

# PSS – Istanbul Monitoring PSI/SI in DVB MPEG-2 TS

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### Scope

The present presentation provides a practical monitoring overview using the PSI/SI metadata within the TR 101.290 checks at a DVB Mpeg2 Transport Stream .

The following referenced documents are:

- ETSI TR 101 290 V1.3.1 (2014-07)
- ISO/IEC 13818-1 (ITU-T Recommendation H.222.0): "Information technology - Generic coding of moving pictures and associated audio information: Systems".
- ETSI EN 300 468: "Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems".
- ETSI TR 101 211: "Digital Video Broadcasting (DVB); Guidelines on implementation and usage of Service Information (SI)".



### Introduction

Metadata is a term which is attributed to Nicholas Negraponte and appears in his book, "Being Digital".

Metadata can be defined as data describing other data.

Searching through metadata is much faster than searching through the actual content.



### **Introduction MPEG**

- MPEG stands for Moving Picture Experts Group
- The MPEG working group of authorities was formed by the International Organization for Standardization (ISO) and the International Electro technical Commission (IEC) to set standards for audio and video compression and transmission
- MPEG was established in 1988



### **Introduction MPEG-2 transport stream**

- MPEG transport stream (MPEG-2 TS or TS) is a standard digital format for transmission and storage of audio and video content
- The Transport Stream is specified in MPEG-2 Part 1, Systems (formally known as ISO/ICE standard 13818-1 or ITU-T Rec. H.222.0)
- Globally adopted by the most Digital TV broadcasters
- Devices interact with the physical layer by an Asynchronous Serial Interface (ASI - BNC connector) or on Internet Protocol (MPEGoIP - RJ 45 connector)



### **Introduction MPEG Video compression standards**

- MPEG 2 codec for Standard Definition in aspect ratio 4:3 or 16:9 broadcast bandwidth @ 3.5 – 5 Mbit/s Supported by the older and cheaper receivers
- MPEG 4 part 10 (AVC/H264) codec for Standard Definition in aspect ratio 4:3 or 16:9 broadcast bandwidth @ 1,5 – 3,5 Mbit/s Both Mpeg 2 and Mpeg 4 part 10 are supported by newer receivers
- MPEG 4 part 10 (AVC/H264) for High Definition 16:9 broadcast bandwidth
   @ 6 15 Mbit/s
   Only supported by special HD receivers

Remark: MPEG 4 part 10 is also known as Advanced Video Coding (AVC) and H264



### **Introduction Audio compression standards**

- MPEG 1 Layer 2 for stereo audio broadcast bandwidth @ 98 256 kbit/s Is only supported by older receivers
- Advanced Audio Coding (AAC) for stereo audio broadcast bandwidth
   @ 50 192 kbit/s
   Is supported by newer receivers
- AC3 and Dolby 5.1 broadcast bandwidth @ 192–356 kbit/s Only supported by special HD receivers



### **Introduction MPEG coding standards**

Acronym for a group of standards	Title ◆	ISO/IEC standards +	First public release date (First edition)	Description +
MPEG-1	Coding of moving pictures and associated audio for digital storage media. Commonly limited to about 1.5 Mbit/s although specification is capable of much higher bit rates	ISO/IEC 11172	1993	
MPEG-2	Generic coding of moving pictures and associated audio information	ISO/IEC 13818	<mark>1</mark> 995	
MPEG-3				abandoned, incorporated into MPEG-2
MPEG-4	Coding of audio-visual objects	ISO/IEC 14496	1999	
MPEG-7	Multimedia content description interface	ISO/IEC 15938	2002	
MPEG-21	Multimedia framework (MPEG-21)	ISO/IEC 21000	2001	
MPEG-A	Multimedia application format (MPEG-A)	ISO/IEC 23000	2007	
MPEG-B	MPEG systems technologies	ISO/IEC 23001	2006	
MPEG-C	MPEG video technologies	ISO/IEC 23002	2006	
MPEG-D	MPEG audio technologies	ISO/IEC 23003	2007	
MPEG-E	Multimedia Middleware	ISO/IEC 23004	2007	
(none)	Supplemental media technologies	ISO/IEC 29116	2008	will be revised in MPEG-M Part 4 – MPEG extensible middleware (MXM) protocols
MPEG-V	Media context and control	ISO/IEC 23005 <sup>[37]</sup>	2011	
MPEG-M	MPEG extensible middleware (MXM)	ISO/IEC 23006 <sup>[42]</sup>	2010	
MPEG-U	Rich media user interfaces	ISO/IEC 23007 <sup>[44]</sup>	2010	
MPEG-H	High Efficiency Coding and Media Delivery in Heterogeneous Environments	ISO/IEC 23008 <sup>[48]</sup>	2013	
MPEG-DASH	Information technology – DASH	ISO/IEC 23009	2012	



