Multimedia Communication & Services

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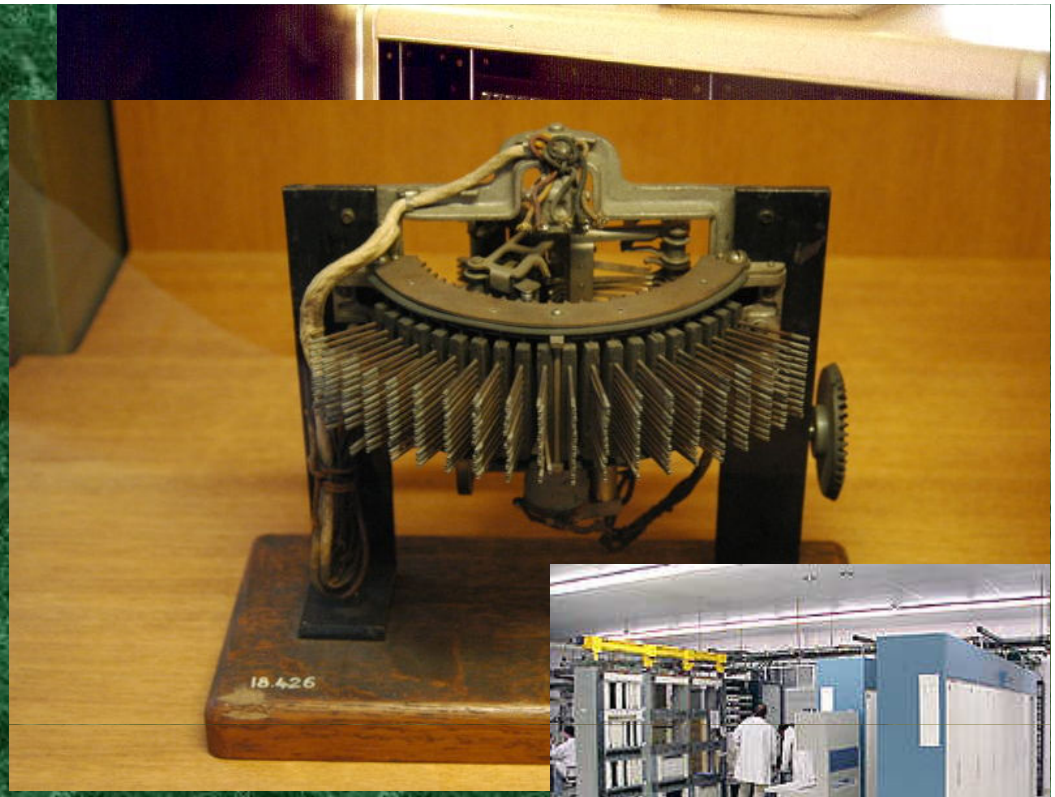
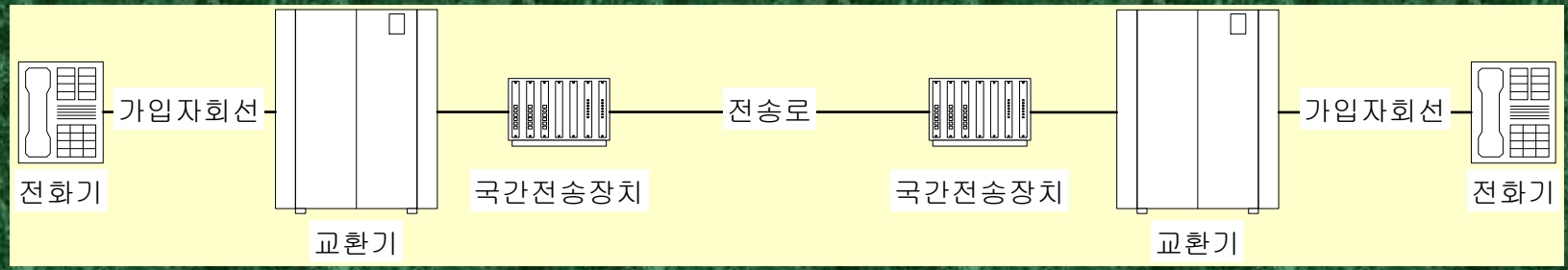
Telecom. Networks in view of Multimedia

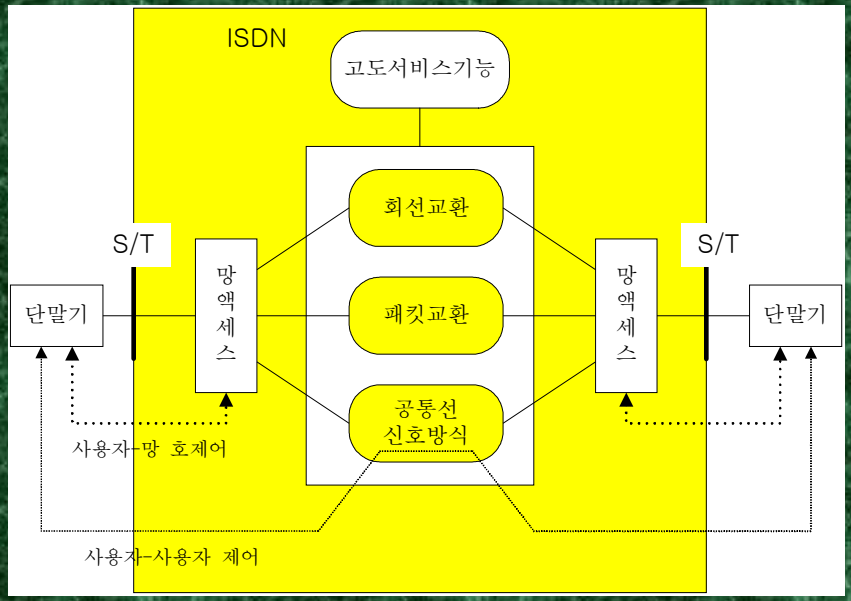
PSTN(~현재)
ISDN(80년대)
B-ISDN(90년대)
Internet(2000년대)
NGN(2010년대)
Future Internet

Public Switched Telephone Network





Integrated Services Digital Network



Features:

- Using existing 2-wire copper line
- First digital subscriber's loop (Full digital, full duplex)
- First convergence network
- BRI : 2B+1D (144kbps)
- PRI : 23B+1D (1,536 kbps)
- Out-of-band (common channel) signalling

Broadband Integrated Services Digital Network

Features:

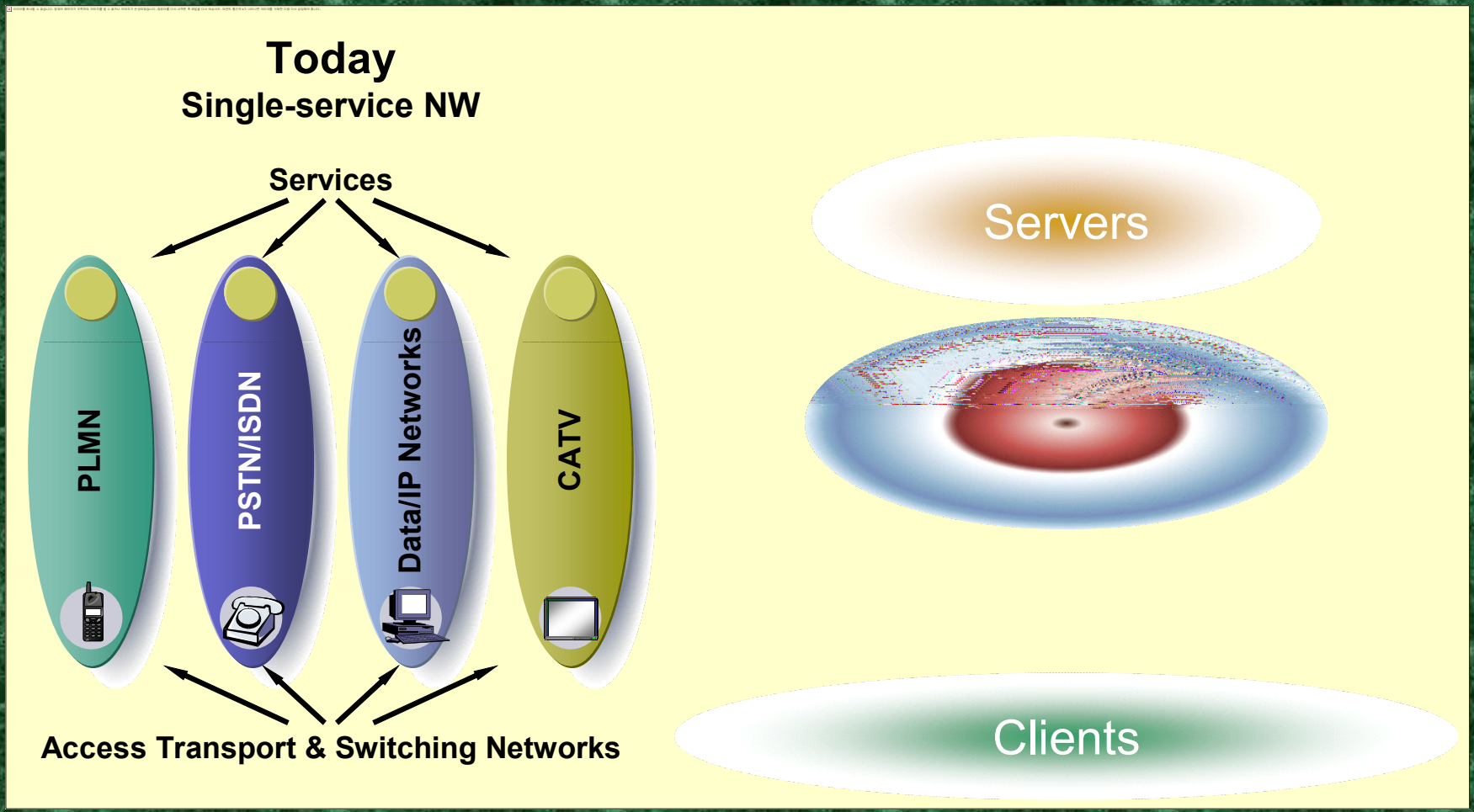
- 53 Byte ATM cell
  (5B header + 48B payload)
- First packet-based convergence network
- AAL-1/2/3/4/5
  - SAR
  - CS

	등급A	등급B	등급C	등급D
종단간 시간관계	실시간	실시간	비실시간	비실시간
비트율	고정비트율	가변비트율	가변비트율	가변비트율
연결모드	연결형	연결형	연결형	비연결형
대응 AAL 유형	AAL-1	AAL-2	AAL-3/4,5	AAL-3/4,5
응용서비스	고정비트율 영상 또는 음성	가변비트율 영상 또는 음성	연결형 데이터	비연결형 데이터

Internet

- data-centric
- send and pray
- no guarantee of QoS
- simple and scalable
- robust and widely-deployed
- …

NGN Next Generation Network



BCN: Korean version of NGN

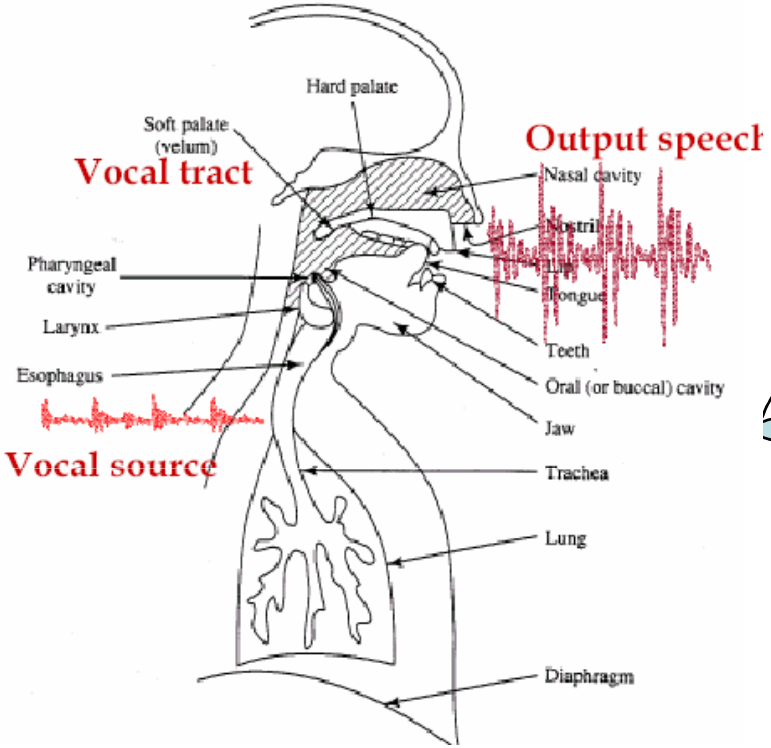
Audio & Video Coding Technologies

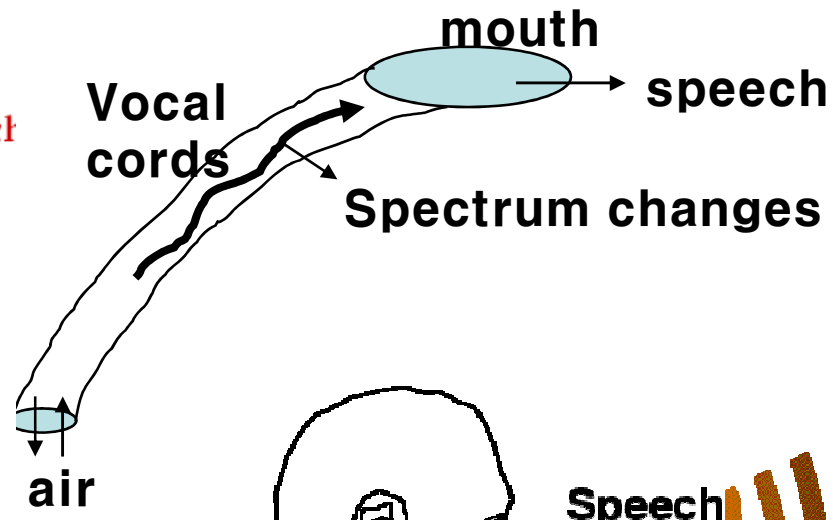
Speech coding
MPEG Audio coding
Video coding
Video over Network

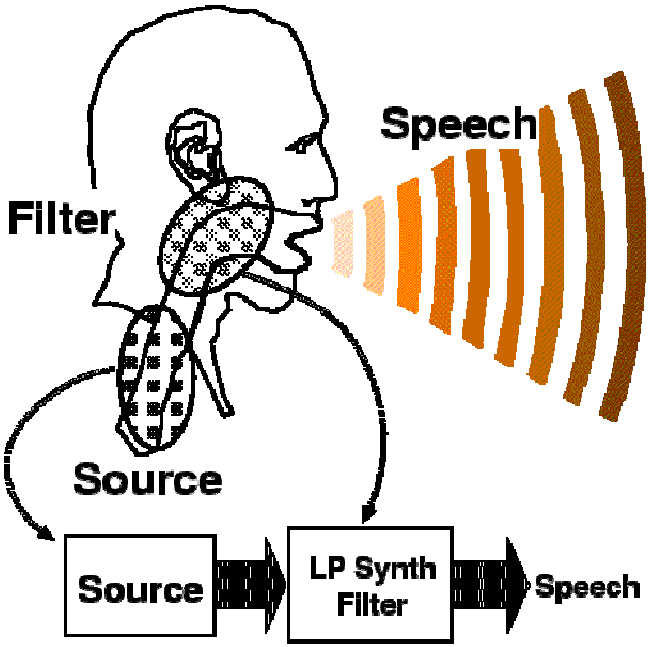
Three Acoustic Signals

	Frequency range	Sampling rate	bit/smpl	Bit rate
Narrowband speech (telephone)	300~3,400 Hz	8 KHz	8	64 Kbps
Wideband speech	50~7,000 Hz	16 KHz	14	224 Kbps
Wideband audio (CD Quality)	10~20,000 Hz	48 KHz	16	768 Kbps

Speech Generation







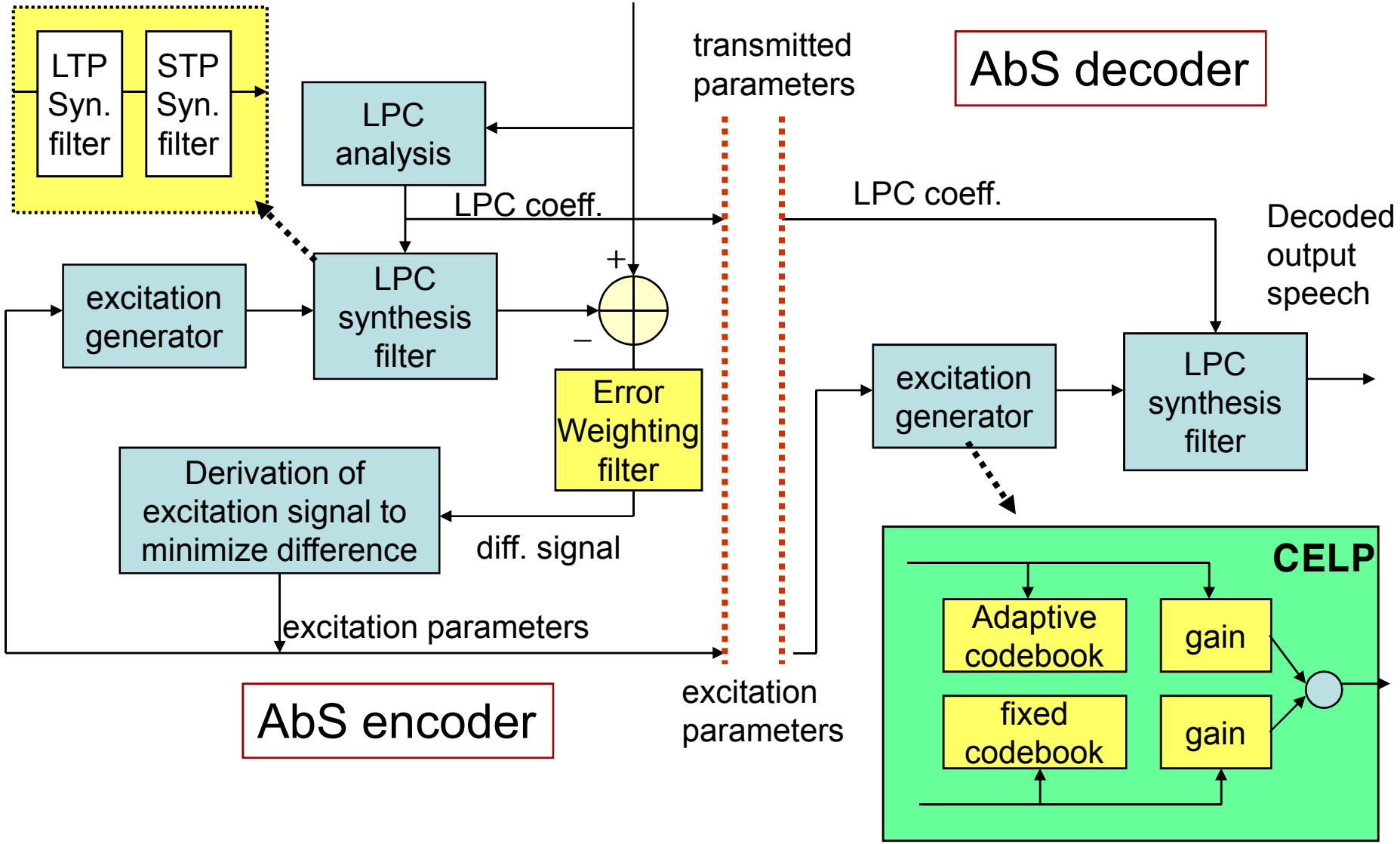
LP Synth Filter: Linear Prediction Synthesis Filter

Speech Coding Standards

ITU-T Recomm.	Sampling frequency	Bandwidth	Bitrate	Coding scheme
G.711	8kHz	300Hz~3.4kHz	64kbps	PCM
G.721	8kHz	300Hz~3.4kHz	32kbps	ADPCM
G.722	16kHz	50Hz~7kHz	64/56/48kbps	SB-ADPCM
G.722.1	16kHz	50Hz~7kHz	24 kbit/s , 32 kbit/s	MLT
G.722.2	16kHz	50Hz~7kHz	6.6 ~ 23.85 kbps	ACELP
G.723	8kHz	300Hz~3.4kHz	40/20kbps	ADPCM
G.723.1	8kHz	300Hz~3.4kHz	5.3kbps	LPAS- ACELP
			6.3kbps	LPAS- MP-MLQ
G.726	8kHz	300Hz~3.4kHz	40/32/24/16kbps	ADPCM
G.727	8kHz	300Hz~3.4kHz	40/32/24/16kbps	Embedded ADPCM
G.728	8kHz	300Hz~3.4kHz	16kbps	LD-CELP
G.729	8kHz	300Hz~3.4kHz	8/13kbps	CS-ACELP
G.729.1	1 6KHz	50Hz~7kHz	8kbps-32kbps	CELP+MDCT

