

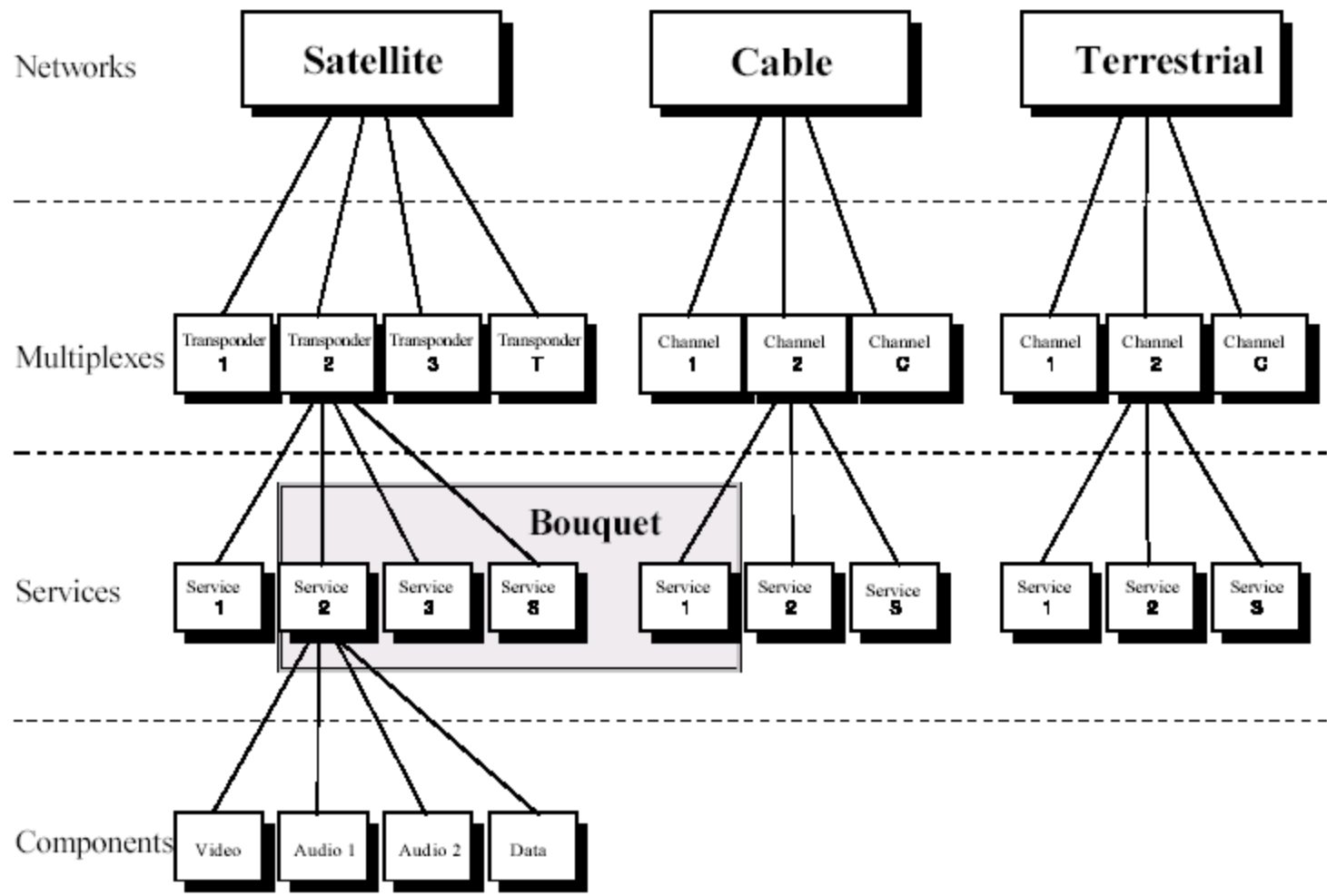
Lecture 4

Digital television

The DVB transport stream

- The need for a general transport stream
- DVB overall stream structure
- The parts of the stream
 - Transport Stream (TS)
 - Packetized Elementary Stream (PES)
 - Program Specific Information (PSI -> ESG)

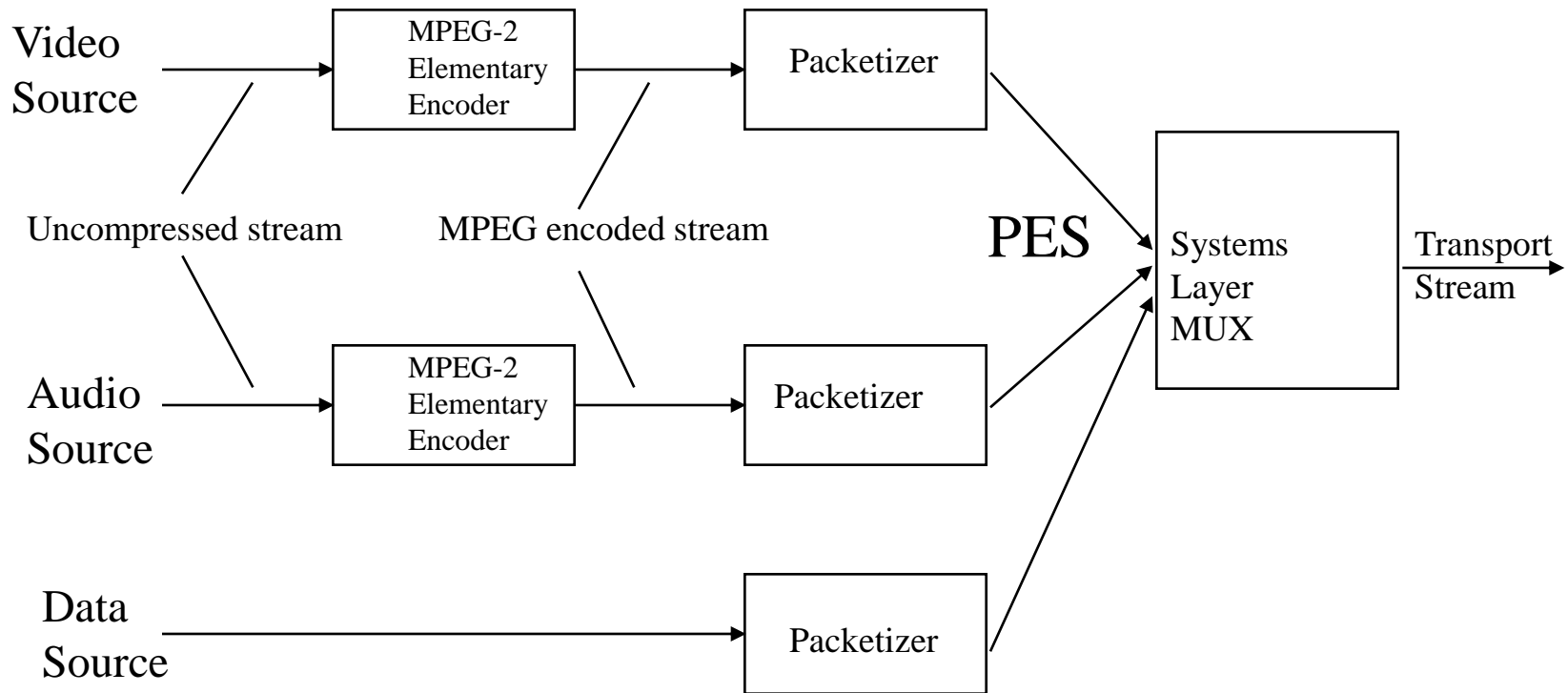
Digital broadcasting, service delivery model



Standards

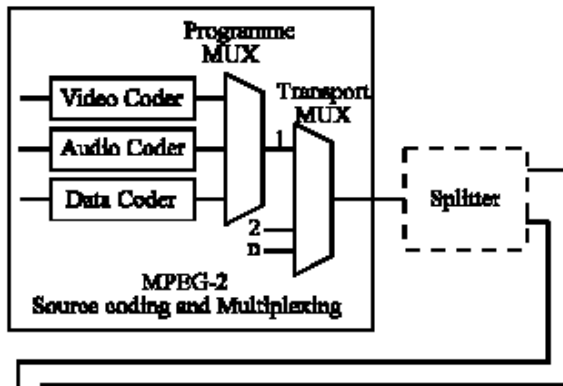
- MPEG standard (ISO-13818-1) defines ways of multiplexing more than one stream (video, audio and data) in order to produce one program
- Used by -
 - DVB
 - DVD
 - HDTV
- Provides basic framework for integrated video, audio and data services
- ETS 300 486 gives PSI documentation (for DVB)