### Introduction History Digital Video Broadcast (DVB)

Until late 1990, digital television broadcasting to the home was thought to be impractical and costly to implement. During 1991, broadcasters and consumer equipment manufacturers discussed how to form a concerted pan-European platform to develop digital TV for consumers using the available ether space used by the analog TV channels.

Depending of the transmission path DVB has created dedicated standards

Environment	DVB standard
Terrestrial	DVB T/T2*
Satellite	DVB S/S2*
Cable	DVB C/C2*
Data network	IPTV

\*DVB T2/S2/C2 are the newest transmission standards. The newer standard is more robust, efficient and carries up to 30% more Transport Stream bandwidth in relation to the "older" DVB T/S/C.



### Introduction

# Used Digital Terrestrial Television (DTT) distribution standards arround the globe







Base band to compressed domain via transport Stream and decompressed to base band HDSDI 1.485 Gbit/s  $\rightarrow$  6 – 15 Mbit/s SDI 270 Mbit/s  $\rightarrow$  3,5 – 5 Mbit/s







### Syntax MPEG – 2 Transport Stream header

Header of 4 bytes =  $4 \times 8 = 32$  bits

Payload of 184 bytes =  $184 \times 8 = 1472$  bits





### The numbers of PIDs in a Transport stream:

In total there are 8192 Program identifiers **(PIDs)** available (0-8191) within a MPEG-2 Transport Stream.

- PIDs 0x00 0x1E = 0 30 (decimal) are reserved for PSI / SI tables.
- The range from 0x1F-0x1FFE = 31-8190 (decimal) is free to use for content.
- PID number 0xFFF = 8191 (decimal) is reserved for Stuffing.

### Stuffing:

One of the master rules in MPEG-2 TS is that the transport stream bitrate is constant. To accomplice a constant TS the multiplexer enters 0 packages into the stream at PID 8191, this process is also known as stuffing.











### Introduction MPTS and SPTS

A transport stream with more than one program is referred to as **MPTS** - Multi Program Transport Stream

Characteristics:

- Variable bit rate possible (video content driven bandwidth)
  High complexity in DVB tables
  Mostly used at DVB-T/S/C distribution operations
  ASI and IP physical layer

- A transport stream with only one program is referred to as **SPTS** - Single Program Transport Stream

Characteristics:

- Constant bit rate
- Low complexity in DVB tablesMostly used at IPTV distribution
- IP physical layer

Remark: SPTS can also be the internal digital stream from the Encoder output (PES) stream to the Multiplexer. In this case, SPTS can be in Variable bit rate



### Metadata within MPEG PSI / DVB SI

# PSI / SI



### Metadata within MPEG PSI / DVB SI

In MPEG metadata PSI (Program Specific Information) and DVB SI (service information) is very important.

Some types of metadata change often and must be repeated at regular intervals in a carousel, while other metadata is static.

The metadata relation in this presentation is within MPEG/DVB.



### Metadata within MPEG PSI / DVB SI

### In short: The difference between MPEG and DVB



# **DVB** Describes what the decoder should do with the data



### **Program Specific Information (MPEG PSI)**

The PSI information is needed to de-multiplex and decode the video, audio & data information carried in the MPEG-2 TS

MPEG-2 PSI data is structured as two (three\*) distinct tables

- 1. The program association table (PAT)
- 2. The program map table (PMT)
- 3. The conditional access table (CAT)\*
- \* Only in TS with scrambled Program(s)





### **Program Specific Information (MPEG PSI)**

**PAT** = Program association table is a list of all the programs contained in the Transport Stream (TS) multiplex with reference to a program map table (**PMT**).

**PMT** = Program map table gives program features such as name and copyright, and also references packets to the program clock and references data streams to a program.

