

# Digitalni radiodifuzni sistemi i tehnologije

## DTV streaming - DVB

***Doc. dr Jugoslav Joković***

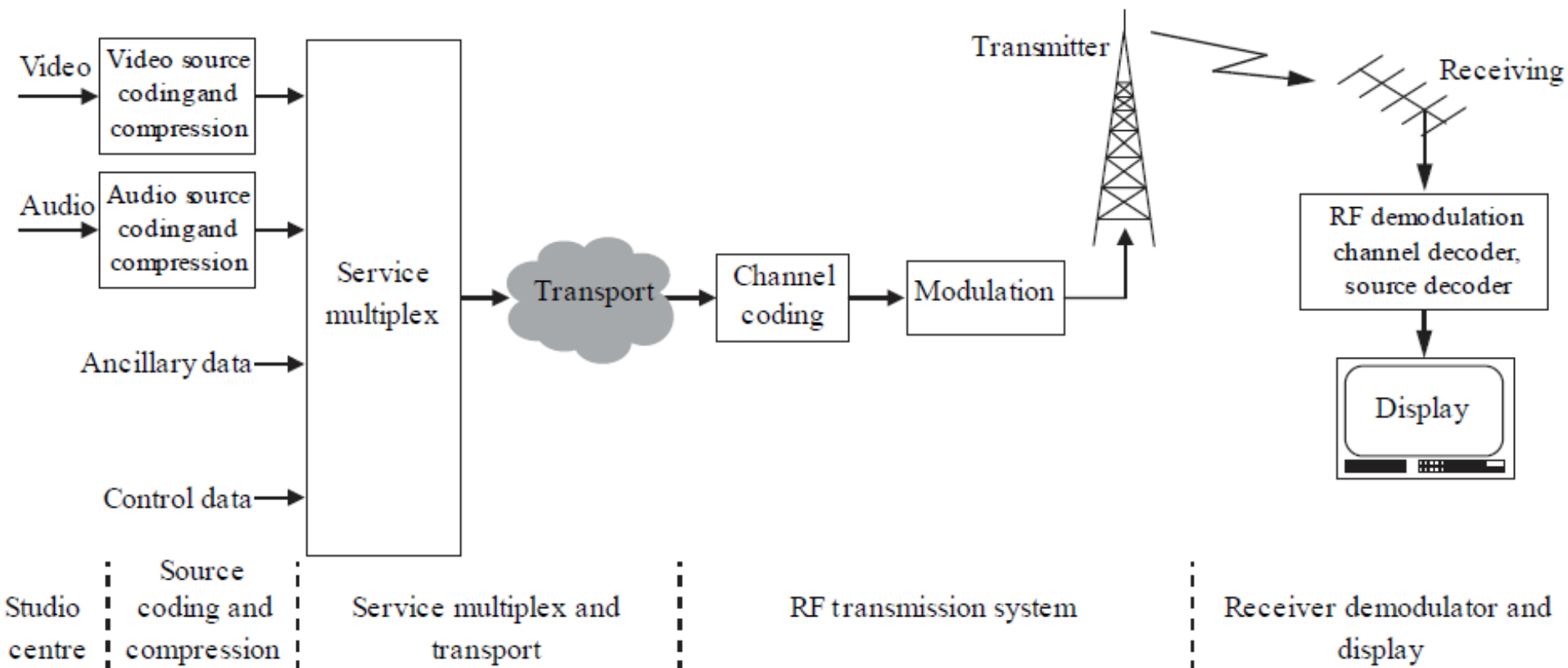
[jugoslav.jokovic@gmail.com](mailto:jugoslav.jokovic@gmail.com)