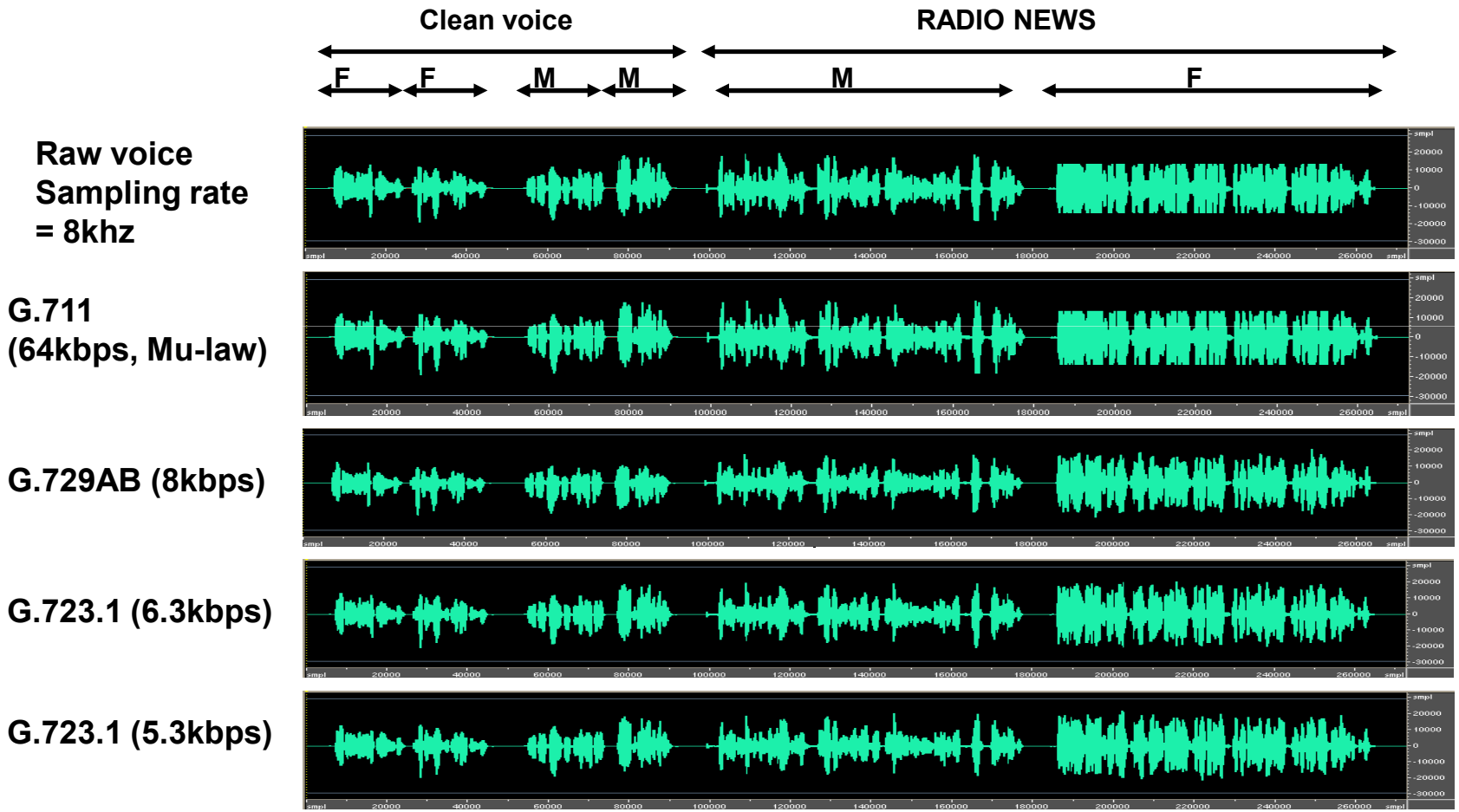
Analysis-by-Synthesis Codec

Westall, et al., "Speech technology for telecommunications," BT Journal, 14(1) Jan. 1996



Quality Comparison : Speech

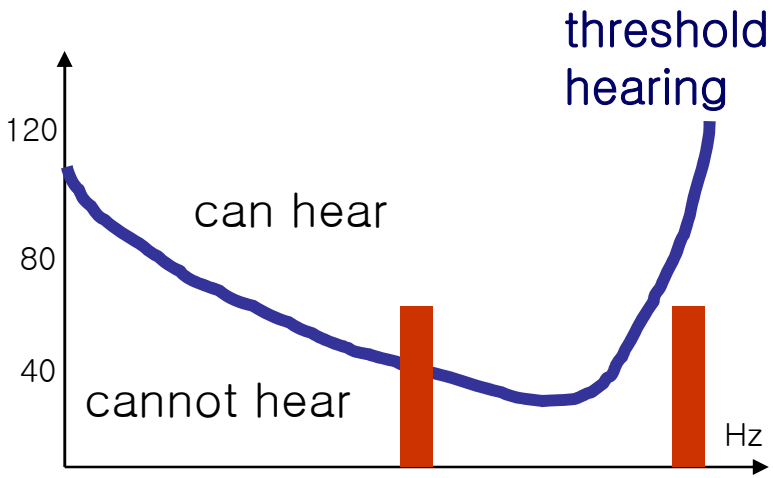
G.711/ 729/ 723.1 En/Decoding

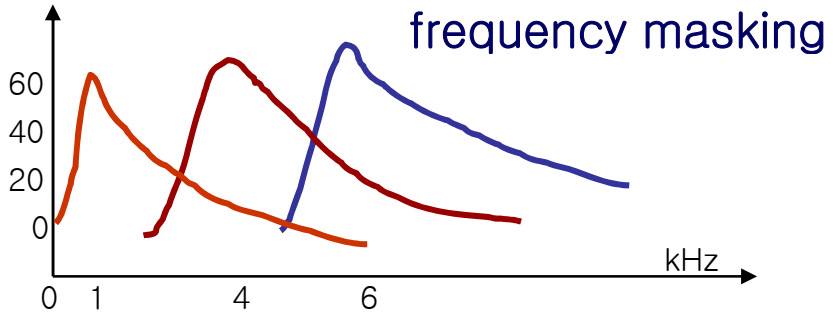


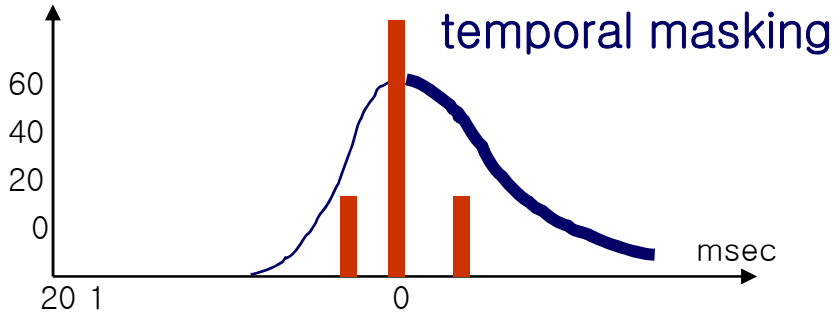
Source : C&S Technology

Psycho-Acoustics

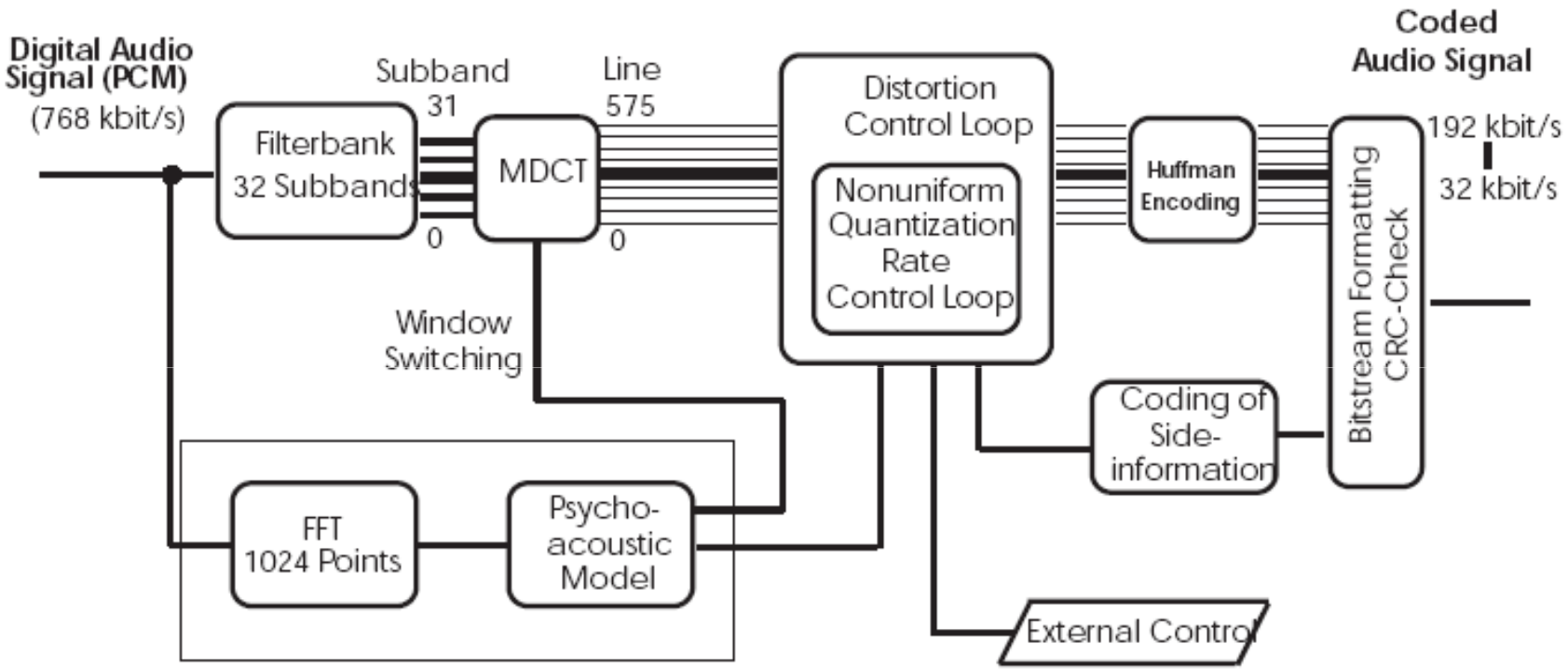
- The target is to remove acoustically irrelevant parts of the audio signal
- Human auditory system cannot hear quantization noise under the conditions of audio masking
- Masking occurs whenever a strong signal makes a neighborhood of weaker audio signals imperceptible





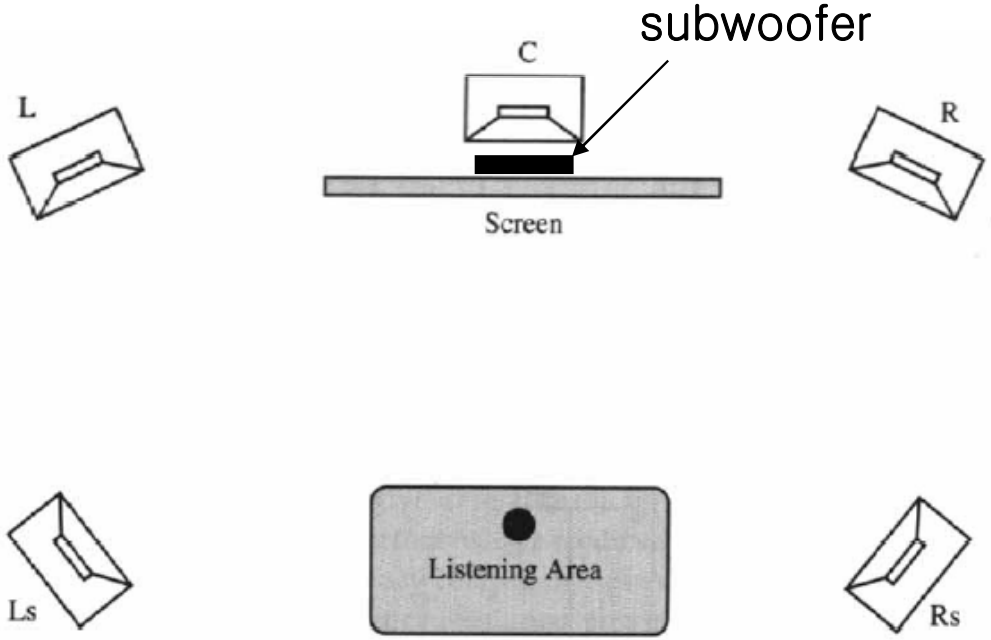


Block Diagram of MP3 Encoder

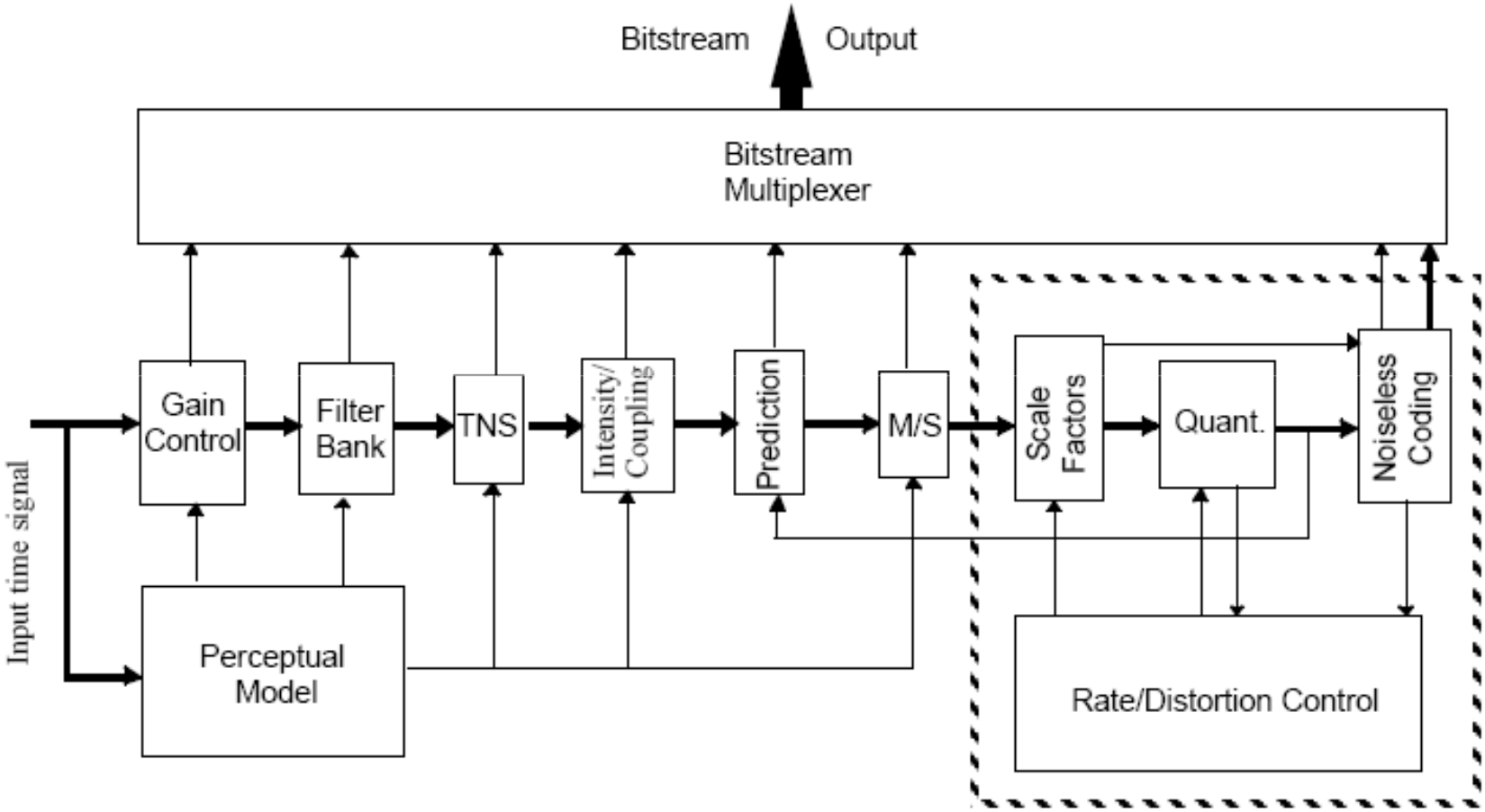


MPEG-2 Audio

- **5.1 channel (5+1 for LFE(subwoofer))**
- **LFE (low freq. enhancement) : 15 Hz – 120 Hz**
- **Backward compatibility with MPEG-1 audio**
  - Lo=L+0.707C+0.707Ls
  - Ro=R+0.707C+0.707Rs