**CAT**<sup>\*</sup> = The conditional access table references a scrambled program





### **DVB delivery model**





### **DVB SI codes**

### *Network\_id:* Identifies a network within DVB systems area

Original\_network\_id: Network id of the network where the Transport Stream originates from in case TS has been transferred from another network. Used as extension to MPEG-2 transport stream\_id

# *Transport\_stream\_id*: Uniquely identifies a Transport Stream within a (original) network

- Service\_id: Identifies a service (program) within transport stream same as program number in PSI
- *Bouquet\_id:* Identifies a bouquet within the DVB systems area

Event\_id:

Identifies an event within the context of a service



The SI information is needed to automatic tune decoders and provide information to the consumer.

The DVB SI data is specified in to seven additional tables of which four are mandatory:

- 1. The network information table (**NIT**)
- 2. The service descriptor (SDT)
- 3. The event information table (EIT p/f)
- 4. The time and date table (TDT)





**NIT** = The network information table (**NIT**) gives information to the receiver/decoder about the network carrying a particular service. e.g.:

- The channel frequency (RF) of the multiplex
- The unique identification number of the network
- Delivery system descriptor informs the kind of transmission Satellite, Terrestrial or Cable
- Service list descriptors contains a list of all services in the multiplex

**SDT** = The service descriptor table (**SDT**) gives information to the receiver/ decoder about the names of the services inside the multiplex.

**EIT p/f** = The event information table of the present and following (**EIT p/f**) gives information about the running and next program. The information is having a short event description and a long event description.

**TDT** = The time and date table (**TDT**) gives the information about the time and date inside the stream.



- 1. The network information table (NIT)
- 2. The service descriptor (SDT)
- 3. The event information table (EIT p/f)
- 4. The time and date table (TDT)
- 5. The event information table (EIT s)
- 6. The time offset table (TOT)
- 7. The bouquet association table (BAT)



**EIT s** = The EIT schedule date in the EIT provides information for up to 64 days in advance. This feature allows the consumer to plan viewing or recording of specific events

**TOT** = The time offset table (**TOT**) gives the information the offset of the time against the Time and date in the TDT. This retrieves the local time and date from an universal time, like UTC. The TOT will indicate the daylight saving settings to a receiver.



**BAT** = The bouquet association table (**BAT**) allows a broadcaster to link services that might be delivered by different methods across different multiplexes



### Actual and Other DVB SI.

Service information can also be categorized as Actual and Other.

**SI actual** refers to the date carried by a multiplex and concerning that multiplex itself. DVB delivery model

**SI others** refers to the other multiplexes that the receiver is capable of decoding from the same transmission medium.





	PID In Transport stream	MPEG-2 PSI Mandatory	Timing Table min – max interval in ms	PID In Transport stream	DVB SI Mandatory	Timing Table min – max interval In ms	PID In Transport stream	DVB SI Optional	Timing Table min – max interval in ms
Network information	0x00 -> 0	ΡΑΤ	25 - 500	0x10 -> 16	NIT Actual	25 – 20.000	0x00->0	NIT Other	25 – 20.000
Bouquet information	0x01 -> 1	CAT	25 - 12.000				0x11 -> 17	BAT	25 – 12.000
Service description	0x02 -> 2	PMT	25 – 500	0x11 -> 17	SDT Actual	25 – 2.000	0x11 -> 17	SDT Other	25 – 20.000
Event information				0x12 -> 18	EIT p/f Actual	25 - 10.000	0x12 -> 18	EIT p/f Other EIT s Actual EIT s Other	25 30.000 25 30.000 25 300.000
Running status				0x14 -> 20	TDT	25 - 60.000			
Time offset							0x14 -> 20	тот	25 - 60.000



### **ETSI TR 101 290 Priority levels of Basic monitoring**

The ETSI TR 101 290 describes three levels of checks:

- 1- The first priority level is **necessary** for de-codability of the Transport Stream and needs to be continuous monitored.
- 2- The second priority level is **recommended** for continuous or periodic monitoring.
- 3- The Third priority is for **application dependant** monitoring



### **ETSI TR 101 290 Priority level indicators**



Figure: Indicators related to TS syntax



### **ETSI TR 101 290 Priority level indicators**



Figure: Indicators related to TS syntax



#### 1.1 TS\_sync\_loss

The most important function for the evaluation of data from the MPEG-2 TS is the sync acquisition. The actual synchronization of the TS depends on the number of correct sync bytes necessary for the device to synchronize and on the number of distorted sync bytes which the device cannot cope with.

It is proposed that five consecutive correct sync bytes (ISO/IEC 13818-1 [i.1], clause G.1) should be sufficient for sync acquisition, and two or more consecutive corrupted sync bytes should indicate sync loss.

