Analyze & Improving of Satellite Data Transmission, Based on DVB-RCS

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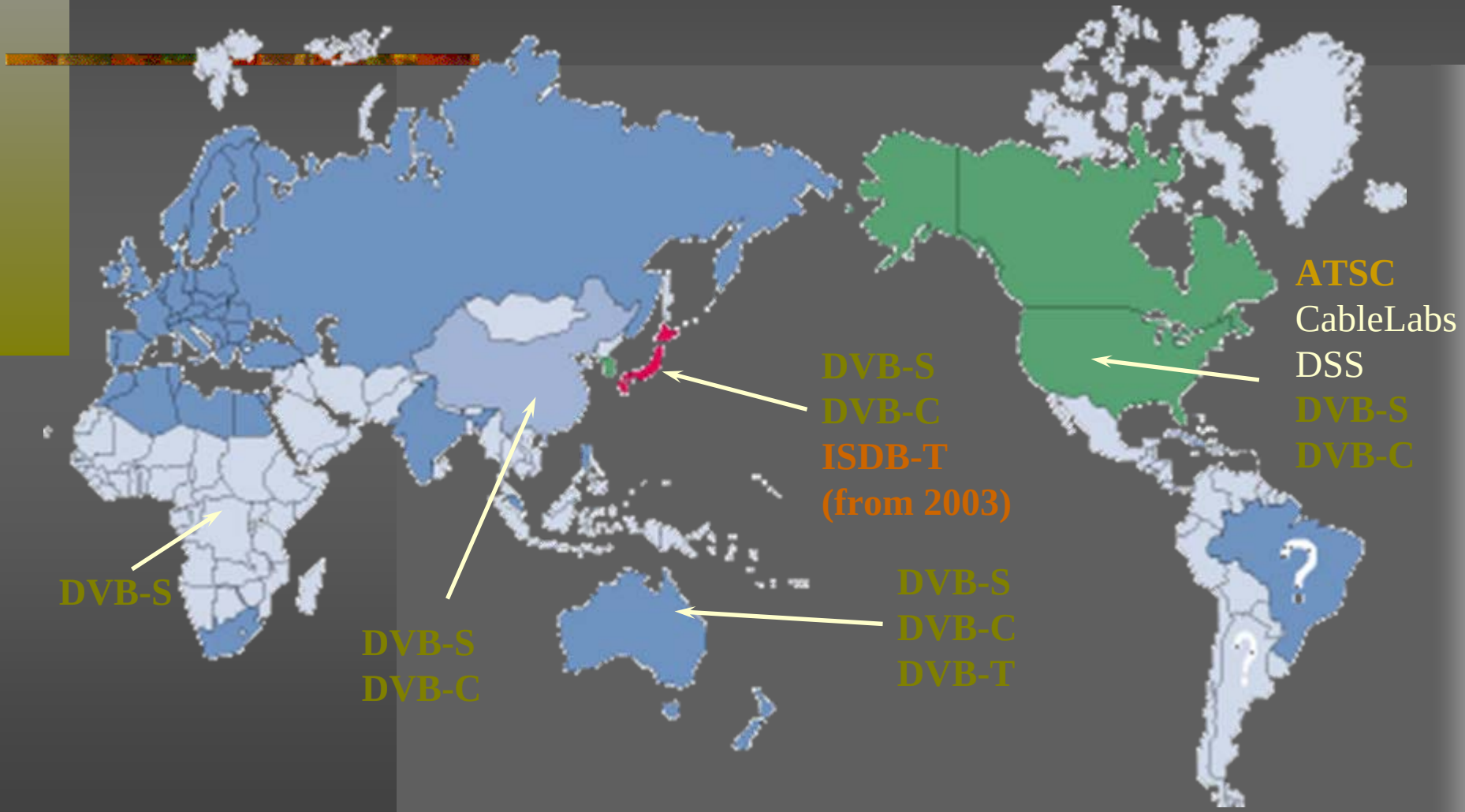
A quick overview !

- **First,** I introduce DVB technology and its technical aspects.
- **Second ,** I describe interactive DVB systems with focus on IP over DVB.
- **Third ,** I introduce DVB-RCS, as one of DVB standards on interactive systems
- **At last ,** I introduce a system design for an IP client-server network based on DVB technology as downlink format.

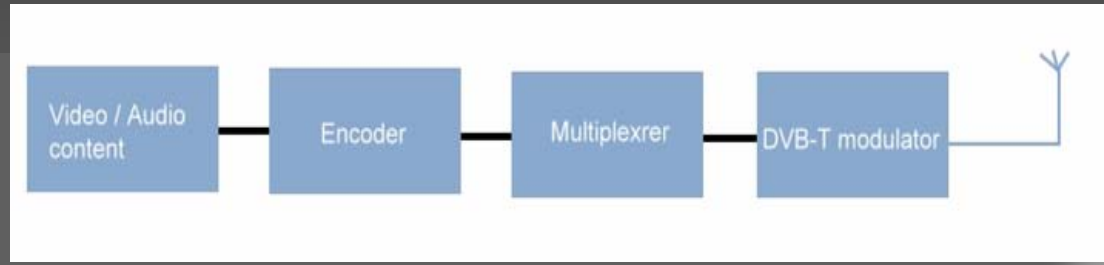
DVB project

- DVB project started at Sep 10,1993 with 84 European authorities to make a standard on DTV
- Three main activities:
  - Promotion of technical DTV standards
  - Introduction of new services
  - Make the research ,development and standards, closer
- ITU
- ISO/IEC
- CENELEC
- EBU
- JTC
- DAVIC (Digital Audio-Video Council)

The World of Digital Television



Source coding: mpeg2



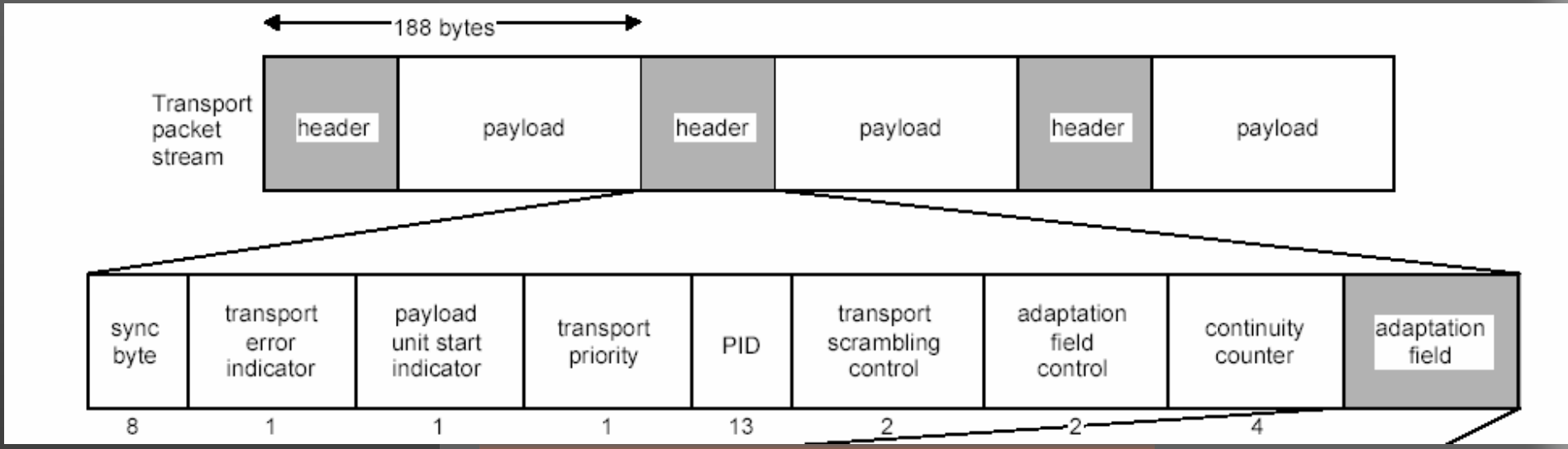
- We have three main kind of stream for broadcast: Video, Audio, Data
- Video and audio need to be compressed
- Then all of them will be multiplexed in order to transmit
- We use stuffing bits or NULL packets to have constant bit rate

< 0.384 Mbps	Video conference	(MPEG-4)
<1.5 Mbps	Video in a window	(MPEG-1)
1-2 Mbps	VHS quality full screen	(MPEG-2)
2-3 Mbps	Broadcast NTSC	(MPEG-2)
4-6 Mbps	Broadcast PAL	(MPEG-2)
8-10 Mbps	Professional PAL	(MPEG-2)
12-20 Mbps	Broadcast HDTV	(MPEG-2)
27.5-40 Mbps	DVB satellite multiplex	(MPEG-2 Transport)
32-40 Mbps	Professional HDTV	(MPEG-2)
34-50 Mbps	Contribution TV	(MPEG-2-I)
140 Mbps	Contribution HDTV	(MPEG-2-I)
168 Mbps	Raw NTSC	(uncompressed)
216 Mbps	Raw PAL	(uncompressed)
270 Mbps	Raw contribution PAL	(uncompressed)
1-1.5 Gbps	Raw HDTV	(uncompressed)

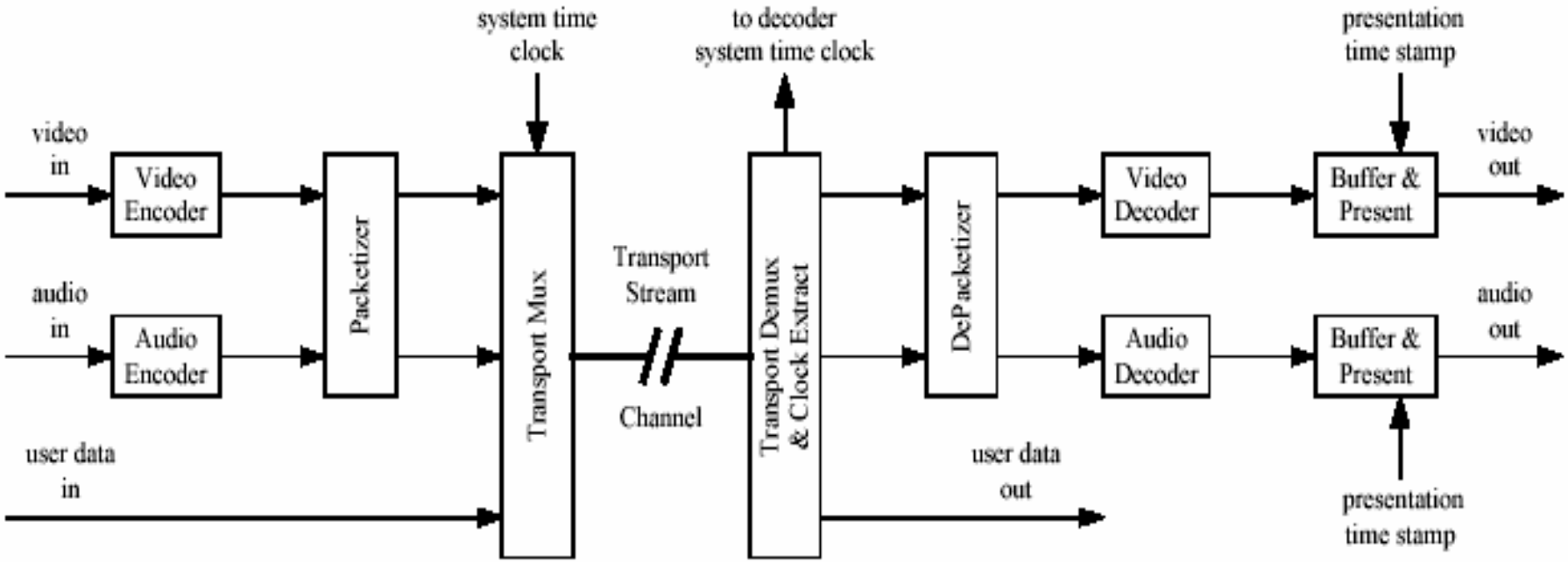
Mpeg2 stream

- There exists two kinds of streams:
  - Program stream : a variable length stream which is suitable for storage media
  - Transport stream: a fixed length (188 bytes) stream which is suitable for broadcast

