf
bouquet_id	16	uimsbf
reserved	2	bslbf
version_number	5	uimsbf
current_next_indicator	1	bslbf
section_number	8	uimsbf
last_section_number	8	uimsbf
reserved_future_use	4	bslbf
bouquet_descriptors_length	12	uimsbf
for(i=0;i<N;i++){		
descriptor()		
}		
reserved_future_use	4	bslbf
transport_stream_loop_length	12	uimsbf
for(i=0;i<N;i++){		
transport_stream_id	16	uimsbf
original_network_id	16	uimsbf
reserved_future_use	4	bslbf
transport_descriptors_length	12	uimsbf
for(j=0;j<N;j++){		
descriptor()		
}		
}		
CRC_32	32	rpchof
}		

Example: Service Description Table (SDT)

- Each sub_table of the SDT shall describe **services that are contained within a particular TS**. The services may be part of the actual TS or part of other TSs, these being identified by means of the **table_id**.
- The SDT shall be segmented into **service_description_sections** using the syntax of table below.
- Any sections forming part of an SDT shall be transmitted in TS packets with a **PID value of 0x0011**.
- Any sections of the SDT which describe the actual TS (that is, the TS containing the SDT) shall have the **table_id value 0x42**, and any sections of an SDT which refer to a TS other than the actual TS shall take a **table_id value of 0x46**.

Syntax	No. of bits	Identifier
service_description_section(){		
table_id	8	uimsbf
section_syntax_indicator	1	bslbf
reserved_future_use	1	bslbf
reserved	2	bslbf
section_length	12	uimsbf
transport_stream_id	16	uimsbf
reserved	2	bslbf
version_number	5	uimsbf
current_next_indicator	1	bslbf
section_number	8	uimsbf
last_section_number	8	uimsbf
original_network_id	16	uimsbf
reserved_future_use	8	bslbf
for (i=0;i<N;i++){		
service_id	16	uimsbf
reserved_future_use	6	bslbf
EIT_schedule_flag	1	bslbf
EIT_present_following_flag	1	bslbf
running_status	3	uimsbf
free_CA_mode	1	bslbf
descriptors_loop_length	12	uimsbf
for (j=0;j<N;j++){		
descriptor()		
}		
}		
CRC_32	32	rpchof
}		

If set to 0, means none of the component streams of the service is scambled,
If set to 1, means one or more components are controlled by CA system.

Value	Meaning
0	undefined
1	not running
2	starts in a few seconds (e.g. for video recording)
3	pausing
4	running
5 to 7	reserved for future use

Figure 6: running status (3bit) shows the status of the service

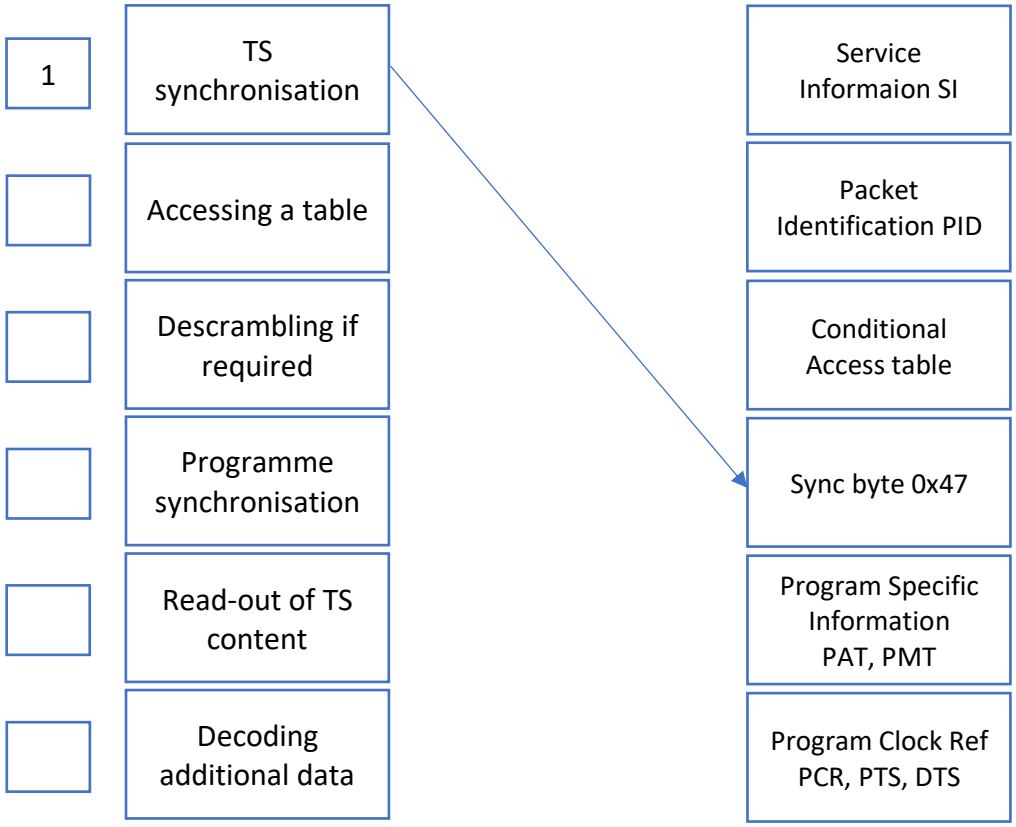
Example: Event Information Table (EIT)