MPEG-2 Systems Layer (Transport Stream)

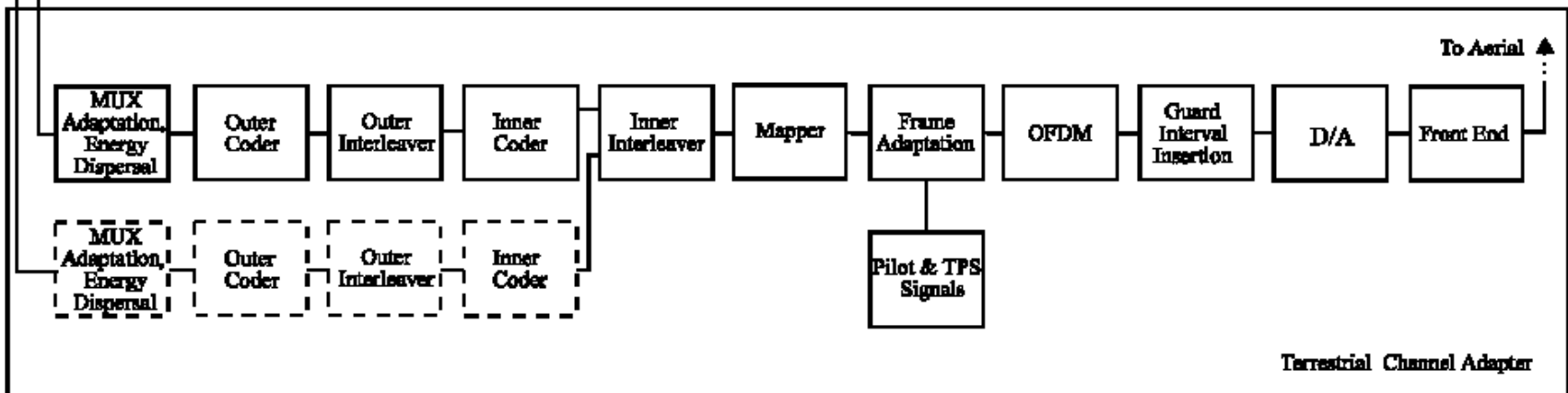


DVB transmitter

- A program consists of one or more elementary streams, which may or may not be MPEG encoded
- Possible to have streams with private data
- 2 schemes for the multiplexing process
 - Program Stream
 - Transport Stream



FEC – Forward Error Correction



- Program Stream
 - Primarily intended for storage and retrieval from storage media
 - Grouping of video, audio, and data elementary streams that have a common time base
 - Each program stream consists of only one program
 - Useful in error free environments
 - Large packet size
 - Packets size may be variable (hard for decoder to predict start and end of packets)
 - DVD standard uses the MPEG-2 Program Stream

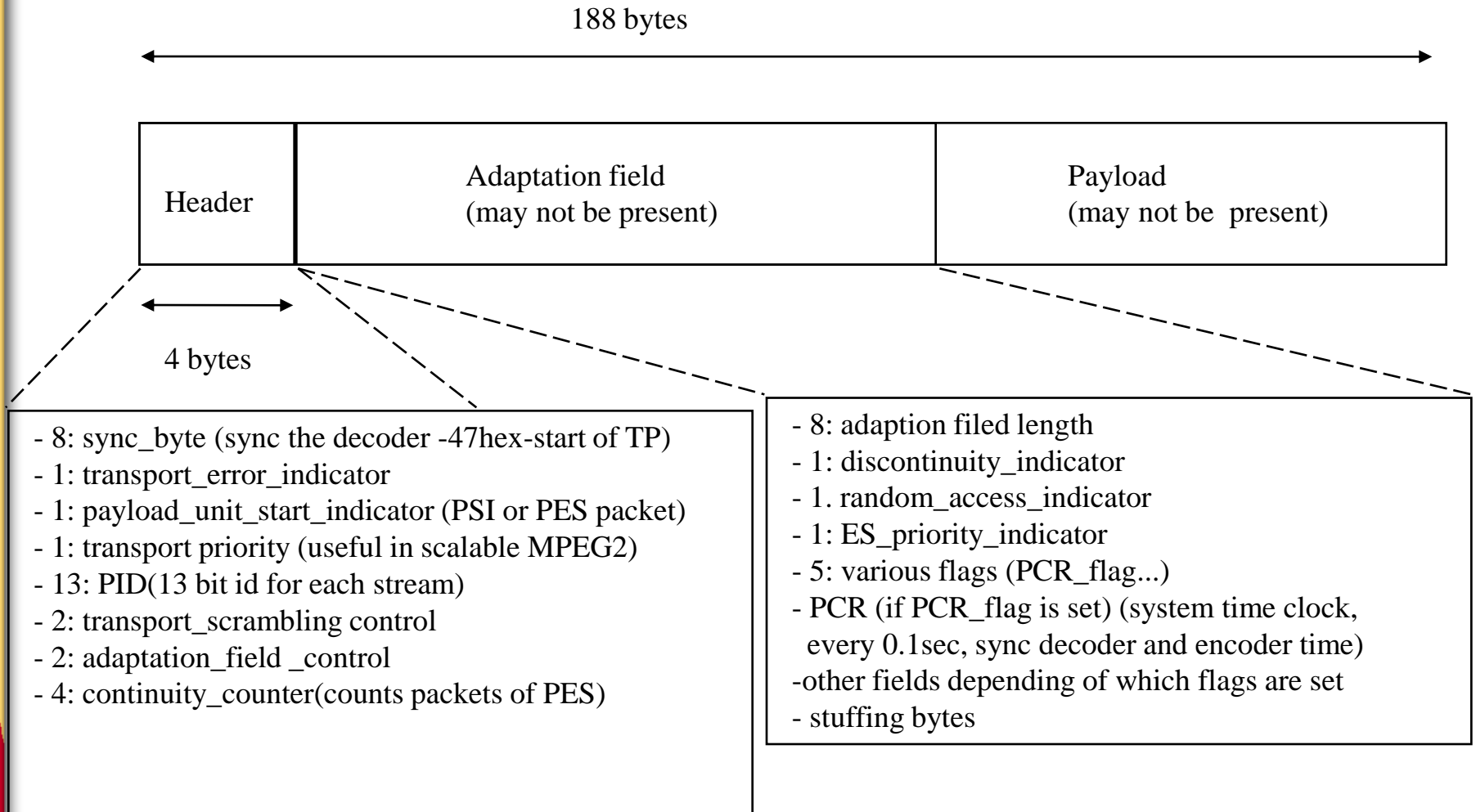
Transport Stream

- Multiplexes various PES into one stream along with information for synchronizing between them
- Short, fixed length packets 188 bytes (4 byte header + adaptation field or payload or both)
- Constraints for forming transport packets:
 - First byte of PES packet must be first byte of transport packet payload
 - Each transport packet must contain data from only one PES packet