Elektrotehnički fakultet Banja Luka



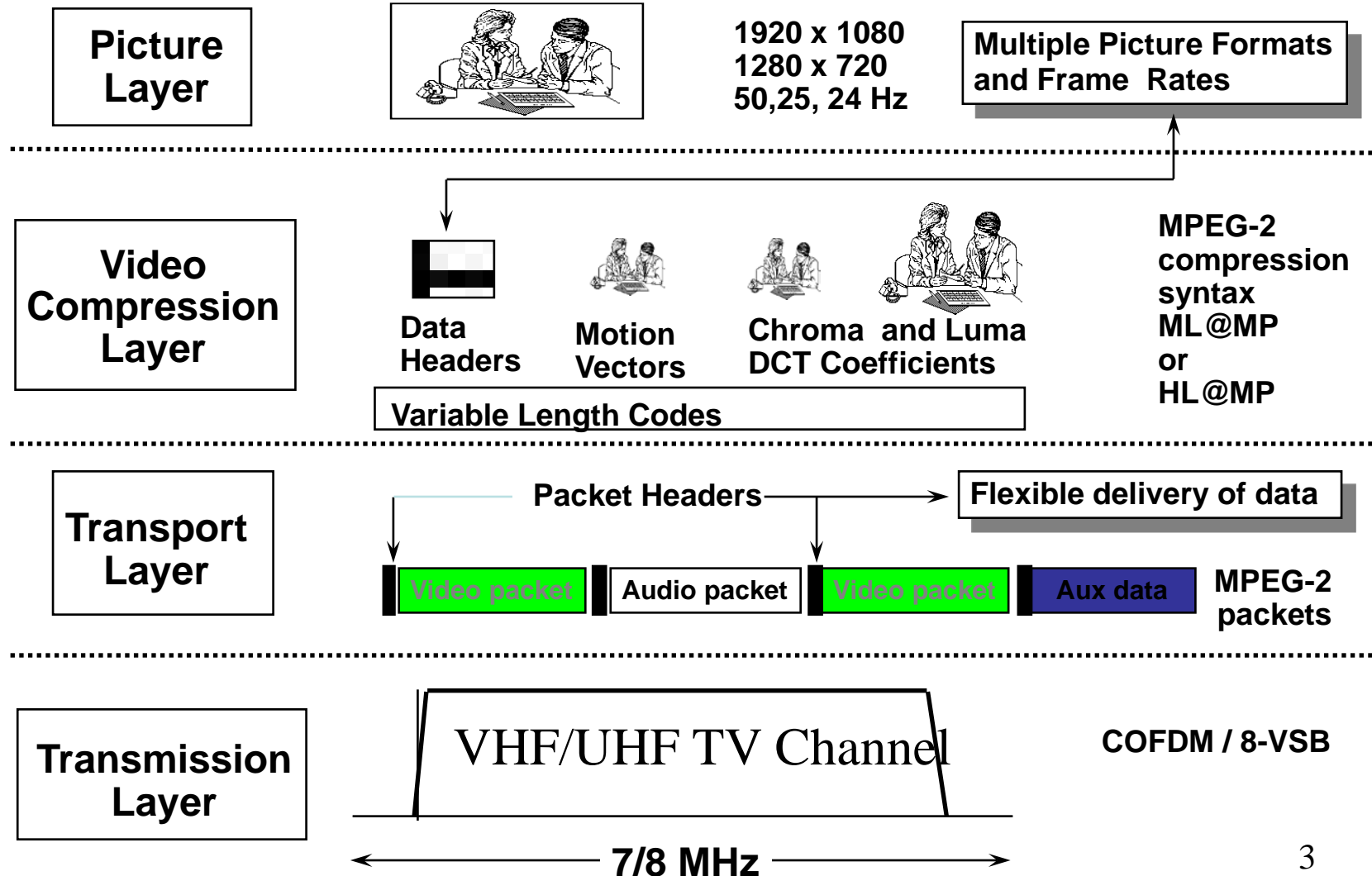
***Banja Luka, 2017.***

# DTV System Model

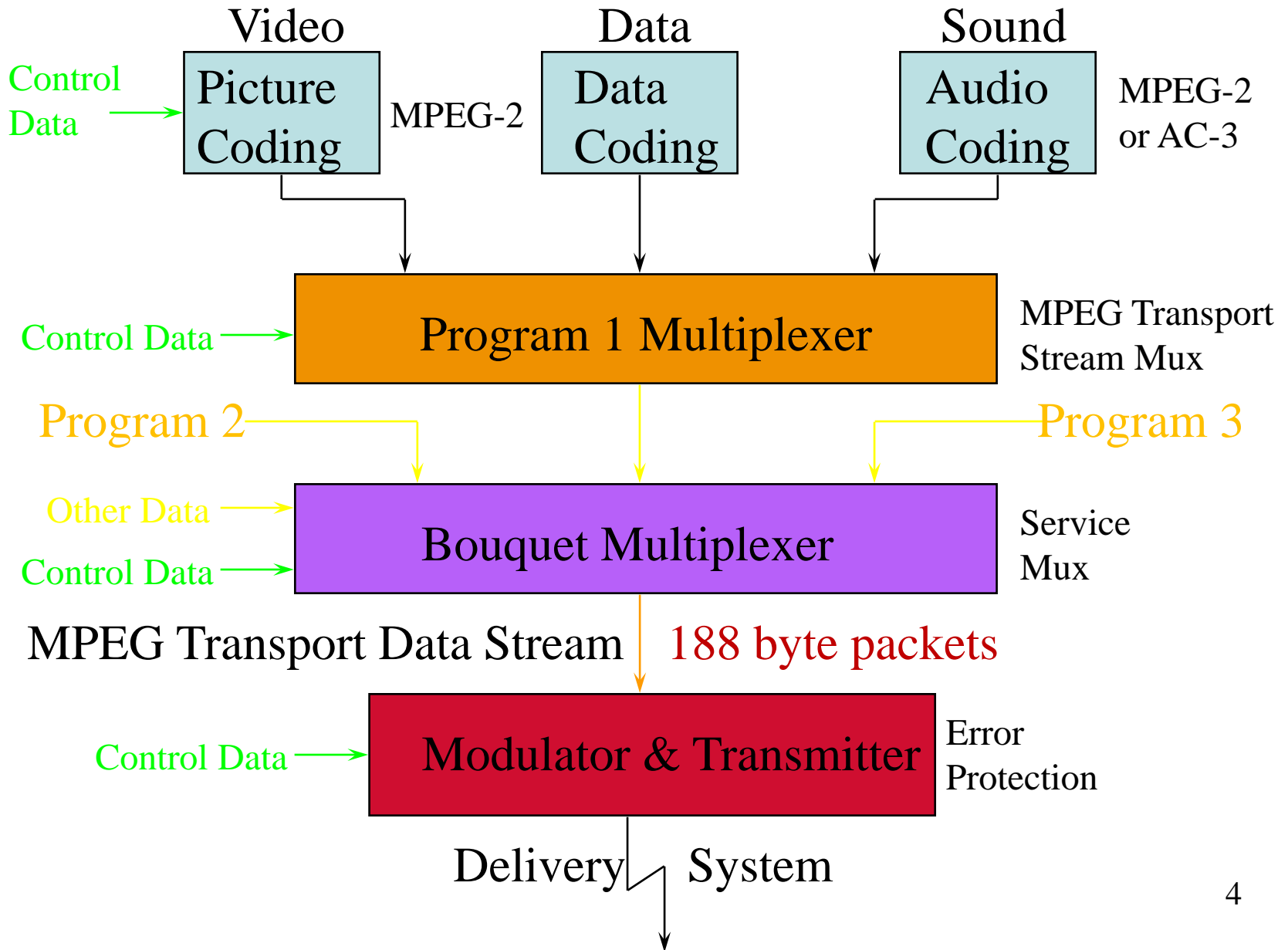


# Digital Terrestrial TV - Layers

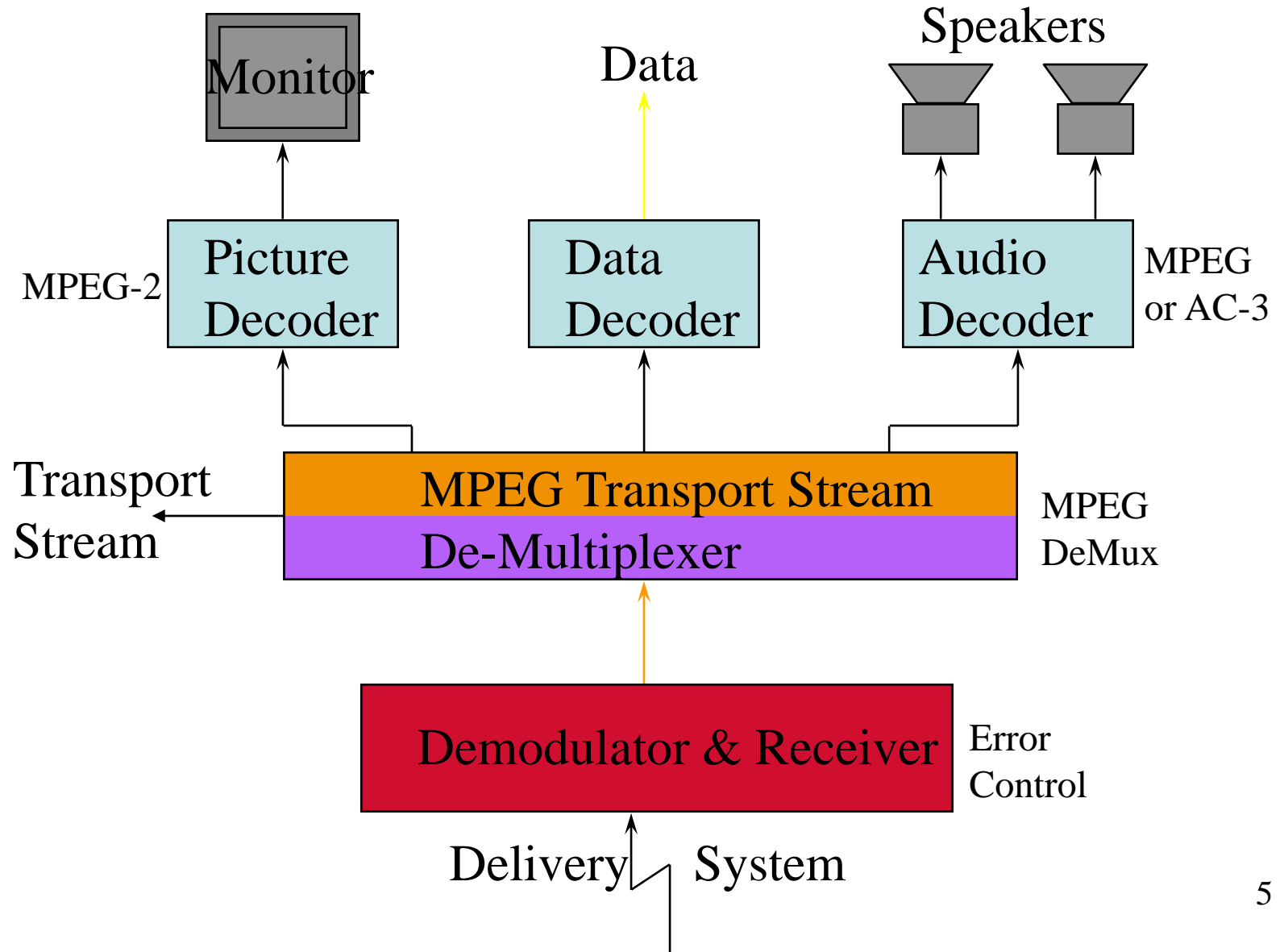
... provide clean interface points. ...