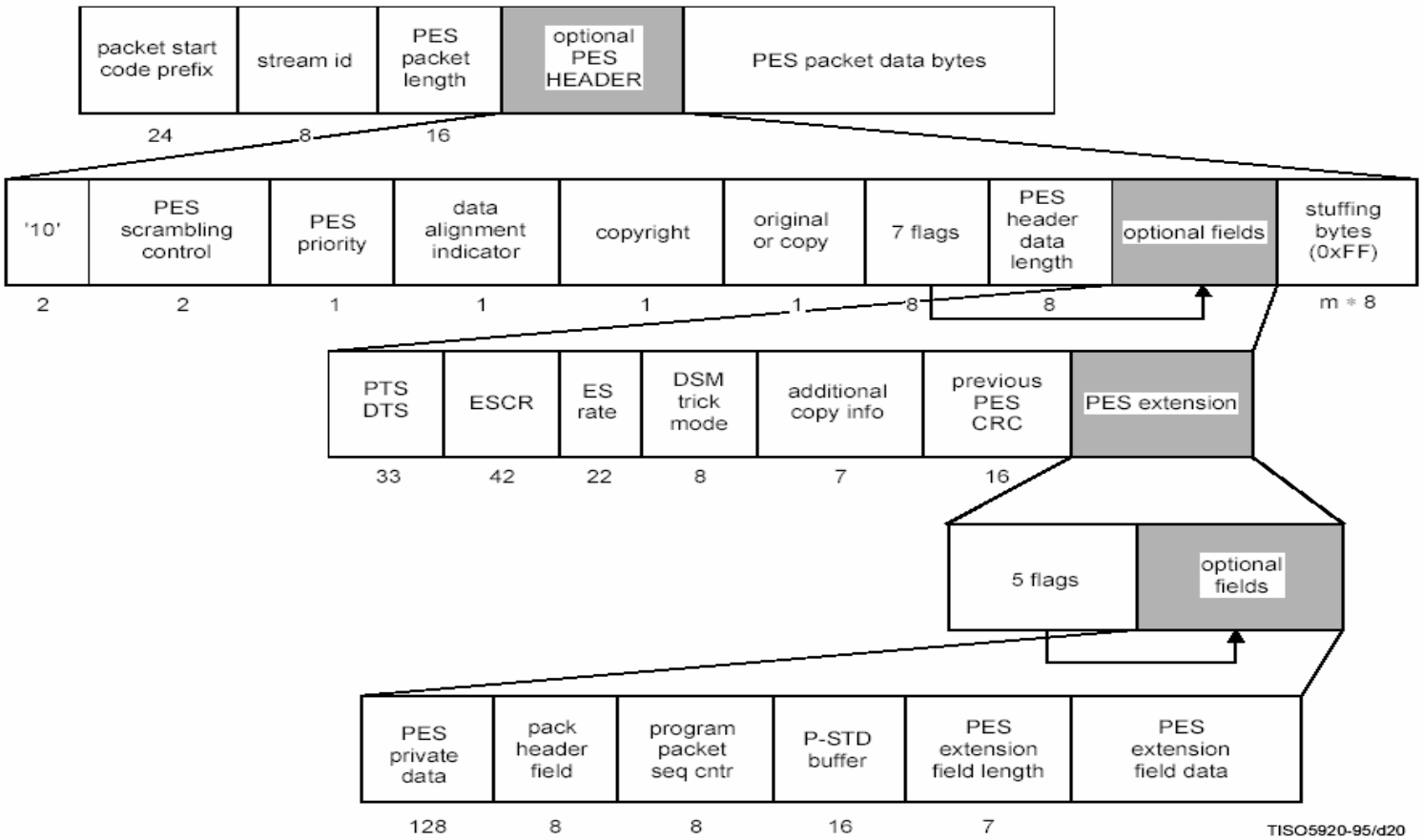
TS packet:



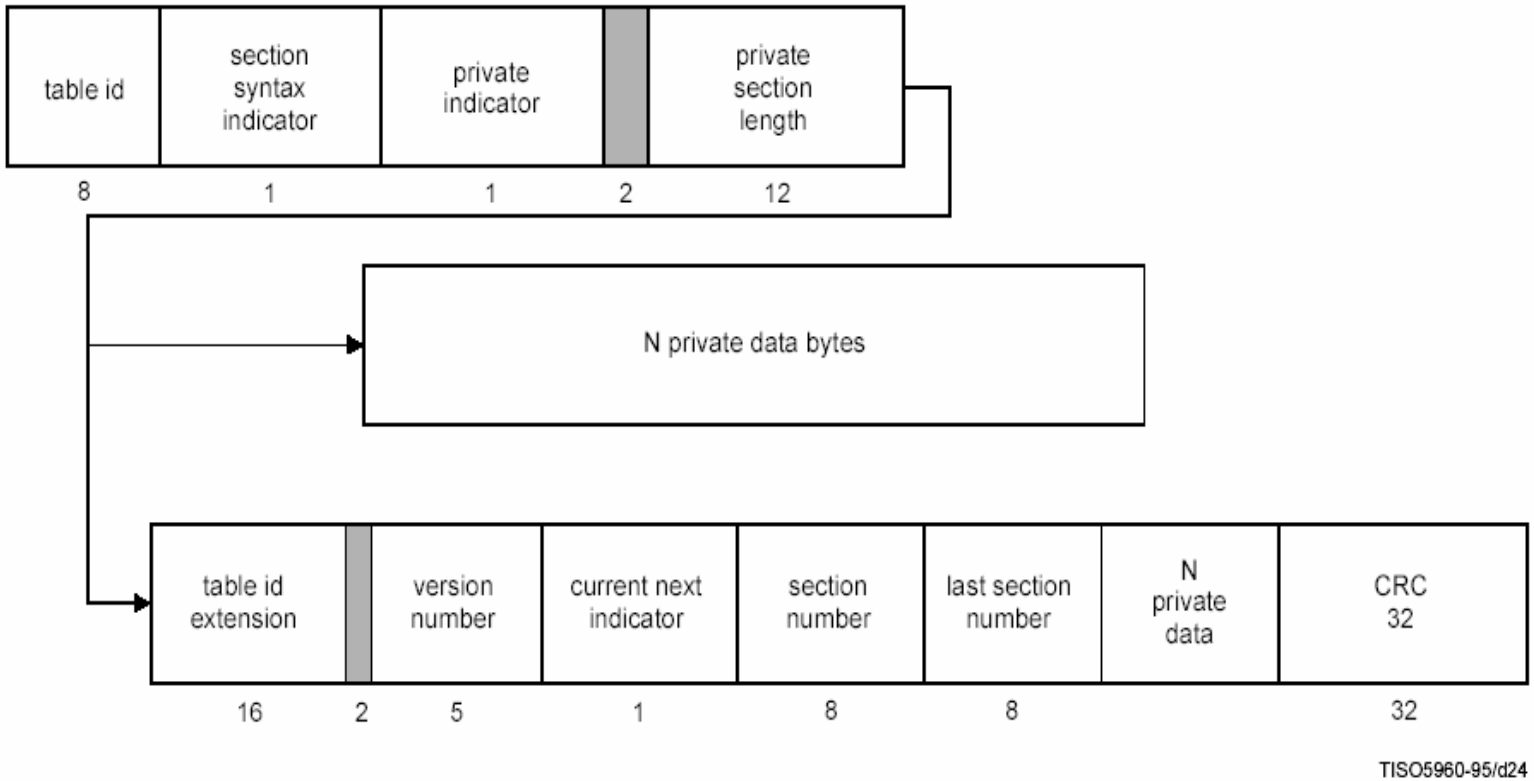
Multiplex


system time clock
to decoder system time clock
presentation time stamp
video in
Video Encoder
Packetizer
Transport Mux
Transport Stream
Channel
Transport Demux & Clock Extract
DePacketizer
Video Decoder
Buffer & Present
video out
audio in
Audio Encoder
Audio Decoder
Buffer & Present
audio out
user data in
user data out
presentation time stamp

Packetizing of Video & Audio: PES packets



Section format (private section)