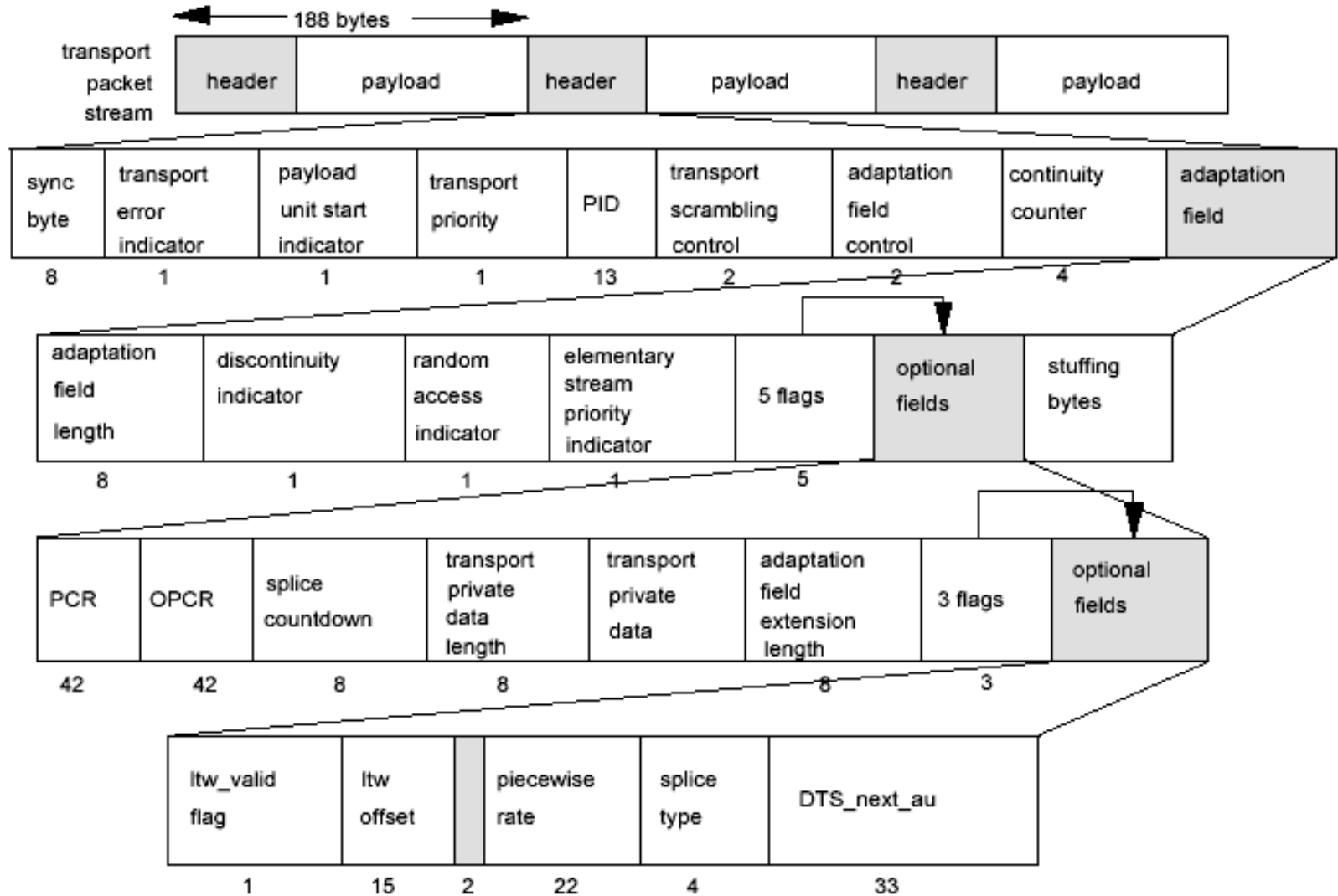
Role of transport stream

- General bit-stream that transports all programming information
- Transports all the information that a particular service provider transmits (on a certain frequency)
- Minimize processing effort in order to
 - Retrieve coded data from one stream
 - Extract transport stream packets of one or more programs, from one or more transports and output a new transport stream
 - Enable to transport a program stream over a lossy environment, then recover a valid identical stream.

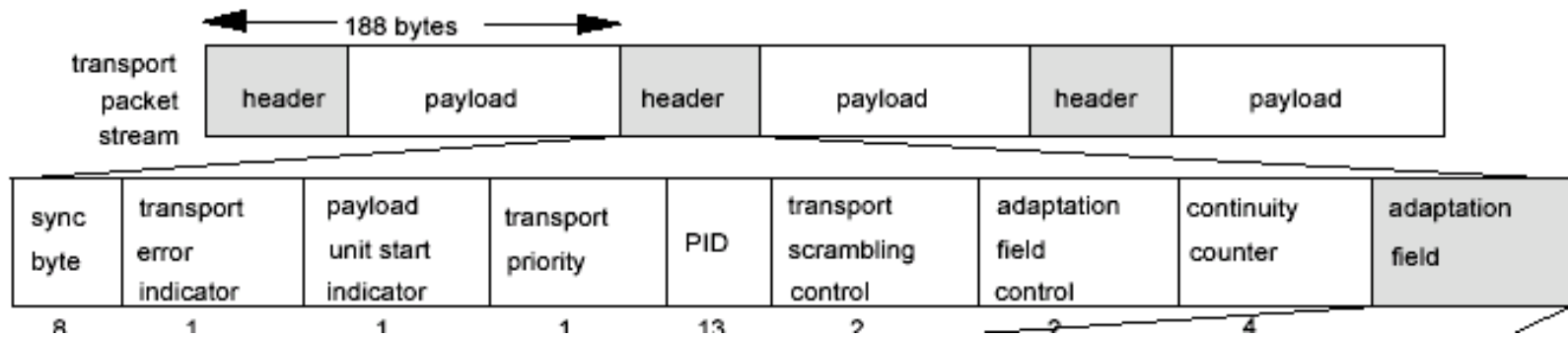
Transport Packet Structure



Overall transport stream



Transport stream header



Sync byte – always hex 47 (bin 1000 1111)

Transport error – error during transport

Payload start (PES or PSI data)

Transport priority

PID (13 bits : dec value 0-8192, hex 0-1FFF)

Transport scrambling (only payload): 0 or 1,2,3

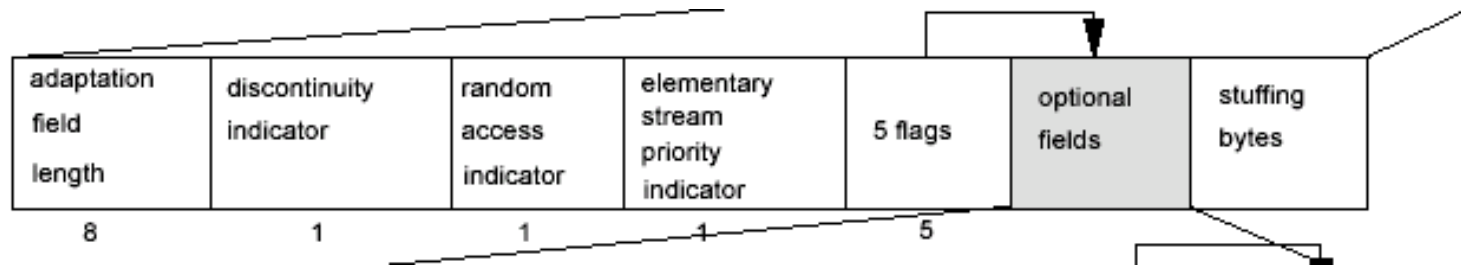
Adaption: 1: P, 2: A, 3: A, P

Continuity pointer: Increases modulo per PID basis

PID values

0	Program association table (PAT)
1	Conditional access table (CAT)
2 to F	Reserved
10	Network information table
11	Service description table (SDT), bouquet information table (BAT) and stuffing table (ST)
12	Event information table (EIT) and stuffing table (ST)
13	Running status table (RST) and stuffing table (ST)
14	Time/date table (TDT), time offset table (TOT) stuffing table (ST)
15 to 1F	Reserved for future use
20-1FFE	Video / audio / private data
1FFF	NULL packets

Adaptation field (1)



Field length

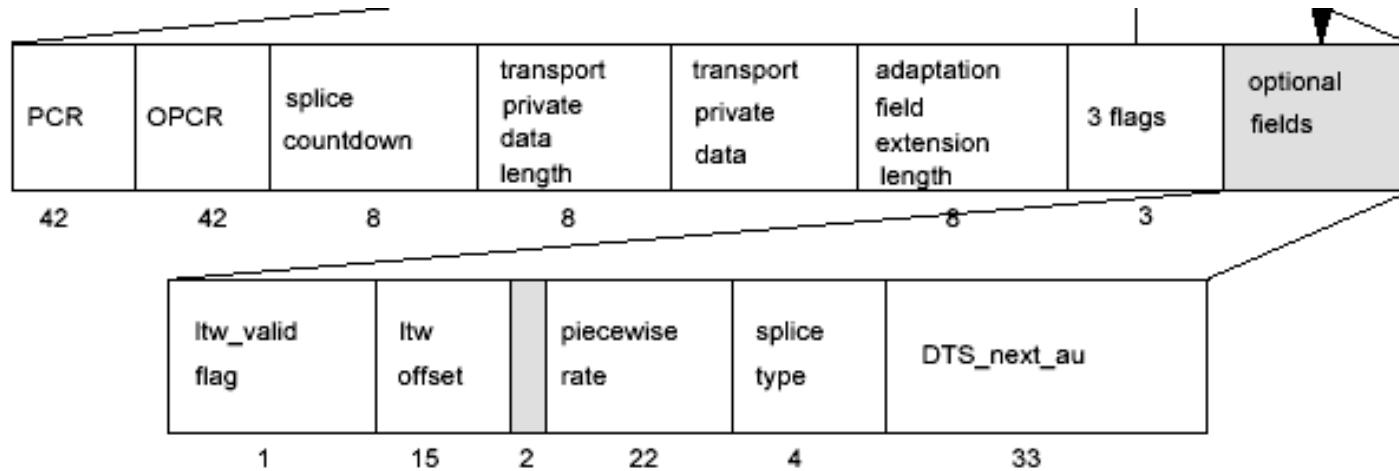
Discontinuity indicator

Random access indicator – helps random access

Elementary stream priority (e.g. Video Intra-coded slice)