# DTV Encode Layers



# DTV Decode Layers



**Kako formirati MPEG stream?**

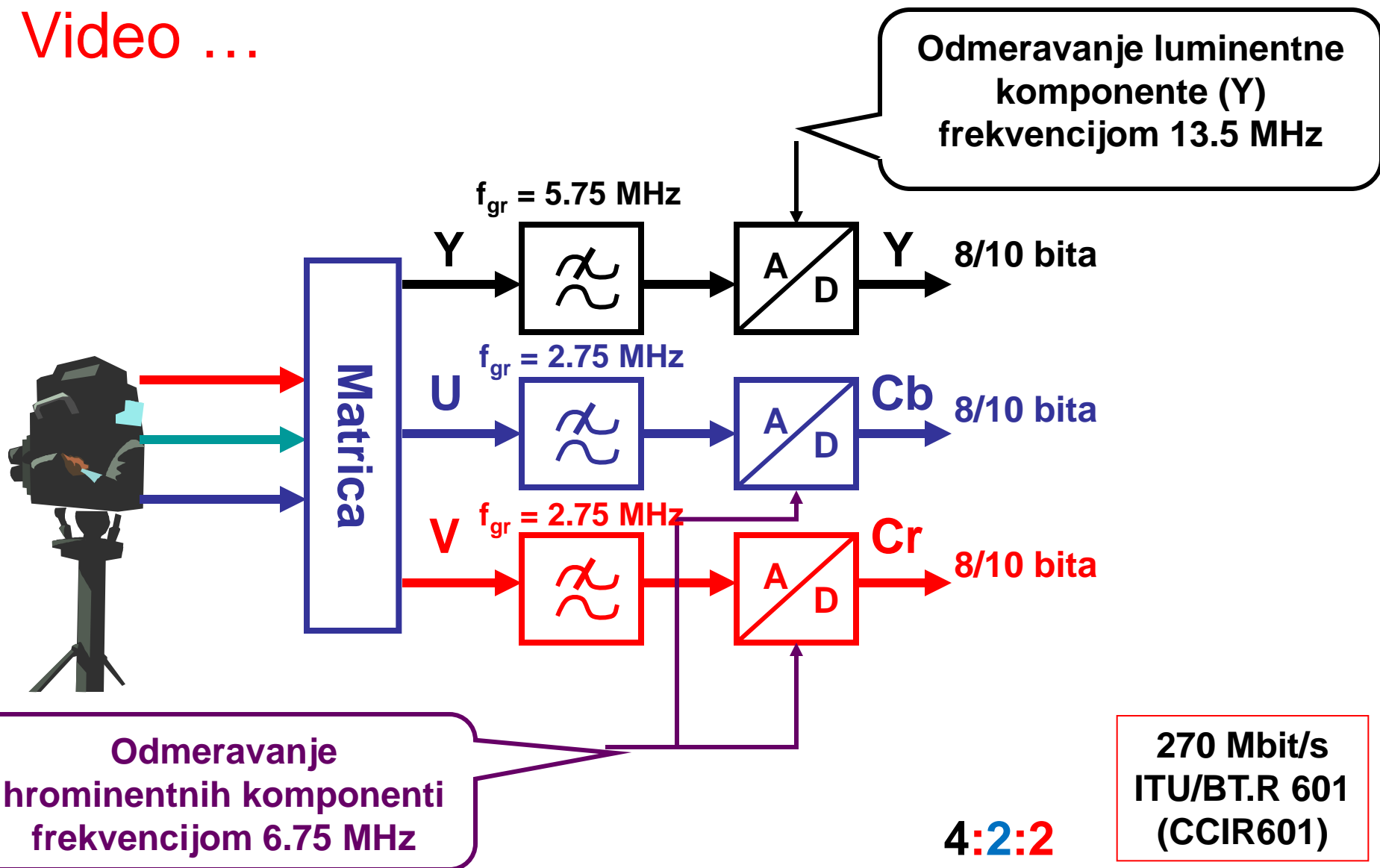


Levi kanal  
audio standard AES/EBU

Desni kanal  
audio standard  
AES/EBU

video standard ITU-R BT 601

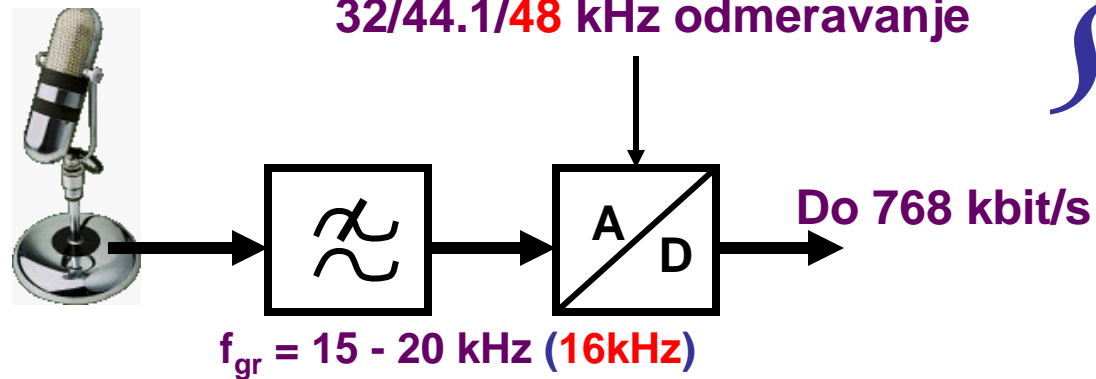
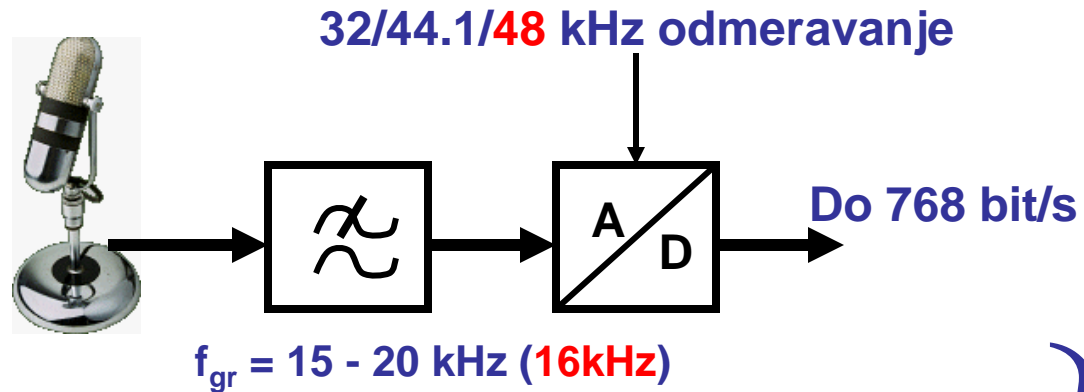
# Video ...





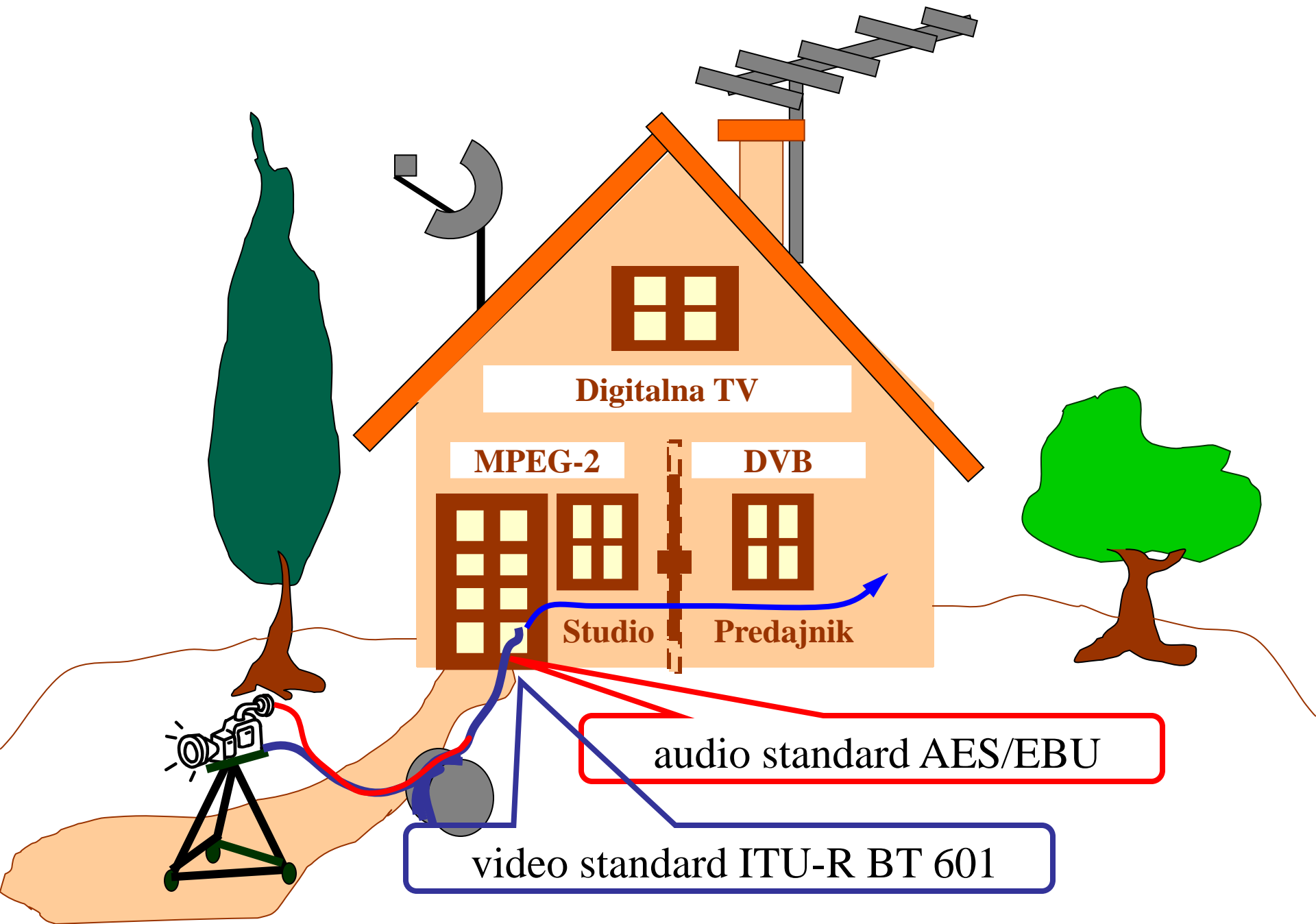
# Audio...