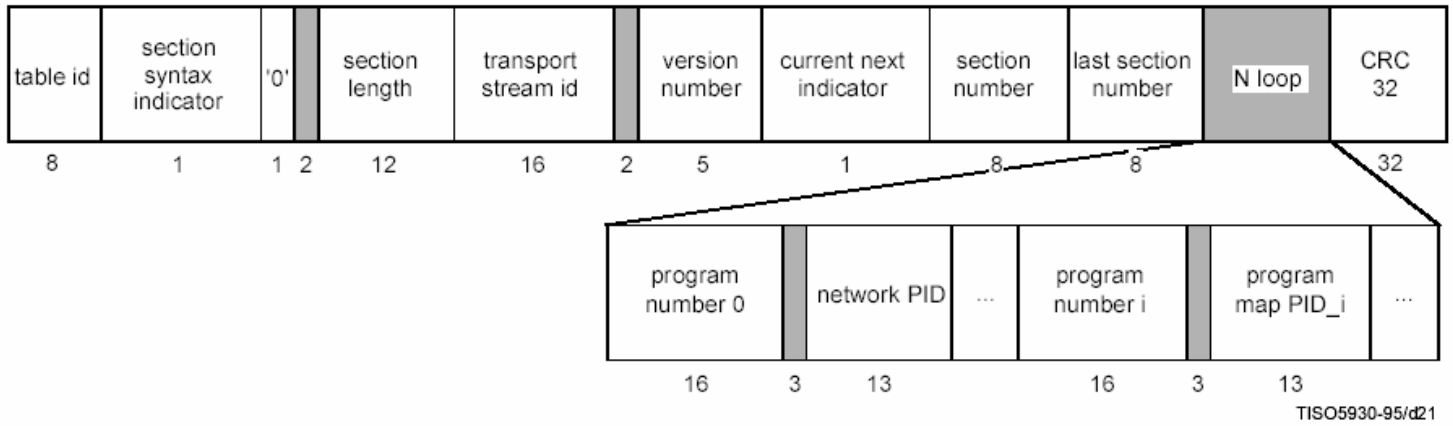


PSI & SI & Descriptors

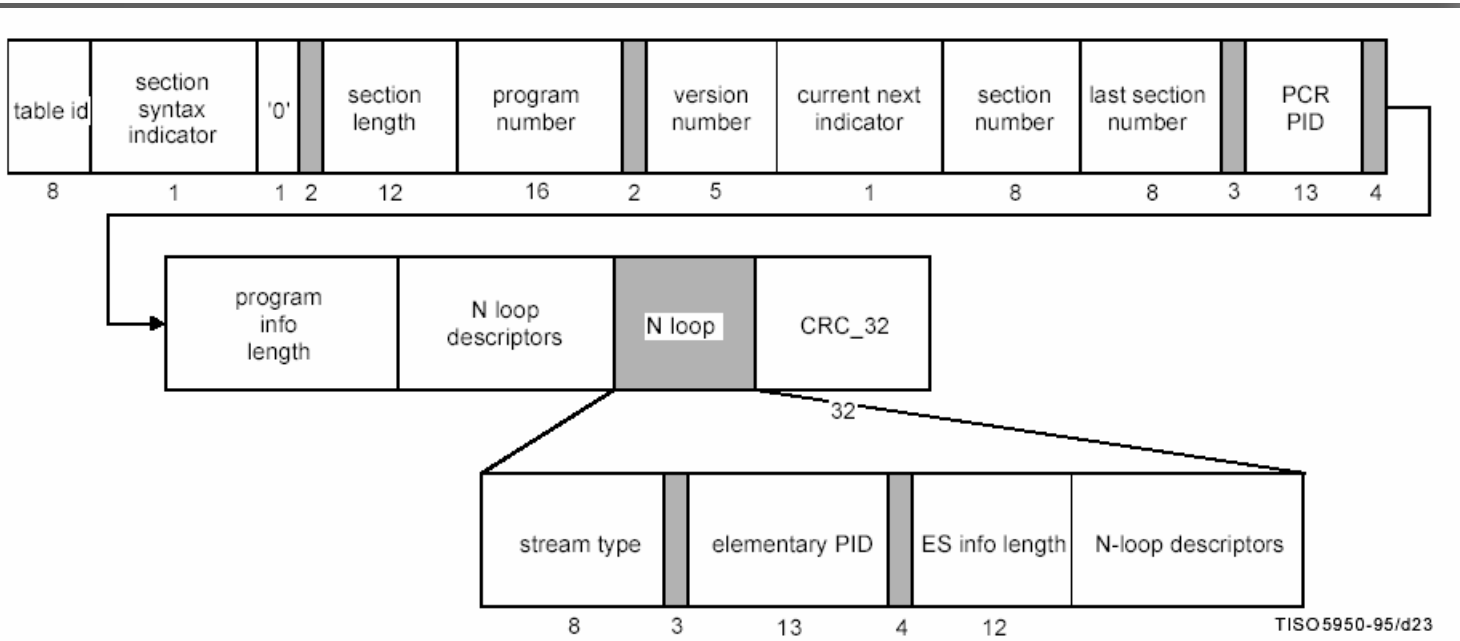
- PSI (Program Specific Information) carries parameters of the stream for decoder
  - Defined by MPEG2 standard
  - They are called tables which are inserted in TS packets as “section “
  - Like: PAT,PMT,CAT,NIT, Private sections (user defined)
- SI (Service Information) carries parameters of the streams and the whole network
  - Defined by DVB standard
  - All in Private section format
- Descriptors are data structures which come in Tables to present the parameters

PSI frame format

- PAT



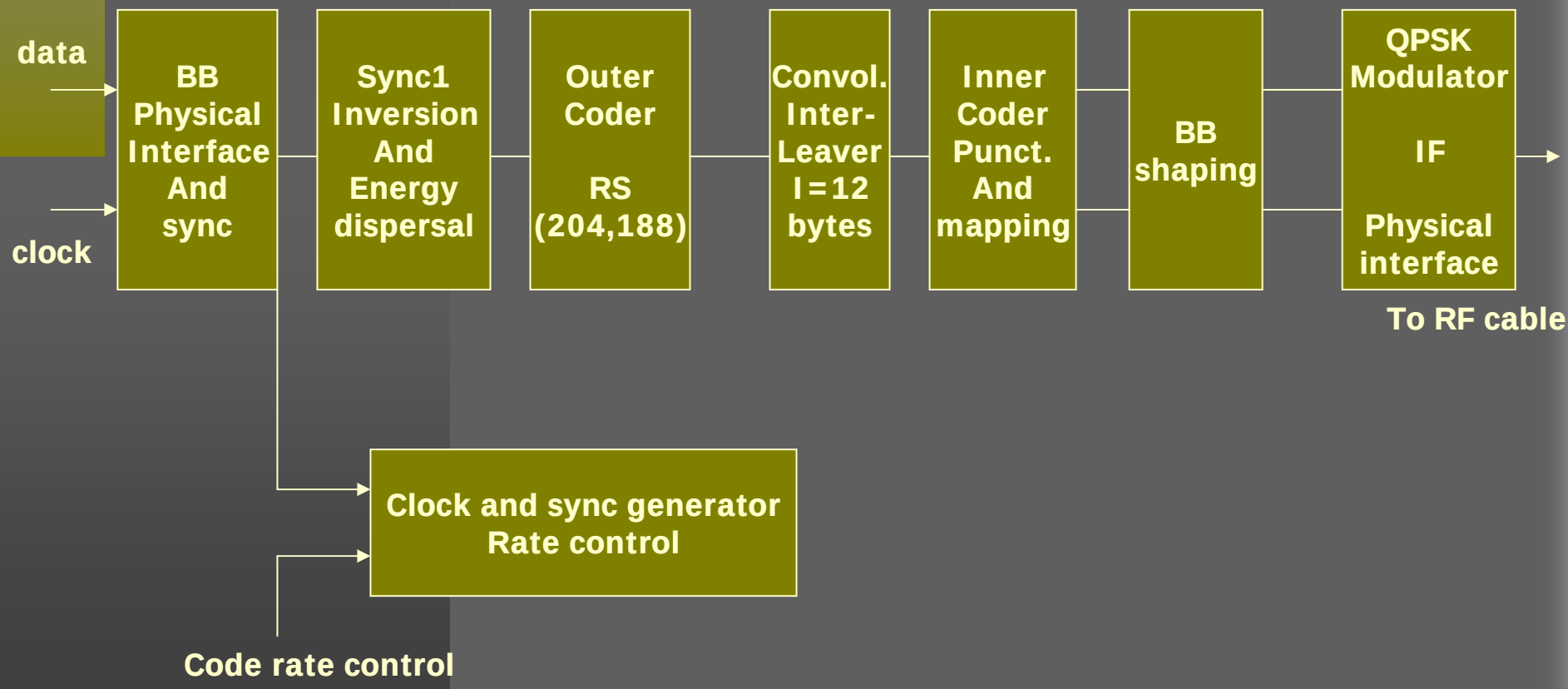
- PMT



DVB transmission

- DVB satellite
- DVB cable
- DVB terrestrial
- A matter of physical layer!
- Modulation , channel (de)coding , …

DVB-S encoding system



DVB-S

- Bandwidth
- Carrier frequency (for television)

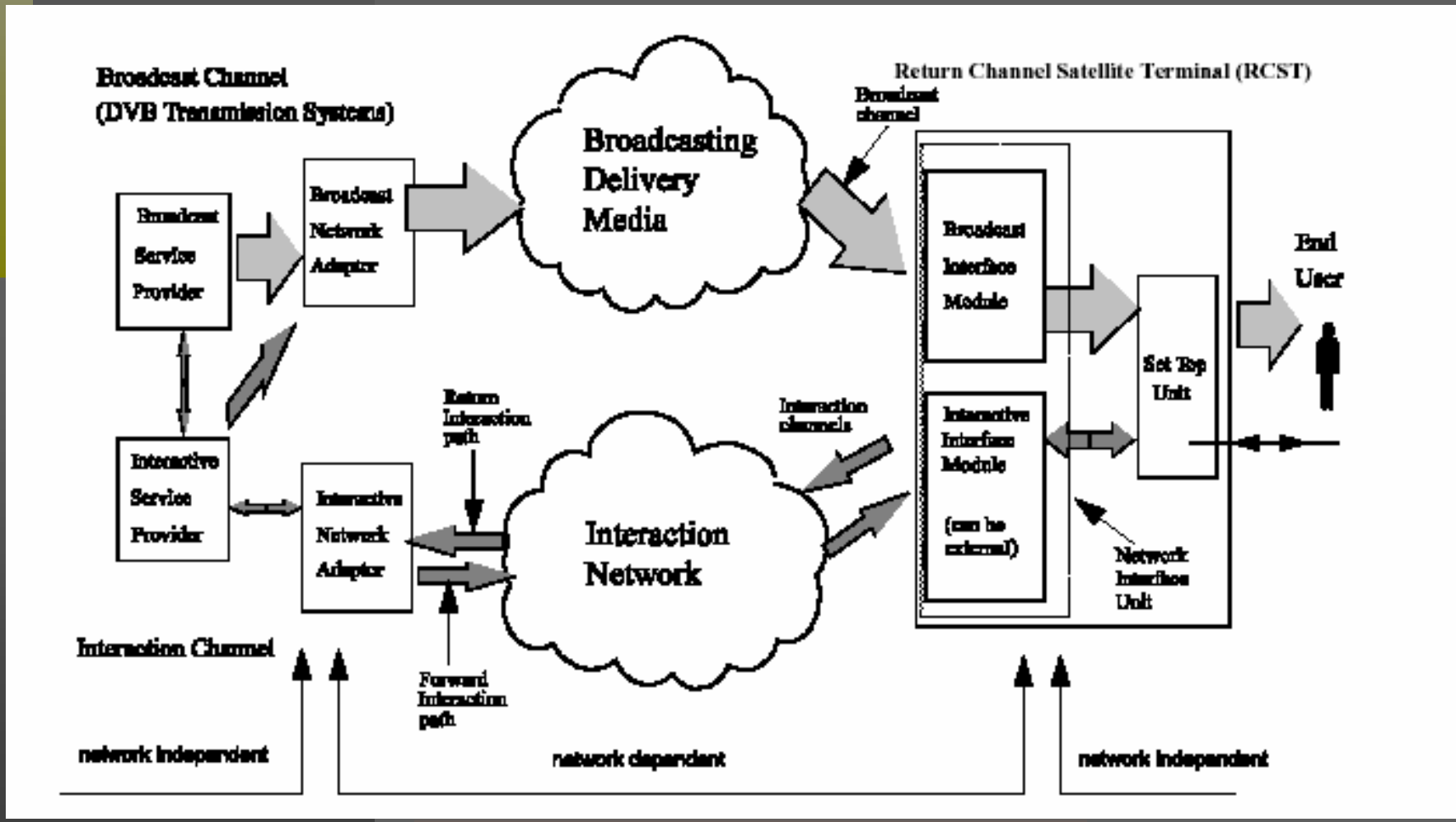
Frequency range (GHz)	Restriction
2.52-2.655	c
11.7-12.2	1,3
12.2-12.5	1,2
12.5-12.7	2,3
12.7-12.75	3 c
21.4-22	1,3
40.5-42.5	
84-86	

Notes:
C=community reception only
1=Europe, Africa, former USSR, Mongolia
2=North and South America and Greenland
3=Asia(except Mongolia and former USSR),Australia and Southwest Pacific.