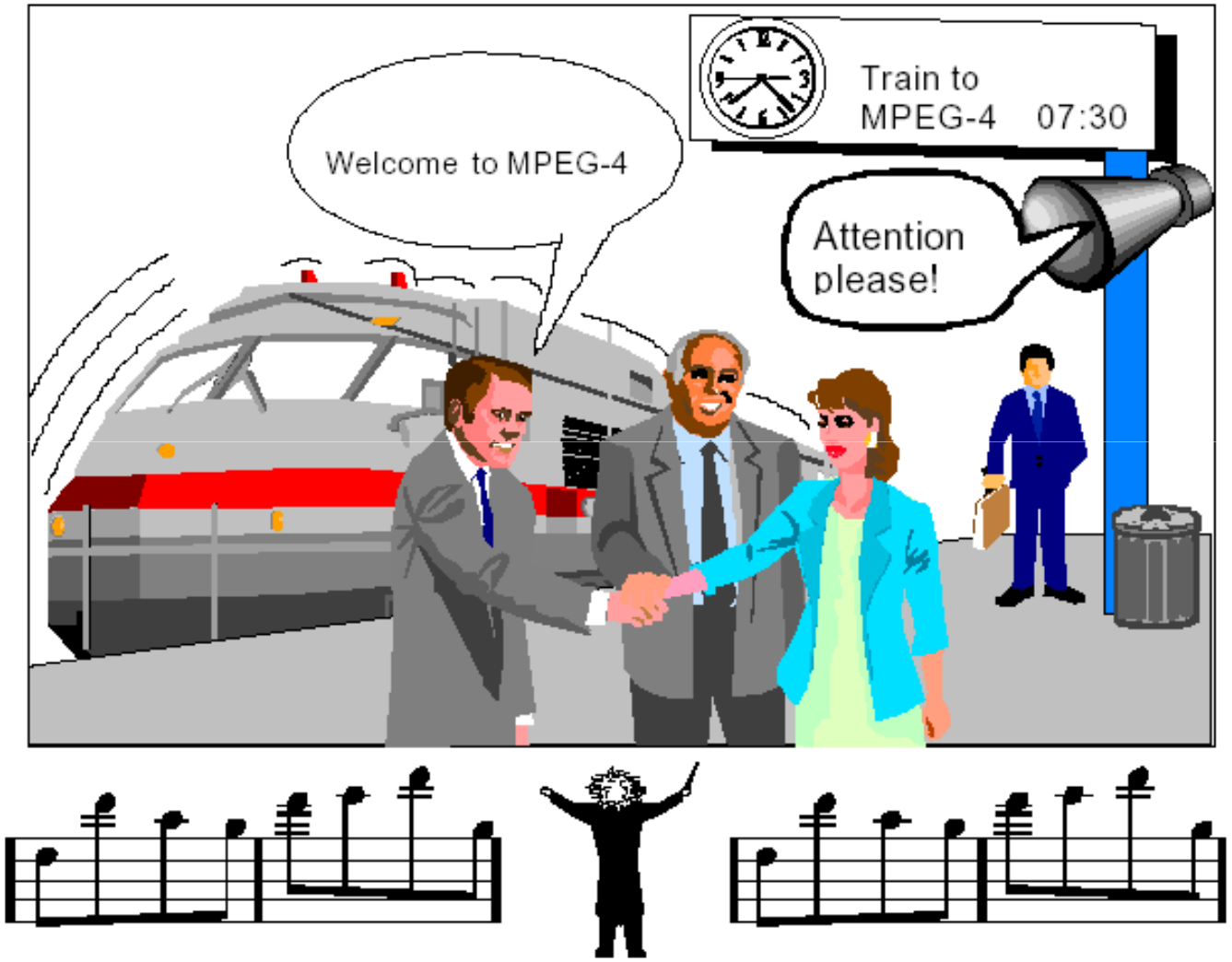


Block Diagram of MPEG-2 AAC Encoder

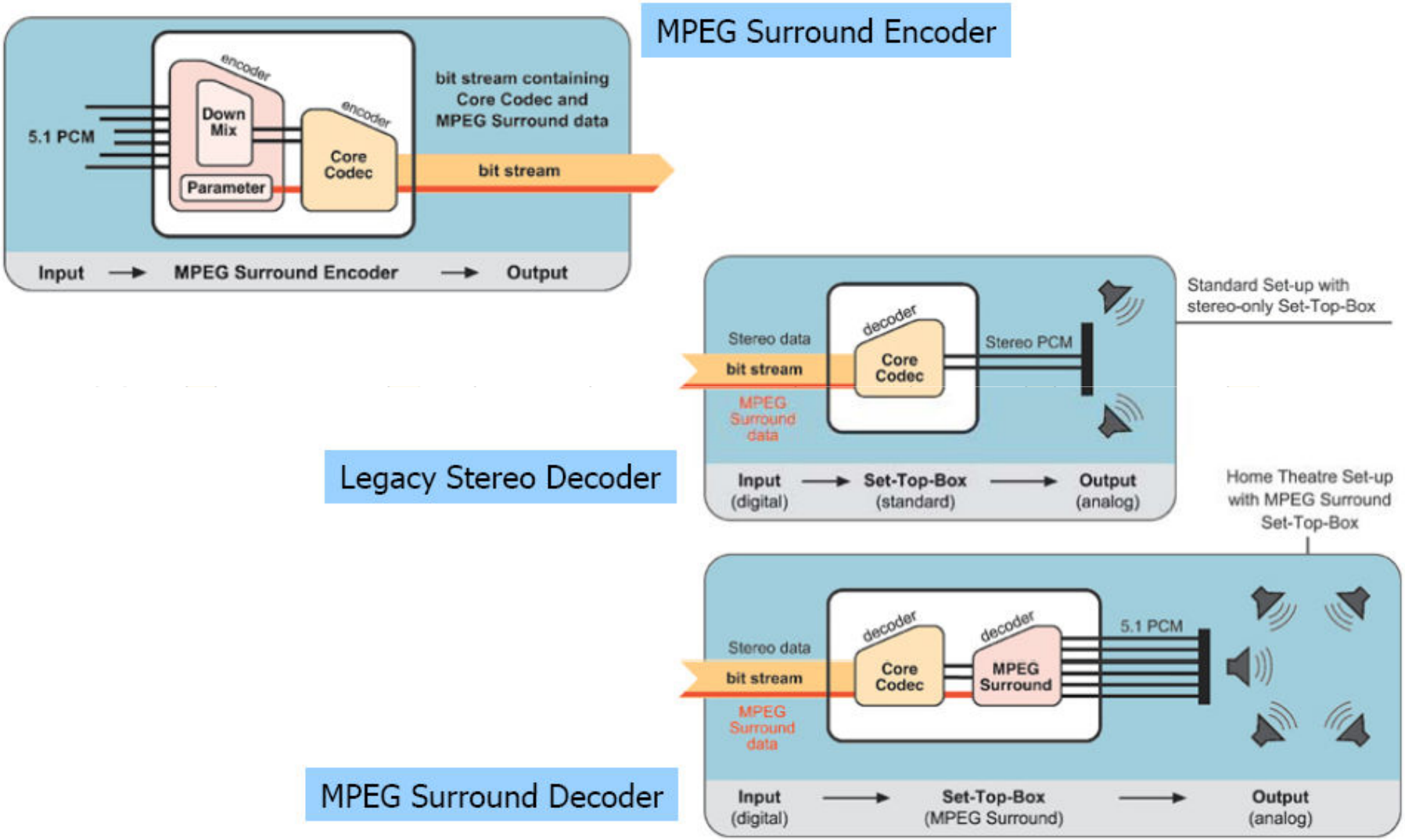


Non-backward Compatibility version

MPEG-4 Audio



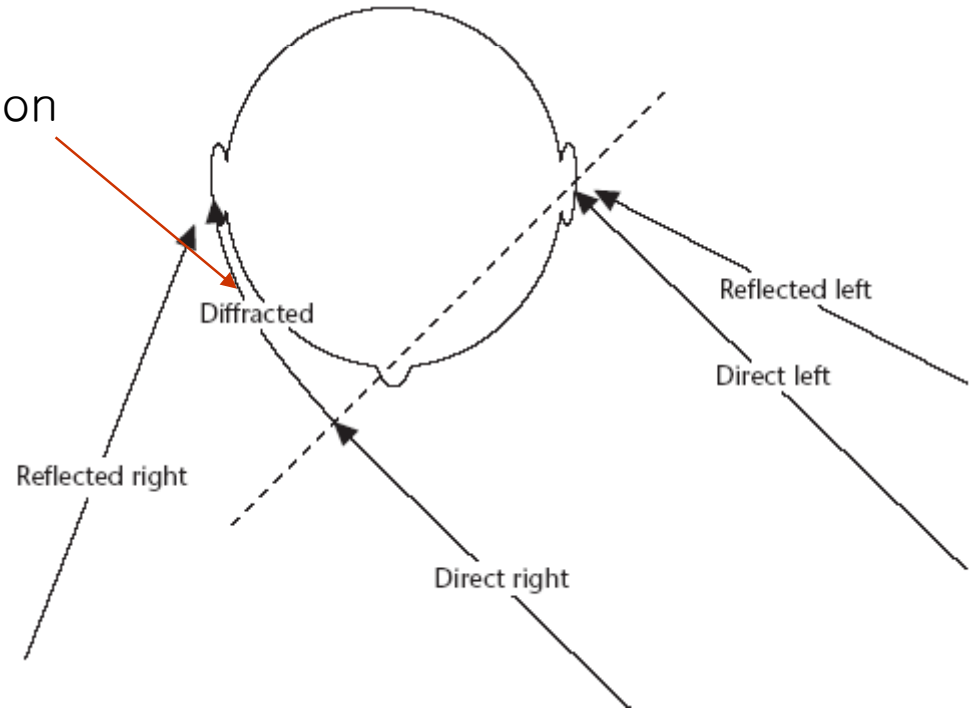
MPEG Surround



Spatial Parameters

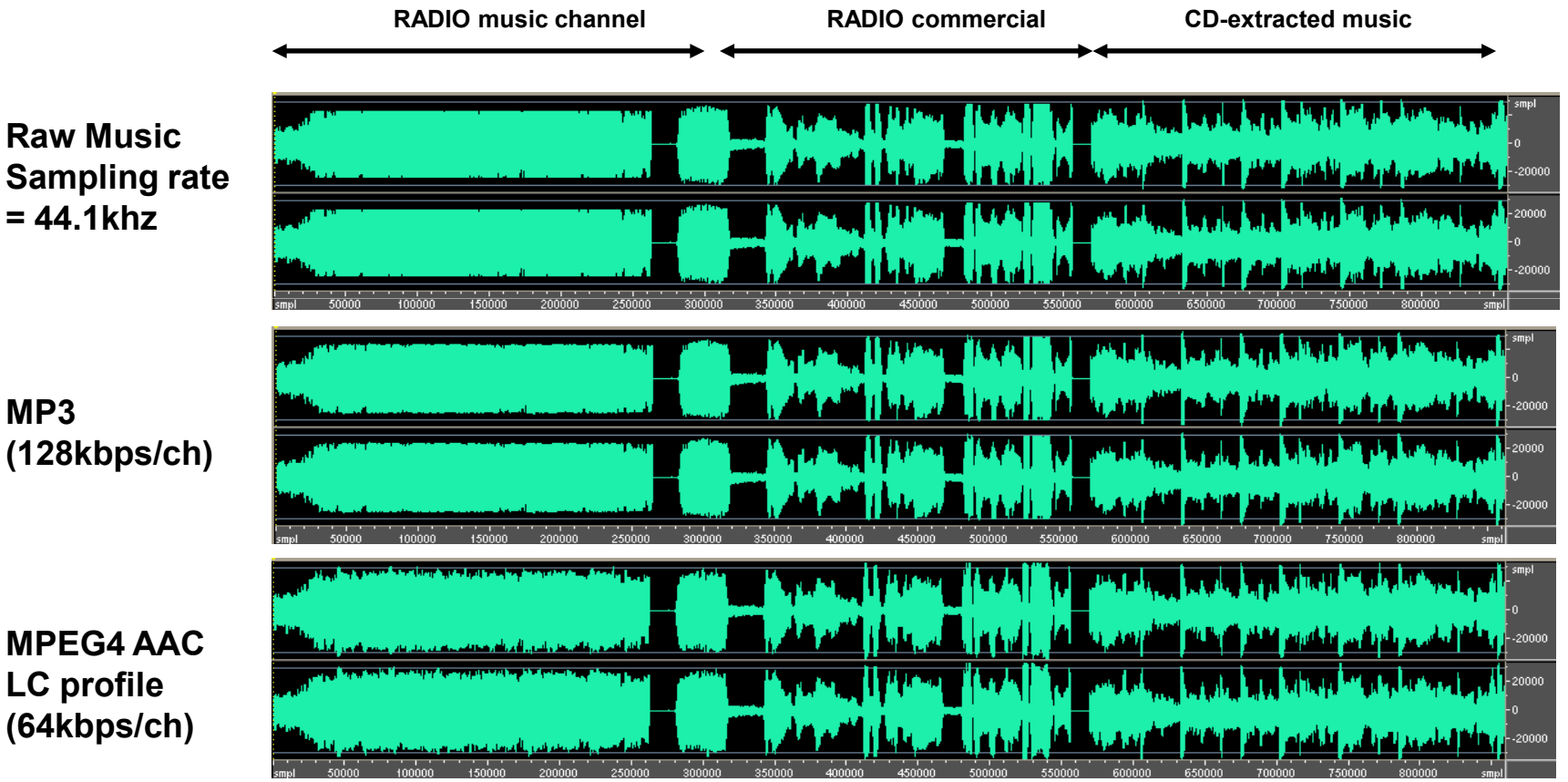
- **ILD : interaural level differences**
- **ITD : interaural time difference**
- **IC : interaural coherence (reflected)**

Time delay and level attenuation
(ILD, ITD)



Quality Comparison : Audio

MP3/AAC Encoding/Decoding



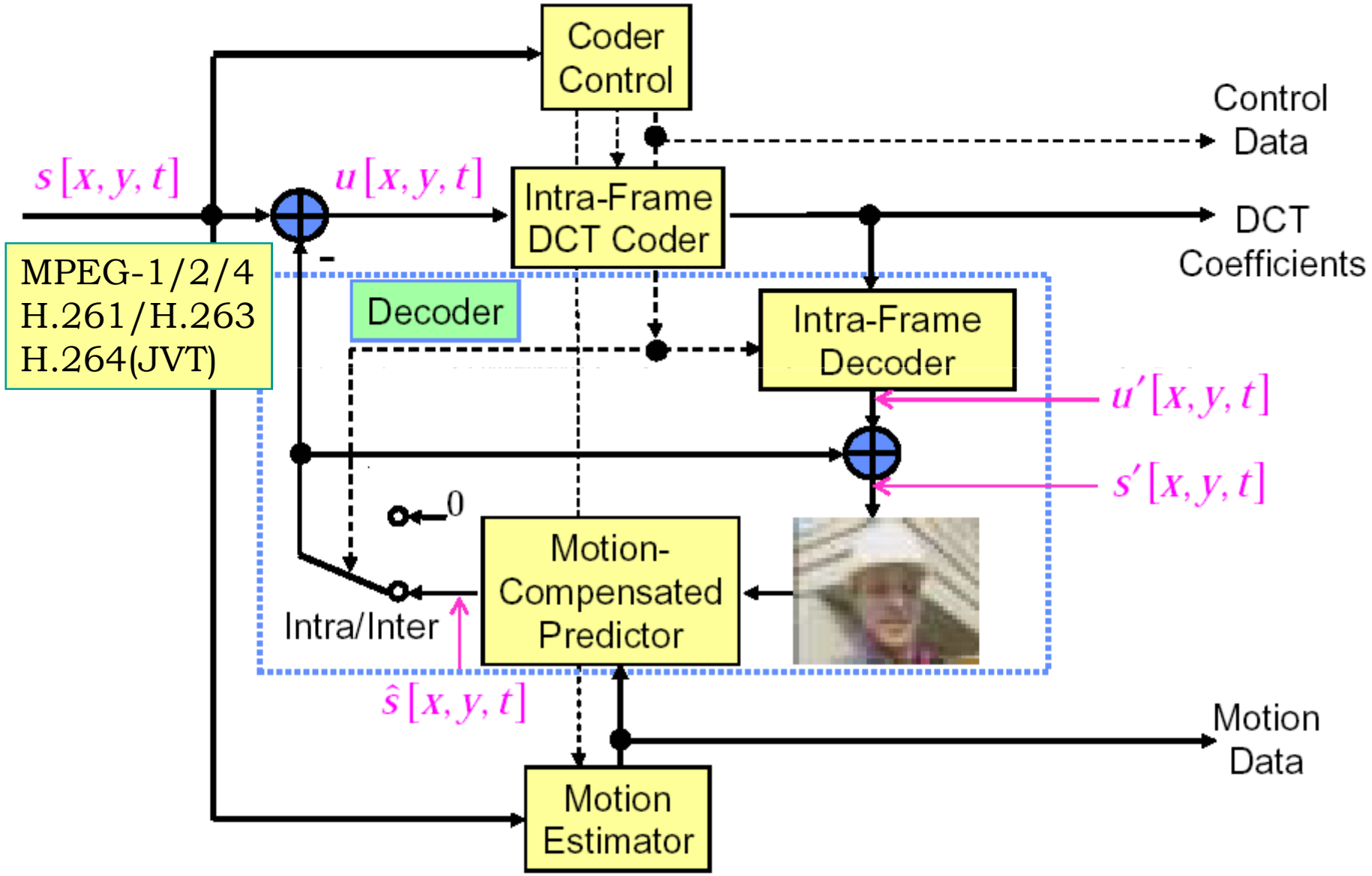
Why Video Compression ?

	Resolution (pelsxlinesxfps)	Uncompressed bit rate (RGB)	Compressed bit rate
NTSC video	720x480x29.97	249 Mbps	4-8 Mbps
PAL video	720x576x25	249 Mbps	4-9 Mbps
HDTV video	1920x1080x30	1,493 Mbps	10-30 Mbps
ISDN videophone	352x288x29.97	73 Mbps	64-1920 kbps
PSTN videophone	176x144x29.97	18 Mbps	10-30 kbps

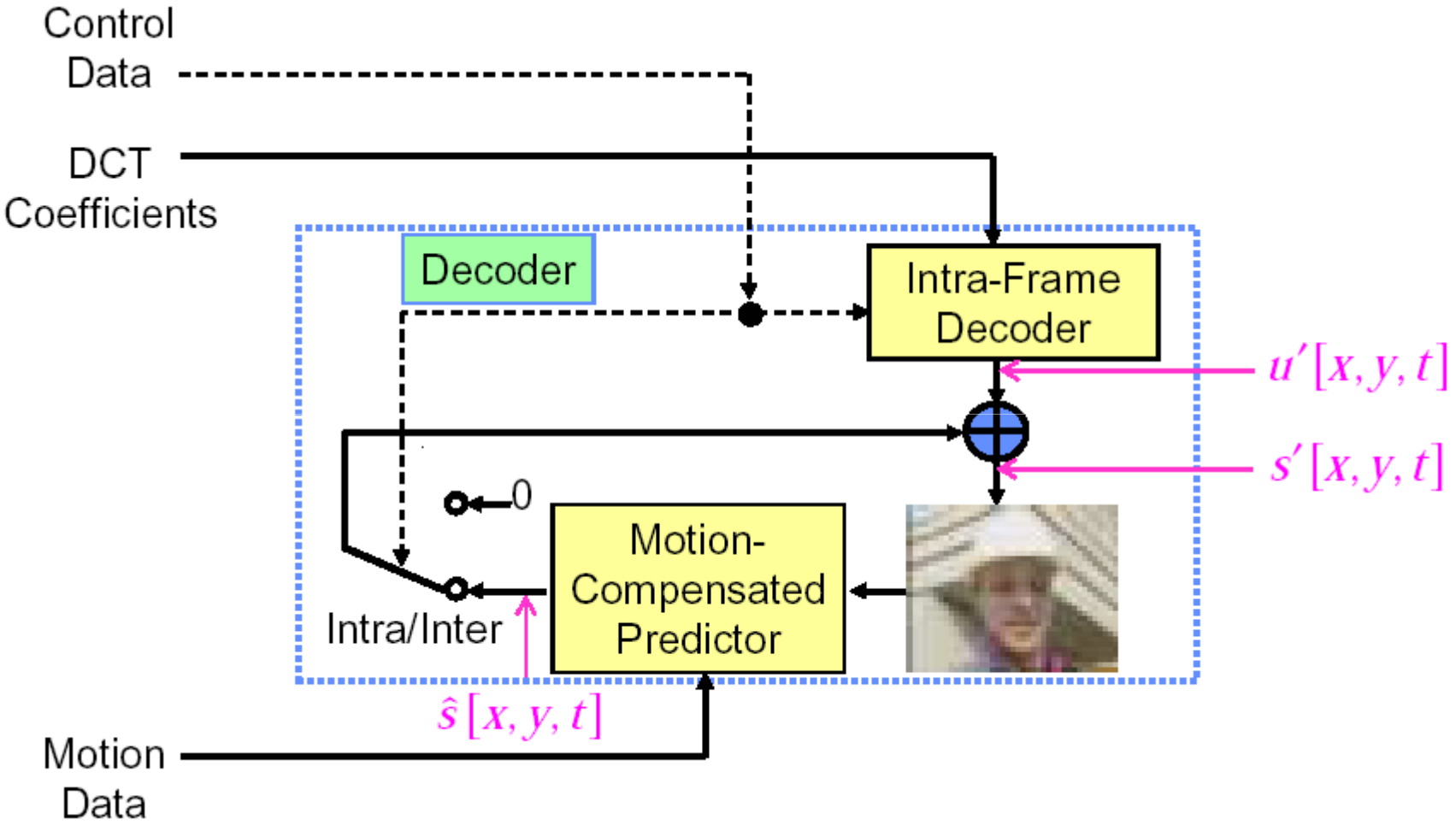
Principles of Video Compression

- **Human visual system**
  - Low pass filter
  - Not sensitive to color component
  - Spatio-temporal mask effect
- **Spatial redundancy (intra-frame redundancy)**
  - Transform and quantization
- **Temporal redundancy (inter-frame redundancy)**
  - Motion estimation/compensation
- **Probabilistic redundancy**
  - Entropy coding(Huffman/Arithmetic coding)