After synchronization has been achieved the evaluation of the other parameters can be carried out.

#### 1.2 Sync\_byte\_error

The indicator "Sync\_byte\_error" is set as soon as the correct sync byte (0x47) does not appear after 188 or 204 bytes. This is fundamental because this structure is used throughout the channel encoder and decoder chains for synchronization. It is also important that every sync byte is checked for correctness since the encoders may not necessarily check the sync byte. Apparently some encoders use the sync byte flag signal on the parallel interface to control randomizer re-seeding and byte inversion without checking that the corresponding byte is a valid sync byte.

#### 1.3 PAT\_error

The Program Association Table (PAT), which only appears in PID 0x0000 packets, tells the decoder what programs are in the TS and points to the Program Map Tables (PMT) which in turn point to the component video, audio and data streams that make up the program.

If the PAT is missing then the decoder can do nothing, no program is decodable. Nothing other than a PAT should be contained in a PID 0x0000.



#### 1.3a PAT\_error\_2

The reworded description of the error in PAT\_error\_2 refers to the possibility that the Program Association Table may consist of several (consecutive) sections with the same table\_id 0x00.

#### 1.4 Continuity\_count\_error

For this indicator three checks are combined. The preconditions "Incorrect packet order" and "Lost packet" could cause problems for IRD which are not equipped with additional buffer storage and intelligence. It is not necessary for the test equipment to distinguish between these two preconditions as they are logically OR-ed, together with the third precondition, into one indicator.

The latter is also covering the packet loss that may occur on ATM links, where one lost ATM packet would cause the loss of a complete MPEG-2 packet.

The precondition "a packet occurs more than twice" may be symptomatic of a deeper problem that the service provider would like to keep under observation.

#### 1.5 PMT\_error

The Program Association Table (PAT) tells the decoder how many programs there are in the stream and points to the PMTs which contain the information where the parts for any given event can be found. Parts in this context are the video stream (normally one) and the audio streams and the data stream (e.g. Teletext). Without a PMT the corresponding program is not decodable.



#### 1.6 PID\_error

It is checked whether there exists a data stream for each PID that occurs. This error might occur where TS are multiplexed, or demultiplexed and again remultiplexed.

The user specified period should not exceed 5 s for video or audio PIDs (see note). Data services and audio services with ISO 639 [i.17] language descriptor with type greater than '0' should be excluded from this 5 s limit.

NOTE: For PIDs carrying other information such as sub-titles, data services or audio services with ISO 639 [i.17] language descriptor with type greater than '0', the time between two consecutive packets of the same PID may be significantly longer.

In principle, a different user specified period could be defined for each PID.



#### 2.1 Transport\_error

The primary Transport\_error indicator is Boolean, but there should also be a resettable binary counter which counts the erroneous TS packets. This counter is intended for statistical evaluation of the errors. If an error occurs, no further error indication should be derived from the erroneous packet.

There may be value in providing a more detailed breakdown of the erroneous packets, for example, by providing a separate Transport\_error counter for each program stream or by including the PID of each erroneous packet in a log of Transport\_error events. Such extra analysis is regarded as optional and not part of this recommendation.

#### 2.2 CRC\_error

The CRC check for the CAT, PAT, PMT, NIT, EIT, BAT, SDT and TOT indicates whether the content of the corresponding table is corrupted. In this case no further error indication should be derived from the content of the corresponding table.

#### 2.3 PCR\_error

The PCRs are used to re-generate the local 27 MHz system clock. If the PCR do not arrive with sufficient regularity then this clock may jitter or drift. The receiver/decoder may even go out of lock. In DVB a repetition period of not more than 100 ms is permitted, previously a maximum of 40ms was recommended



#### 2.3a PCR\_repetition\_error

The PCRs are used to re-generate the local 27 MHz system clock. If the PCR do not arrive with sufficient regularity then this clock may jitter or drift. The receiver/decoder may even go out of lock. In DVB a repetition period of not more than 100 ms is permitted, previously a maximum of 40ms was recommended The error indication that may result from the check of this repetition period should be called PCR\_repetition\_error in future implementations

#### 2.3b PCR\_discontinuity\_indicator\_error

The PCR\_discontinuity\_indicator\_error is set in the case that a discontinuity of the PCR values occurs that has not been signalled appropriately by the discontinuity indicator. The usage of this indicator is recommended for future implementations.