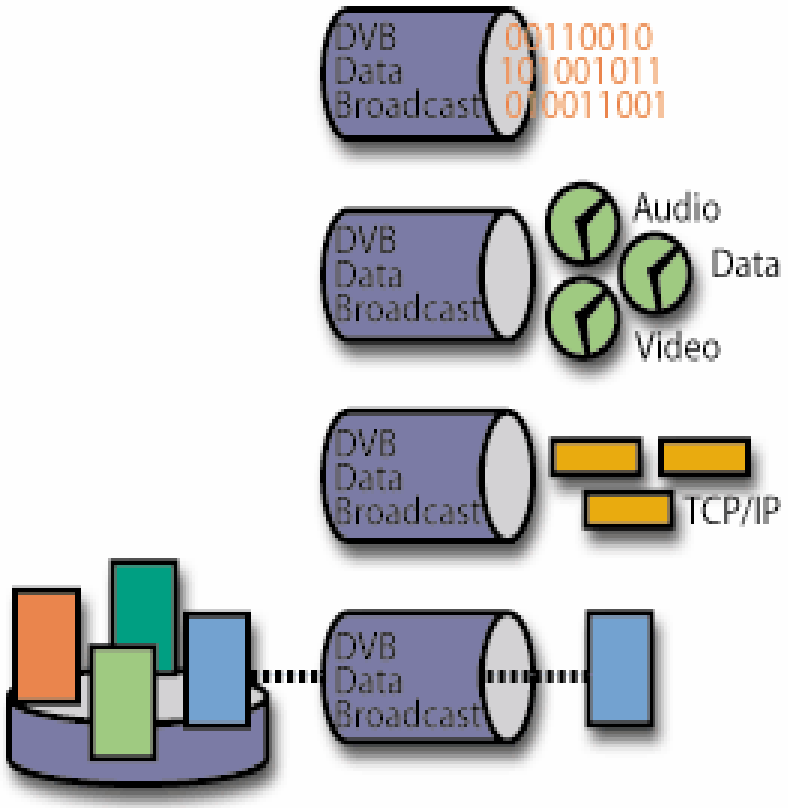
Interactive Services

- Using in pay-per-view, teletext, video on demand, Internet,…
- Out-of-Band & In-Band models
- Return channel via:
  - Cable (CATV)
  - PSTN/ISDN
  - Satellite (DVB-RCS)

Interactive system architecture



Data Broadcasting/DVB Protocols



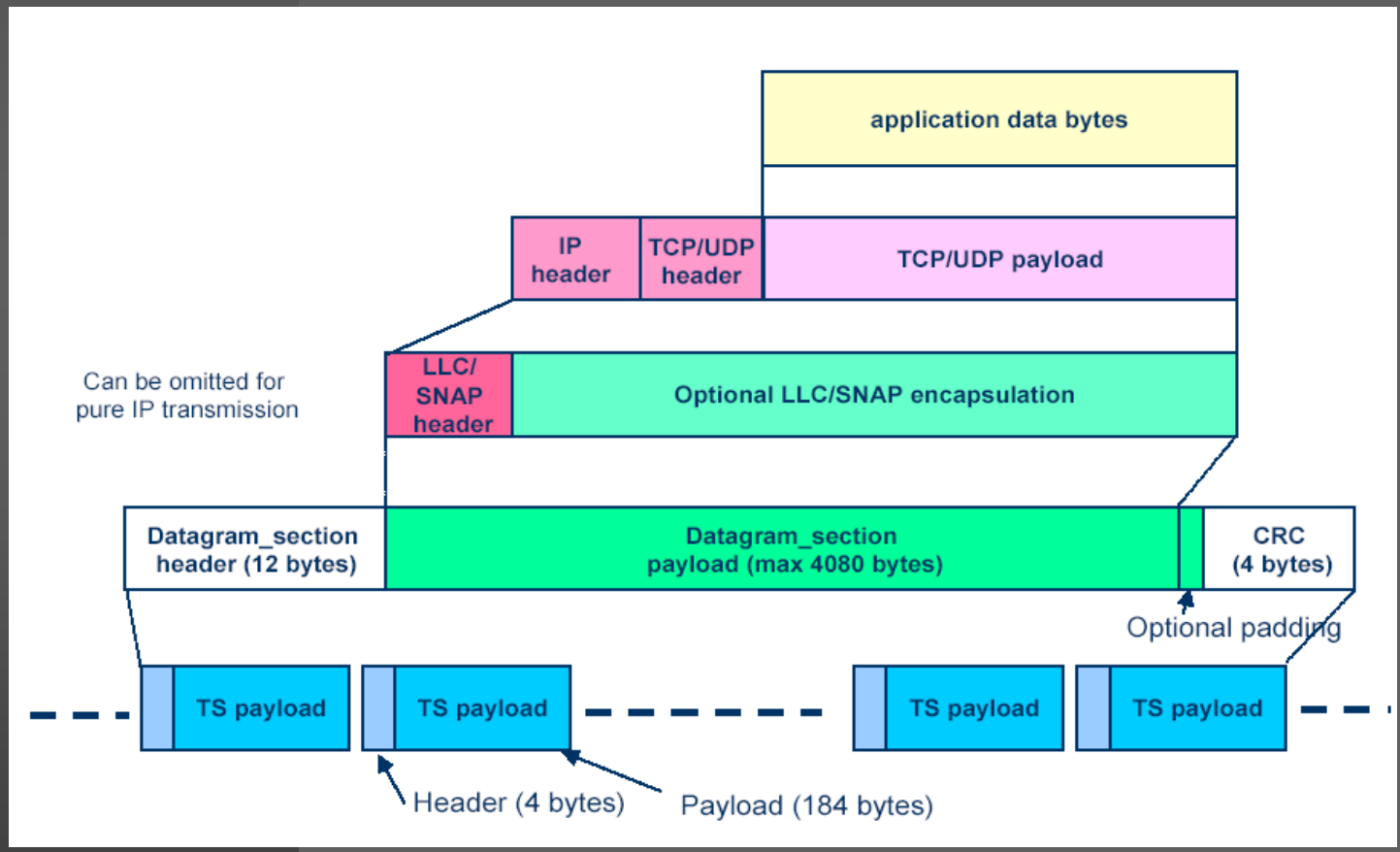
Data Piping:
Transport of anonymous non-synchronized bitstreams

Data Streaming:
Transport of synchronous or synchronized bitstreams

Multiprotocol Encapsulation:
Use of DVB transport mechanism for different communication services

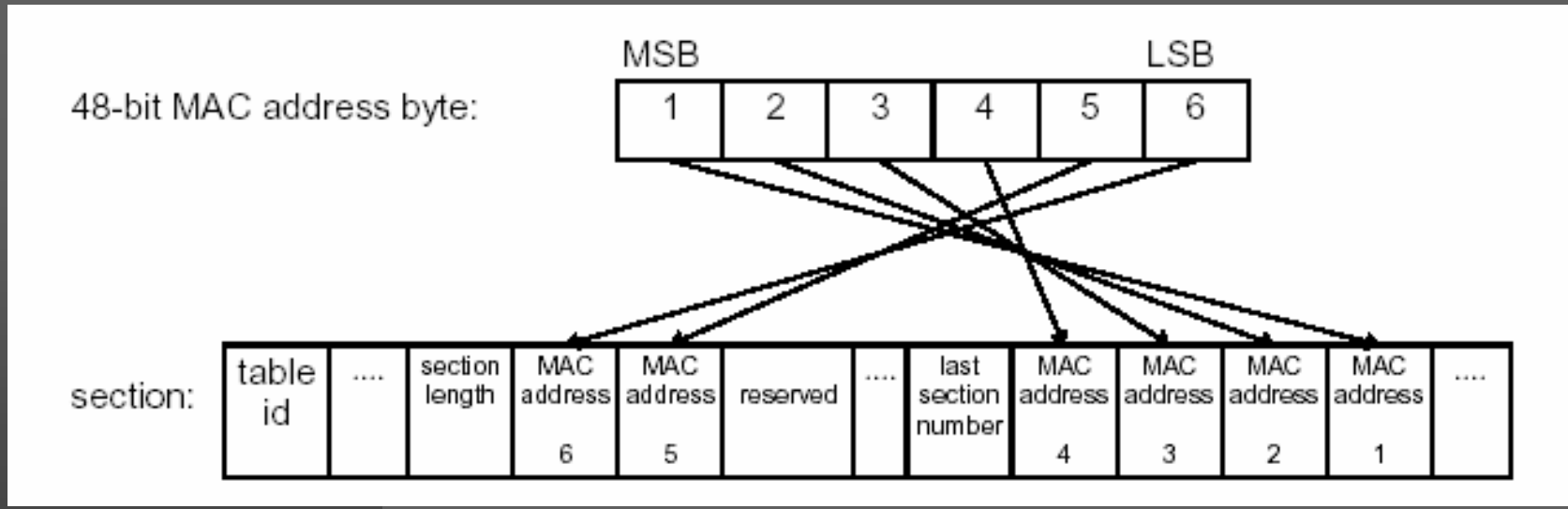
Data Carousel:
Periodic transmission of comprehensive files of data