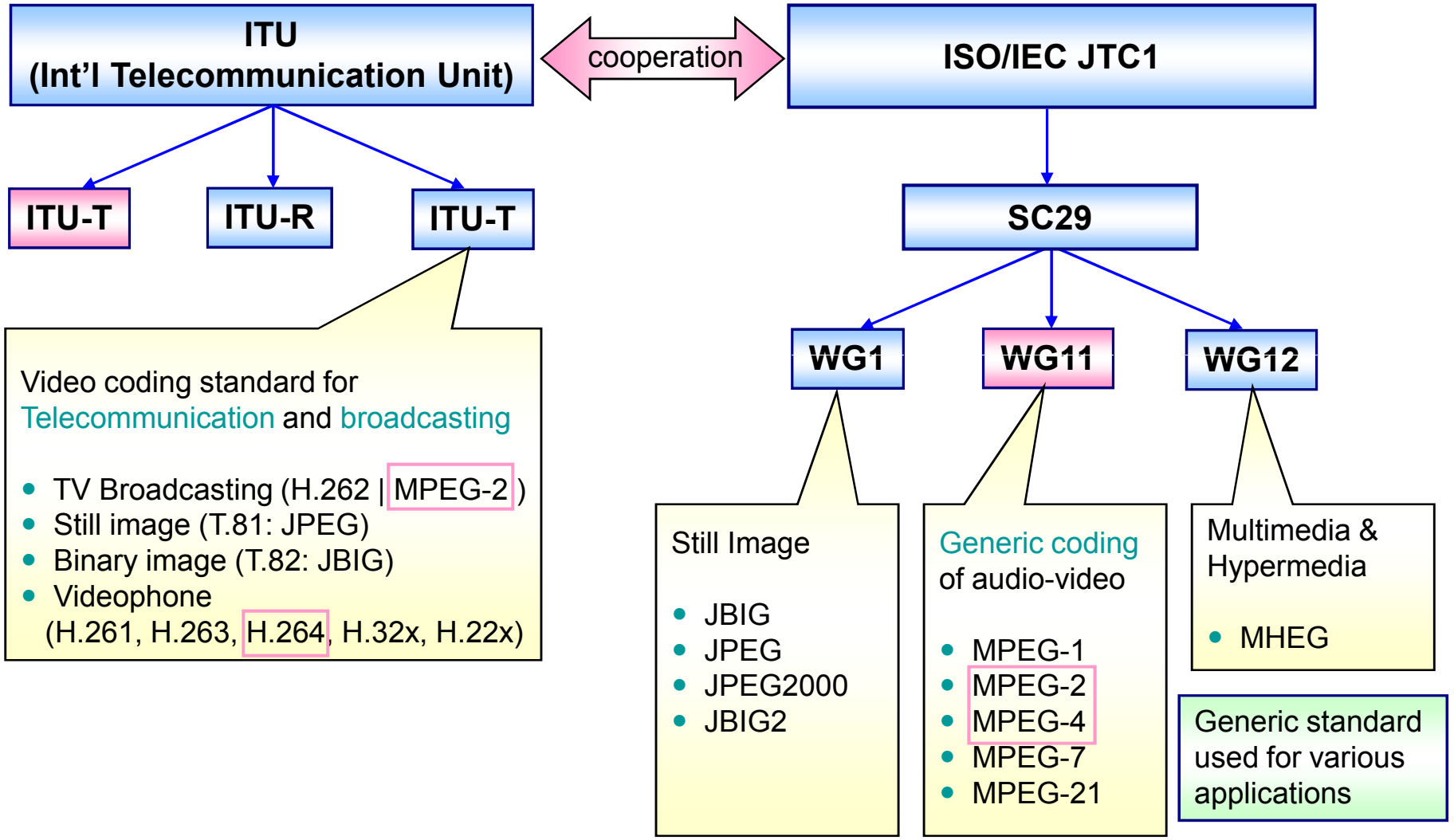
Typical Hybrid-encoding Structure



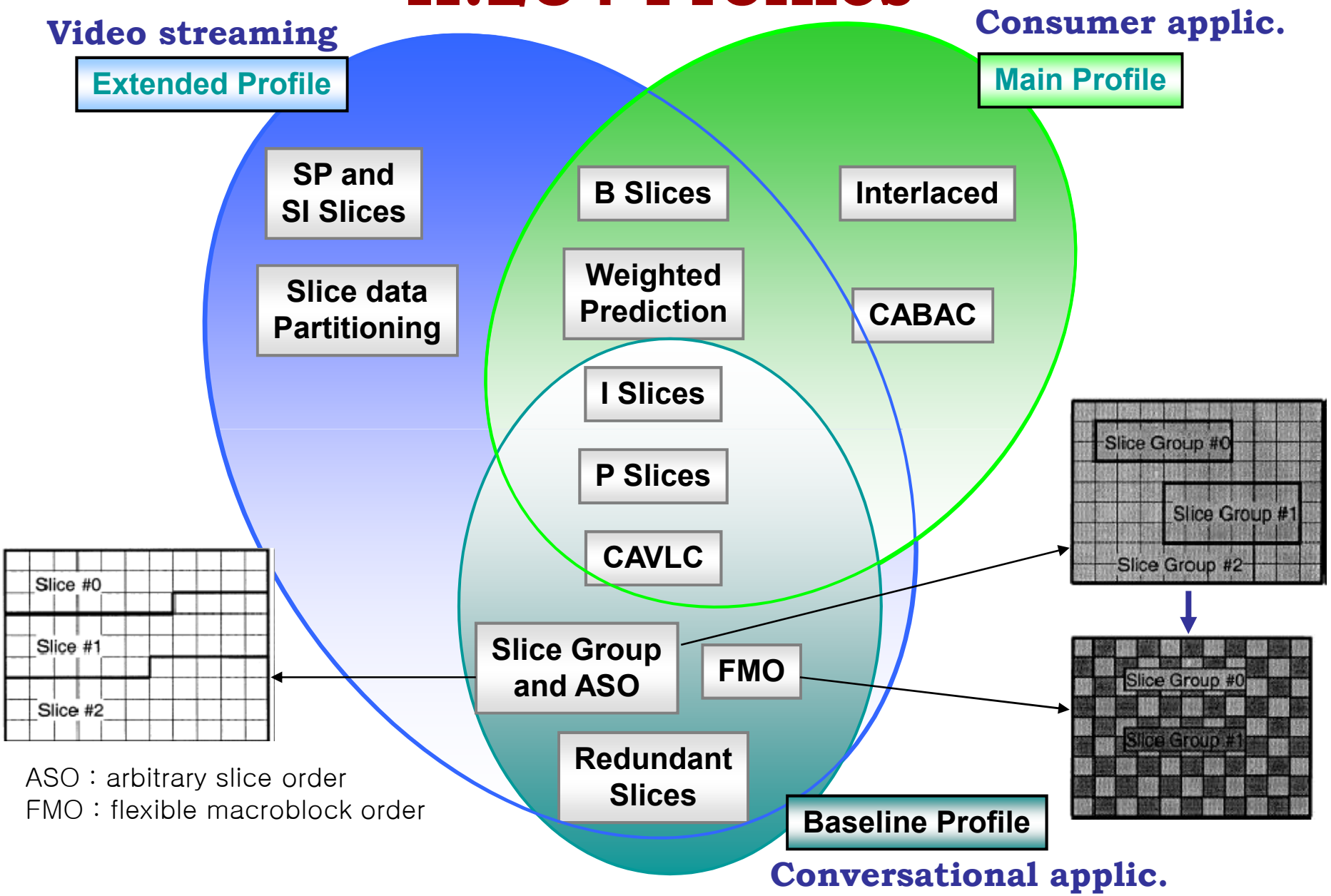
Hybrid Video Decoder



Standard Organization for Video Coding



H.264 Profiles

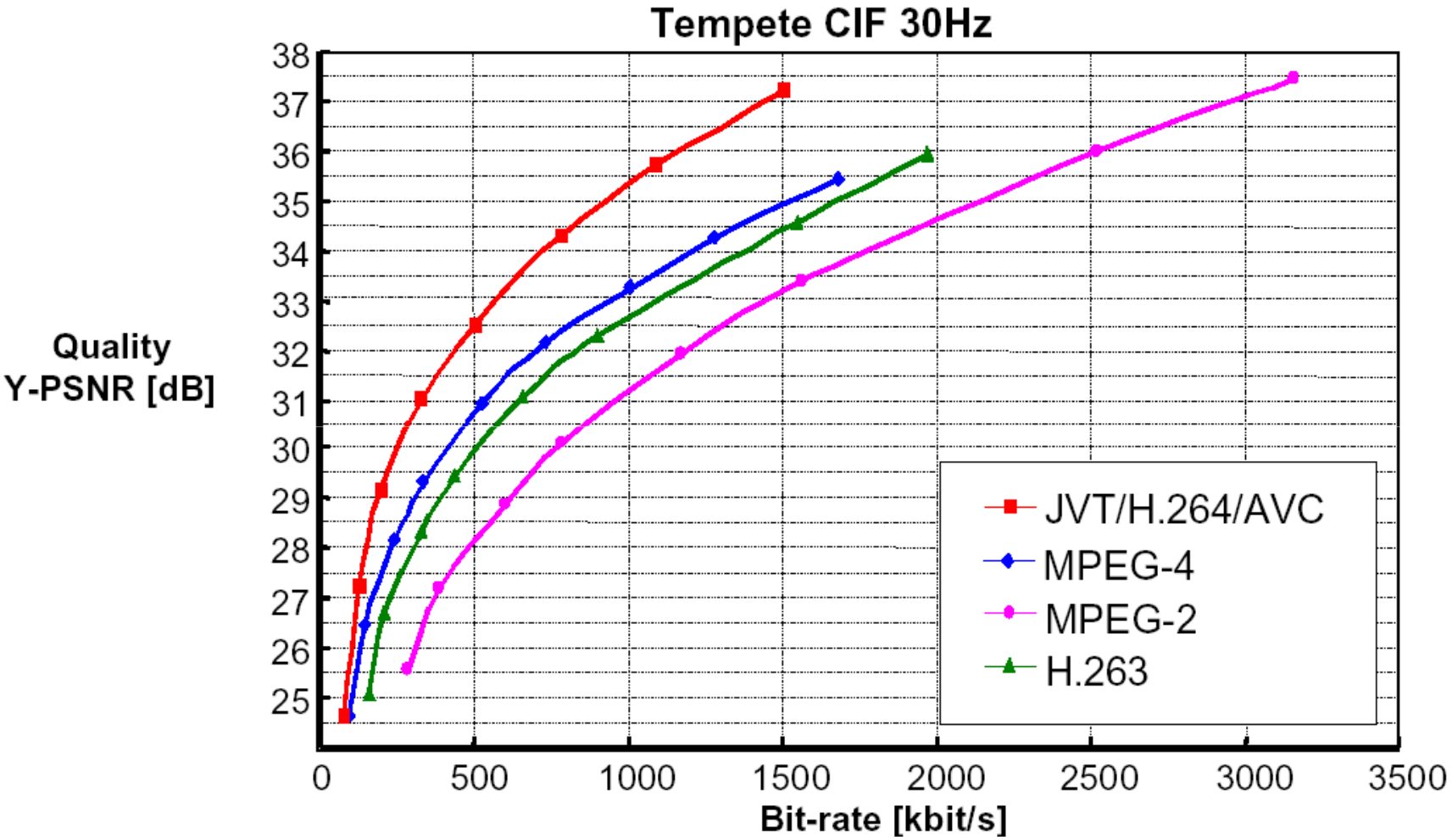


ASO : arbitrary slice order
FMO : flexible macroblock order

Summary of Coding Algorithms

	MPEG-1	MPEG-2	MPEG-4	H.264
Video type	rectangular	rectangular	Rectangular, arbitrary	rectangular
Video format	SIF	SIF, CCIR 601	CIF/n, CIF*m	CIF/n, CIF*m
Scan type	progressive	Progressive, interlaced	Progressive, interlaced	Progressive, interlaced
Compr. Effic.	low	medium	medium	High
Video streaming		Scalable coding	Scalable coding	Switching slices
min MC blk size	16x16	16x16	8x8	4x4
MV accuracy	half	half	Half or quarter	quarter
# of ref. pict.	1,2	1,2	1,2	Multiple
Transform	8x8 floating DCT	8x8 floating DCT	8x8 floating DCT	4x4 integer DCT
Built-in deblock	no	yes	yes	yes
Intra coding	DC prediction	DC prediction	DC/AC prediction	Spatial prediction
VLC	Huffman, RLE	Huffman, RLE	Huffman, RLE	Exp-Golomb, RLE

Performance Comparison



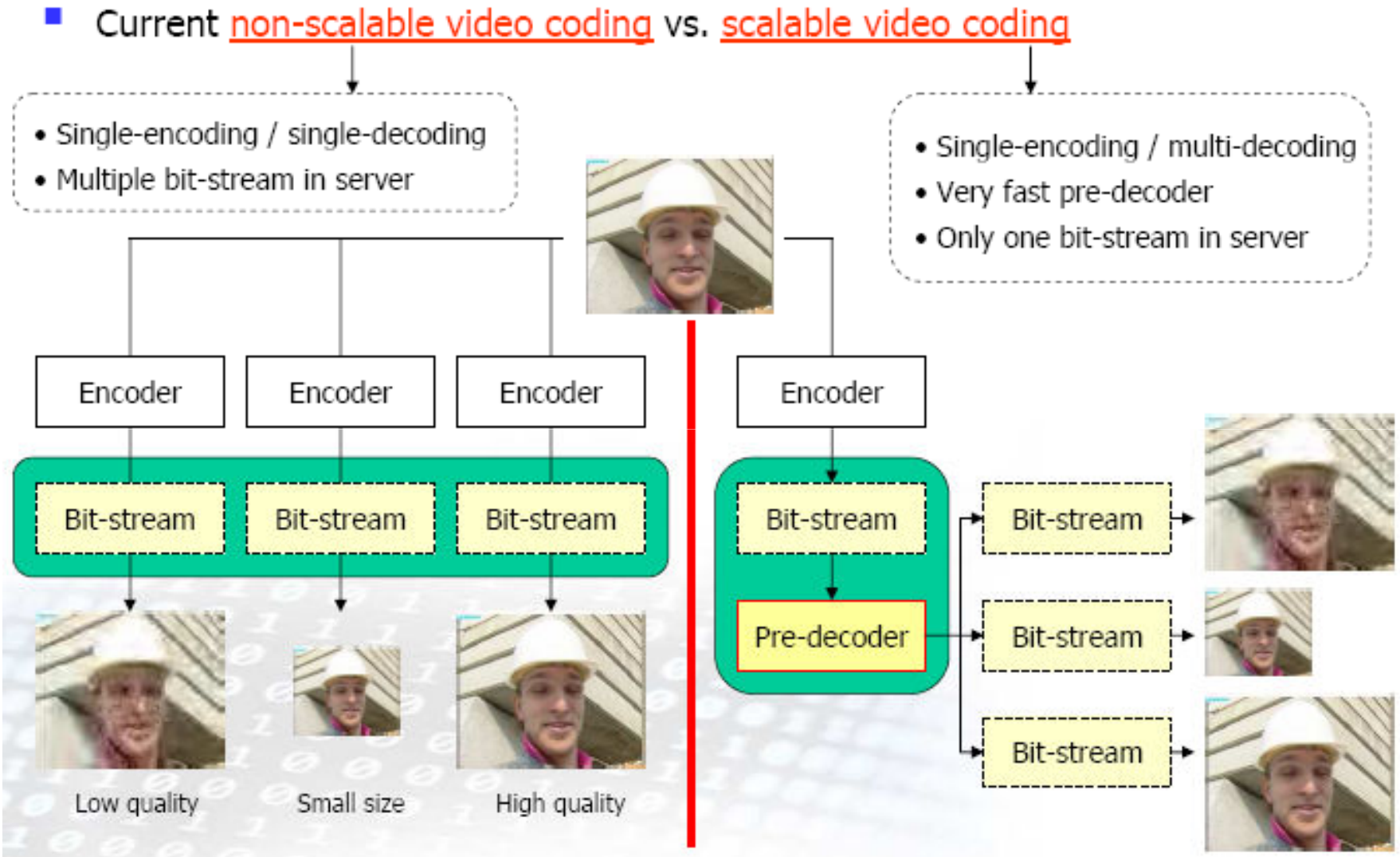
Codec Comparison

Features	H.261	MPEG-1	MPEG-2	H.263	MPEG-4
Picture Coding Type	I, P	I, P, B	I, P, B	I, P, B	I, P, B
Entropy Coding	VLC	VLC	VLC	VLC, SAC	VLC
MV Resolution	Int. Pel	½ pel	½ pel	½ pel	¼ pel
Transform	8×8 DCT	8×8 DCT	8×8 DCT	8×8 DCT	8×8 DCT
Vector Block Size	16×16	16×16	16×16, 16×8	16×16, 8×8	16×16, 8×8
Spatial Intra Prediction	No	No	No	No	No
Formats Supported	Prog.	Prog.	Prog./Intr.	Prog.	Prog./Intr.
Prediction Modes	Frame	Frame	Field & Frame	Frame	Field & Frame
De-Blocking Filter	In-loop	None	Post	Annex J In-loop	Post

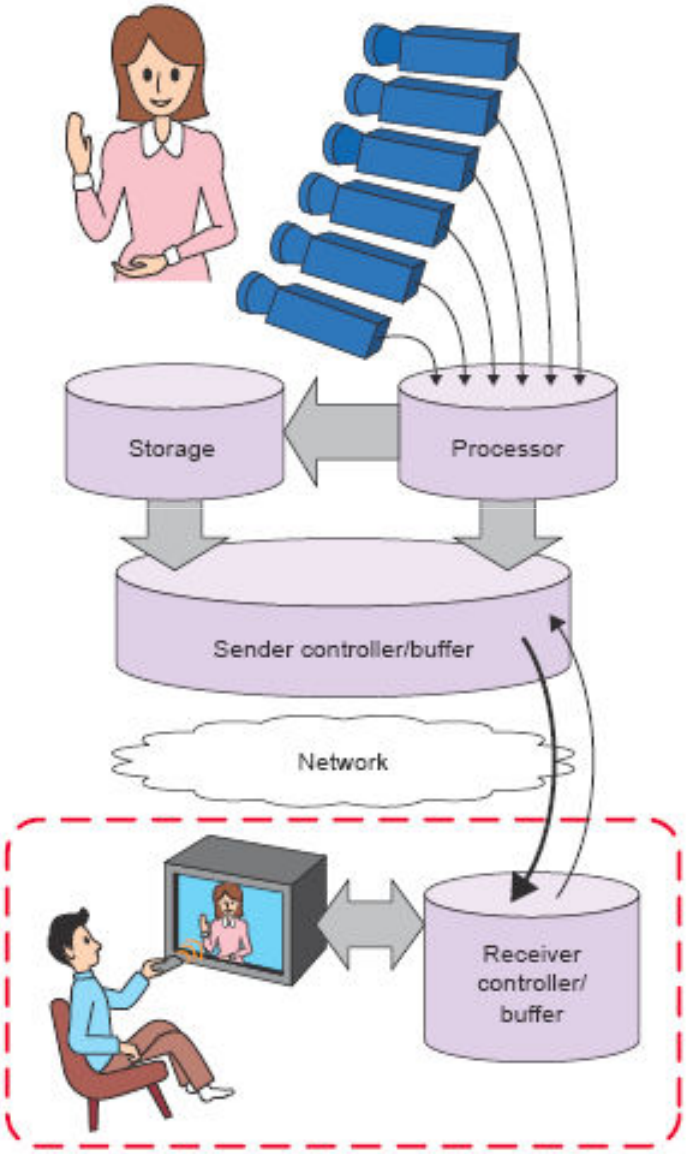
Features	H.264	WMV9/VC-1	AVS
Picture Coding Type	I, P, B	I, P, B	I, P, B
Entropy Coding	UVLC, CAVLC, CABAC	Multiple table VLC	Adaptive VLC
MV Resolution	¼ pel	¼ pel	¼ pel
Transform	4×4 & 8×8 Integer	8×8, 8×4, 4×8, 4×4 Integer DCT	8×8 integer
Vector Block Size	16×16, 16×8, 8×16, 8×8, 8×4, 4×8, 4×4	16×16, 8×8	16×16, 16×8, 8×16, 8×8, 8×4, 4×8, 4×4
Spatial Intra Predictio	Yes	No	Yes
Formats Supported	Prog/Intr	Prog/Intr	Prog/Intr
Prediction Modes	Field & Frame	Field & Frame	Field & Frame
De-Blocking Filter	In-loop	In-loop	In-loop

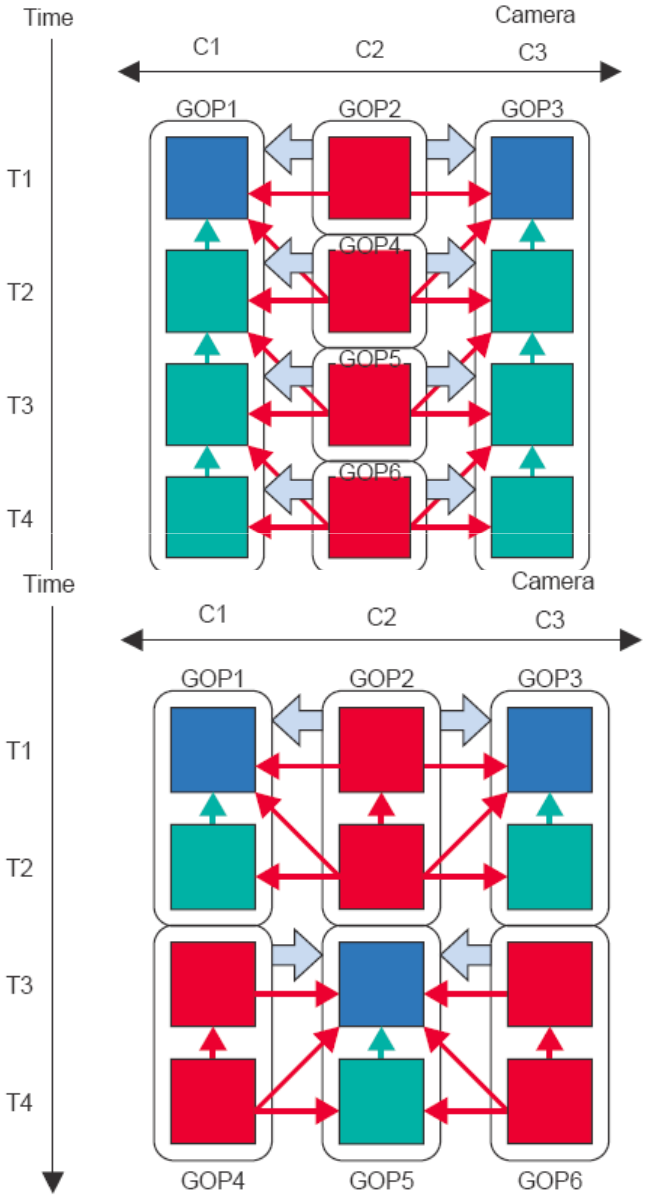
SVC : Scalable Video Coding

- Current non-scalable video coding vs. scalable video coding



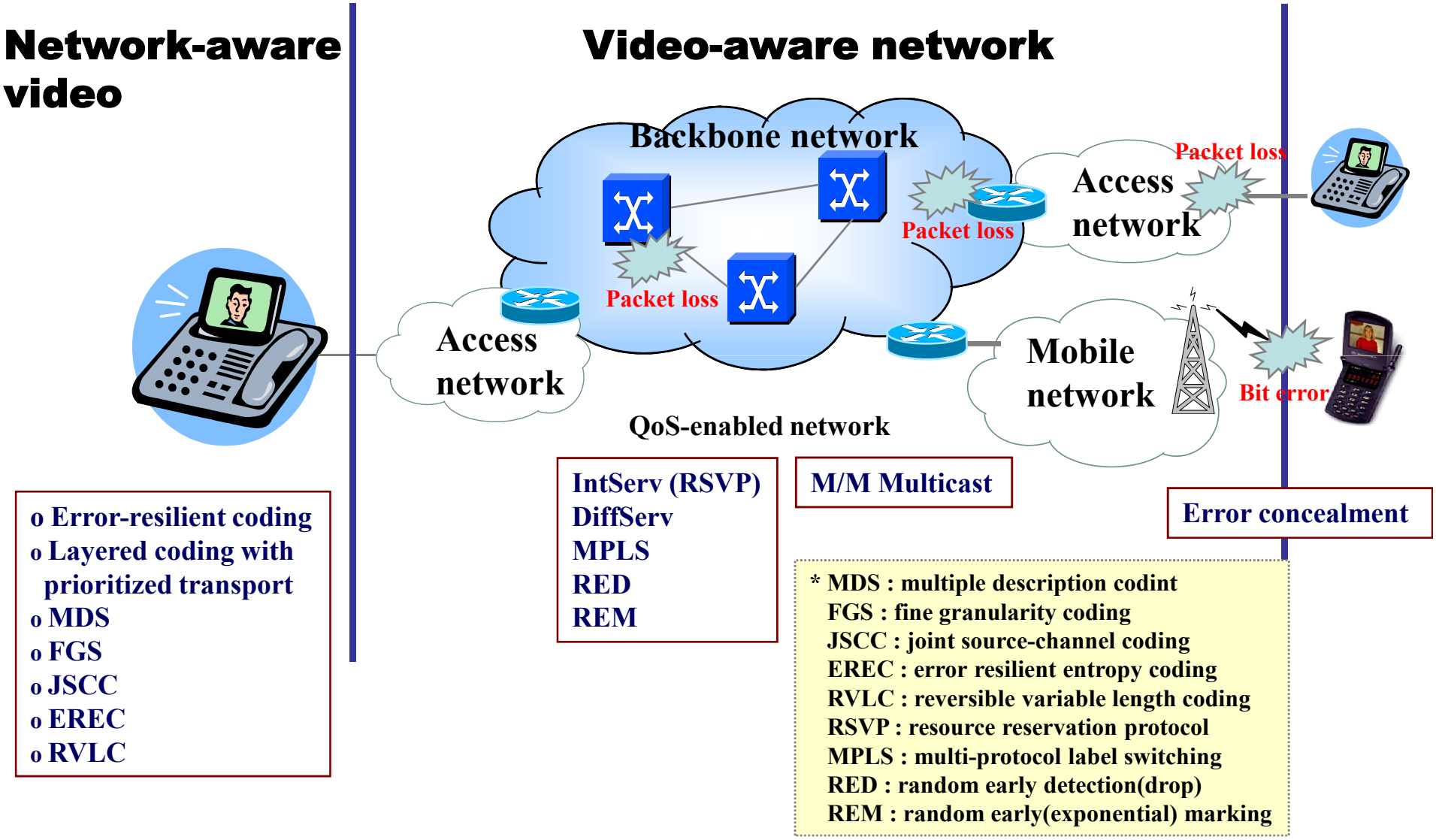
Free Viewpoint Video Coding





(b) Structure of GoGOP #2

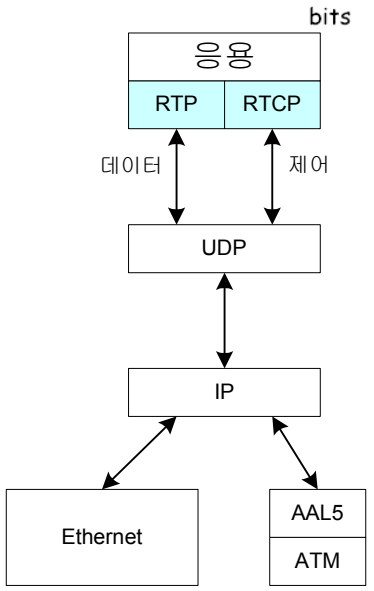
Multimedia over Networks

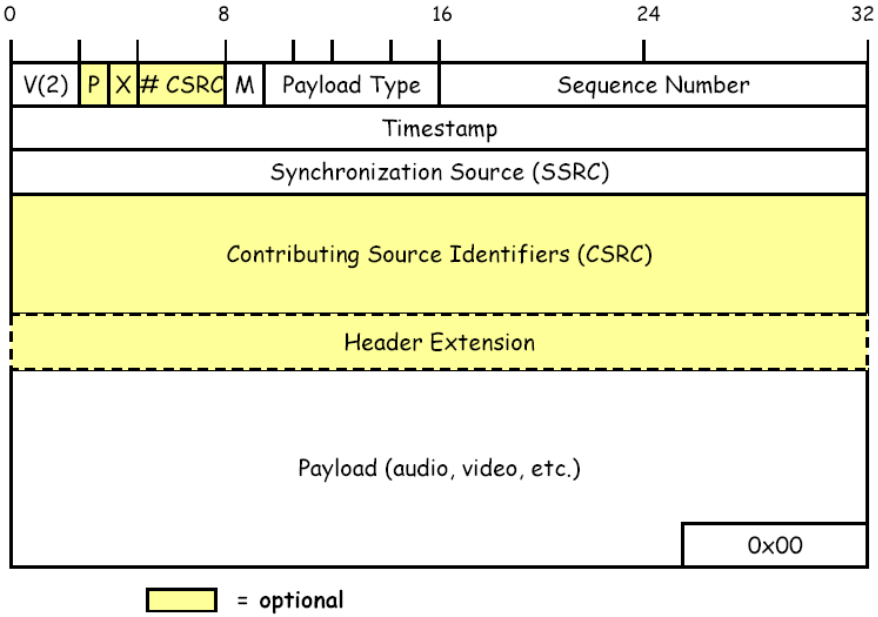


RTP (Real-time Transport Protocol)