#### 2.4 PCR\_accuracy\_error

The accuracy of  $\pm 500$  ns is intended to be sufficient for the colour subcarrier to be synthesized from system clock. This test should only be performed on a constant bitrate TS as defined in ISO/IEC 13818-1 [i.1] clause 2.4.2.2.

#### 2.5 PTS\_error

The Presentation Time Stamps (PTS) should occur at least every 700 ms (see note 3 in table 5.0b). They are only accessible if the TS is not scrambled.



#### 2.6 CAT\_error

The CAT is the pointer to enable the IRD to find the EMMs associated with the CA system(s) that it uses. If the CAT is not present, the receiver is not able to receive management messages.



#### 3.1 NIT\_error

Network Information Tables (NITs) as defined by DVB contain information on frequency, code rates, modulation, polarization, etc. of various programs which the decoder can use. It is checked whether NITs are present in the TS and whether they have the correct PID.

#### 3.1a NIT\_actual\_error

Network Information Tables (NITs) as defined by DVB contain information on frequency, code rates, modulation, polarization, etc. of various programs which the decoder can use. It is checked whether the NIT related to the respective TS is present in this TS and whether it has the correct PID.

#### 3.1b NIT\_other\_error

Further Network Information Tables (NITs) can be present under a separate PID and refer to other TSs to provide more information on programms available on other channels. Their distribution is not mandatory and the checks should only be performed if

#### 3.2 SI\_repetition\_error

For SI tables a maximum and minimum periodicity are specified in EN 300 468 [i.7] and TR 101 211 [i.8]. This is checked for this indicator. This indicator should be set in addition to other indicators of repetition errors for specific Tables.



#### 3.3 Buffer\_error

For this indicator a number of buffers of the MPEG-2 reference decoder are checked whether they would have an underflow or an overflow.

#### 3.4 Unreferenced\_PID

Each non-private program data stream should have its PID listed in the PMTs.

#### 3.5 SDT\_error

The SDT describes the services available to the viewer. It is split into sub-tables containing details of the contents of the current TS (mandatory) and other TS (optional). Without the SDT, the IRD is unable to give the viewer a list of what services are available. It is also possible to transmit a BAT on the same PID, which groups services into "bouquets".

#### 3.5a SDT\_actual\_error

The SDT (Service Description Table) describes the services available to the viewer. It is split into sub-tables containing details of the contents of the current TS (mandatory) and other TS (optional). Without the SDT, the IRD is unable to give the viewer a list of what services are available. It is also possible to transmit a BAT on the same PID, which groups services into "bouquets".



#### 3.5b SDT\_other\_error

This check is only performed if the presence of a SDT for other TSs has been established.

#### 3.6 EIT\_error

The EIT (Event Information Table) describes what is on now and next on each service, and optionally details the complete programming schedule. The EIT is divided into several sub-tables, with only the "present and following" information for the current TS being mandatory. The EIT schedule information is only accessible if the TS is not scrambled.

#### 3.6a EIT\_actual\_error

The EIT (Event Information Table) describes what is on now and next on each service, and optionally details the complete programming schedule. The EIT is divided into several sub-tables, with only the "present and following" information for the current TS being mandatory. If there are no 'Present' or 'Following' events, empty EIT sections will be transmitted according to TR 101 211 [i.8]. The EIT schedule information is only accessible if the TS is not scrambled.

#### 3.6b EIT\_other\_error

This check is only performed if the presence of an EIT for other TSs has been established.



#### 3.7 RST\_error

The RST is a check on a quick updating mechanism for the status information carried in the EIT.

#### 3.8 TDT\_error

The TDT carries the current UTC time and date information. In addition to the TDT, a TOT can be transmitted which gives information about a local time offset in a given area.

The carriage of the following tables:

- NIT\_other;
- SDT\_other;
- EIT\_P/F\_other;
- EIT\_schedule\_other;
- EIT\_schedule\_actual;

This check is optional and therefore these tests should only be performed when the respective table is present.

When these tables are present this will be done automatically by measuring the interval rather than the occurrence of the first section.



### **Bibliography**

- ETSI TS 102 154: "Digital Video Broadcasting (DVB); Implementation guidelines for the use of Video and Audio Coding in Contribution and Primary Distribution Applications based on the MPEG-2 Transport Stream".
- ETSI TR 101 290 (V1.3.1) 2014-07: "Digital Video Broadcasting (DVB); Measurement guidelines for DVB systems".
- Understanding Digital Terrestrial Broadcasting, by Seamus O'Leary



### Thanks for your attention