DVB MPE Protocol Mapping

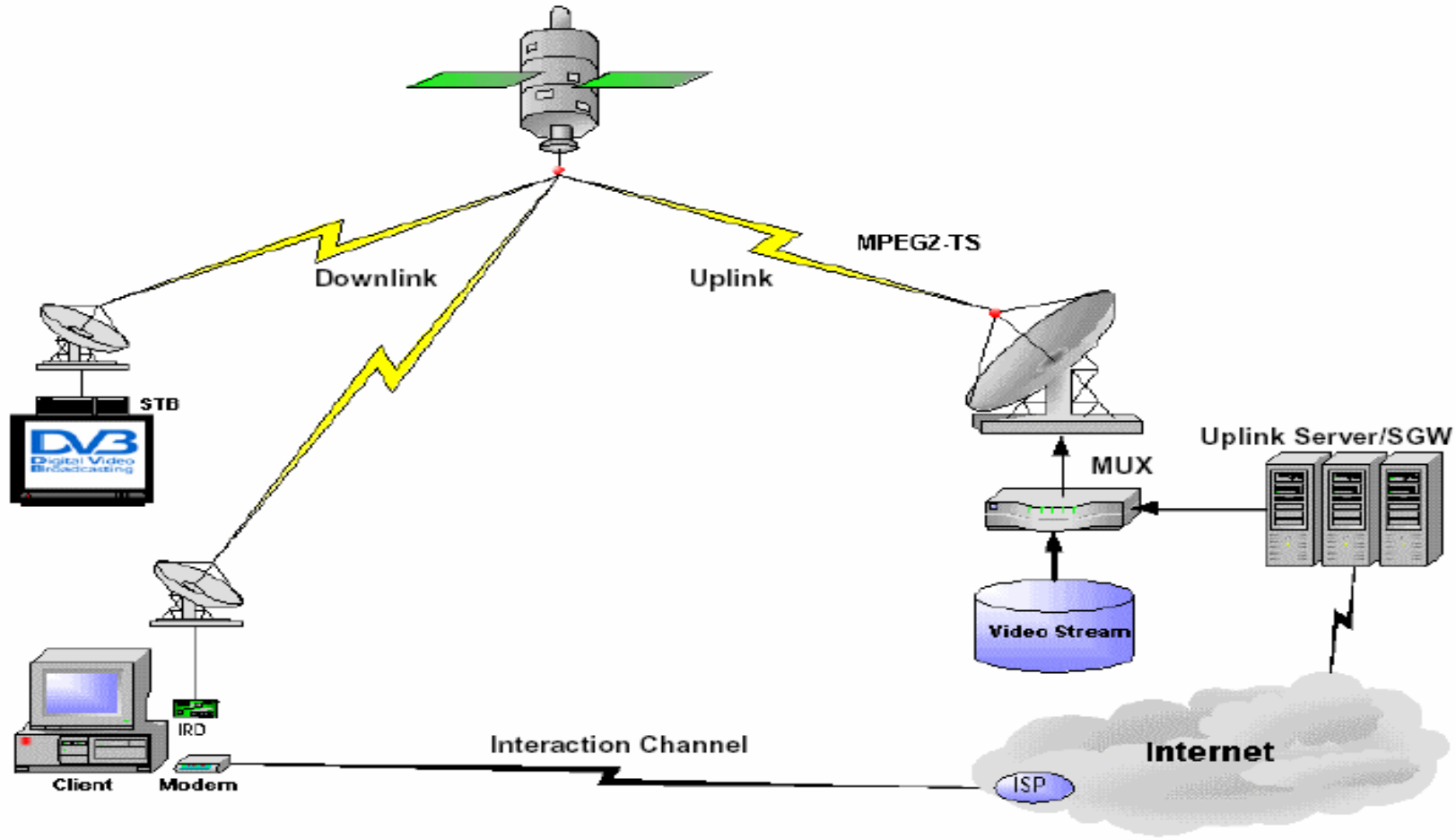


MPE

- MPE has MAC address

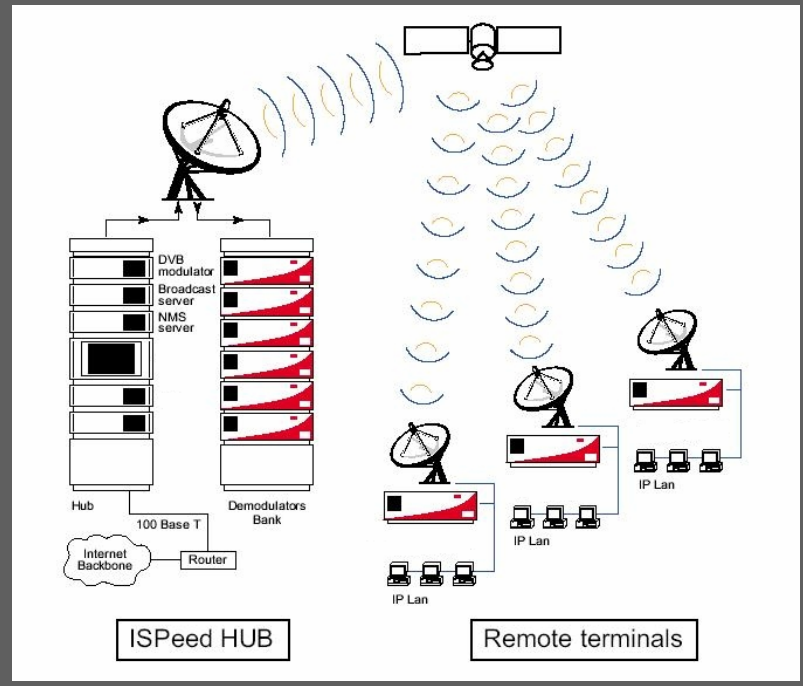


A typical DVB downlink system

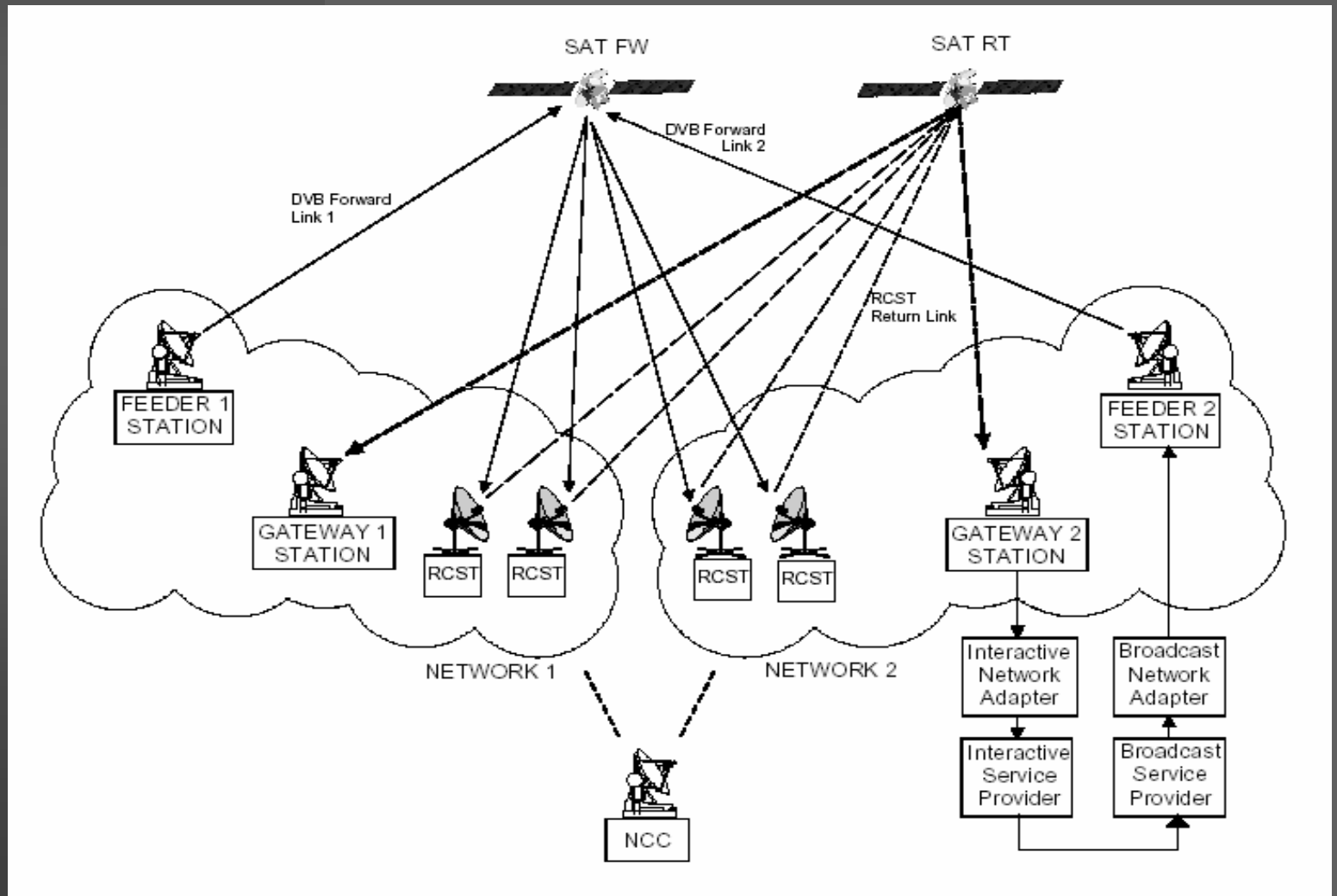


DVB-RCS
(Return Channel via Satellite)

- ETSI EN 301 790 was published in Dec. 2000
- Downlink is an extension of DVB-S
- Uplink is RCS
- Now it is a turn-key solution for Internet access
- Alcatel's 9780 DVB-RCS product is a good example!

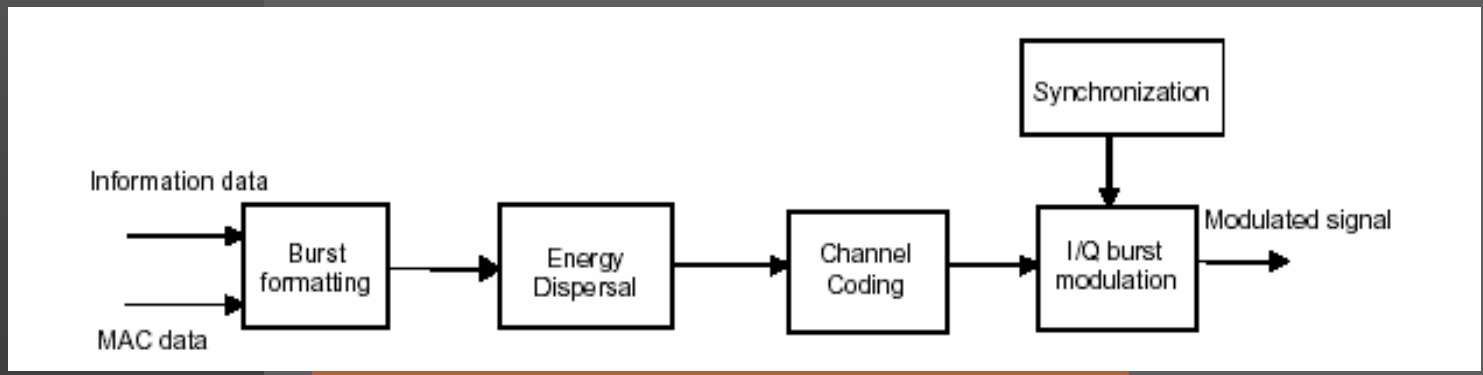


Reference model



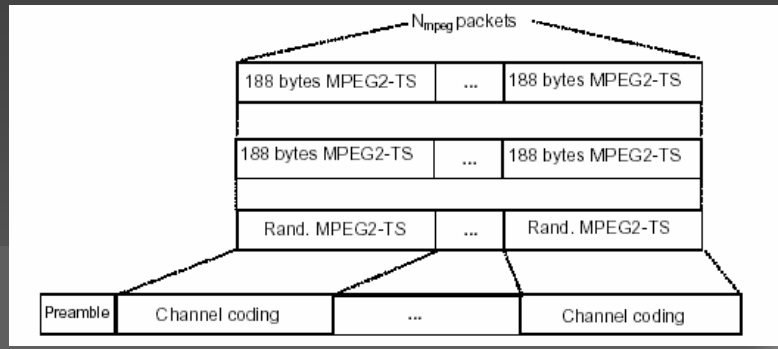
Downlink & Uplink

- Downlink:
  - like DVB-S ,data is in MPEG2 TS
  - FLS (Forward Link Signaling): MPEG2 PSI + DVB SI + RCS specific Tables & descriptors + TS packets containing NCR
- Uplink:
  - It is Burst format: TRF, SYNC, ACQ, CSC
  - The access method is MF-TDMA
  - Turbo code ,QPSK

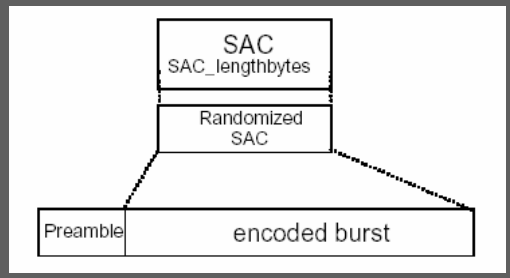


Uplink Burst

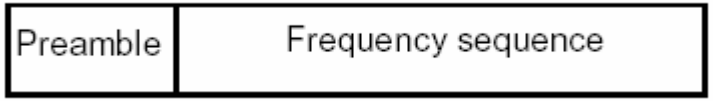
- TRF: for data
  - ATM or MPEG2



- SYNC: for synchronization & sending control information

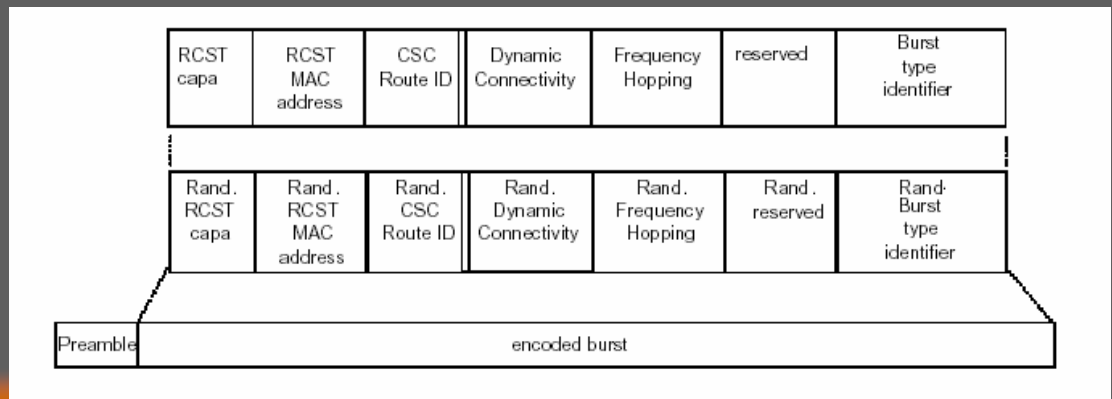


- ACQ: for synchronization prior to connect to network



- CSC:

identifying RCST during logon

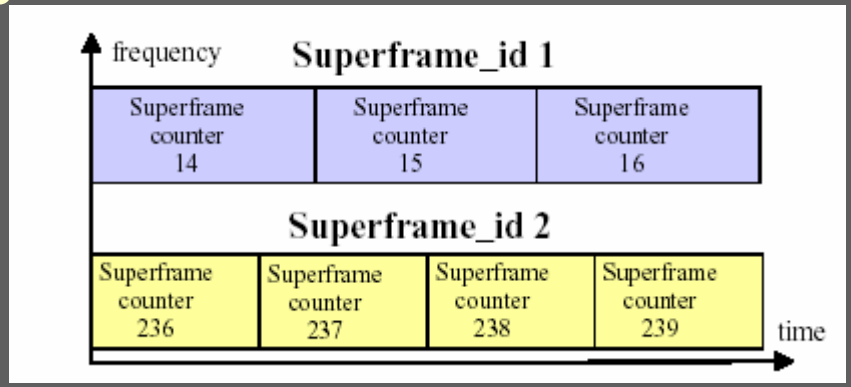


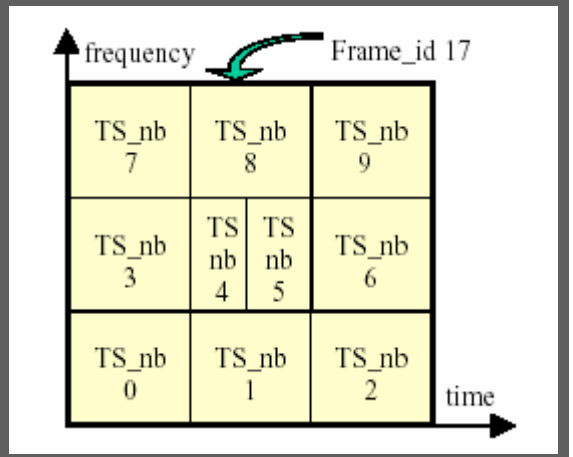
Capacity Request

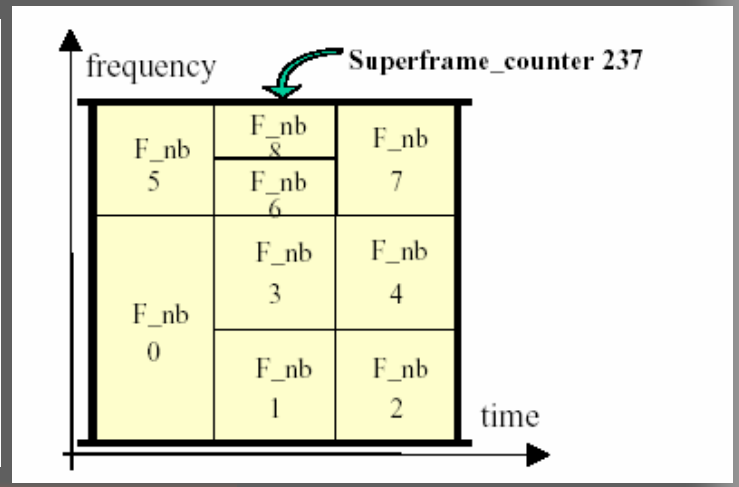
- 2 way:
  - Using SAC (Satellite Access Control) field
    - In SYNK burst
    - As prefix of ATM TRF
  - Using DULM (Data Unit Labeling Method)
    - In ATM TRF or MPEG2 TRF in IEs (Information Element)

Return link resources

- MF-TDMA: Static or Dynamic
- Resources:
  - Super frame
  - Frame
  - Timeslot



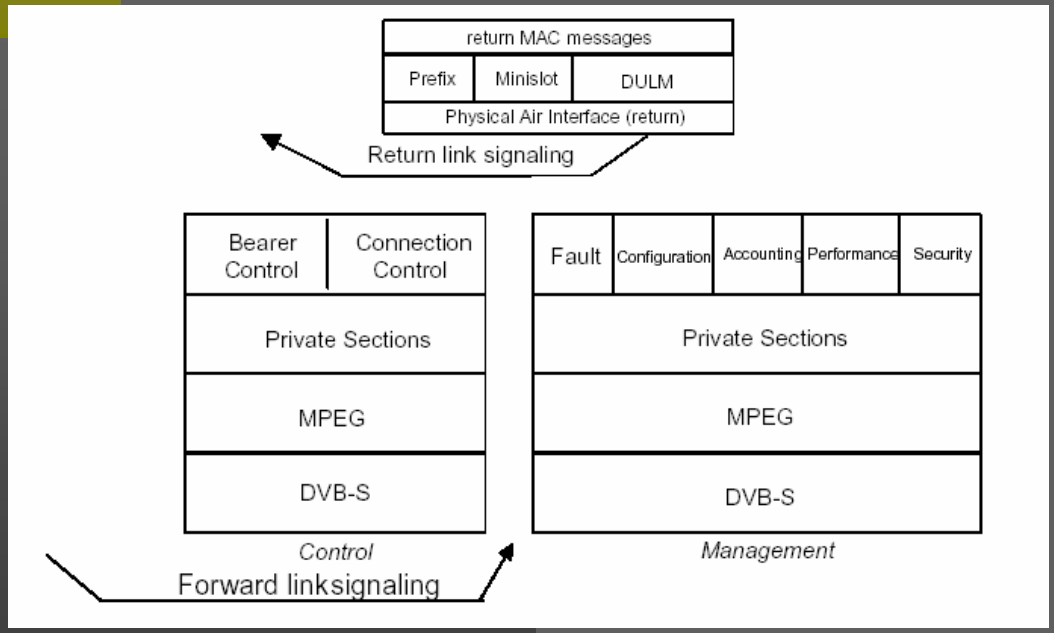




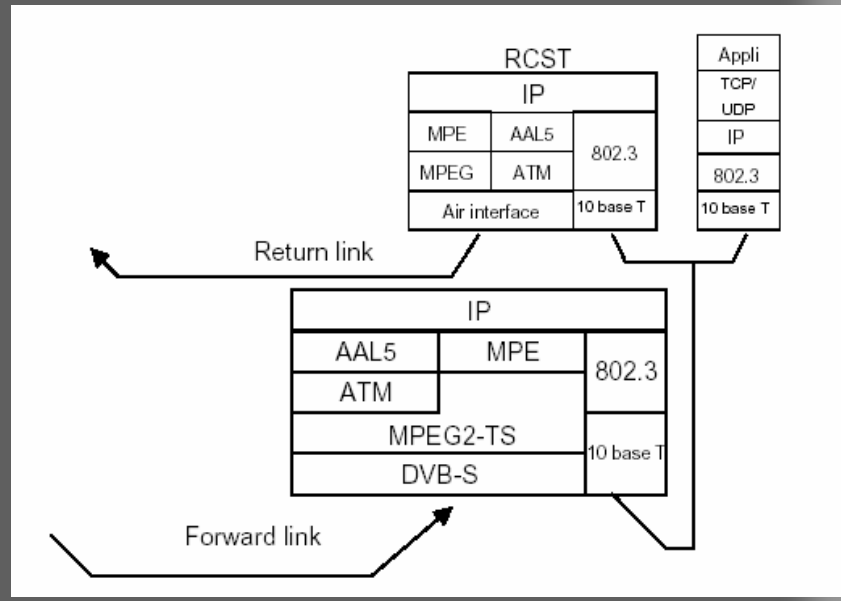
IP transmission

- Type A supports IP transmission
- Addressing: MAC address, logical address (group-ID, logon-ID)

protocol stack of signaling



protocol stack of IP



FLS

- General SI tables (for RCS):
  - SCT: gives super frame resources parameters
  - FCT: gives frame resources parameters
  - TCT: gives timeslot resources parameters
  - SPT: gives satellites position
  - CMT: as a feedback to RCSTs for physical parameters
  - TBTP: assigns timeslots to RCSTs
  - TIM: configure an RCST or entire network
- RMT: links RCSTs to appropriate FLS
- TS packets containing NCR (Network Clock Reference)
- RCS descriptors

RLS
(Return Link Signaling)

- RCST synchronization and Identification messages :

Forward:	Message/DSM-CC and SI Section/MPEG2-TS/DVB-S
Return:	Special bursts/Air Interface
Messages used:	TIM (forward) - [DSM-CC] or TBTP [SI]
	CMT (forward) - [SI]
	CSC (return)
	ACQ (return)
	SYNC (return)

- Configuration parameters between RCST and NCC (optional) :

Forward:	SNMP/UDP/IP/DSM-CC/MPEG2-TS/DVB-S
Return:	SNMP/UDP/IP/Traffic bursts/Air Interface
Messages:	get-request [MIB variable] (forward)
	get-next-request [MIB variable] (forward)
	get-response [MIB variable, value] (return)
	set-request [acknowledgement flag] (forward)

RLS
(Return Link Signaling)

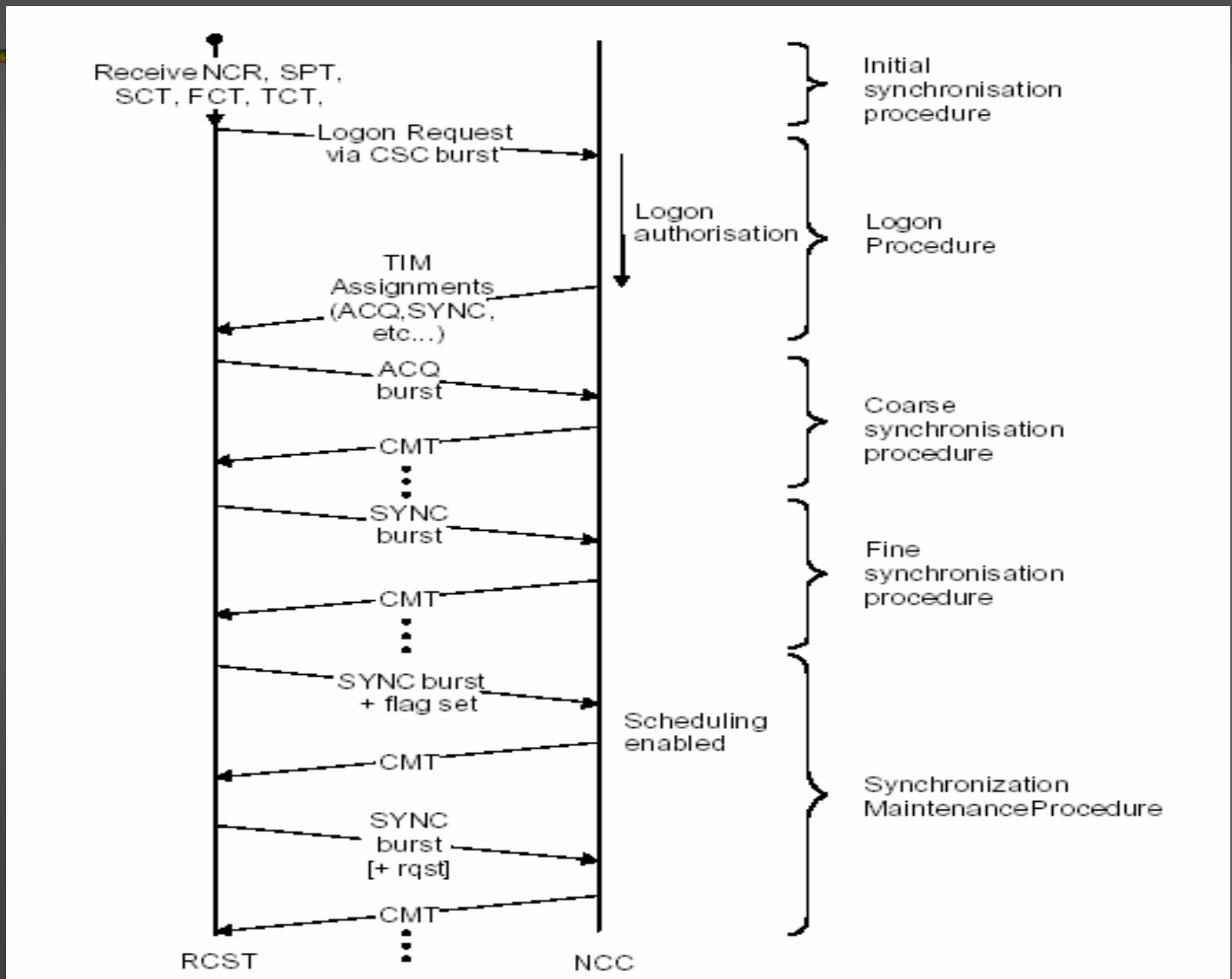
- messages for network management (optional) :