- e2e transport for real-time data over datagram network
- provides time-stamping, sequence numbering
- does not provide any mechanism to ensure timely delivery
- does not assume anything about the underlying network
- run on the top of UDP to make use of its multiplexing and checksum service
- does not offer any form of reliability or flow/congestion control

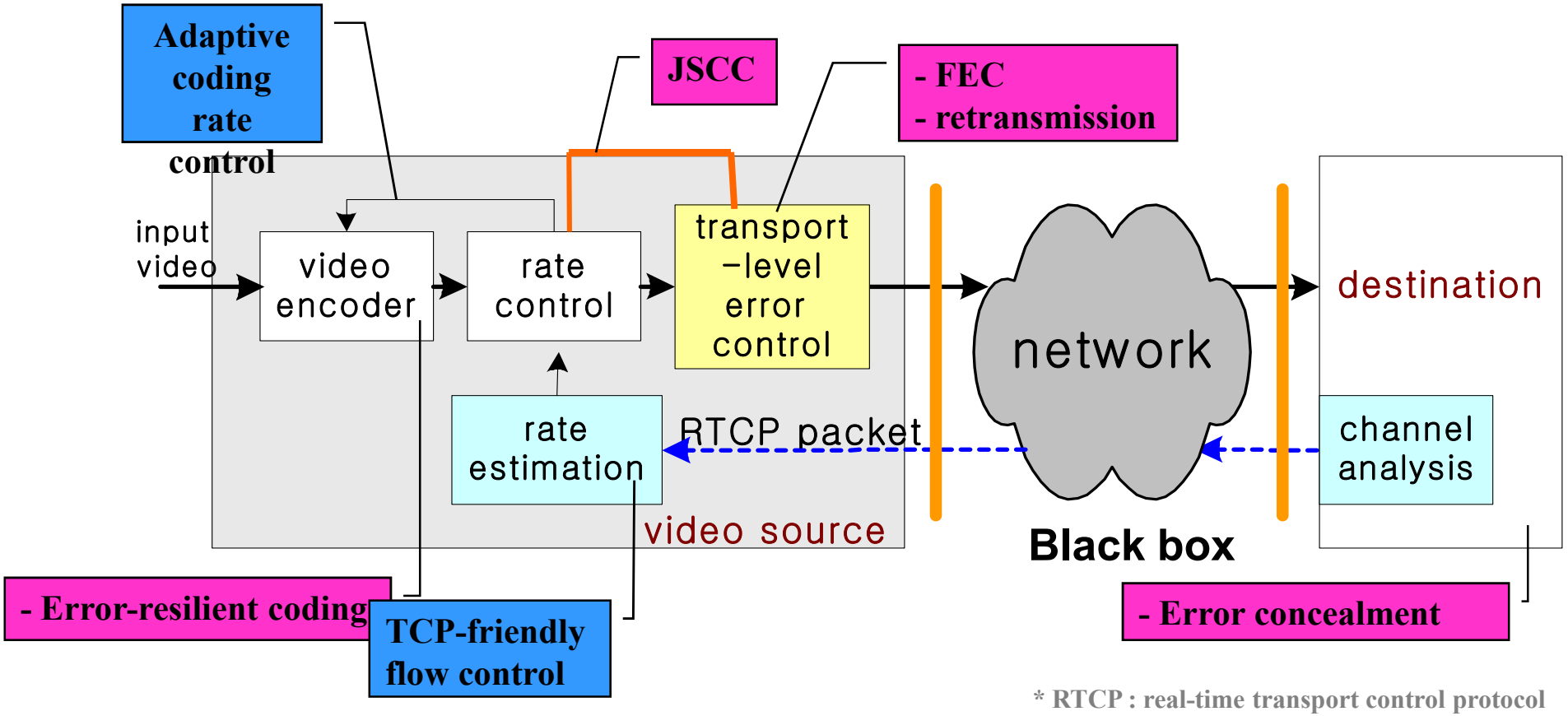
Companion protocol :
RTCP
(RTP control protocol)





Application Layer QoS Control

Best-effort Internet as a "Black box"

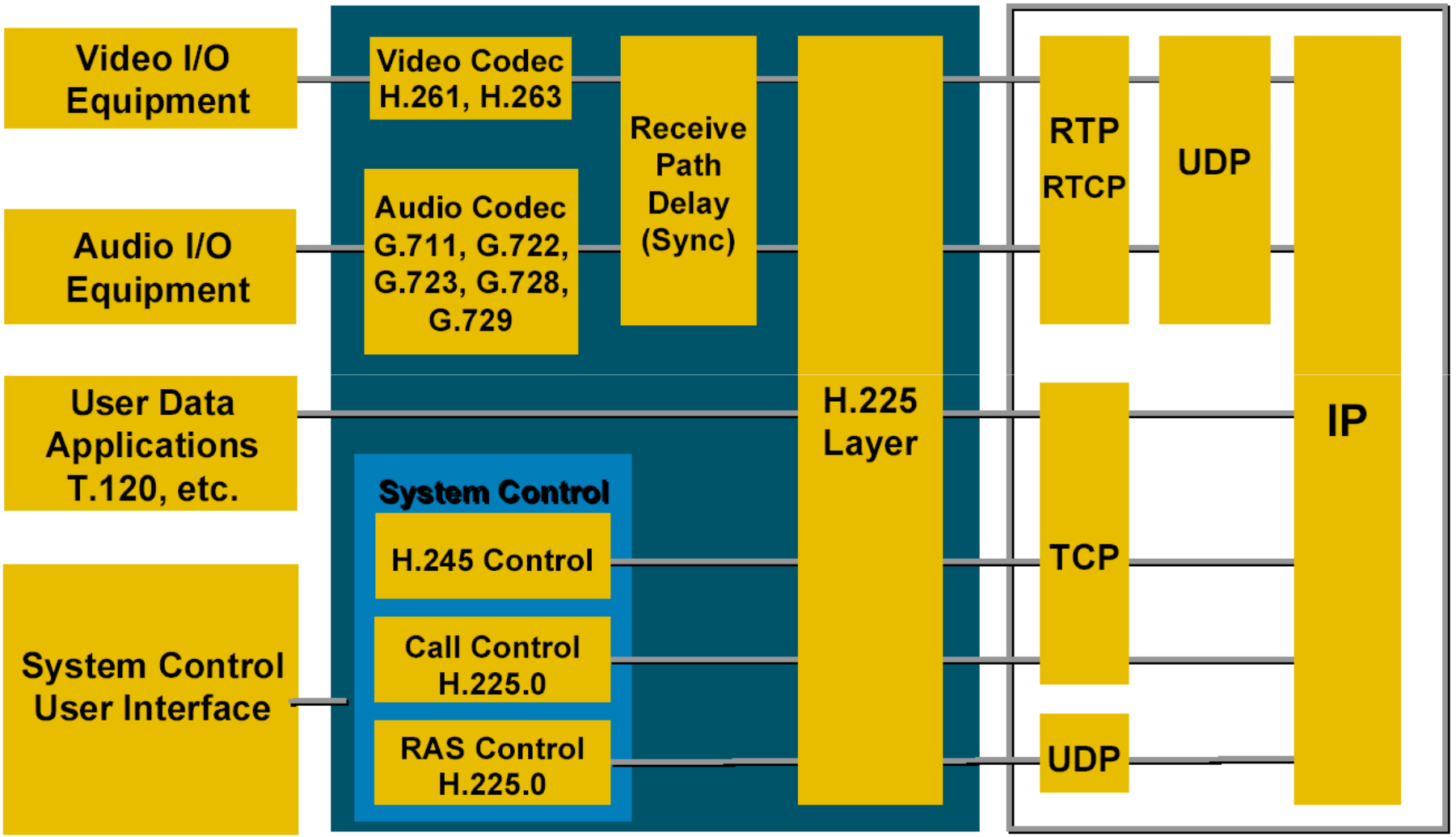


* RTCP : real-time transport control protocol

Error Concealment

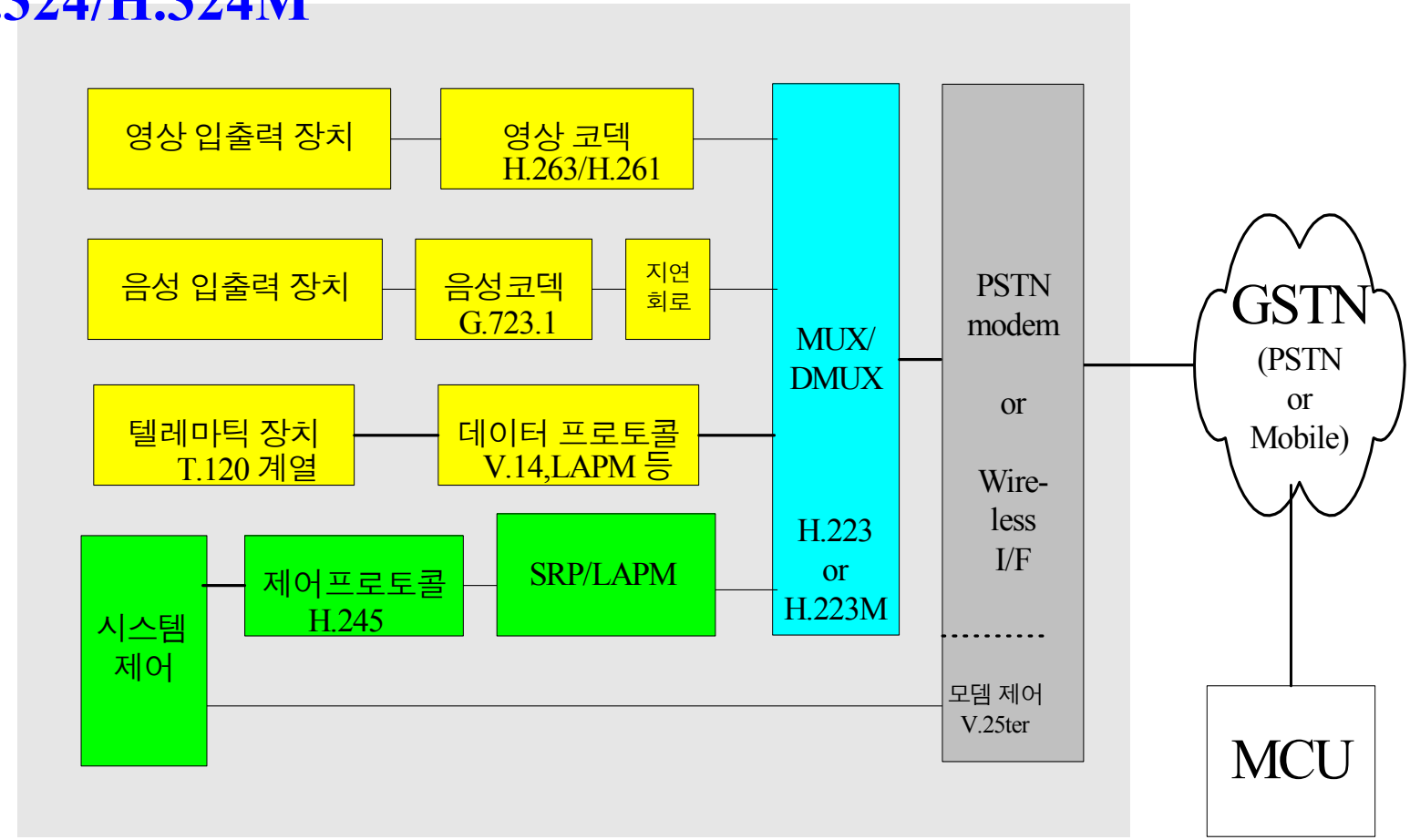
1% Packet Error | **3% Packet Error** | **10% packet Error**