Stuffing bytes – fill the transport packet to 188 bytes

Adaptation field (2)



Program clock reference – intended time of arrival

Spliced – signed counter for splicing

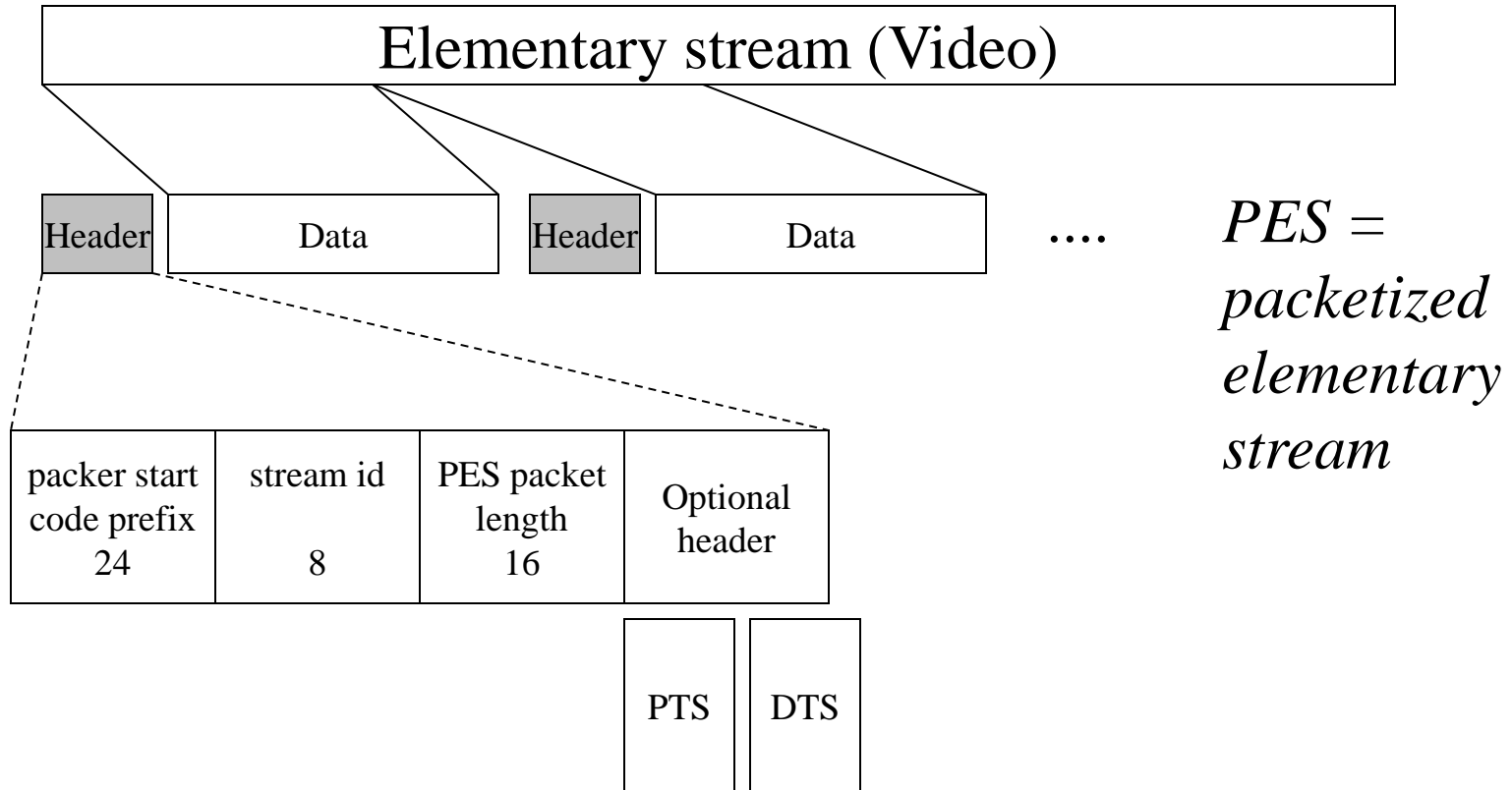
Private data length – up to transport

Extension length

Packetized Elementary Stream (PES)

- Result of the packetization process
- The payload is the data bytes taken sequentially from the original elementary stream
- No specific format for forming the PES packet
 - Entire video frame in one PES packet (but need variable size frames)
 - Fixed size packets
- PES headers distinguish PES packets of various streams and also contain timestamp information

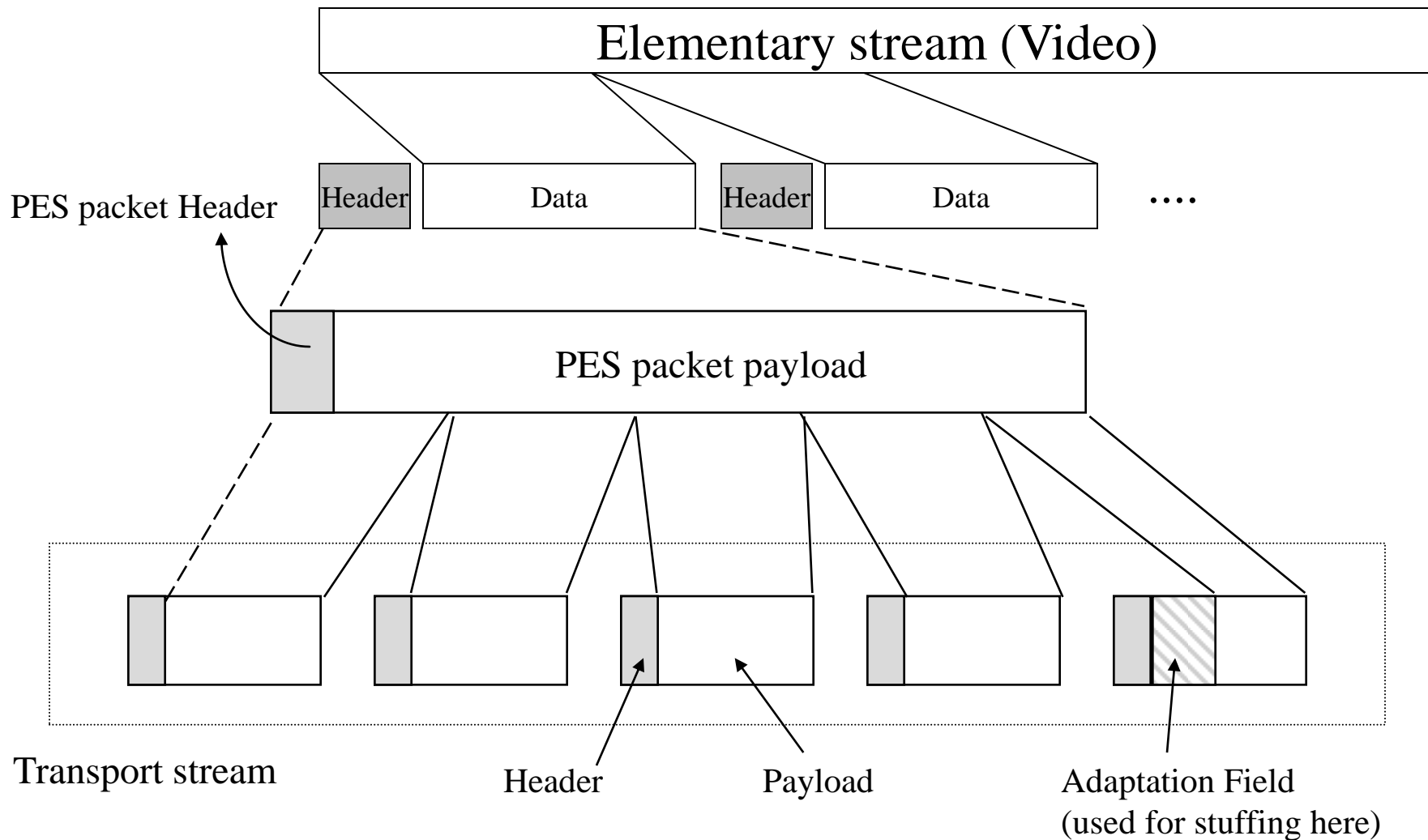
PES and Elementary streams



Synchronization

- In PES
 - Presentation Time Stamp (PTS)
 - when an access unit should be displayed in the receiving end
 - at least every 100 ms
 - Decoding Time Stamp (DTS)
 - When it should be decoded (but presented later)
- Program Clock Reference (PCR)
 - 33 bit value, update frequency 90 kHz
 - Used for synchronizing receiver and transmitter
 - Per program, but several programs may share one common clock reference