## Desni kanal

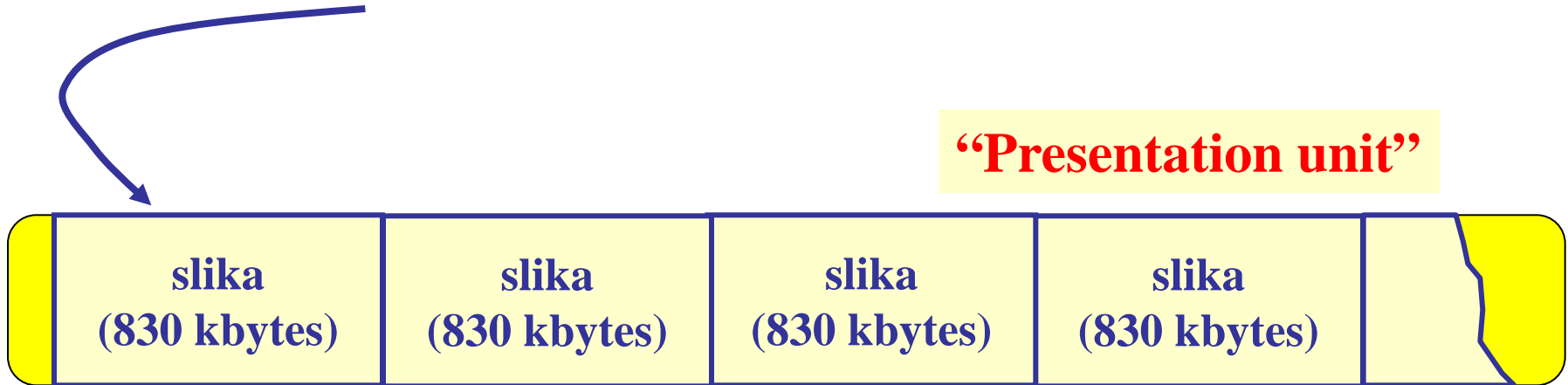


Približno 1.5 Mbit/s

## Levi kanal



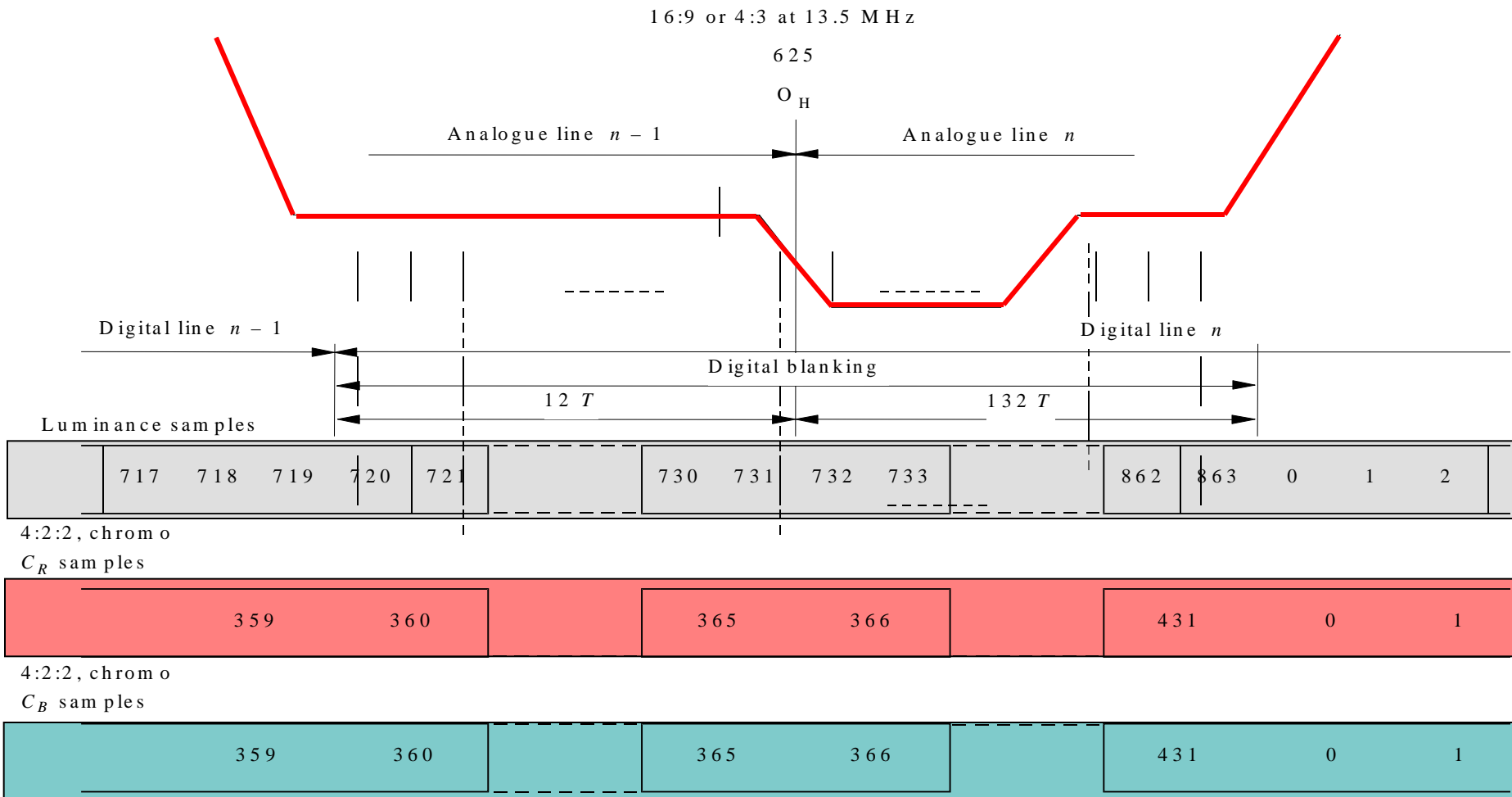
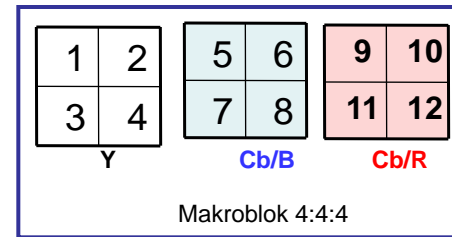
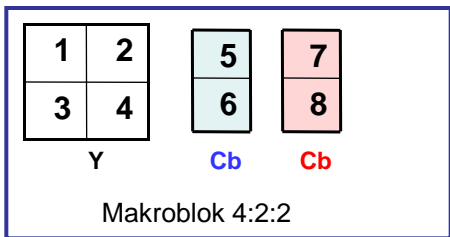
## Nekompresovani video stream (CCIR 601)



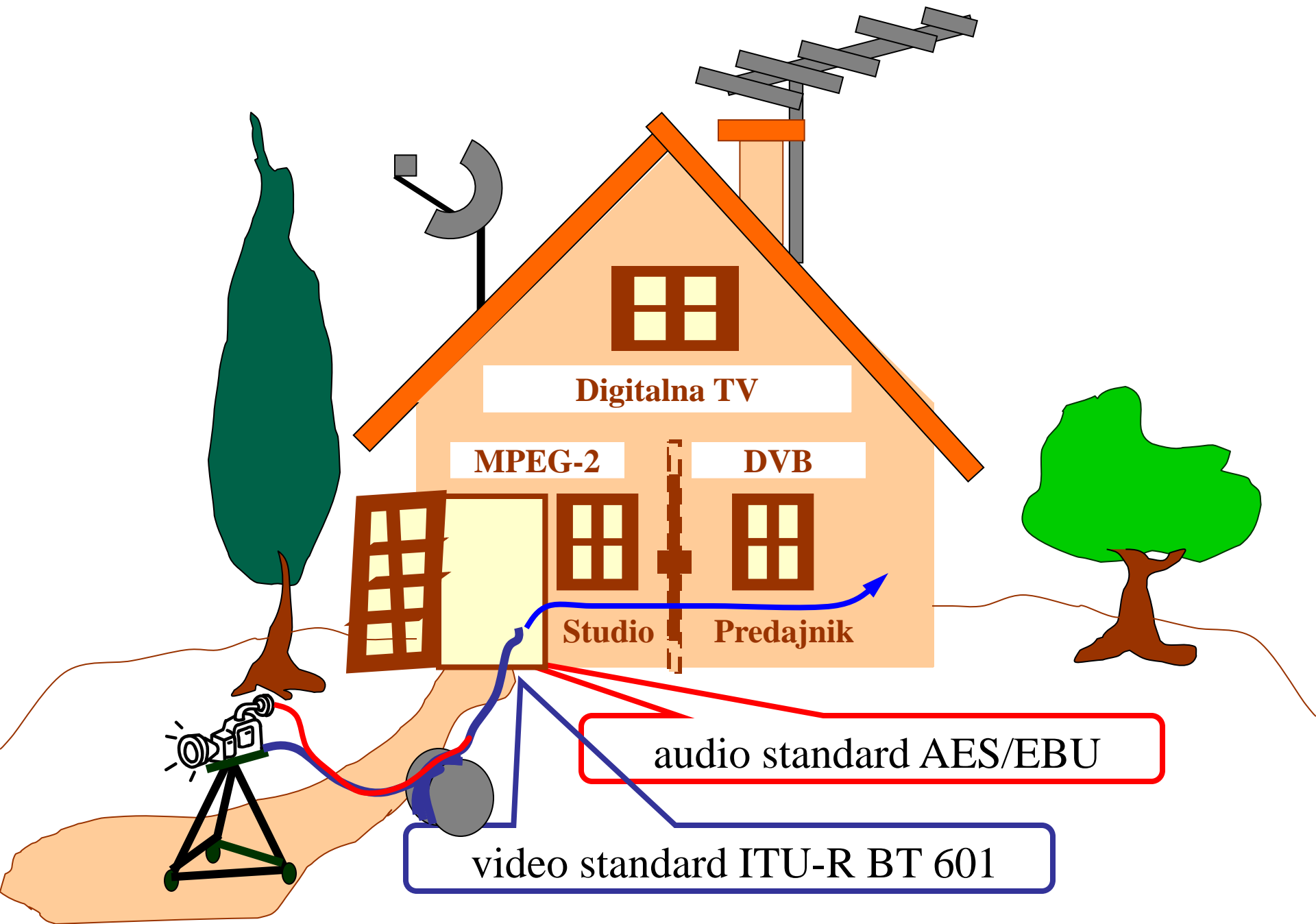
Svaka slika (1 *frame*) u nekompresovanom obliku naziva se “**presentation unit**” (prezentaciona jedinica)