Structure of H.323 System



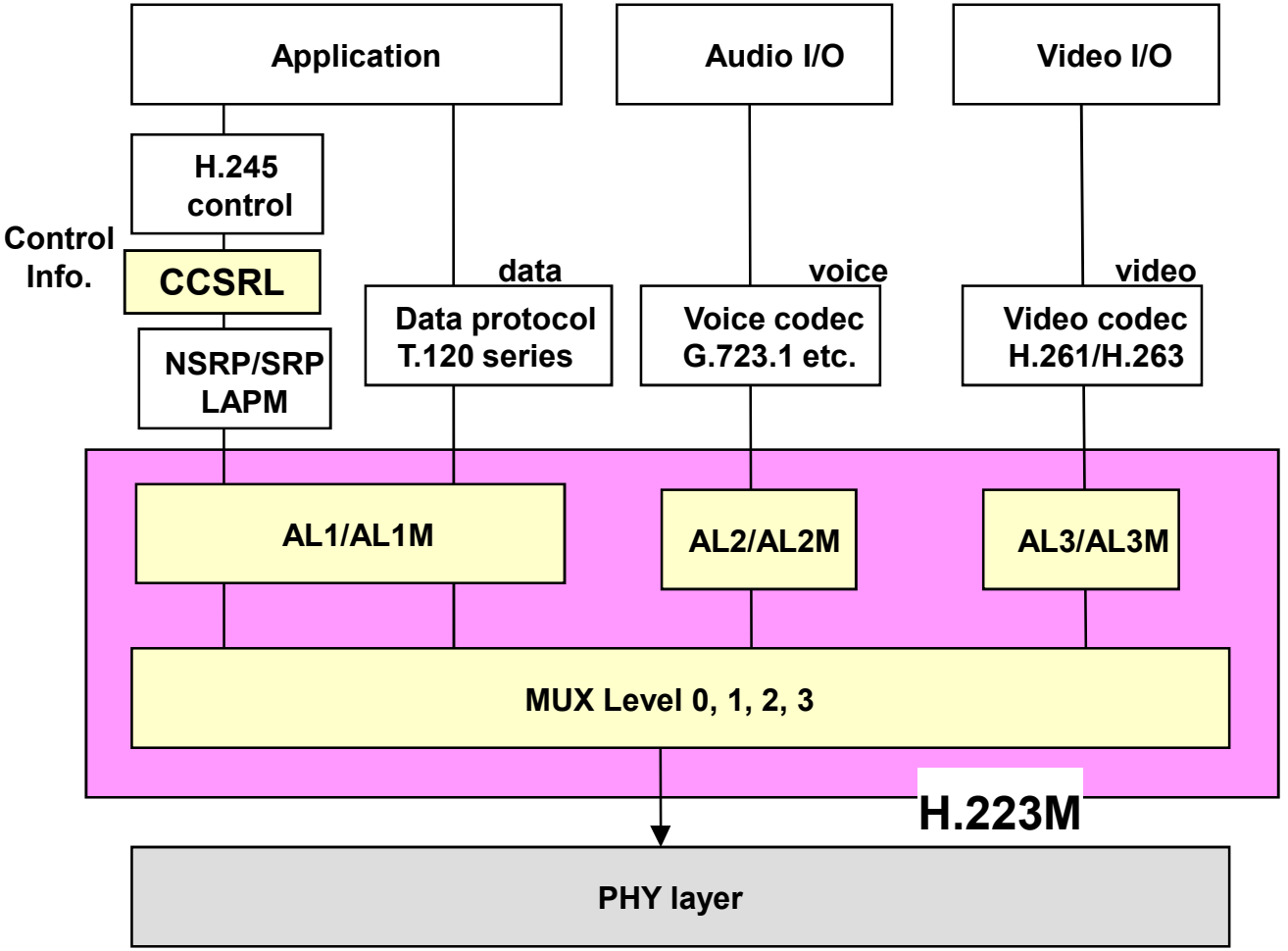
Structure of H.324 System

H.324/H.324M



System For Circuit Network

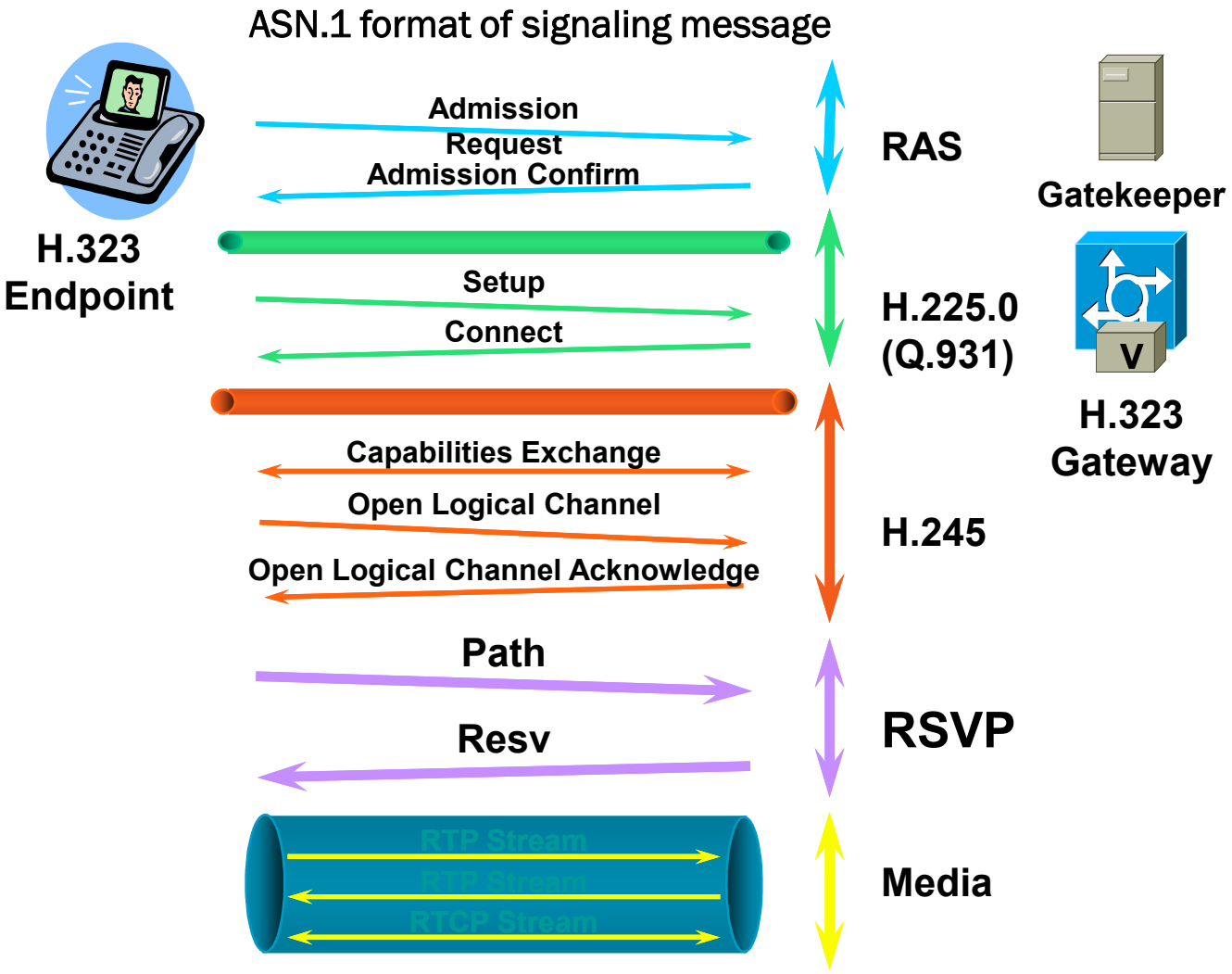
H.324M : Protocol Stack



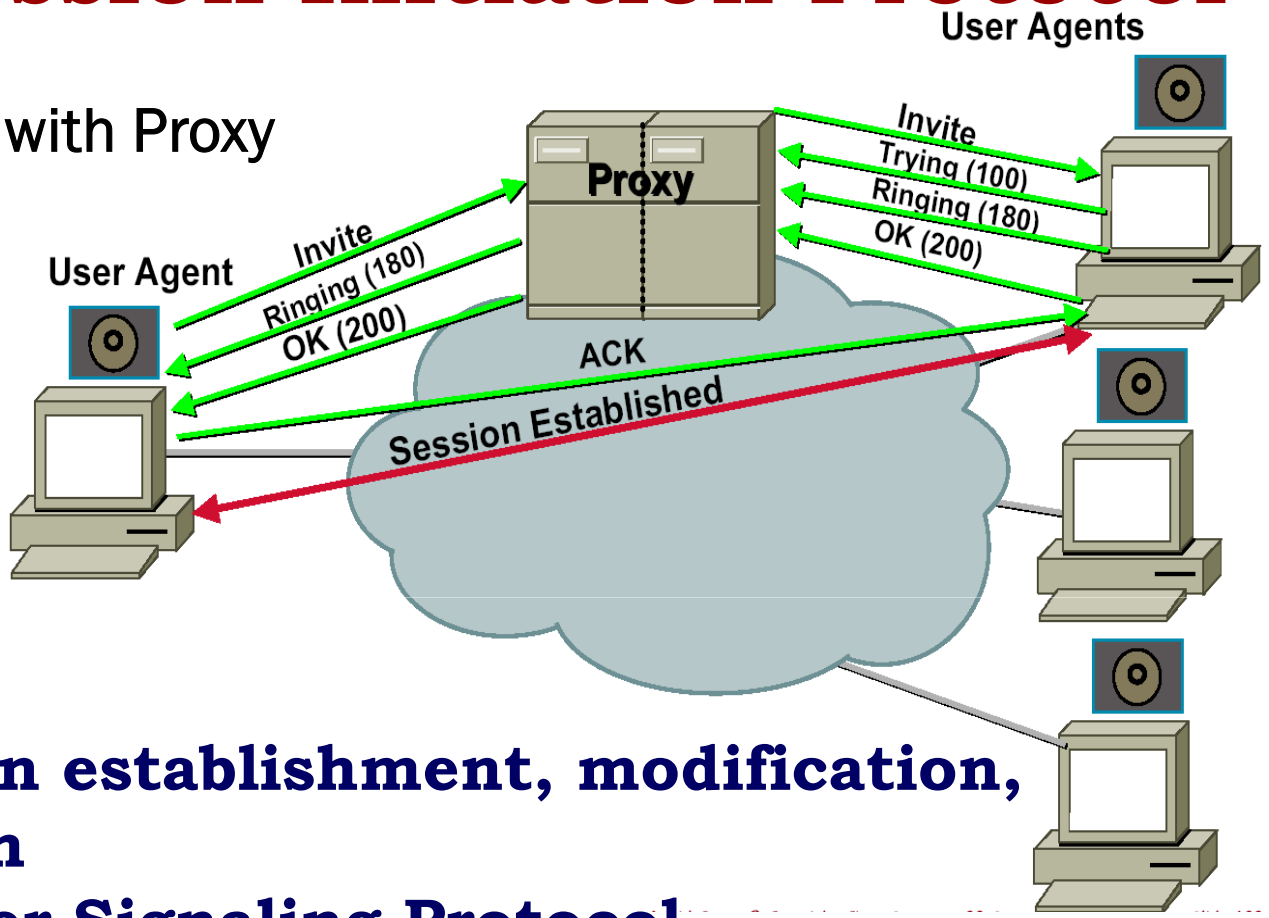
Multimedia Services

VoIP
Video Streaming
Video Multicasting
DTV & DMB
Digital Cinema

H.323 Call Signaling



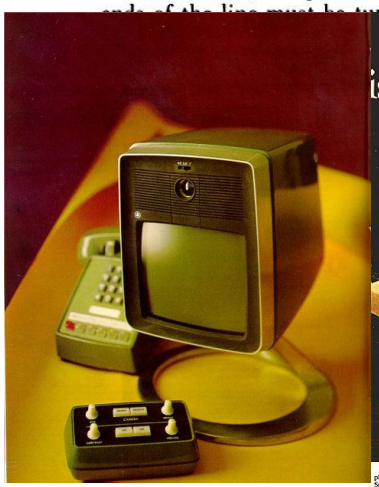
SIP: Session Initiation Protocol

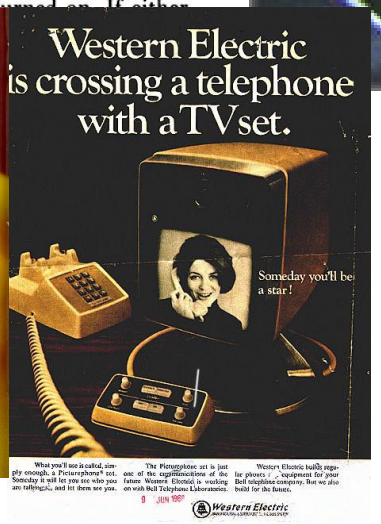


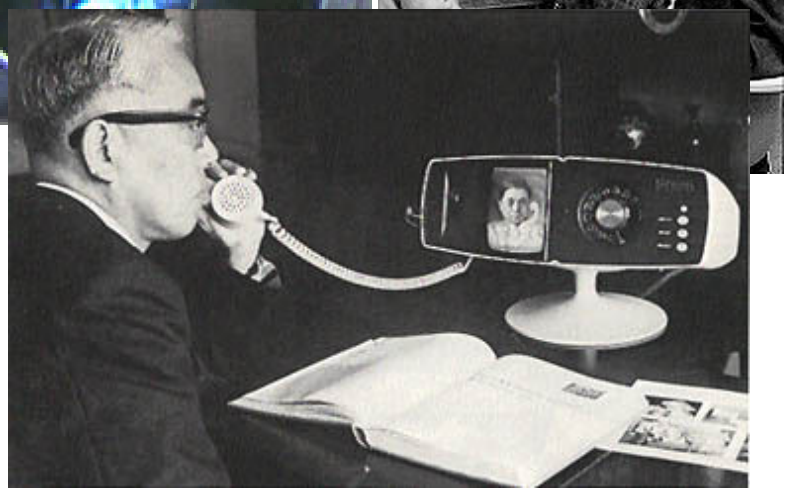
- **Call session establishment, modification, termination**
- **Peer to Peer Signaling Protocol**
- **SIP-URL**
  - E-mail style user ID
- **Higher layer than transport protocol**

V²oIP Phones(1)

A picture phone? Well here's a Bell Labs experimental model that works. As a home or office item, it's a ways in the future. However, telephone people have brought it to the point where it requires only one more ordinary telephone line in addition to the one that carries your voice. It's possible to get the picture of the person you're calling by dialing his number. Of course, the picture switches at both







V²oIP Phones(2)

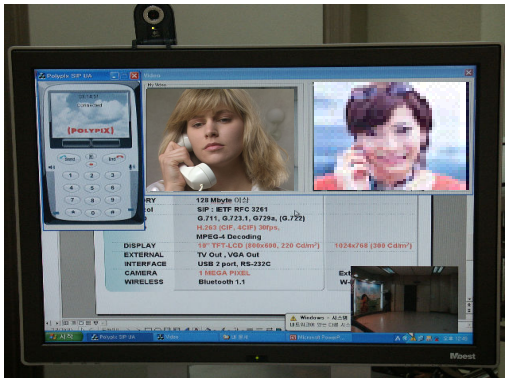
LCD형 영상전화기

STB형
영상전화기

휴대 단말

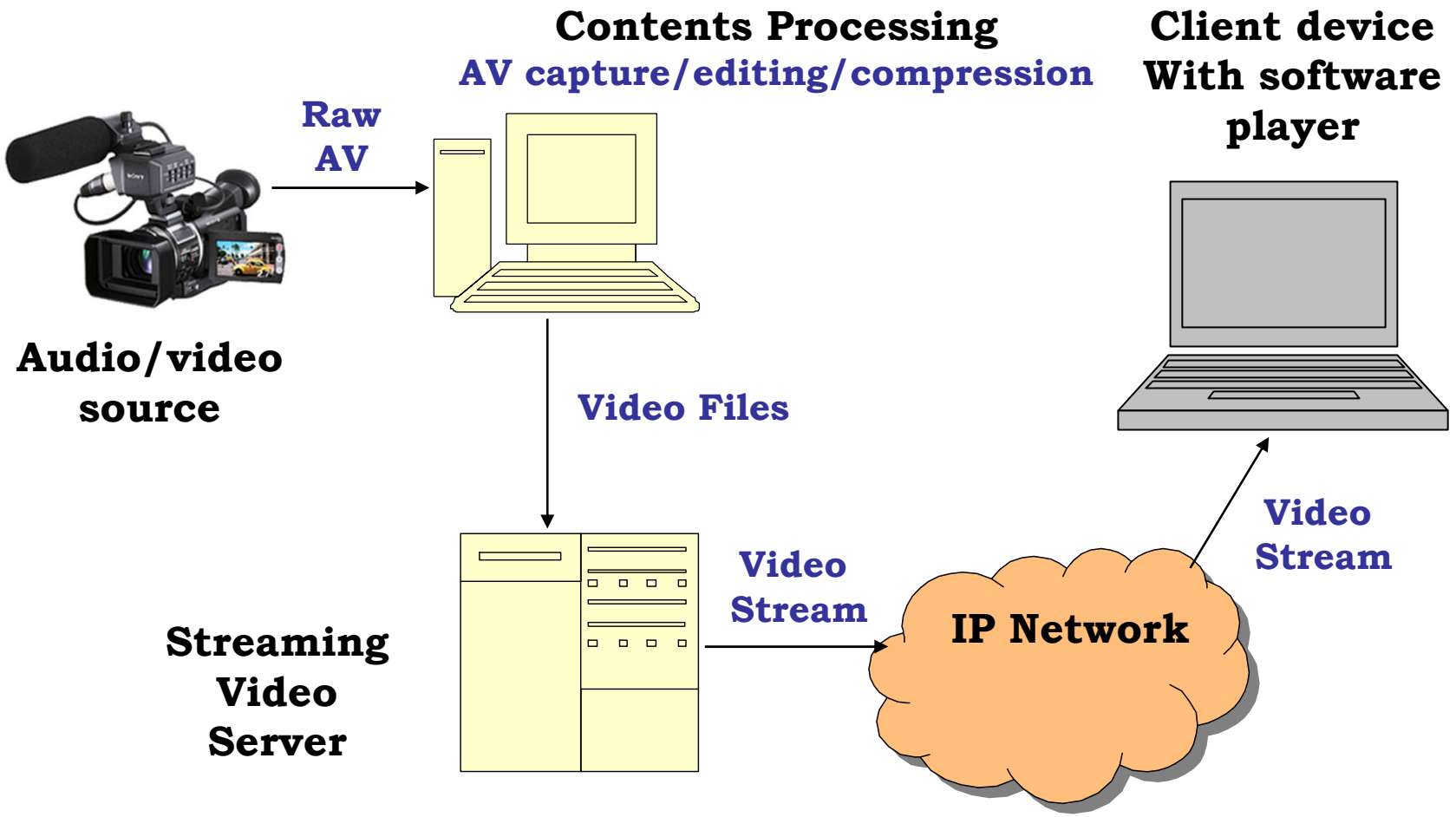
STB형 영상회의시스템

소프트폰

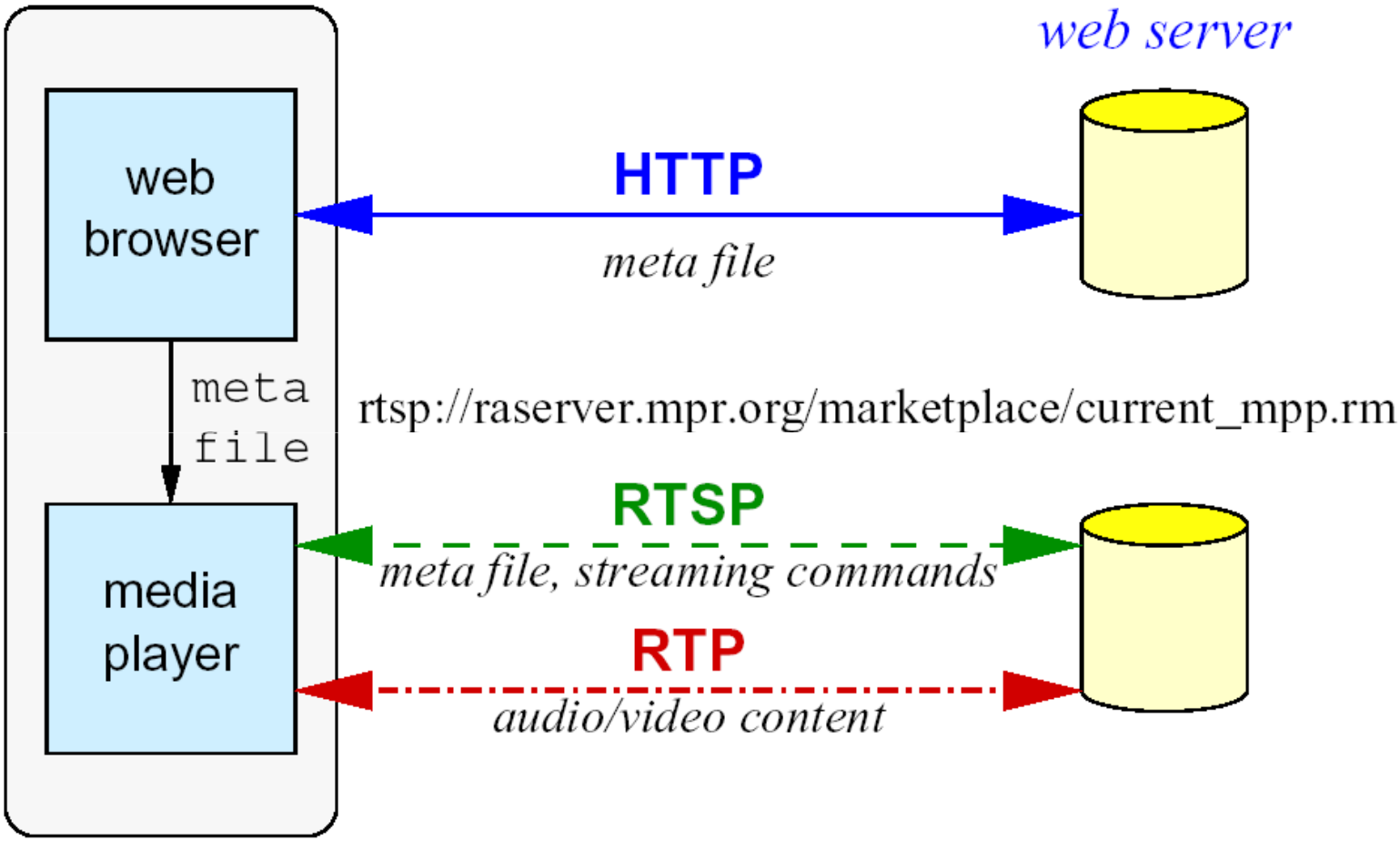


코덱 카메라

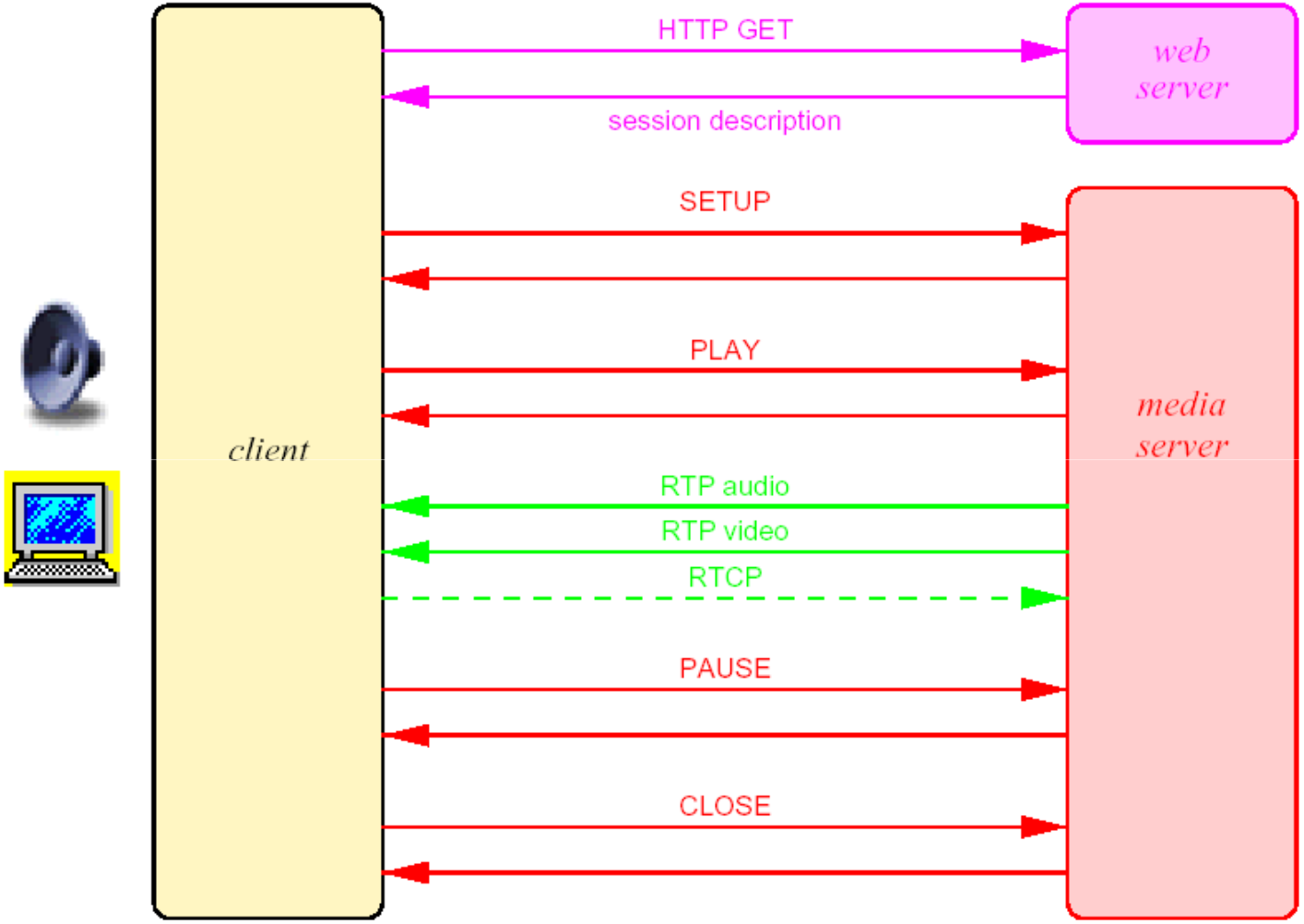
Typical Video Streaming System



Streaming Media : RTSP



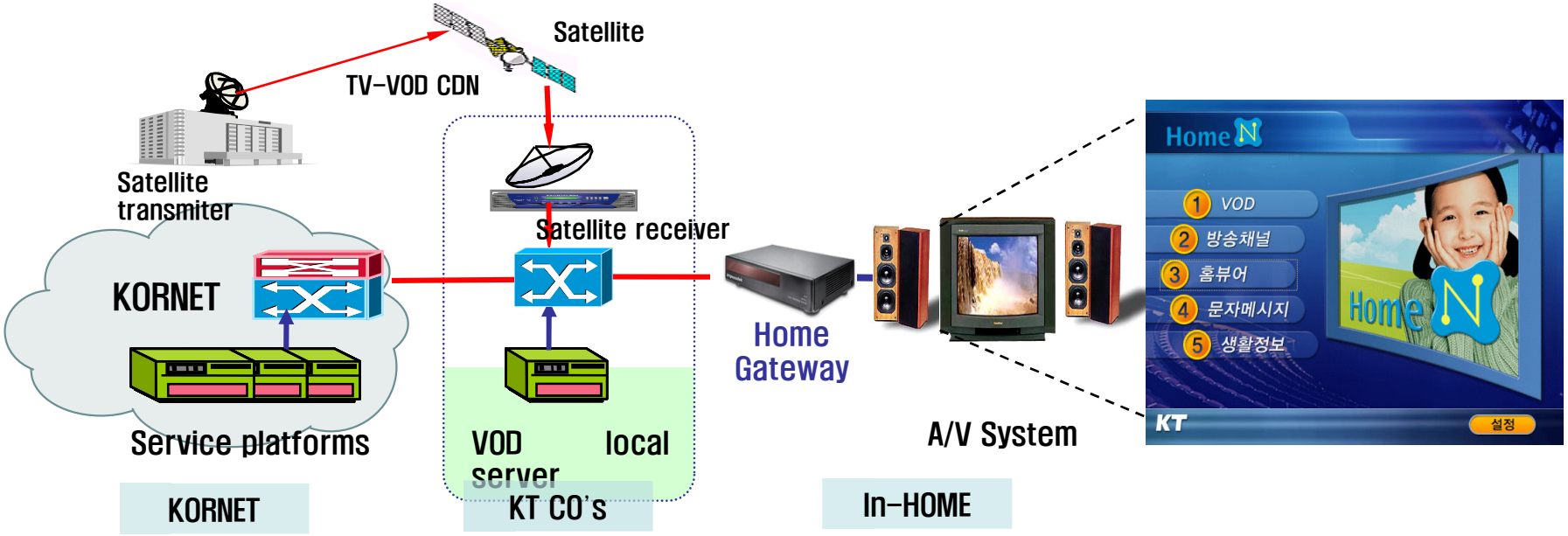
RTSP Operation



VoD (Video on Demand)