Forward:	SNMP/UDP/IP/DSM-CC/MPEG2-TS/DVB-S
Return:	SNMP/UDP/IP/Traffic bursts/Air Interface
Messages:	get-request [MIB variable] (forward)
	get-next-request [MIB variable] (forward)
	get-response [MIB variable] (return)
	set-request [MIB variable, value] (forward)
	trap [MIB variable value, value] (return)

- Burst time plan exchange :

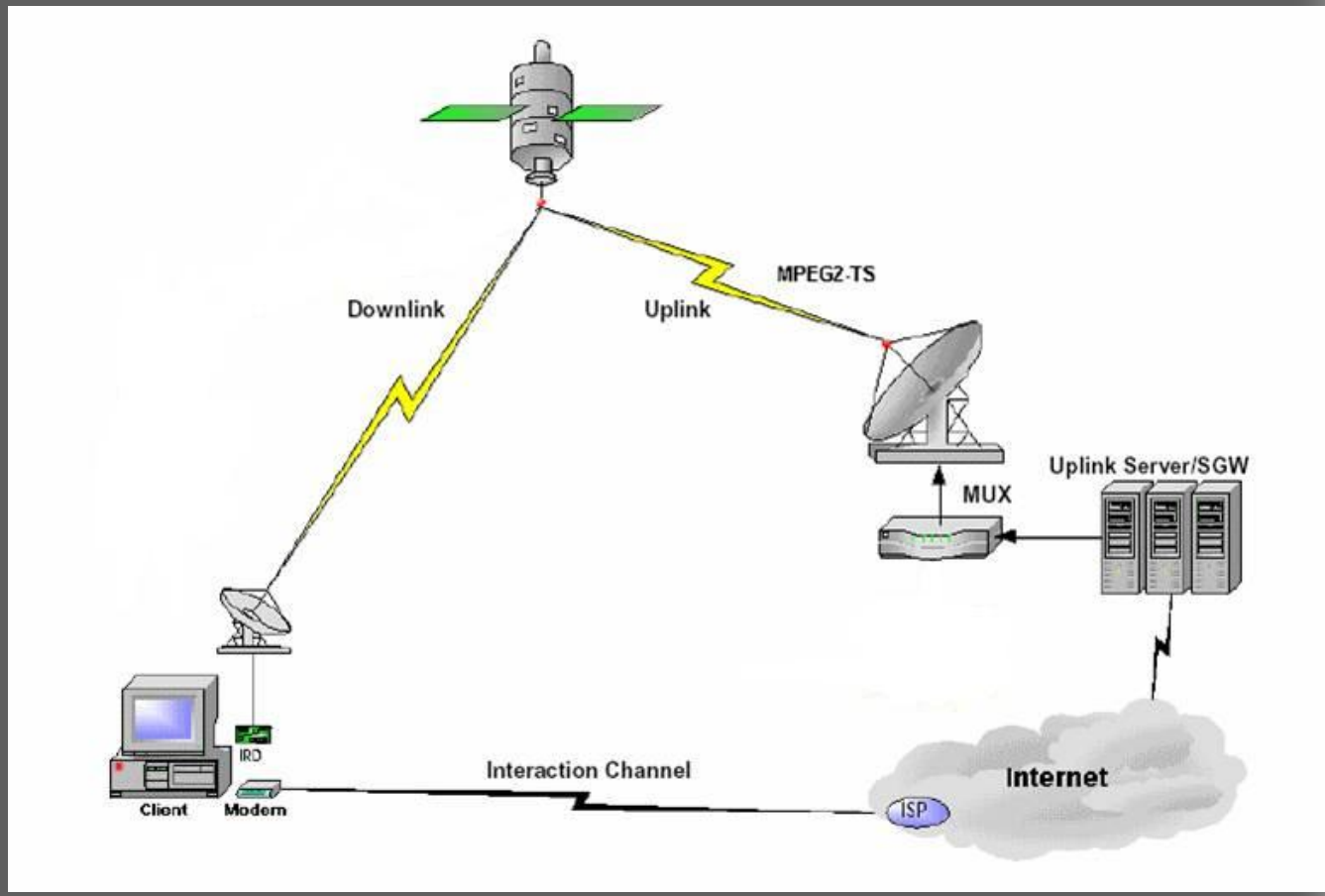
Forward:	Message/SI Table/MPEG2-TS/DVB-S
Return:	Capacity requests (CR)/Air Interface
Messages:	TBTP (forward)
	CR (return)

Network Entry Signaling Flow

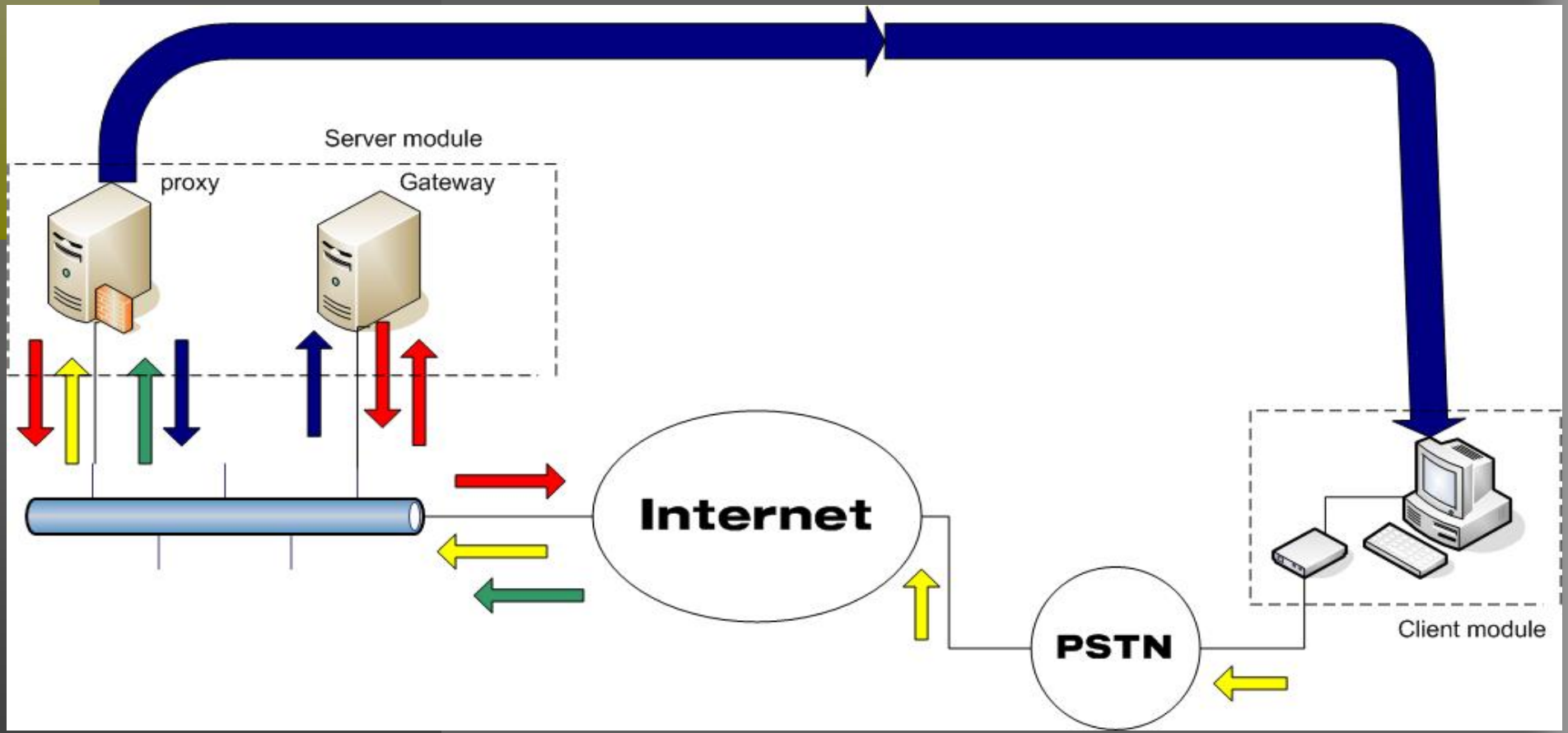


An innovative system

- *This is an internet access client-server (star) system with DVB as Forward Channel*



System Architecture

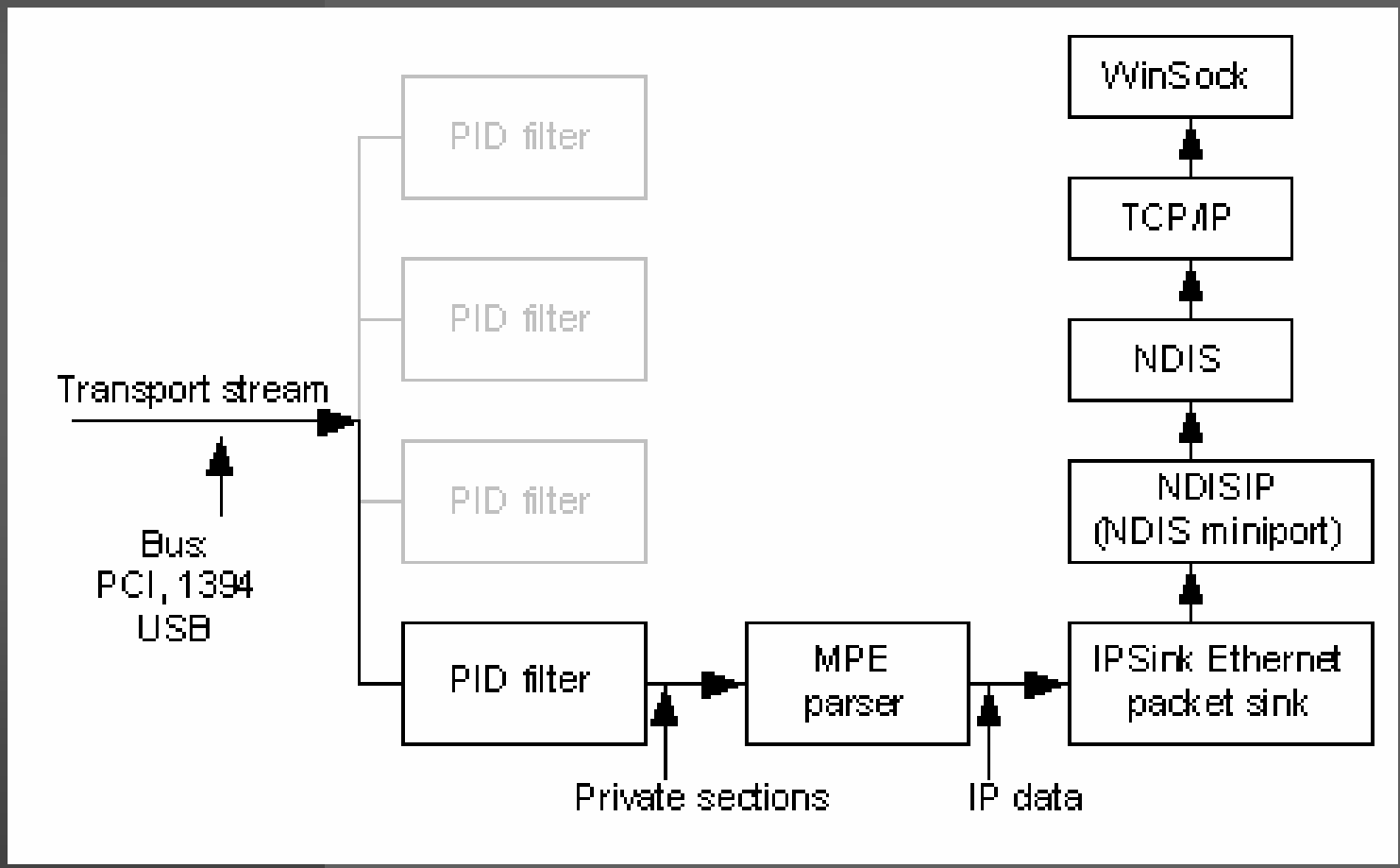


Client-side Design

- Microsoft BDA (Broadcast Driver Architecture) ,solves all the problems!
  - It has a “filter based” architecture.