# ITU-R BT.601-5

625 linijski sistem (864 x 432 pixela)  
odmeravanje sa 13.5MHz ili 18MHz



$T$  : lum inance sam pling period



Digitalna TV

MPEG-2

DVB

Studio

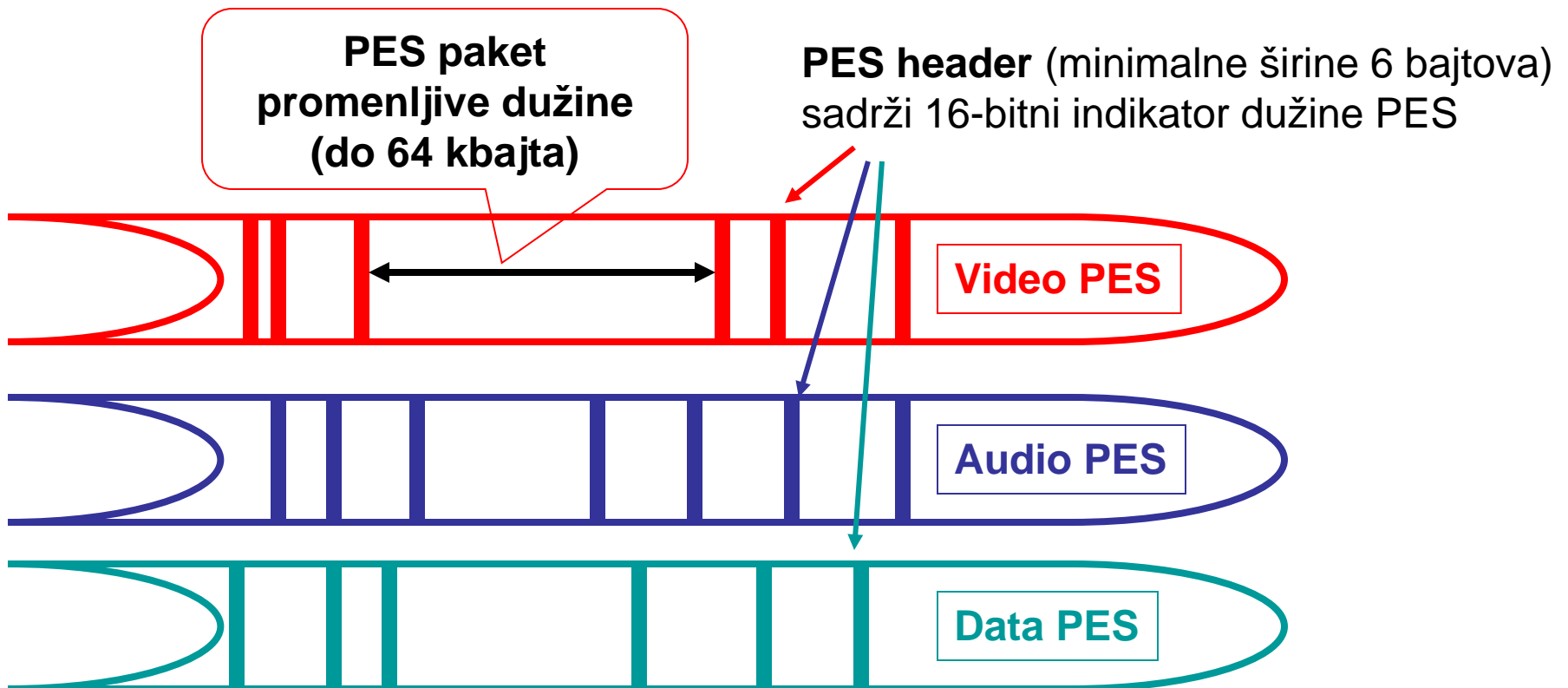
Predajnik

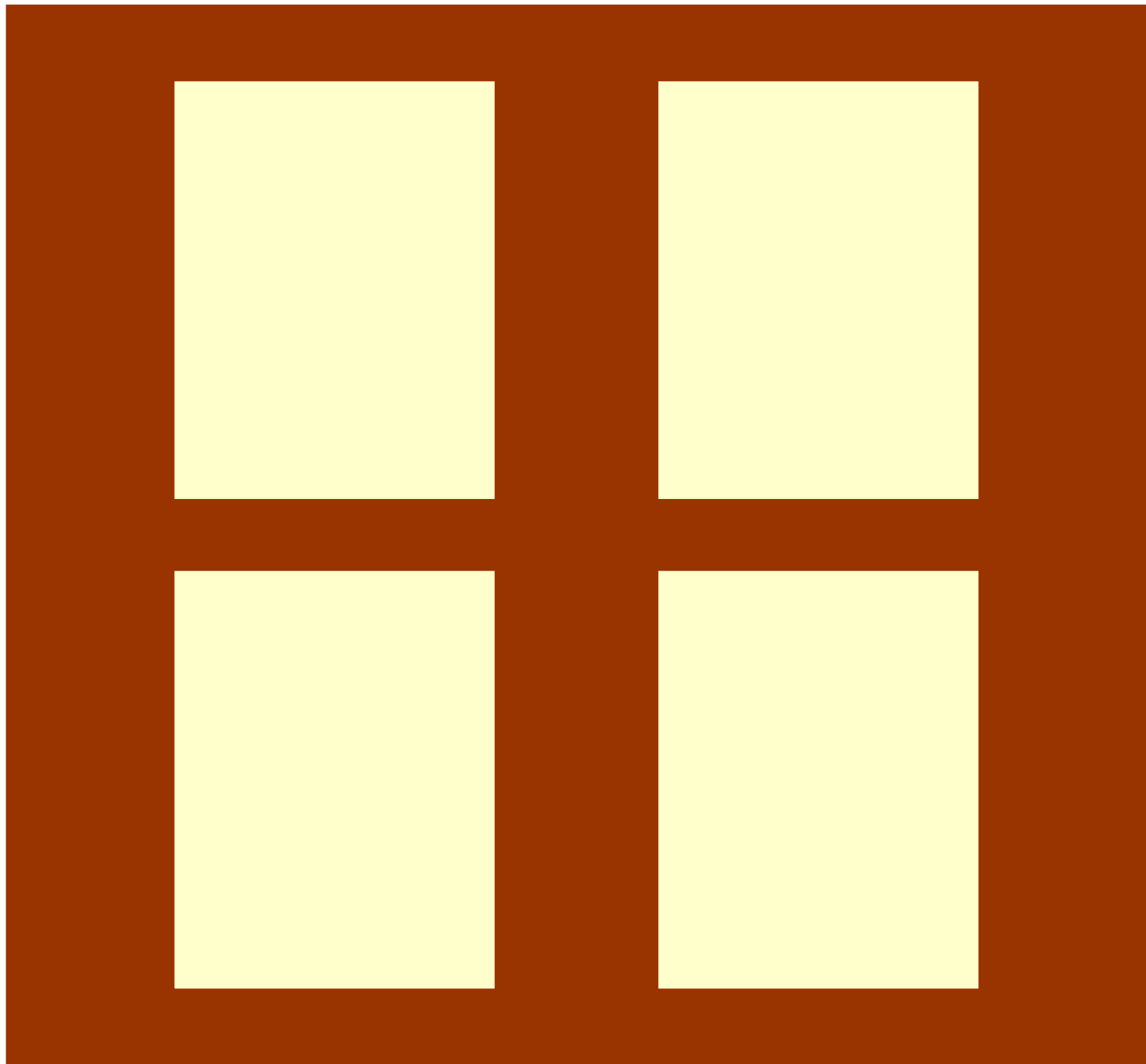
audio standard AES/EBU

video standard ITU-R BT 601

# Elementary Stream ES

- Elementarni niz (**Elementary Stream**, ES) – osnovni tip MPEG-2 signala koji generiše koder
- nezavisni i odvojeni za video, audio i signale podataka
- PES – **Packetised Elementary Stream**





# Formiranje PES paketa

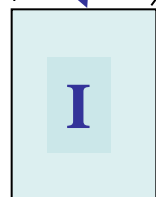
Nekompresovani video stream (CCIR 601)

**“Presentation unit”**



MPEG-2 kompresija na xMbit/sec

**“Access unit”**



100 kB



12 kB



12 kB



33 kB



14 kB



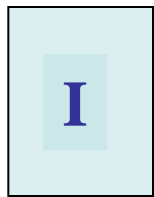
# Video/Audio Elementary Stream

- dobija se sjedinjavanjem "Access units".