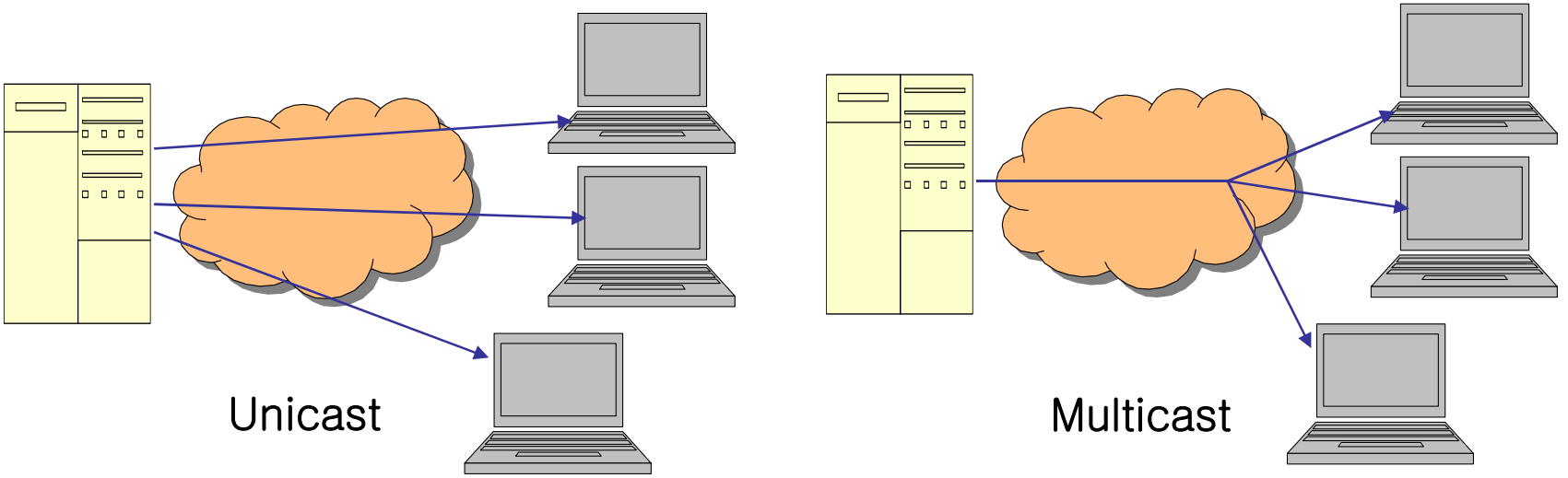
HomeN

❑ Features
- TV -based (MPEG-2, 4Mbps streaming) high quality video on demand service
- DVD-quality, 5.1 ch Dolby surround audio

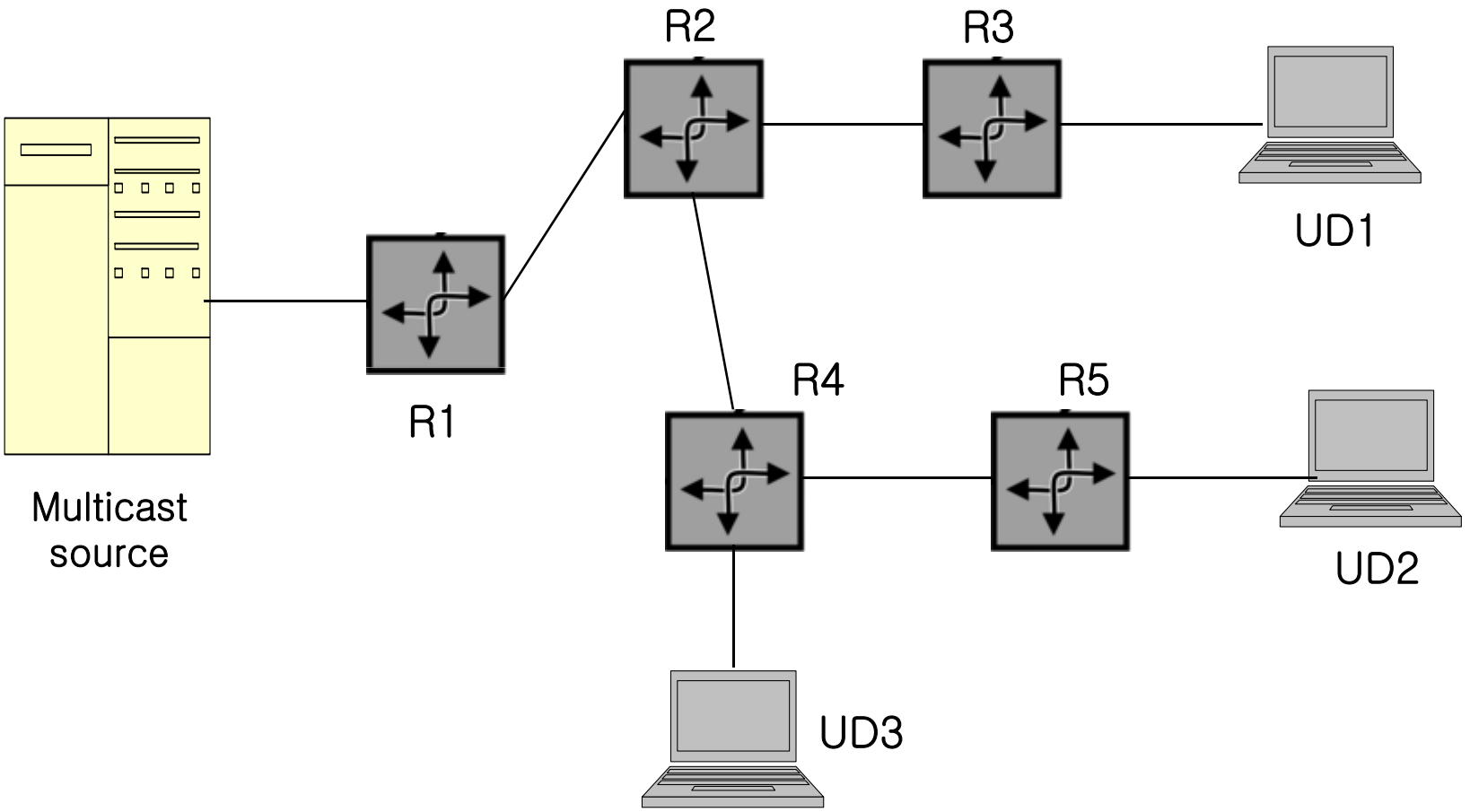


Video Multicast

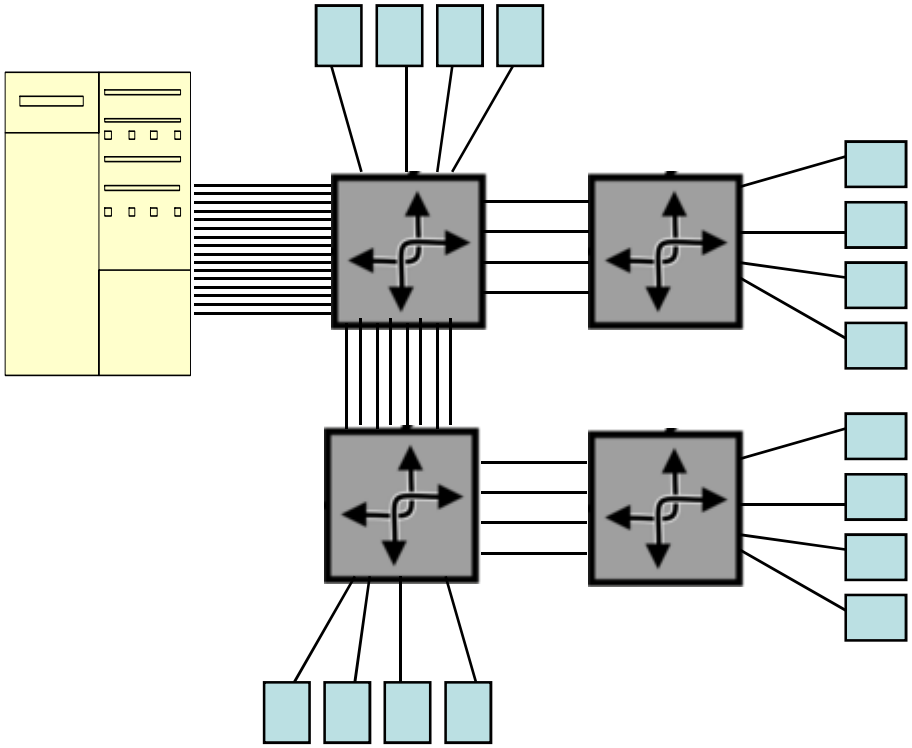
- Application: IPTV
- Efficient use of network bandwidth
- 1:N service
- Join & Leave the multicast group by IGMP message



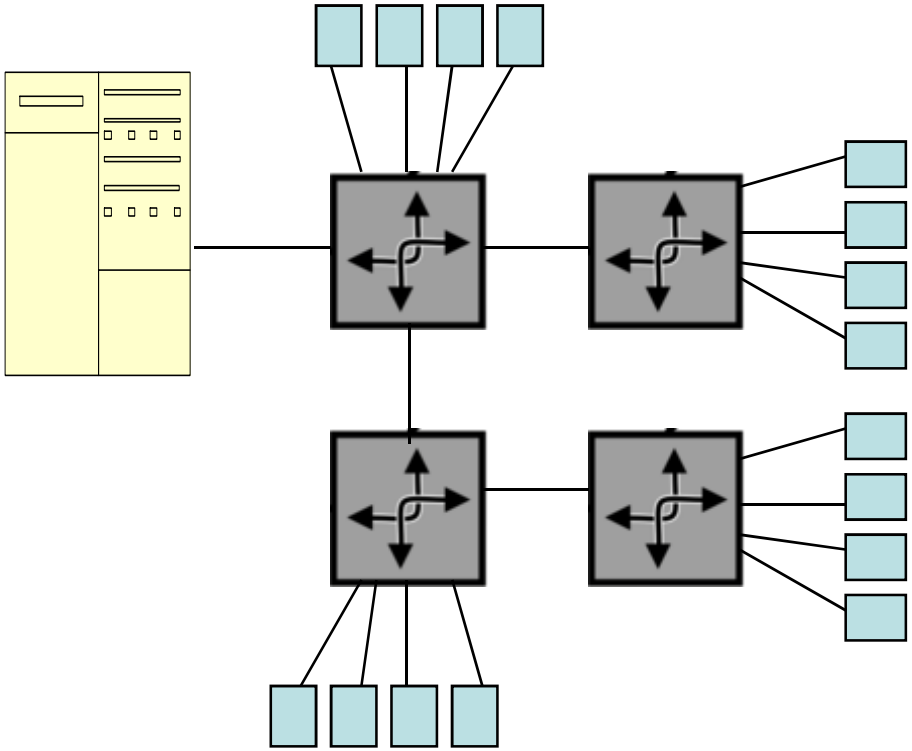
Multicast Join/Leave Network



Multicasting Bandwidth Comparison



Unicast

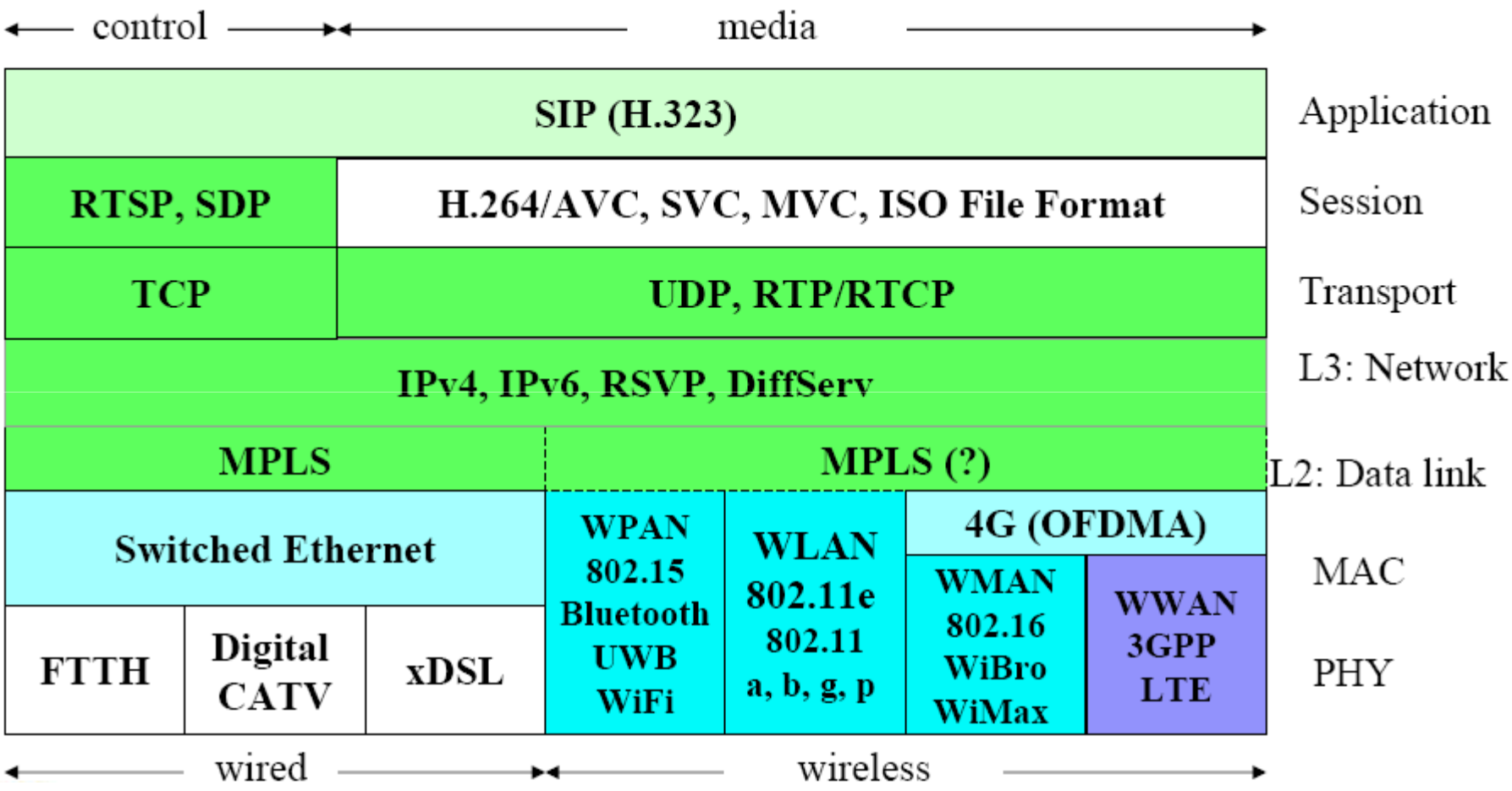


Multicast

IPTV- Key Technologies and Standards

Tech	Standard	Org
Access Tech	ADSL, VDSL, FTTC/FTTH, Wireless	ITU-T
Architecture	ITU-T NGN Recommendations DSL Forum Tech Report: TR-058 and TR-094	ITU-T, DSL Forum
Codec	H.264 and MPEG series	ITU-T, IETF
IP Multicast	IGMPv2 and IGMPv3 (RFC 3376)	IETF
Transport Protocol	RTSP (Real Time Streaming Protocol) (RFC2326) RTP/RTCP and SDP	IETF
QoS	Y.1541, MPLS-TE, Diffserv, IEEE 802.1p QoS, IEEE 802.1q VLAN, CEA2007 VLAN Mapping	ITU-T, IEEE
Network Management	TMF, DSL Forum Tech Report TR-069 (CPE WAN Mgmt Protocol)	ITU-T, DSL Forum

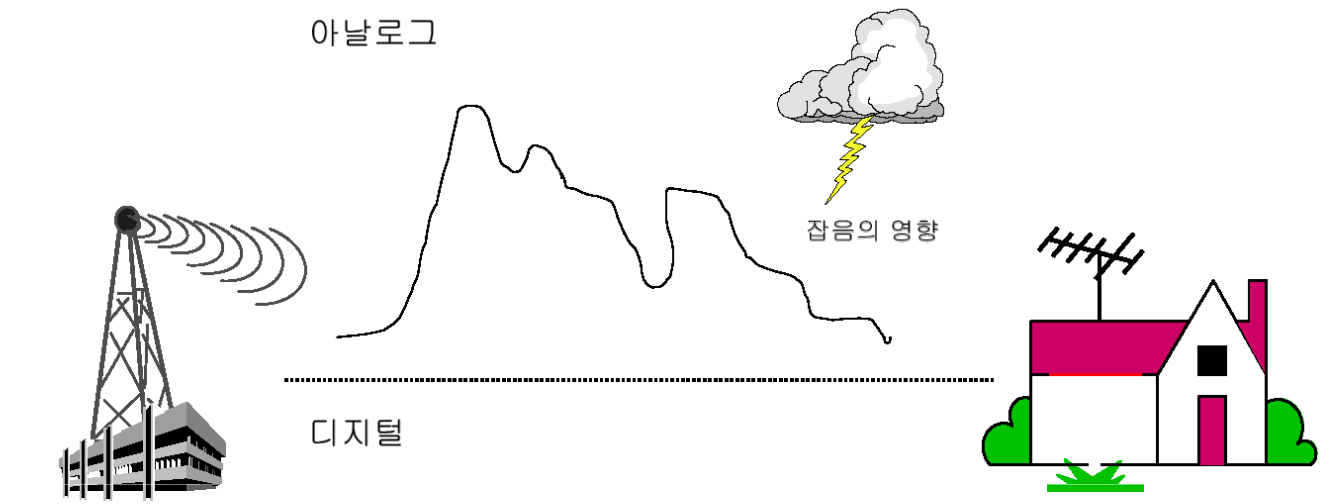
Protocol stack for IPTV Transport



Outstanding Work Items of IPTV Focus Group

- Set Top Box or home gateway functionality and associated interfaces.
- Video and Audio Codec functions and selection.
- Middleware capabilities such as Electronic Program Guide (EPG) and other
- user interfaces.
- Billing/accounting interfaces and protocols.
- Program Control functions
- Operational and Maintenance capabilities
- Security/authentication and Digital Rights Management (DRM) aspects.
- Quality of Service / Experience capabilities and performance.
- Bandwidth and network resource requirements
- IP/UDP/RTP/MPEG2TS/codec wrapper
- Consideration of OCAP/MHP/GEM for an application framework.
- Ad Insertion
- IPTV endpoint management
- Customized channel lineup
- Viewership data management

Digital TV



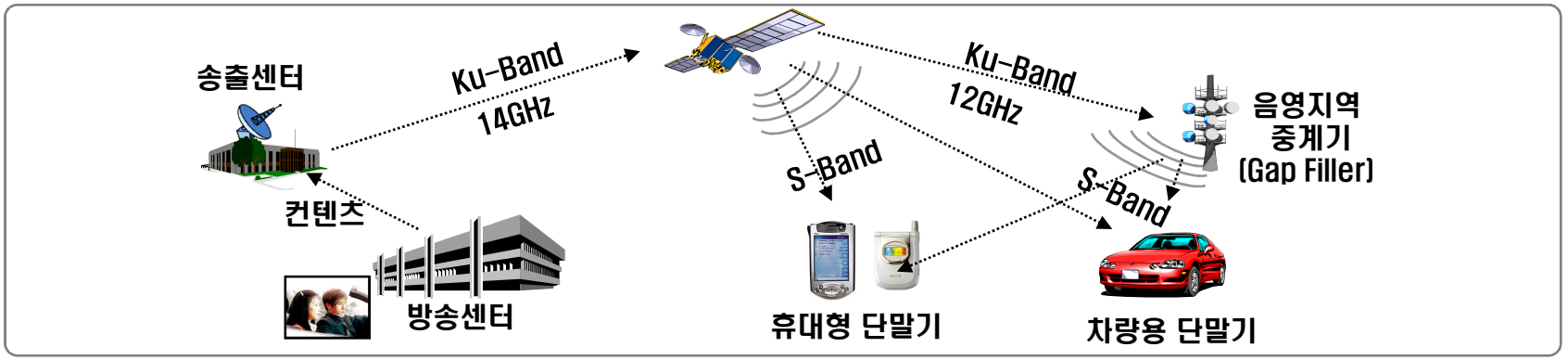
- 균일한 품질 : **Noise**와 **Ghost** 의 감소
- 서비스 통합 : 방송+통신, 데이터방송
- 유연한 방송 프로그램 편성 : **SDTV/HDTV** 프로그램
- 더 많은 정보량 전송 : **TV 1** 채널->**HDTV 1**채널 **or SDTV 3-4** 채널
- 계층화 서비스 : **scalability**

우리나라의 DTV 규격

시스템 항목	위성방송	지상파 방송
비디오 형식	MPEG-2 MP@ML/HL	MPEG-2 MP@ML/HL
오디오 형식	MPEG-1 Layer 2/MPEG-2	Dolby AC-3
서비스 다중화	MPEG-2 System TS	MPEG-2 System TS
전송 방식	QPSK	8 VSB
주파수(채널) 대역폭	27 MHz	6 MHz
심볼 속도	21.3 Msymols/sec	10.76 Msymbols/sec
전송 데이터 속도	34.351 Mbps	19.39 Mbps

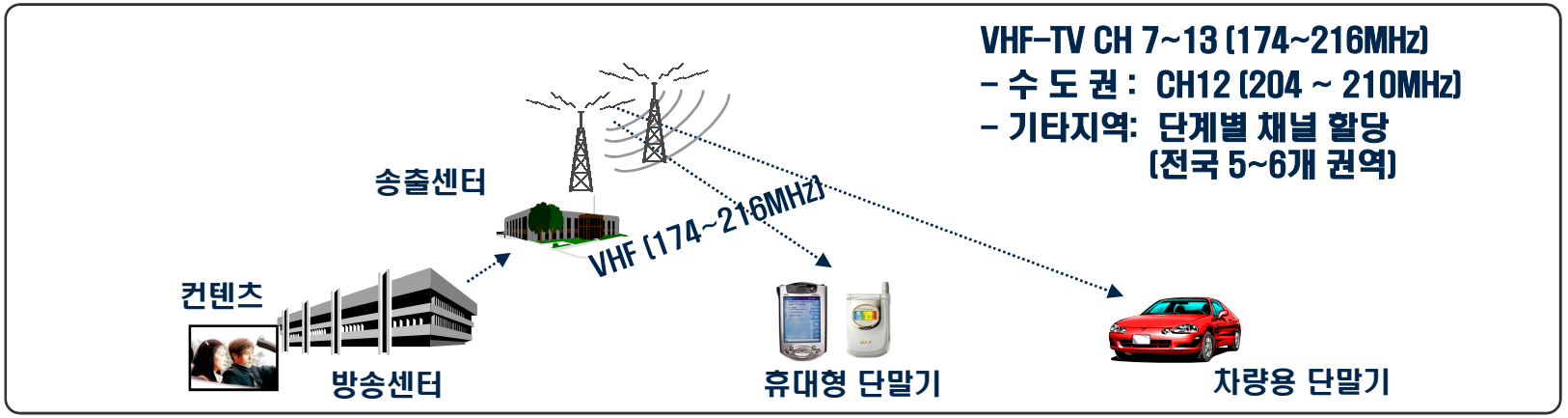
DMB (digital multimedia broadcasting)