Transport Stream Generation



Program Specific Information (PSI)

- PSI transport packets - used by decoder to learn about the transport stream
 - Program Association Table (PAT)
 - Contains complete list of all programs in the transport stream along with the PID for the PMT for each program
 - Transmitted in transport packets with PID 0
 - Program number 0 point to the NIT
 - Program Map Table PMT
 - contains the PID for each of the channels associated with a particular program

Program Specific Information (cont.)

– Network Information Table NIT

- Optional and contents are private(not part of MPEG standard)- can be used to provide useful information about the physical network such as channel frequencies, service originator and service name
- Conditional Access Table CAT
- must be sent when the elementary stream is scrambled
- provides details of the scrambling system in use and provides the PID values of the transport packets that contain the CA information (exact format for this information is not specified)

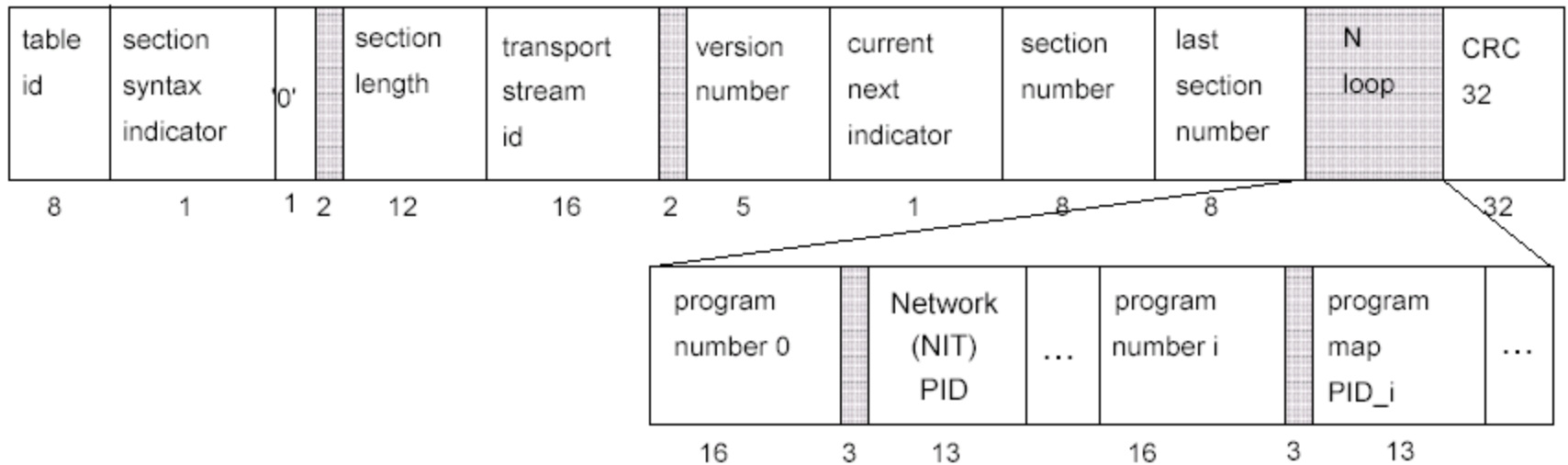
PSI Data

The PSI data provides information to enable automatic configuration of the receiver to demultiplex and decode the various streams of programs within the multiplex.

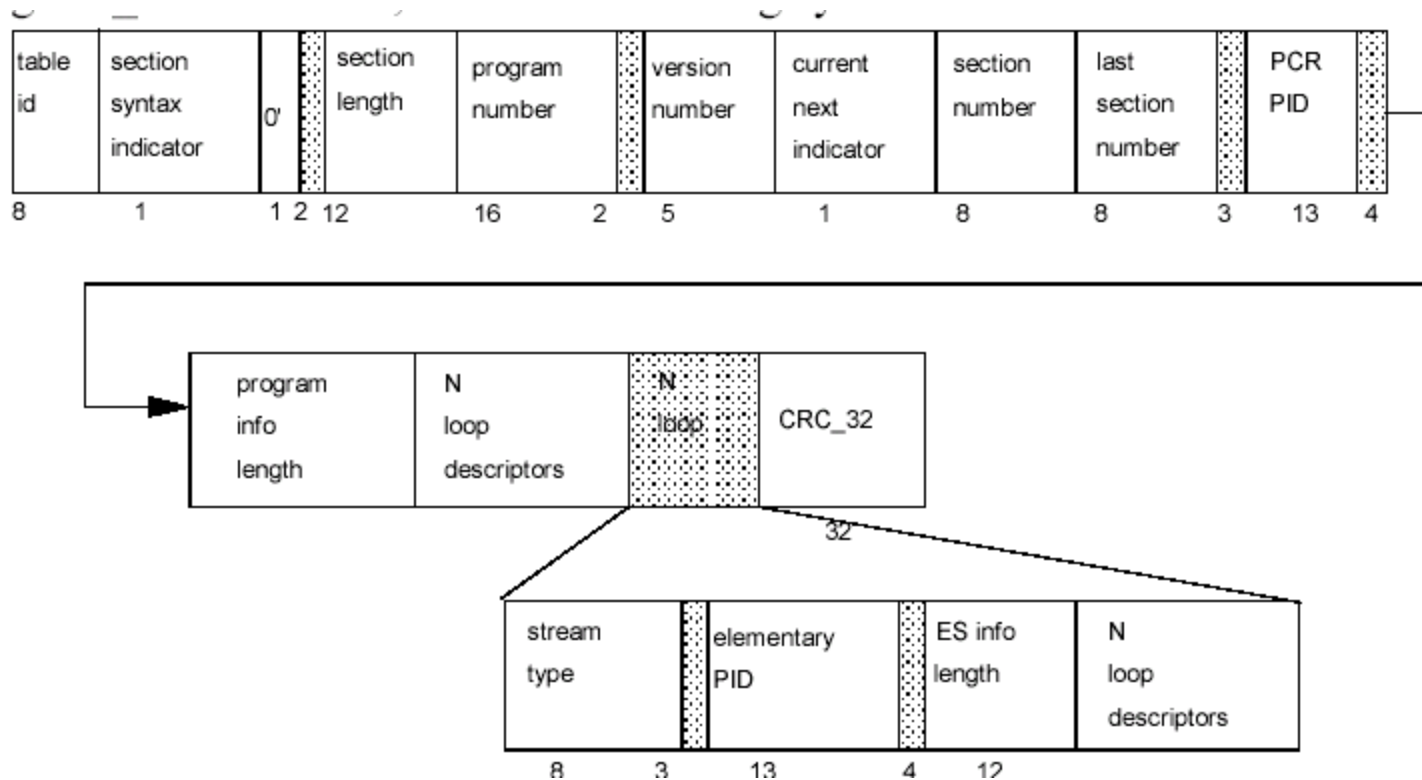
Important

- Program Association Table (PAT)
- Conditional Access Table (CAT)
- Program Map Table (PMT)
- Network Information Table (NIT)

Program association table – TS PID=0



Program map tables – TS PID=from PAT



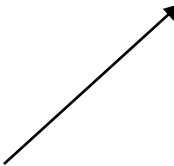
Network information table

Program association table (PAT)

PID: hex 0

Program 0	NIT PID: hex 33
BBC 1	PID: hex 320
BBC 2	PID: hex 200
Channel 4	PID: hex 220
Channel 5	PID: hex 235
etc.	etc

Program map table (PMT)
of Channel 4: PID: hex 220



PCR_PID	PID: hex 218
Video	PID: hex 110
Audio English	PID: hex 121
Audio Spanish	PID: hex 115
ECM	PID: hex 108
etc.	etc