"Access units" predstavljaju kompresovane "Presentation units".

Kompresovani frame-ovi (I B B P B ...)

"Access unit"



100 kB



12 kB



12 kB



33 kB



14 kB

Elementary stream (video ili audio)



# Konverzija Elementary Stream-a daje PES (Packetised Elementary Stream)

Elementary stream



PES Packet

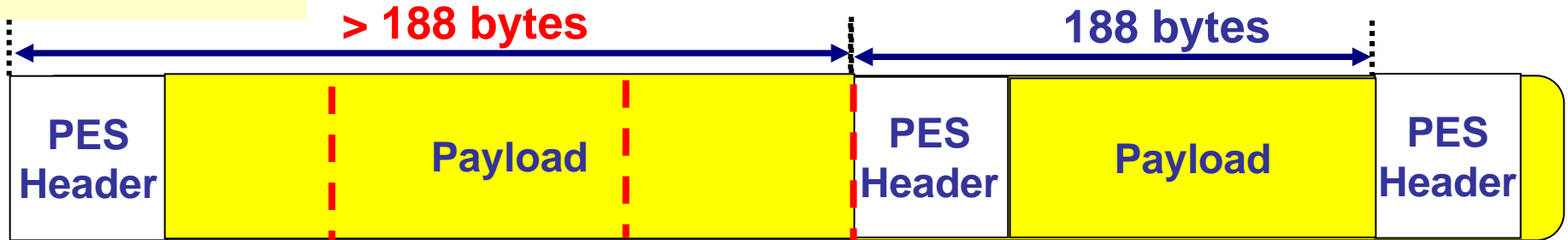
> 188 bytes

188 bytes



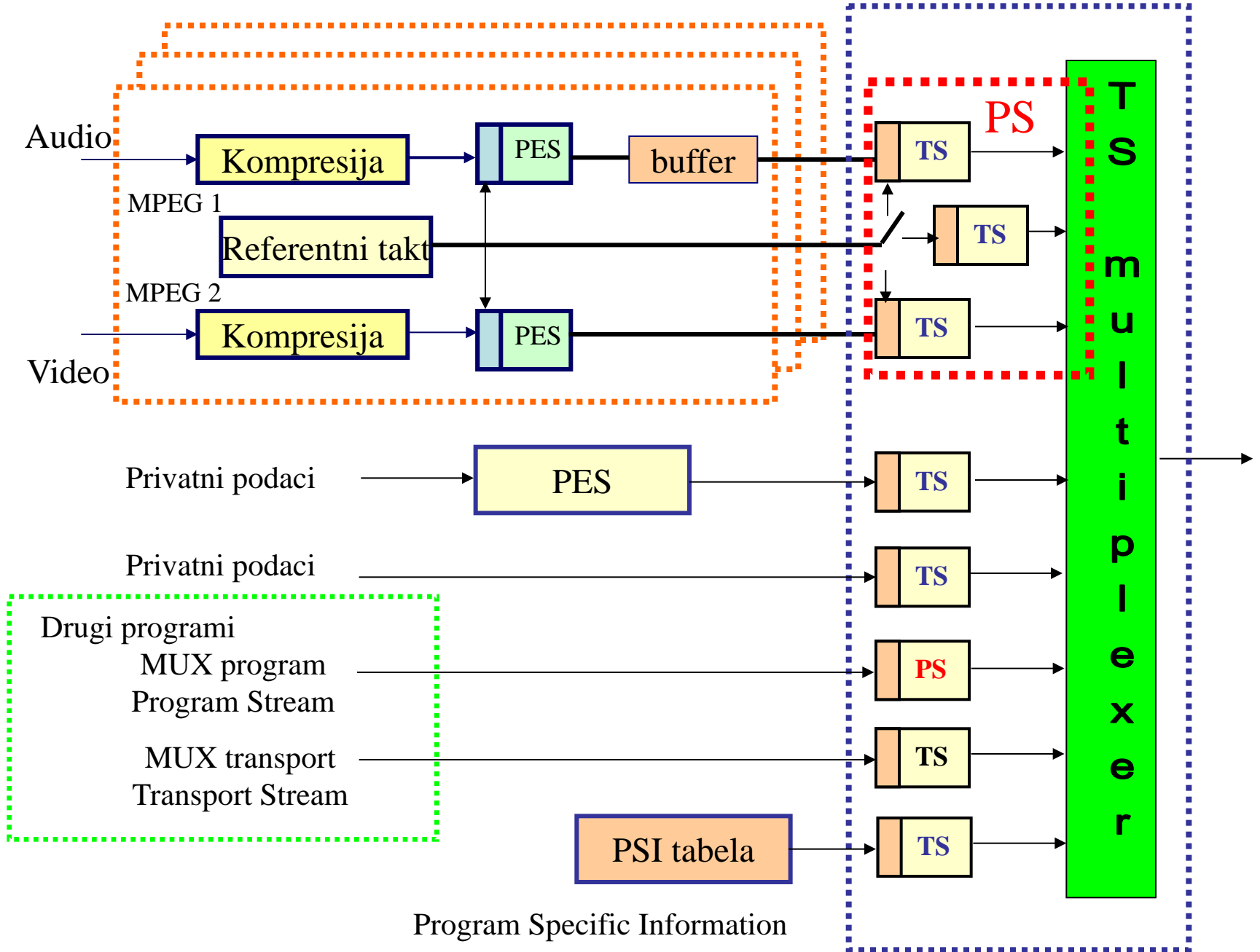
Početak Access jedinice (kompresovanog frame-a) i početak PES nisu usaglašeni .

## PES Packet

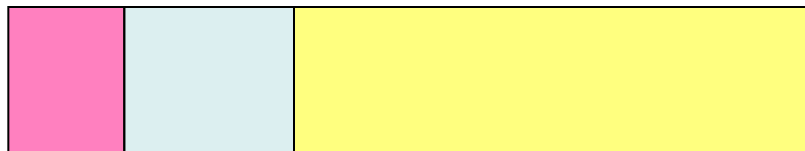


- **Access** jedinica može početi u bilo kojoj tački **PES**
- Nekoliko malih **Access** jedinica može biti sadržano u jednom **PES**.
- **PES** mogu biti promenljive dužine do **max 64 kB**
  - izuzev u paketizaciji video elementarnog niza (ES) unutar TS (Transport stream), kada nema ograničenja za dužinu PES.

# Packet Elementary Stream



# Transport Stream Packet TS (188 bajtova)

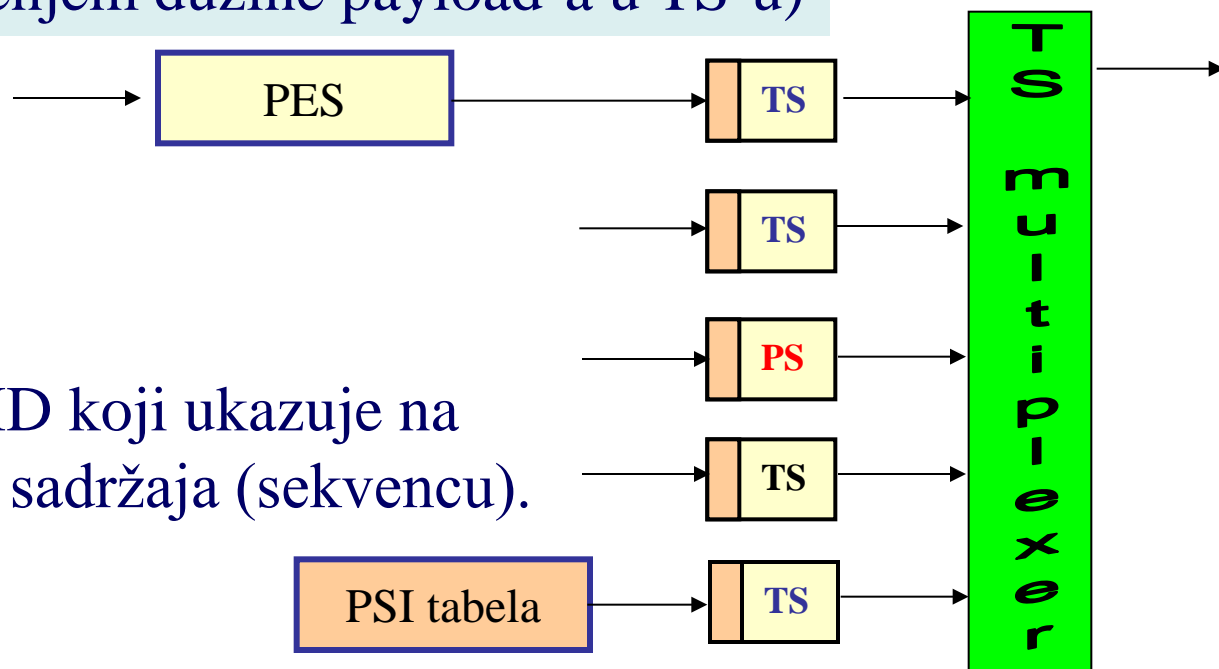


TS header – 4 bajta

Korisnički sadržaj (payload, do 184 bajta)

Adaptaciono polje (opciono – po potrebi, uvodi se smanjenjem dužine payload-a u TS-u)

PSI je povezan sa PID koji ukazuje na poreklo korisničkog sadržaja (sekvencu).