- The EIT provides information in **chronological** order regarding the events contained within each service.
- Four classifications of EIT have been identified, distinguishable by the use of different table_ids:
    - ❖ actualTS, present/following event information=table_id="0x4E"
    - ❖ otherTS, present/following event information=table_id="0x4F"
    - ❖ actualTS,event schedule information=table_id="0x50"to"0x5F"
    - ❖ otherTS,event schedule information=table_id="0x60"to"0x6F"
- The **present/following table** shall contain only information pertaining to the present event and the chronologically following event carried by a given service on either the actual TS or another TS.
    - ❖ Except in the case of a **Near Video On Demand (NVOD)** reference service where it may have more than two event descriptions.
- The **event schedule tables** for either the actual TS or other TSs, contain a list of events, in the form of a schedule, namely, including events taking place at some time beyond the next event. **The EIT schedule tables are optional**. The event information shall be chronologically ordered.
- The EIT shall be segmented into event_information_sections using the syntax of table below.
- Any sections forming part of an EIT shall be transmitted in TS packets with a **PID value of 0x0012**.

Syntax	No. of Bits	Identifier
event_information_section(){		
table_id	8	uimsbf
section_syntax_indicator	1	bslbf
reserved_future_use	1	bslbf
reserved	2	bslbf
section_length	12	uimsbf
service_id	16	uimsbf
reserved	2	bslbf
version_number	5	uimsbf
current_next_indicator	1	bslbf
section_number	8	uimsbf
last_section_number	8	uimsbf
transport_stream_id	16	uimsbf
original_network_id	16	uimsbf
segment_last_section_number	8	uimsbf
last_table_id	8	uimsbf
for(i=0;i<N;i++){		
event_id	16	uimsbf
start_time	40	bslbf
duration	24	uimsbf
running_status	3	uimsbf
free_CA_mode	1	bslbf
descriptors_loop_length	12	uimsbf
for(i=0;i<N;i++){		
descriptor()		
}		
}		
CRC_32	32	rpchof
}		

Exercise:

1) Order the sequence of processes taken place at the receiver to retrieve information and map them with associated parameter(s).



2) In case that video and audio are un-synchronised (lip-sync error), what parameters should be checked in the PES video and audio headers?

A. PCR and STC countrer
B. STC and PCR
C. PTS (repeat cycle of 700ms derived from STC) and DTS
D. STC and DTS

3) ATM cell is 53 Bytes containing 4 bytes of header and 48 bytes of payload. Considering MPEG-2 is also asynchronous, how many ATM cells can be used to transfer one MPEG-2 Transport Stream.

A. 5 ATM cells
B. 4 ATM cells
C. 8 ATM cells
D. ATM cell is not suitable for transmission of MPEG-2 TS