Network information / Finland



B-MUX

PID lista

Voimassa 27.3.2012 alkaen

Service ID	40	209	97	257	241	65	177
Service name	MTV3	MTV3 MAX	Sub	MTV3 Juniori	MTV3 Leffa	Nelonen	Jim
Service provider	MTV Oy	MTV Oy	SubTV Oy	SubTV Oy	SubTV Oy	Sanoma Television Oy	Sanoma Television
LCN	3	40	8	43	42	4	9
PMT PID	256	264	257	260	261	258	259
PCR PID	305*	304*	353*	354*	355*	512*	516*
ECM PID PlusTV (Conax)		1281		1280	1282		
ECM PID TV Viihde (Conax)							
ECM PID TV Viihde (Anjalankoski, Kruunupyyl, Joutseno, Haapavesi, Vuokatti, Koli) (Conax)							
ECM PID TV Viihde (Tervola) (Conax)							
ECM PID PlusTV (Viaccess)		1310		1311	1312		
EMM PID PlusTV (Conax)		192		192	192		
EMM PID TV Viihde (Conax)							
EMM PID PlusTV (Viaccess)		195		195	195		
Components							
Video	305	304	353	354	355	512	516
Audio	501	500	609	610	611	650	690
Audio	502					658	
Teletext	5010	5010	5011		5010	5012	5012
DVB Subtitle	1073	1072	1121	1122	2310	2001	
DVB Subtitle	1074				2311		
Private data							
Private section							