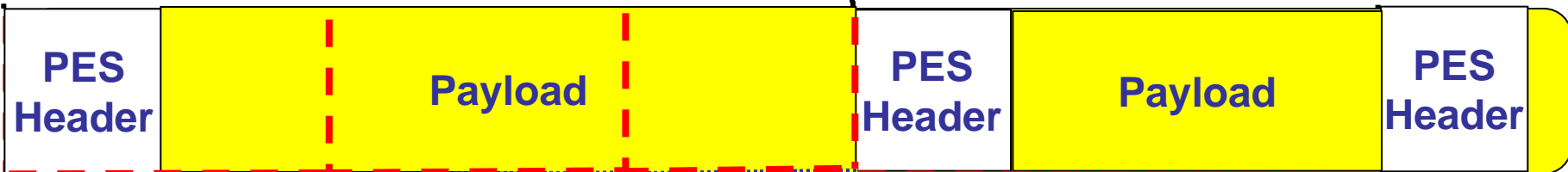


Program Specific Information

# PES Packet

> 188 bytes

188 bytes



PES Header

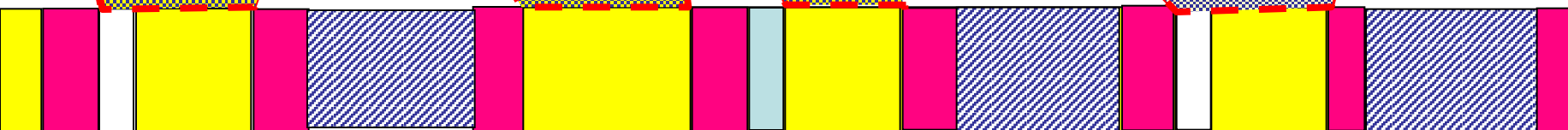
Payload

PES Header

Payload

PES Header

# TS Packet



188 bytes

188 bytes

188 bytes

188 bytes

188 bytes

188 bytes

188 bytes



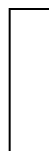
Transport Stream Header



Adaptation field (AF)



Informacija iz nekog drugog izvora



PES Header



Payload (audio, video, data)

# MPEG Transport Stream

*univerzalni nosilac **real-time** i **non-real time** informacija*

- ✓ **Višestruki programi**
- ✓ **Pridružene programske informacije**
  - PSI (Program Specific Information)
  - Druge informacije (ne-programске)
- ✓ **Privatne ili javne informacije**
  - CA (Conditional Access) - Uslovni pristup
  - Zavisno od mreže ili nekih drugih specifičnosti

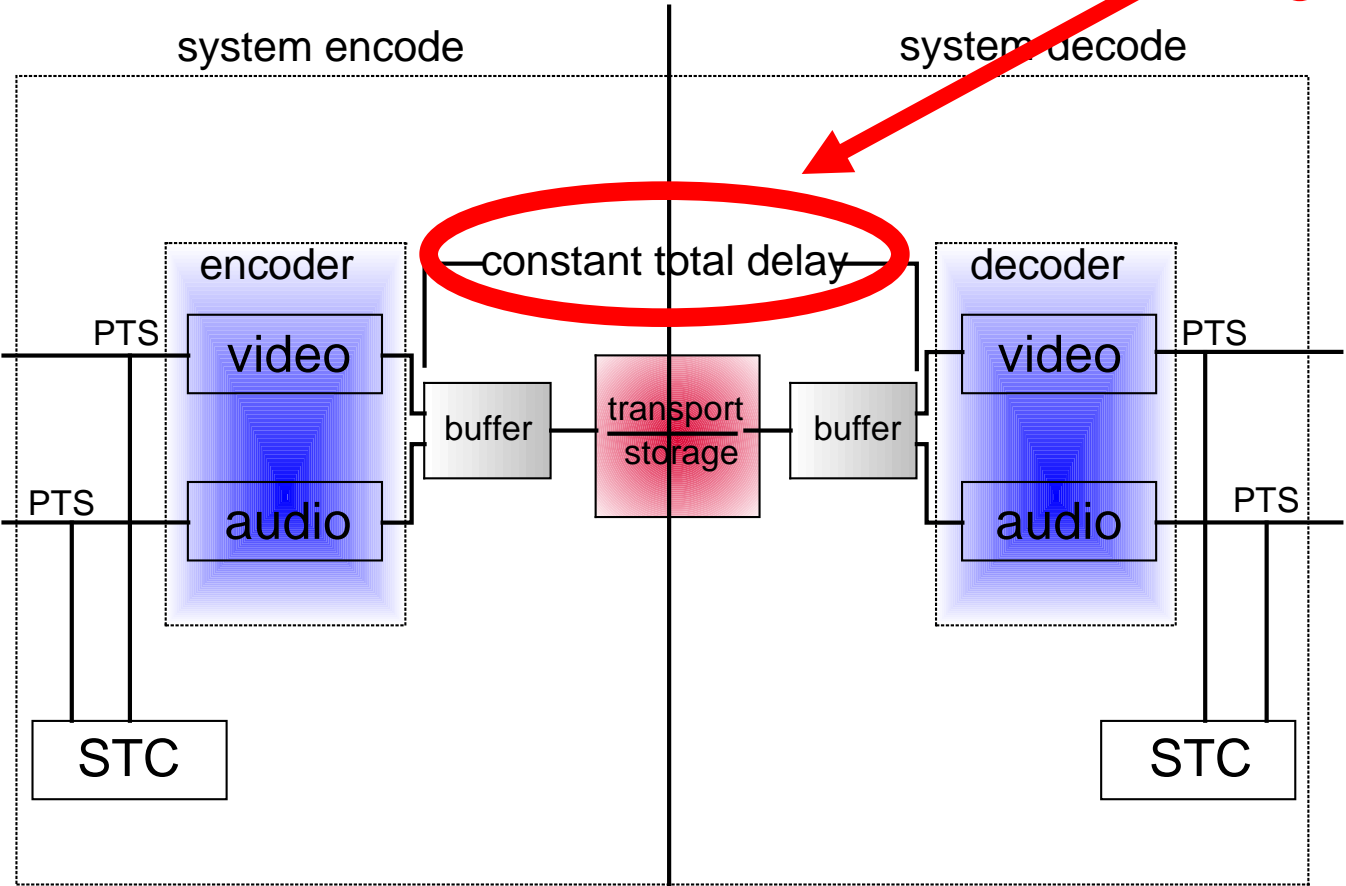
# MPEG-2 - taktom kontrolisani multiplex

- ✿ prenos baziran na *constant delay* modelu
- ✿ Sistemski takt dekodera se prenosi u TS
- ✿ Upravljanje resursima zasnovano na STC
  - **System Time Clock**
- ✿ Sinhronizacija dekodera zasnovana na STC