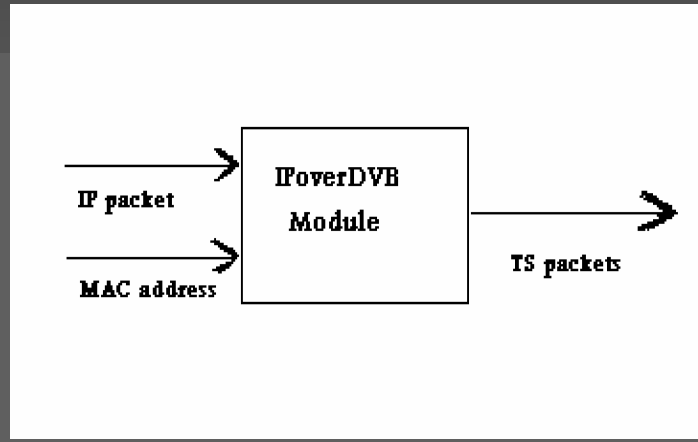
- System is “return channel”-independent.
- IP/MAC resolve may be Static or Dynamic.
- We will use commercial DVB PCI receivers.
- We write BDA filters on PCI card

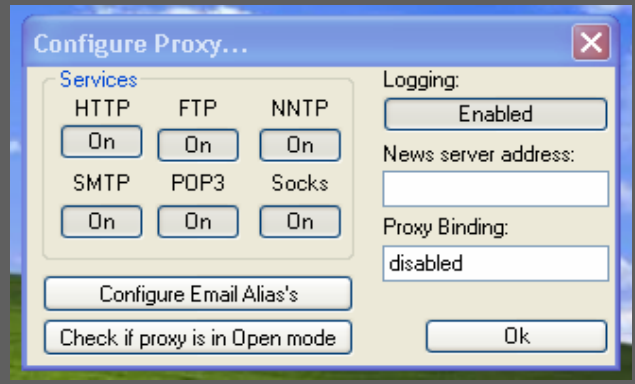
IP processing in BDA



Server-side design: it is more important!

- We decided to implement on Windows.
- Three main part in server:
  - Proxy
  - Packet redirector
  - IP encapsulator
- Proxy:
  - Any efficient is enough!
    - I used AnalogX for test:



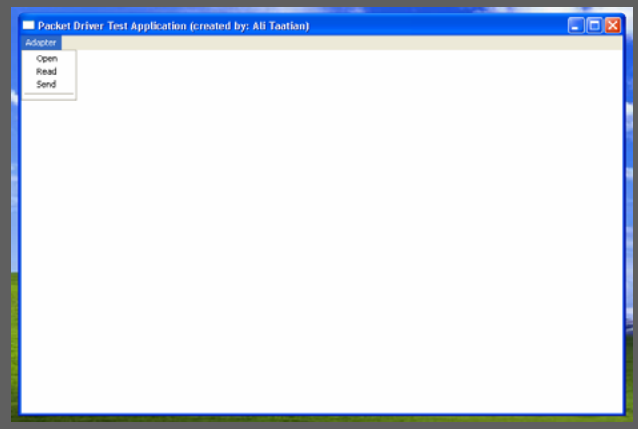


Packet Redirector

- This part should redirect the IP traffic (from server to clients) to DVB transmitter.
- We should capture specific IP packets and send them to “IP encapsulator”
- Packet capture in Windows:
  - Packet Filtering API
    - It works in layer 3
    - But we can not dump all the packet content.
  - Packet dump is in layer 2: WinPcap API

Copy packets with WinPcap

- We used Microsoft DDK 2000 , NDIS driver model to sniff IP packets.
- It is an MFC project using installed NDIS driver.
- So ,we copied all the specific packets and fill them in a buffer



Packet Drop

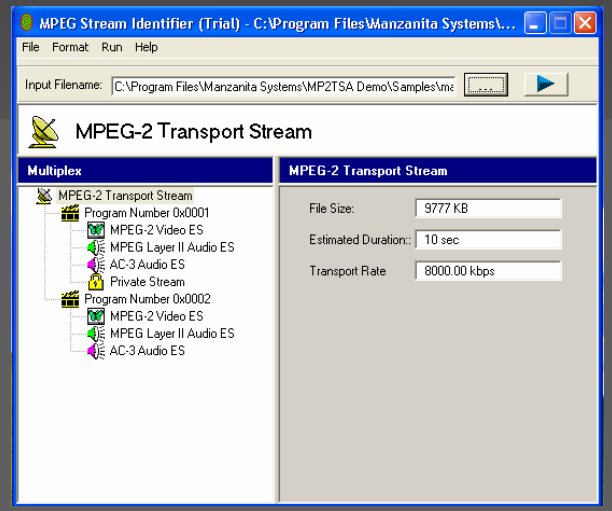
- We can not drop packets in WinPcap!
- So we should drop them in another computer! There ,we used Hook Filter model. It can be a kind of firewall.

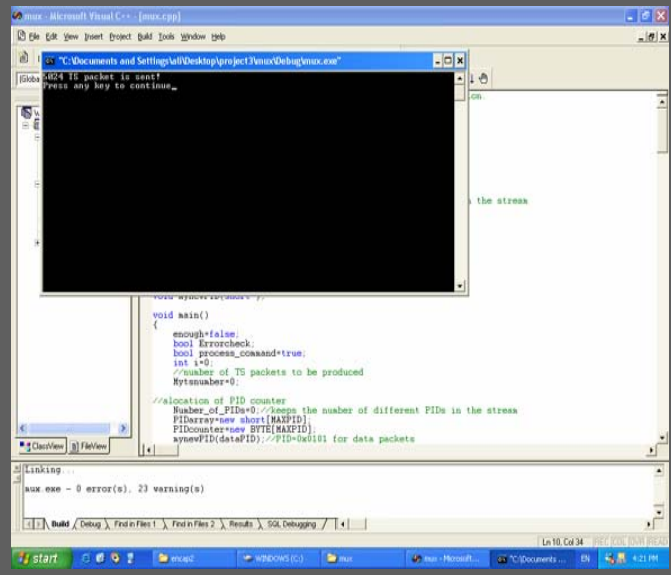
IP Encapsulator
What others have done?

- Only some drafts from University of Aberdeen (U.K.)
- Some commercial black-box as IP encapsulator

IP Encapsulator

- It is a C++ program, which takes data (IP packets) and produces TS packets.
- We make MPE sections and PAT ,PMT, NIT & SDT tables & multiplex them & send them in TS packets
- The result is tested by Manzanita analyzers.
- We wrote the Demultiplexor for that and tested it with a sample from Norsat Co.

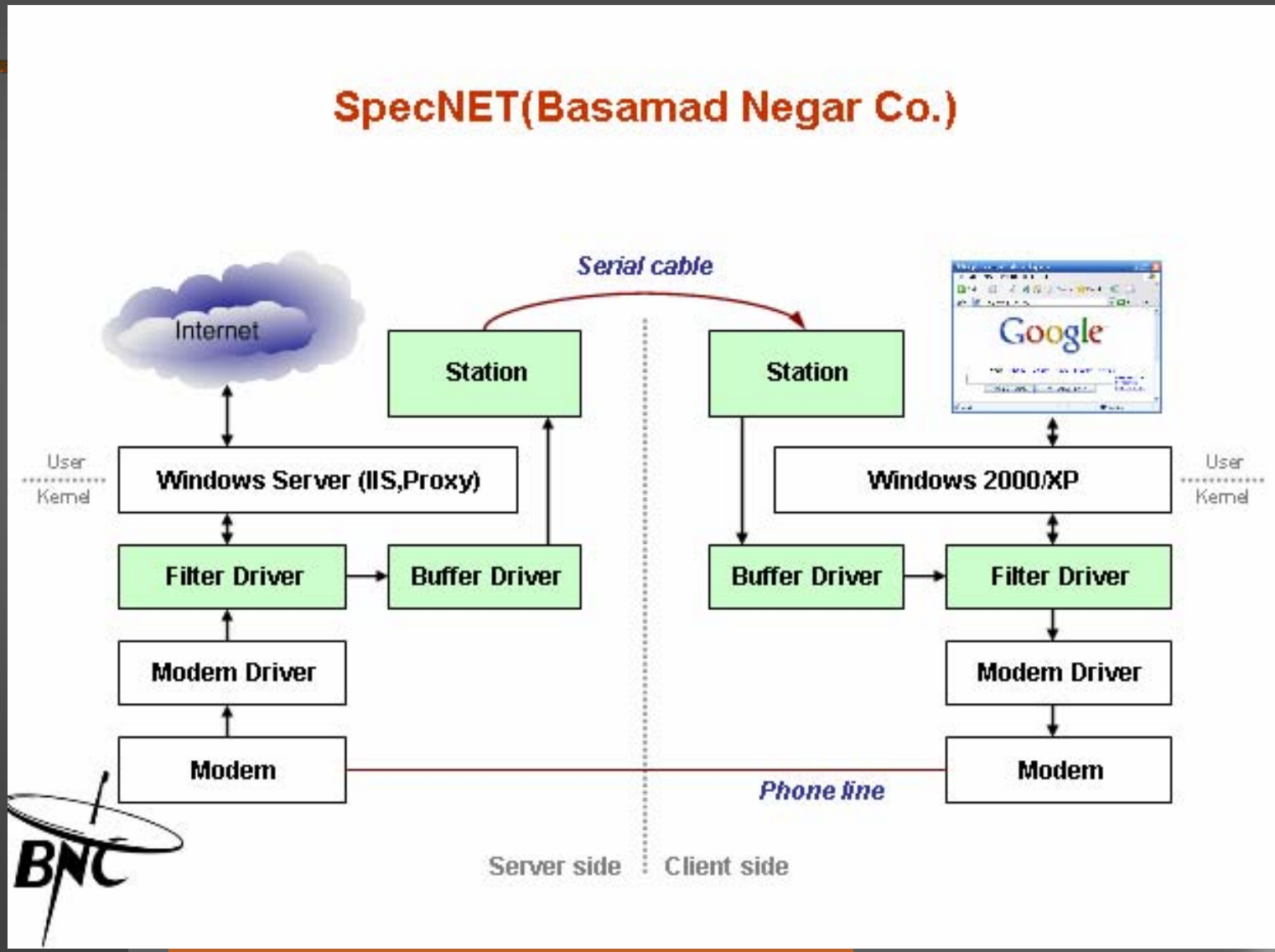




Initializing & IP/MAC resolution

- OOB model or IB model?
- Static or Dynamic resolve?

Other's works



suggestions

- Enhanced TCP/IP
- ULE (Ultra Lightweight Encapsulation)
- Stuffing bytes in TS makes bandwidth waste
- The IPEncapsulator code is in C++. So It can be run on other platforms.

Thanks for your consideration!

Q&A

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