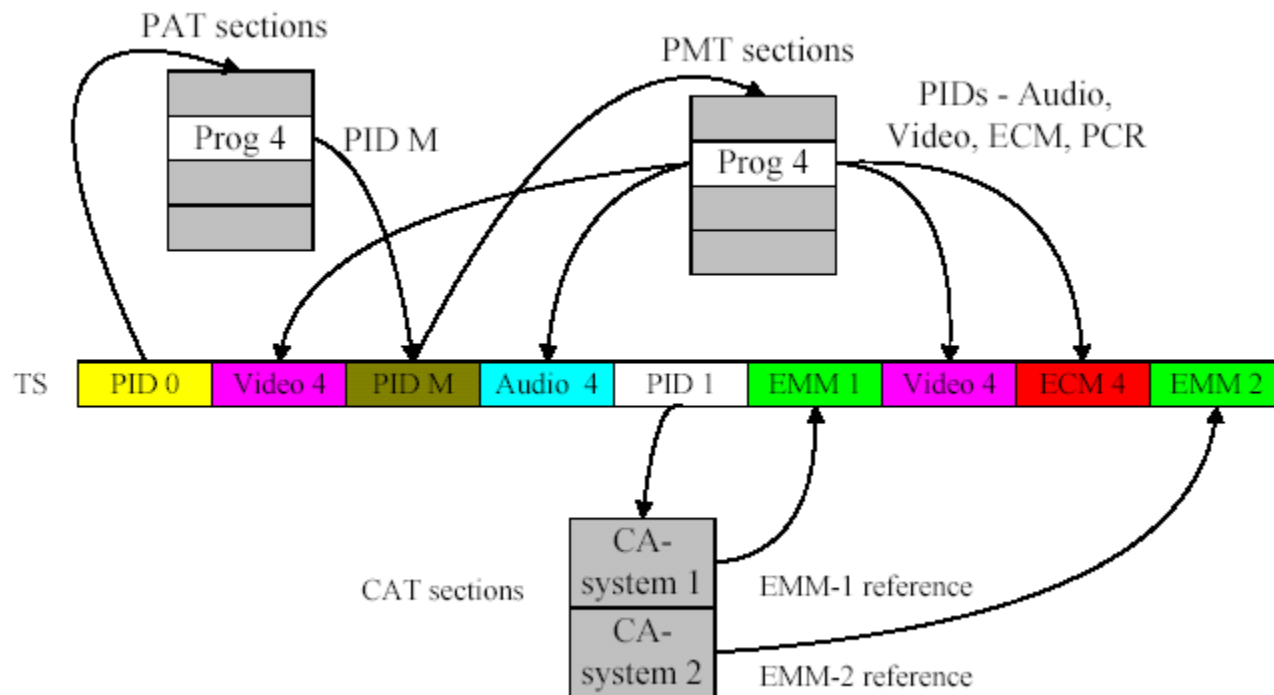
* PCR on Video PID

Source
www.digita.fi

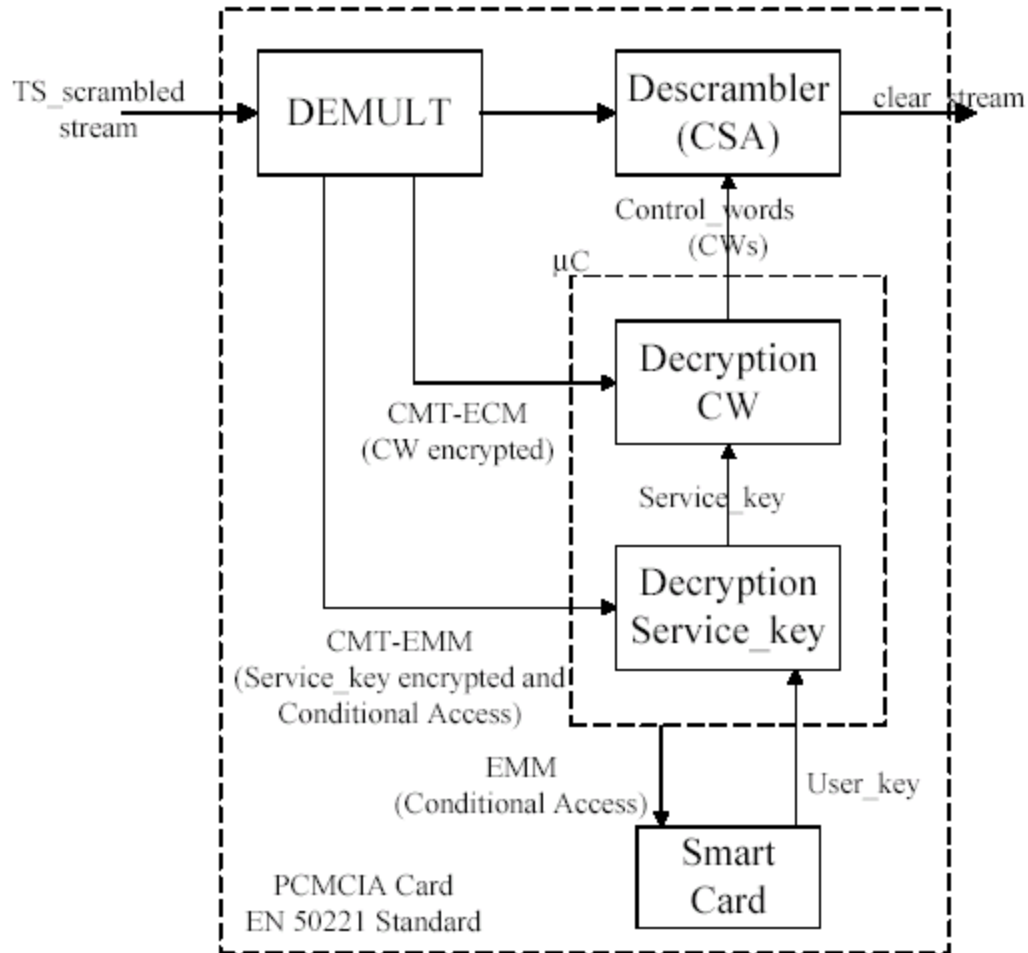
Network information / Finland

Päivitetty 24.2.2012	Kanavanippu A		Kanavanippu B		Kanavanippu C		Kanavanippu E		Kanavanippu F		Digitaalisten omistamien pääasemien koordinaatit leveys,pituus
	kanava-numero	keski-taajuus (MHz)	kanava-numero	keski-taajuus (MHz)	kanava-numero	keski-taajuus (MHz)	kanava-numero	keski-taajuus (MHz)	kanava-numero	keski-taajuus (MHz)	
Pääasema ja täytelähetin											
Ylitornio, Ainiovaara	30	546	37	602			57	762			6.6.2008 alkaen
Pello, Ratasvaara	49	698	53	730							
Ranua, Leppiaho	32	562	36	594							
Turku	51	714	54	738	57	762	60	786	49	698	60 as. 22 min 22 as. 20 min
Korpoo	40	626	47	682	34	578	27	522			
Kustavi, Viherlahti	51	714	54	738	57	762	60	786			
Loimaa	56	754	47	682	25	506	52	722			
Parainen, Houtskari	40	626	47	682	34	578	27	522			
Salo Isokylä	26	514	45	666	47	682	33	570			
Uusikaupunki, Orivo	22	482	26	514	24	498	31	554			
Vaasa	38	610	37	602			57	762			63 as. 12 min 21 as. 32 min
Vuokatti	30	546	52	722	56	754	59	778			64 as. 07 min 28 as. 15 min
Hyrnsalmi	40	626	44	658	34	578					
Hyrnsalmi, Kypärävaara	40	626	44	658	24	498					
Hyrnsalmi, Paljakka	22	482	27	522	46	674					
Kajaani, Pöllövaara	30	546	52	722	56	754					
Kuhmo, Haukela	34	578	40	626	35	586					
Kuhmo, Lentiira	24	498	32	562	42	642					
Kuhmo, Niva	23	490	25	506	49	698					
Paltamo, Kivesvaara	26	514	39	618	49	698					
Puolanka	42	642	45	666	47	682	43	650			
Ristijärvi	22	482	25	506	47	682					
Ylläs	30	546	36	594							67 as. 34 min 24 as. 13 min

PAT -> PMT -> PES



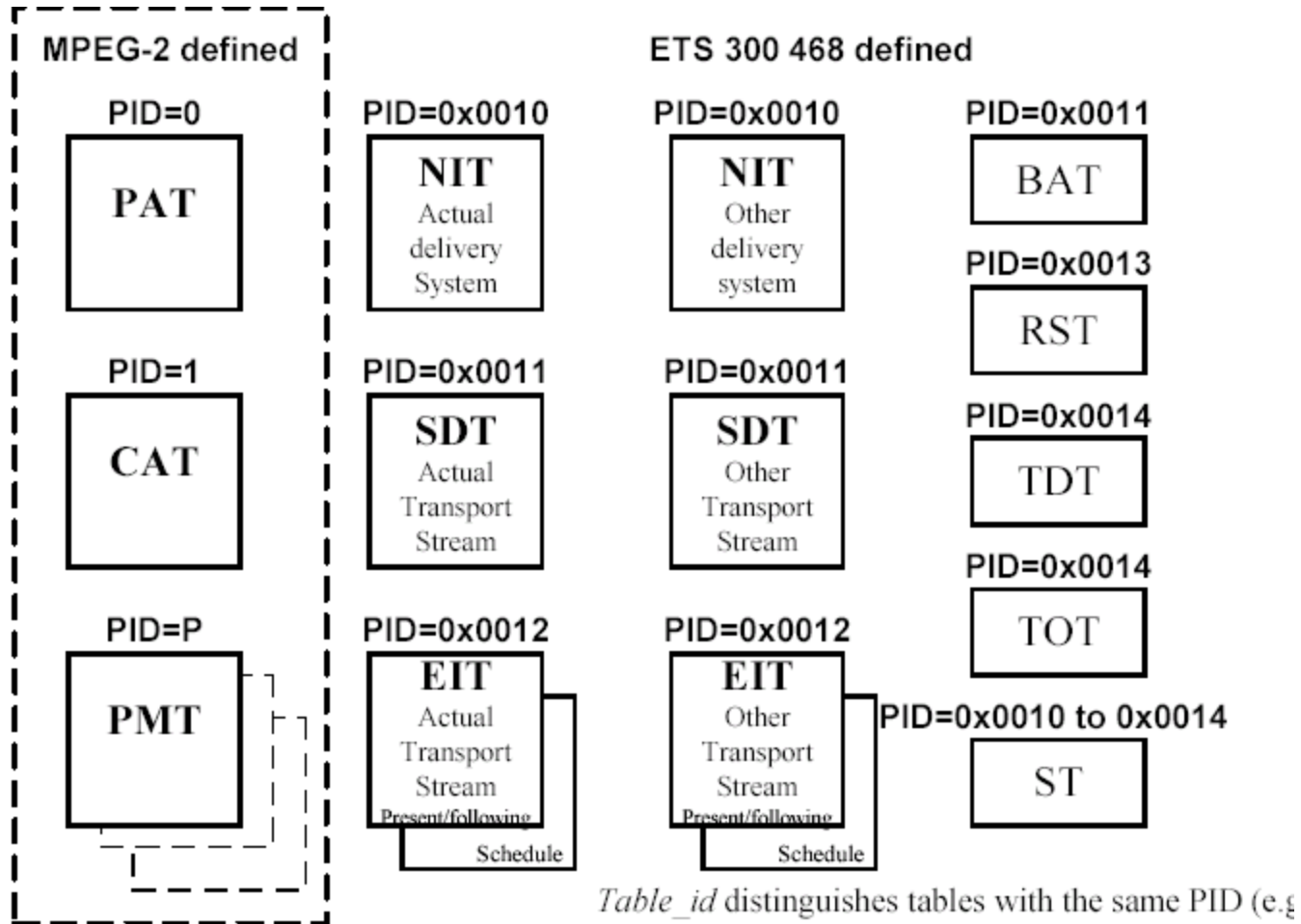
Descrambling transport stream



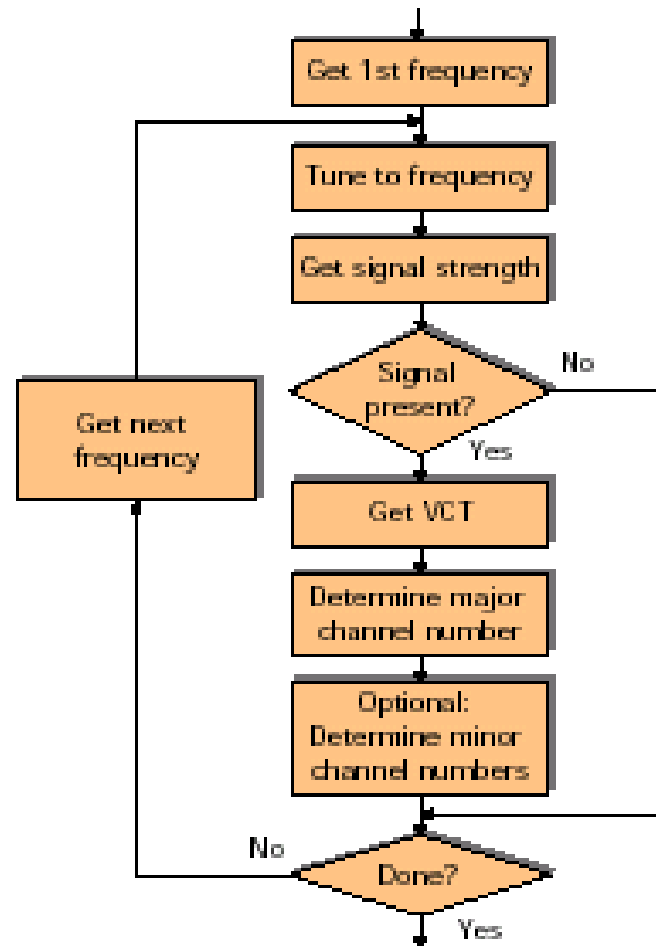
Other tables in ETS 300 468

- Network information table (NIT) - Information on physical network
- Bouquet association table (BAT) – List of services for bouquet (EPG)
- Service description table (SDT) – Service provider names etc.
- Event information table (EIT) – Information on events, start times etc
- Running status table (RST) – Status of an event
- Stuffing table (ST) – Invalidates old data
- Time and date tables (TDT) – Information about present time and date
- Time offset tables (TOT) – Information on local time