❑ 위성 DMB (S-DMB)



※ S-Band 주파수대역 : 25MHz(2.630~2.655 GHz)

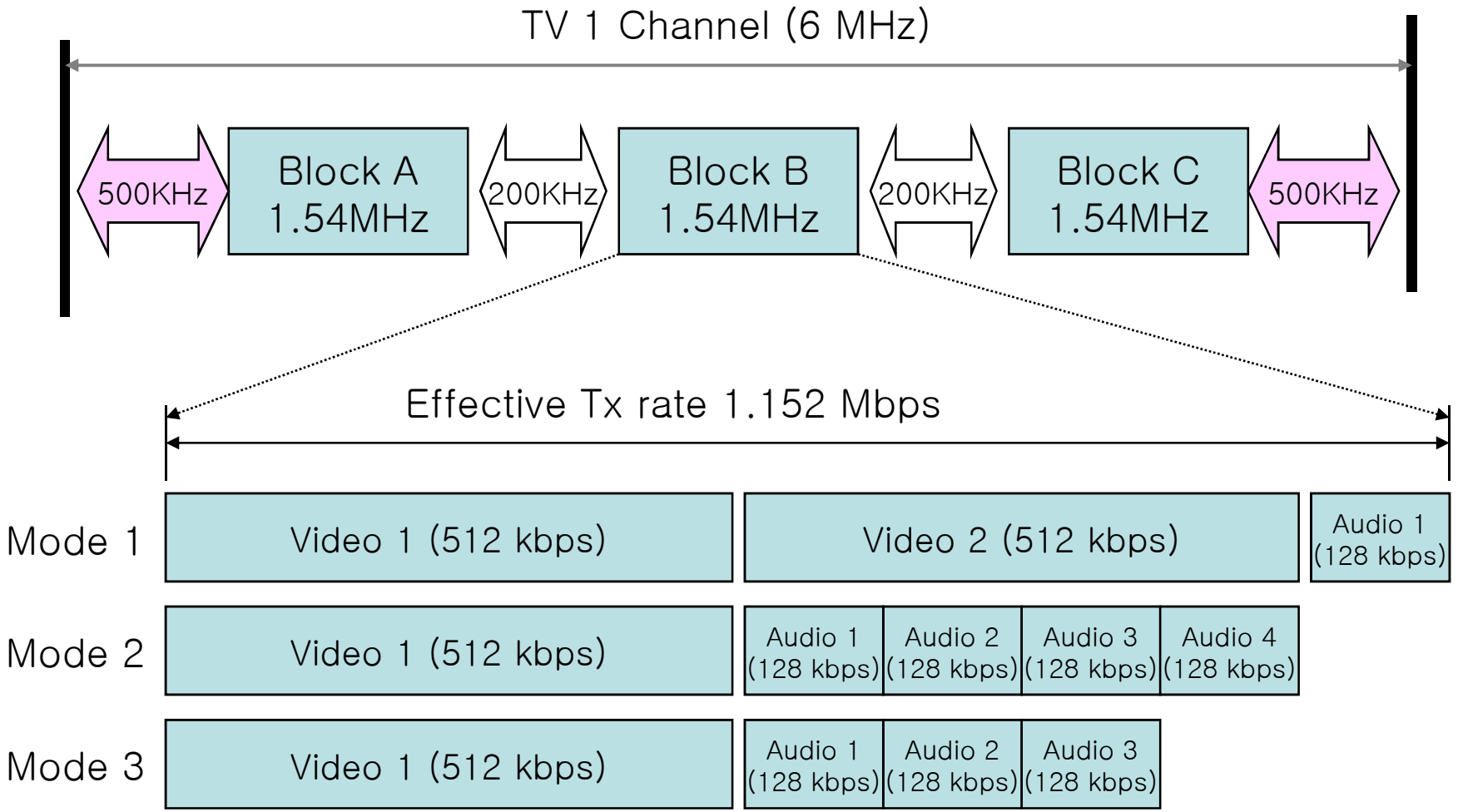
❑ 지상파 DMB (T-DMB)



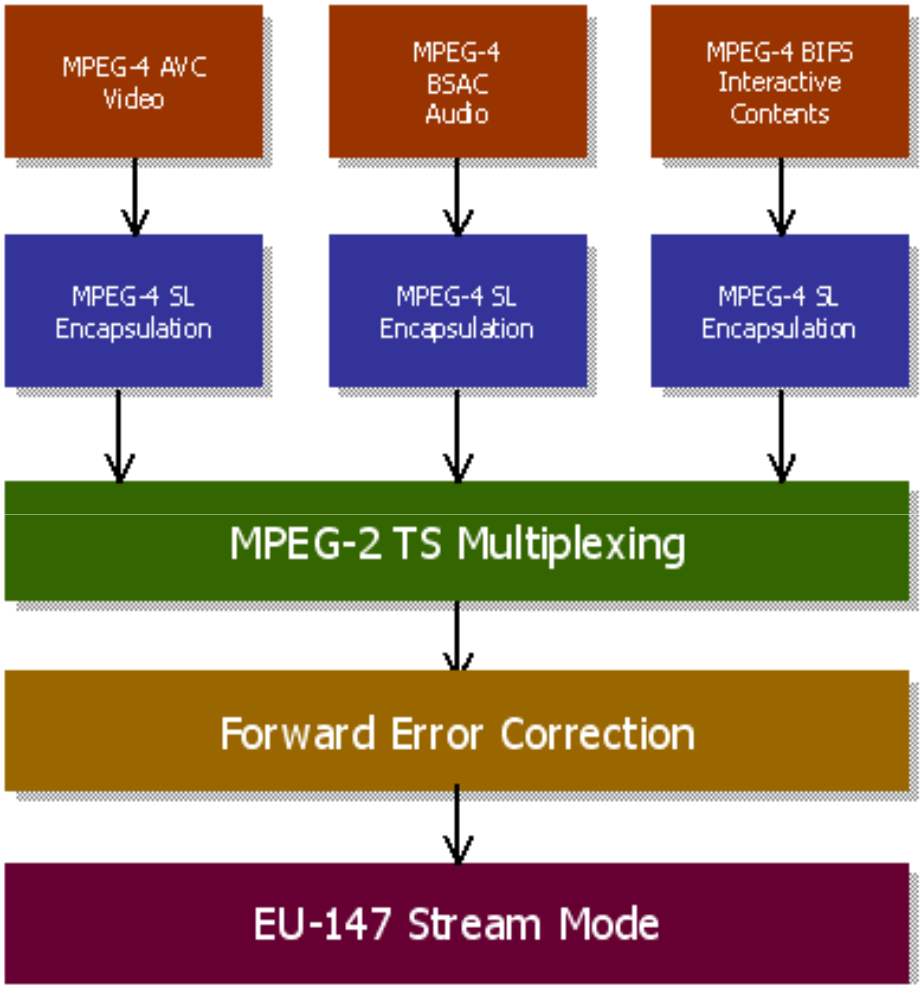
T-DMB vs. S-DMB

	T-DMB	S-DMB
System	**EUREKA-147 (EU's DAB)**	**System E (Similar to CDMA)**
Multiplexing	**OFDM**	**DS-CDM**
Frequency	**VHS (ch#8 and ch#12) (174-240 MHz)**	**2,630-2,655Mhz(S-Band) 12.21-12.23GHz (Ku-Band)**
Video	**MPEG-4 part 10 (H.264 AVC)**	**MPEG-4 part 10 (H.264 AVC)**
Audio	**MPEG-4 Audio BSAC/AAC+ 2ch@128 kbps**	**AAC+ (AAC-HE)**
Terrestrial Link	**Direct receiving**	**Gap filler + Direct receiving**
Service	**KBS, MBC, SBS, etc…**	**SKT**

Frequency Usage of T-DMB



Hierarchical Structure of Video Stream (T-DMB)



- CTS(composition time stamp)
- OCR(object clock reference)
- OTB(object time base):90kHz이하

- PTS(presentation time stamp)
- PCR(picture clock reference)
- STC(system time clock):27MHz

MPEG-4 over MPEG-2 (*)

AV synchronization에서의 역할분담

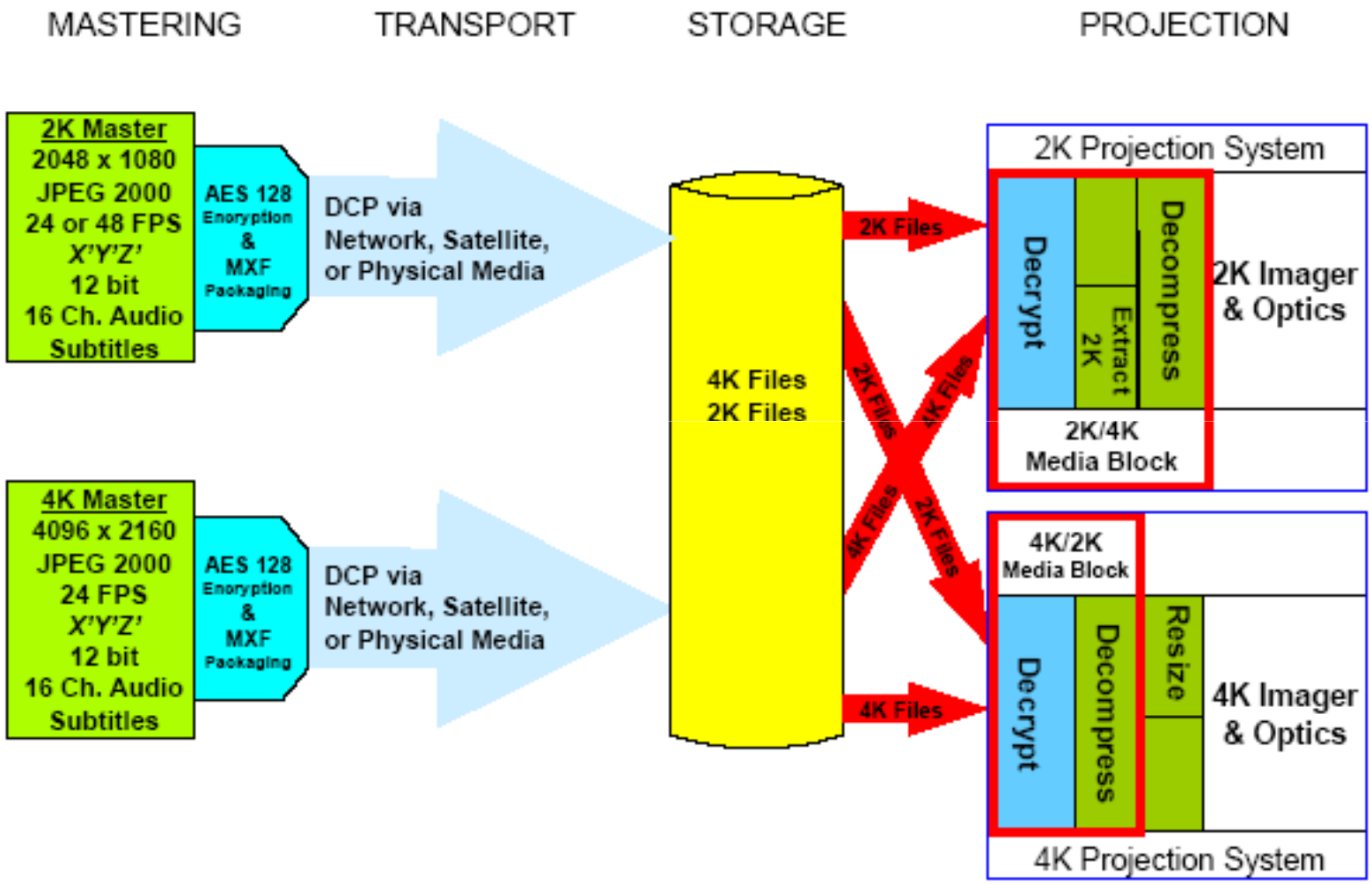
- MPEG-4 SL : 미디어 디스플레이 시간 지정
- MPEG-2 TS : 기준클럭 전달

(*) MPEG-4 over MPEG-2 기반의 다중화 기술 응용:지상파DMB사례,한국통신학회지 2006년 7월호

Digital Cinema

- **Background**
  - High resolution film scanner
  - Digital video compression
  - High speed data networking and storage
  - Advanced digital projection
- **Digital Cinema Initiatives**
  - Disney, Fox, Metro-Glodwyn-Mayer, Paramount Pictures, Sony Pictures Entertainment, Univeral Studios, Warner Brothers Studio
- **Purpose : uniform specification of digital cinema**
  - Digital cinema distribution master(DCDM)
  - Image compression (JPEG2000)
  - Digital Cinema Packaging(DCP) using MXF and XML
  - Transport
  - Theater systems
  - Projection
  - Security

Digital Cinema System Workflow



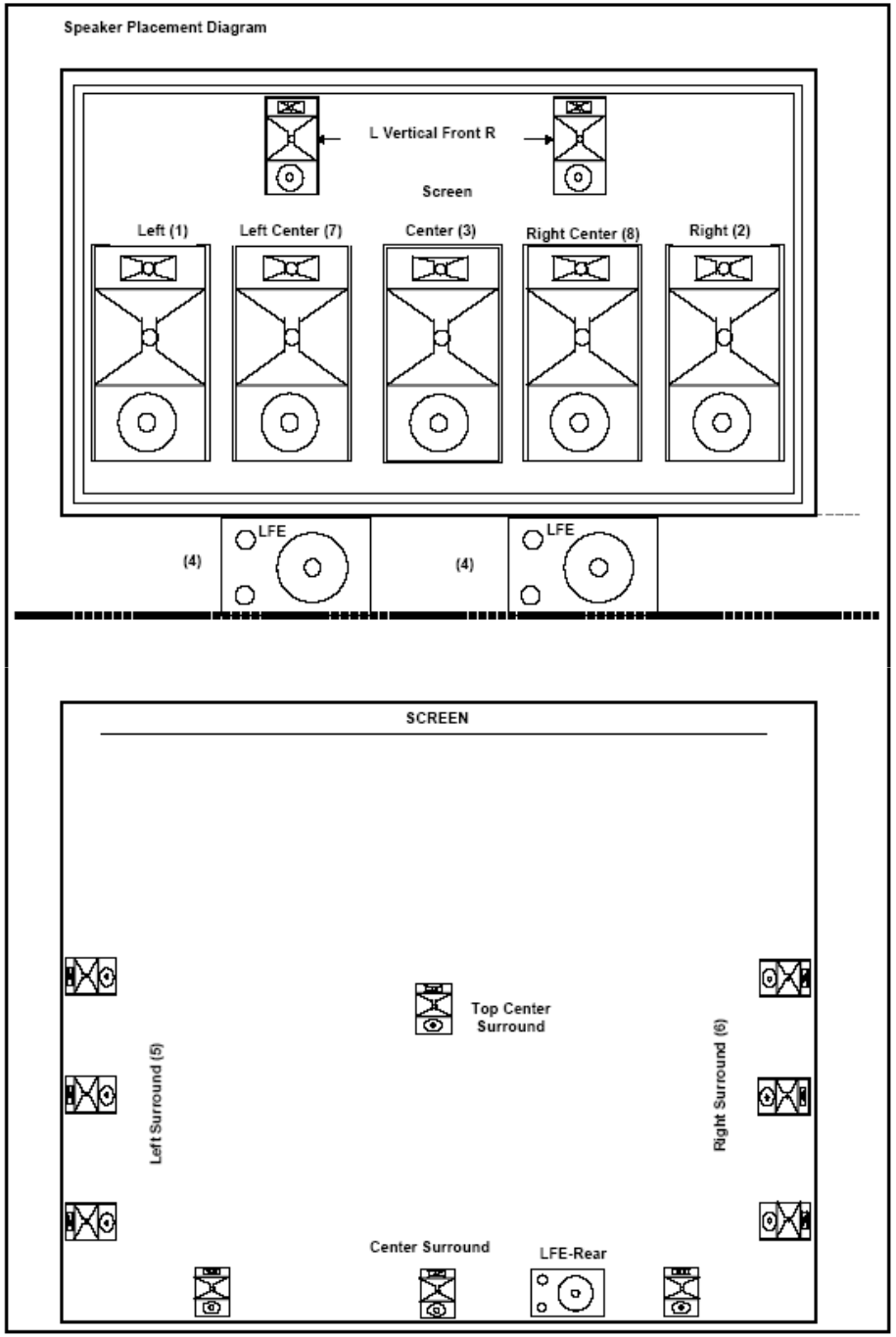
Storage Capacity

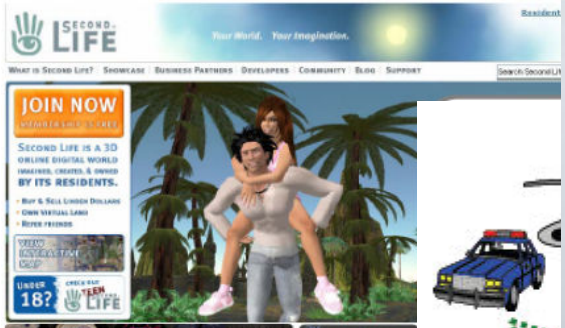
- One three-hour feature
- 20 minutes of pre-show material at the same resolution
- 16 channels of uncompressed audio at 48 kHz at 24 (AES3) bits
- 3,000 sub pictures in PNG file format
- 3,000 Timed Text lines
- A fixed amount of Auxiliary Data (1 MByte)

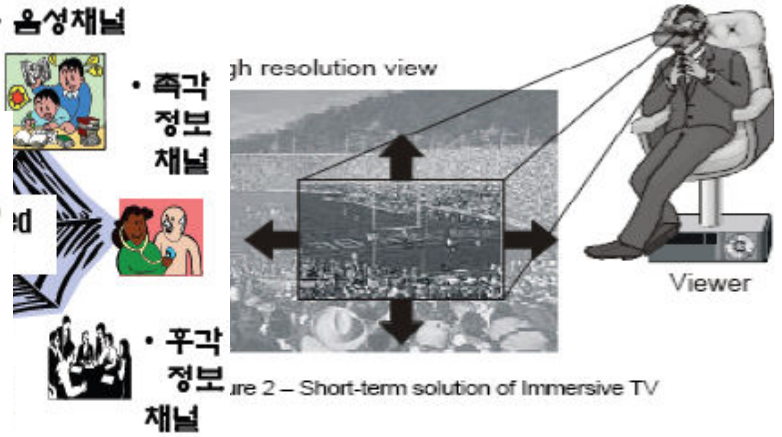
Average Bit Rate (Mbits/sec)	3 Hour Image (GBytes)	3 Hour Audio (GBytes)	20 min. pre-show (Gbytes)	Sub Picture (GBytes)	Timed Text (GBytes)	Aux Data (GBytes)	3 Hour Total (GBytes)
250	371.250	2.281	41.250	0.300	0.001	0.001	415.082
200	297.000	2.281	33.000	0.300	0.001	0.001	332.582
125	185.625	2.281	20.625	0.400	0.001	0.001	208.932
100	148.500	2.281	16.500	0.600	0.001	0.001	167.882
80	118.800	2.281	13.200	0.800	0.001	0.001	135.082

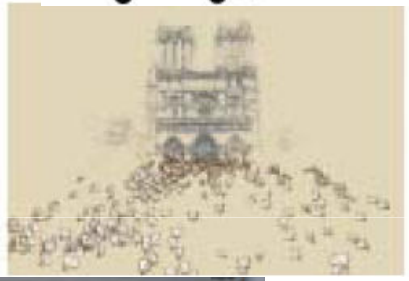
Audio Channel Allocation(7.1ch)

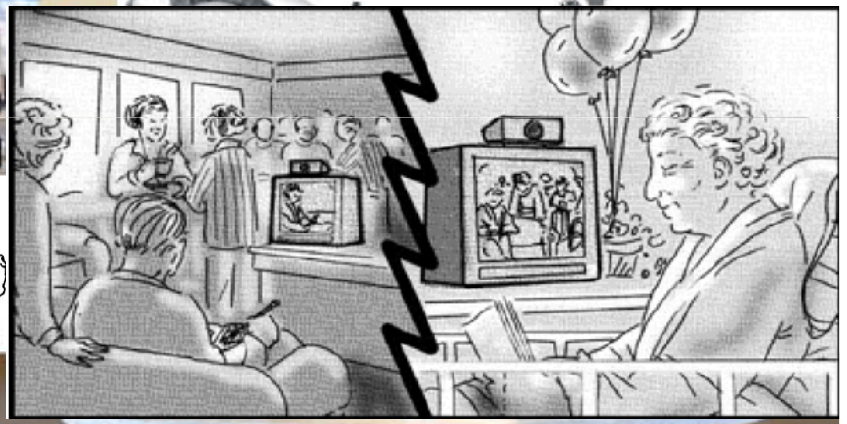
AES Pair#/Ch#	Channel #	Label / Name
1/1	1	L/Left
1/2	2	R/Right
2/1	3	C/Center
2/2	4	LFE/Screen
3/1	5	Ls/Left Surround
3/2	6	Rs/Right Surround
4/1	7	Lc/Left Center
4/2	8	Rc/Right Center
5/1	9	
5/2	10	
6/1	11	
6/2	12	
7/1	13	
7/2	14	
8/1	15	
8/2	16	











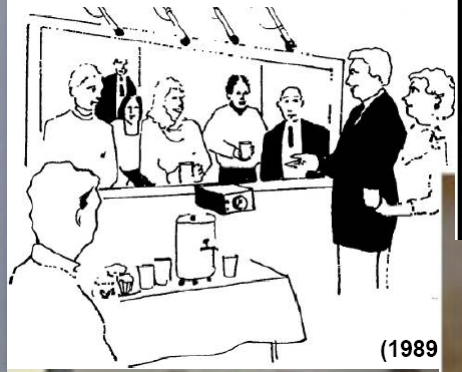


Figure 9: The half-ring camera.

Wonderfull
Life Partner
KT