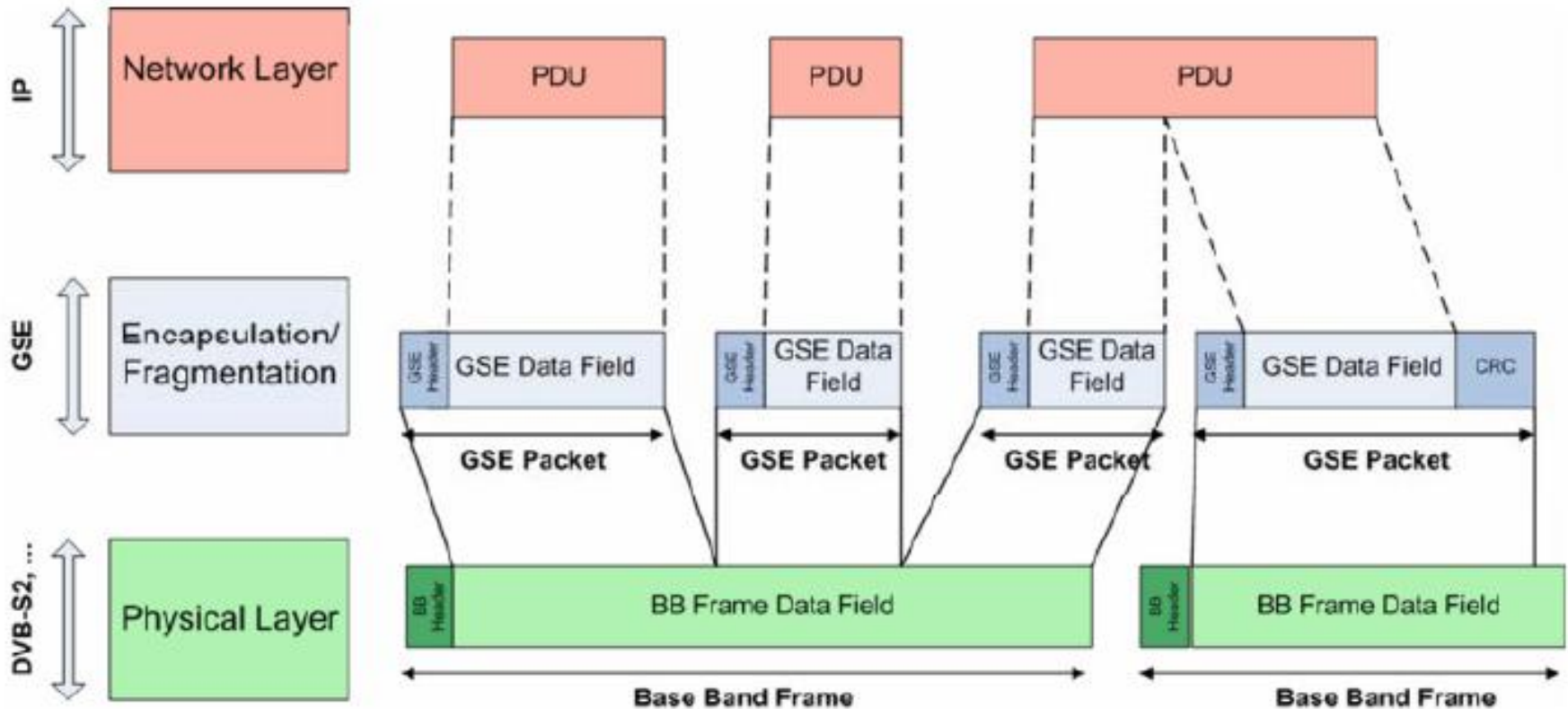
Other tables in ETS 300 468



Autotuning



General Streaming Extension (GSE)



Integrated Video, Audio and Data

- MPEG-2 systems layer provides us with a standardized method of providing integrated video, audio and data services
- Currently programs consist of primarily one video channel and possible multiple audio channels
- The data streams are used only to broadcast program related data, like close captioning
- Multiple video streams for the same program (different camera shots of a football game!!)

Integrated Video, Audio and Data (cont.)

- Interactive broadcasts - news broadcast with related URL
- Data download (non interactive) - create PES stream from the data to be broadcast, split into transport packets, use MPEG-2 system layer to generate either a separate Program stream (channel with data only) or associate the data PES with another Program stream (- viewing news broadcast automatically dumps the daily newspaper on your computer...)

Integrated Video, Audio and Data (cont.)

- Interactive internet type data - can be inserted in MPEG-2 transport stream without affecting any other data, you will still be MPEG-2 system compliant, it is upto the decoders to figure out if they can handle the data or not (TV v/s PC- we can use the same broadcast)
- Interactive internet type data - must be a “program” and not part of another program - therefore decoder must be capable of tuning to two programs

Sources

*European Telecommunications Standards Institute
(Sophia Antipolis, France)*



Digita, Finland



MPEG-2 Profiles

The profiles are specific subset of the bit stream syntax in the MPEG-2 standard (profile-P@level-L):

- **Main Profile** was designed to accommodate most initial applications of MPEG-2, in terms of both functionality requirements and cost constraints
- **High Profile** has more functionalities than Main Profile; allows SNR, spatial and an additional type of scalability giving high quality picture quality when all features are utilized in the decoder
- **Simple profile** is intended for low cost applications; no B-pictures (8 Mbits of memory required)
- **Spatial Scalable Profile** can provide two layer coding with different resolutions on layers (low resolution reproduction and combination gives full-resolution reproduction)
- **SNR Scalable Profile** provides layers with the same pixel resolution by different picture quality (quantization level); the first stream gives a reasonable picture quality and the other stream gives a refinement to the first stream reproduction

MPEG-2 Levels

A level is a defined set of constraints imposed on the parameters of the MPEG-2 bit stream (profile-P@level-L):

- **Main Level** is to be used by initial applications of MPEG-2. Upper bounds of the sampling density correspond to CCIR601 picture format: 720 x 576 (PAL, 25 Hz) or 720 x 480 (NTSC, 30 Hz)
- **High Levels** are intended for HDTV systems. The High Level supports 1920 pixels per line (1920 x 1152), and the High- 1440 Level 1440 pixels per line respectively (1440 x 1152)
- **Low Level** corresponds to the quarter-CCIR601 picture format (SIF)

Levels		Profiles			
		SNR 4:2:0	Spatial 4:2:0	High 4:2:0;4:2:2	Multiview 4:2:0
High	Enhancement			1920 X 1151/60	1920 X 1151/60
	Lower			960 X 576/30	1920 X 1151/60
	Bitrate			100, 80, 25	130, 50, 80
High-1440	Enhancement		1440 X 1152/60	1440 X 1152/60	1920 X 1152/60
	Lower		720 X 576/30	720 X 576/30	1920 X 1152/60
	Bitrate		60, 40, 15	80, 60, 20	100, 40, 60
Main	Enhancement	720 X 576/30		720 X 576/30	720 X 576/30
	Lower			352 X 288/30	720 X 576/30
	Bitrate	15, 10		20, 15, 4	25, 10, 15
Low	Enhancement	352 X 288/30			352 X 288/30
	Lower				352 X 288/30
	Bitrate	4, 3			8, 4, 4

MPEG-2 Profiles & Levels

Table 3: MPEG-2 Profiles @ Levels

Profile @ Level	Resolution	Maximum Frame Rate	Sampling	Rate	Comments
SP@LL—Simple Profile @ Low Level	176x144	15	4:2:0	96Kbps	Wireless handsets
SP@ML—Simple Profile @ Main Level	352x288 320x240	15 24	4:2:0	384Kbps	PDA's
MP@LL—Main Profile @ Low Level	352x288	30	4:2:0	4Mbps	Set-top boxes
MP@ML—Main Profile @ Main Level	720x480	30	4:2:0	15Mbps; limited to 9Mbps for DVDs	DVD
MP@H-14—Main Profile @ High 1440	1080i with 1440 pixels/line or 720p with 1280 pixels/line	1080i: 30 or 720p: 30	4:2:0	60Mbps; limited to 25Mbps for DV tape	HDV Potential to move to tape-based at 50Mbps
MP@HL—Main Profile @ High Level	1080i with 1920 pixels/line or 720p with 1280 pixels/line	1080i: 30 or 720p: 60	4:2:0	80Mbps; limited to 19Mbps for over-the-air	ATSC 1080i 720p60
422P@LL—4:2:2 Profile @ Low Level					
422P@ML—4:2:2 Profile @ Main Level	720x480	30	4:2:2	50Mbps	Sony IMX using I-frame only
422P@H-14—4:2:2 Profile @ High 1440	1080i with 1440 pixels/line or 720p with 1280 pixels/line	1080i: 30 or 720p: 60	4:2:2	80Mbps	Potential future MPEG-2-based HD products from Sony and Panasonic
422P@HL—4:2:2 Profile @ High Level	1080i with 1920 pixels/line or 720p with 1280 pixels/line	1080i: 30 or 720p: 60	4:2:2	300Mbps	Potential future MPEG-2-based HD products from Panasonic