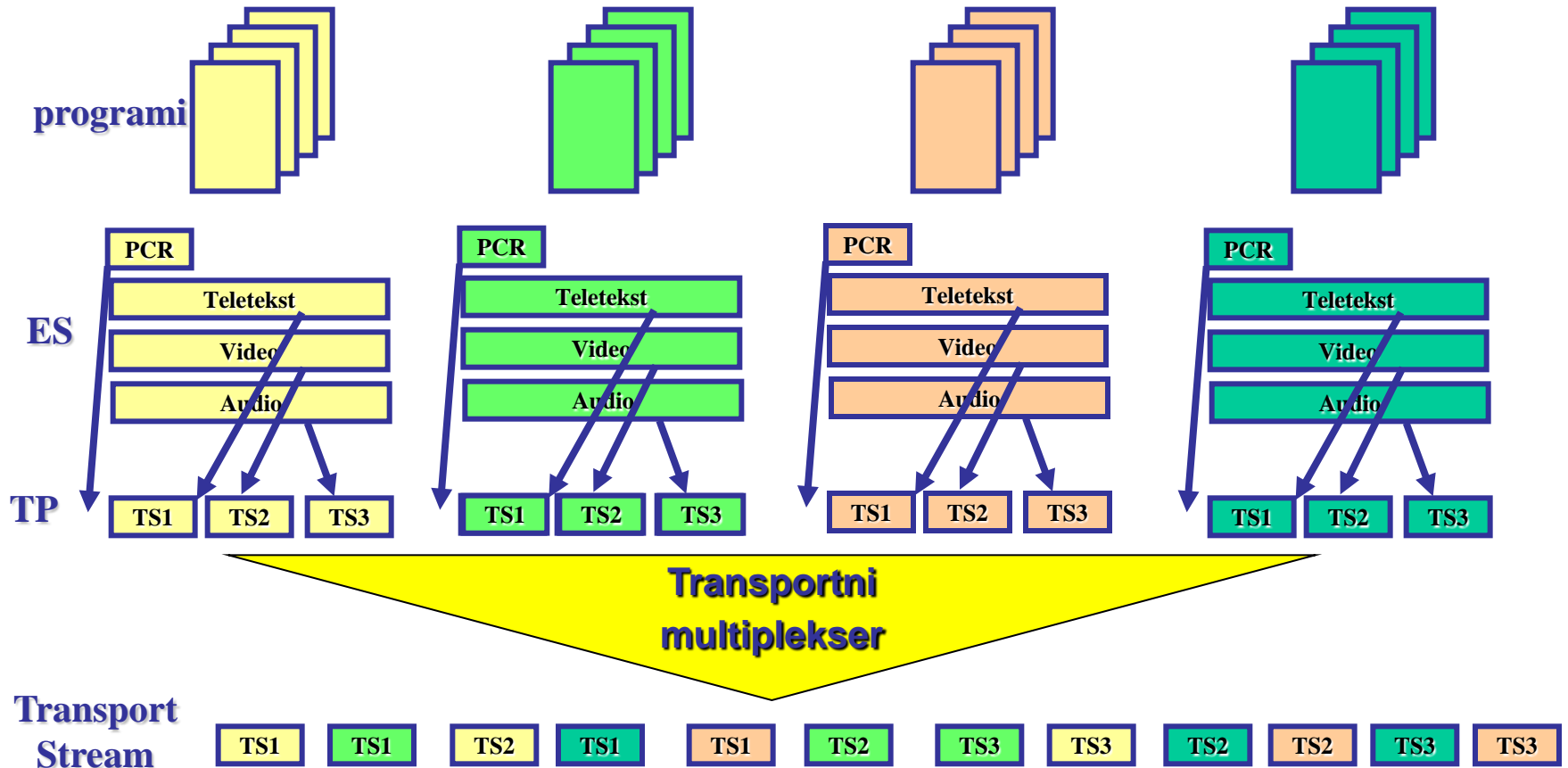
# Audio/Video Synchronization

*cilj*



STC = System Time Clock

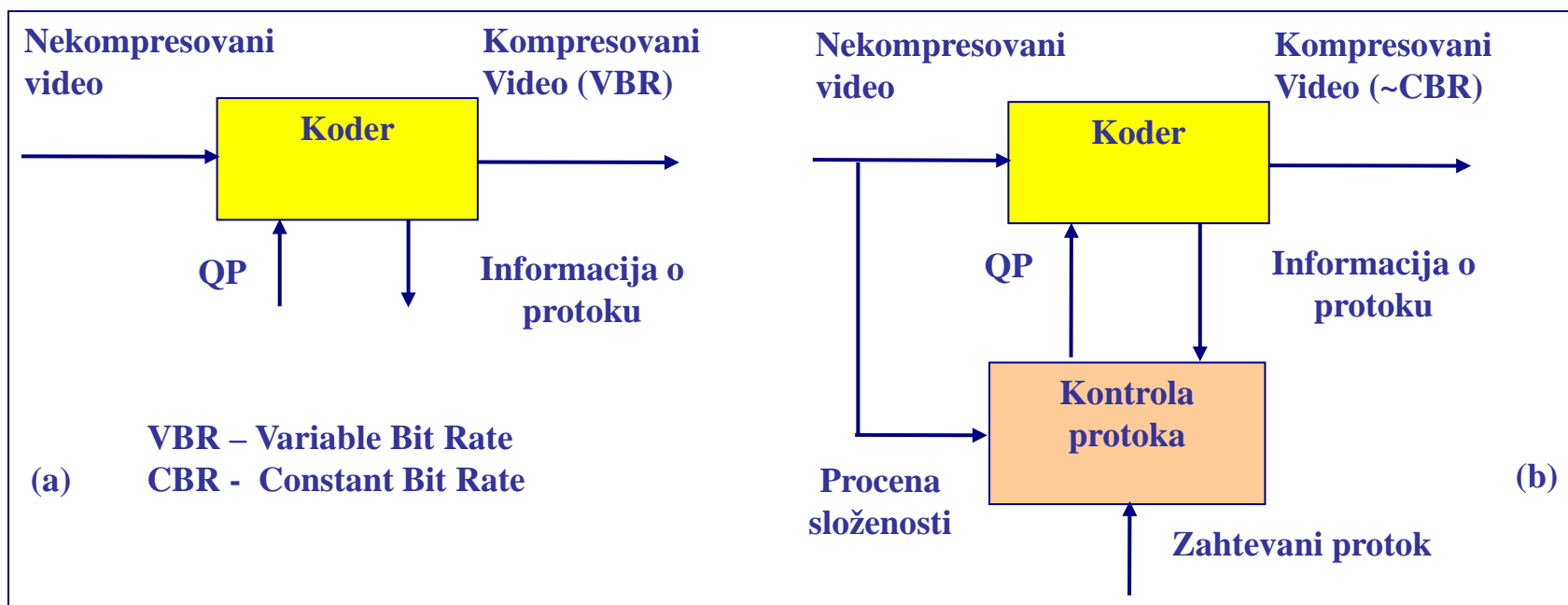
# DVB Transport Stream



# Kompresija videa

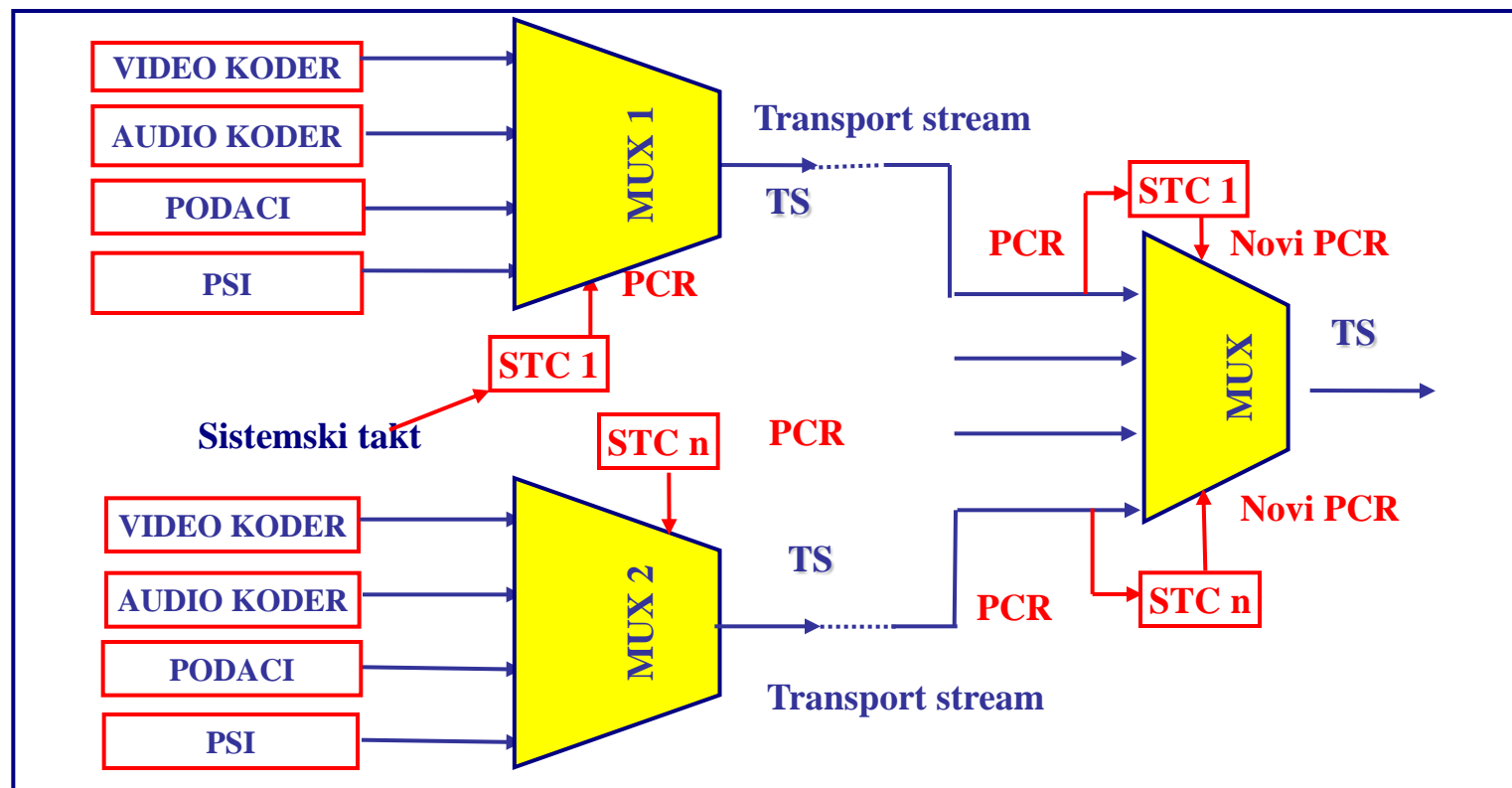
- u opštem slučaju formira VBR saobraćaj.
- Sekvenca VBR tipa ima konstantan kvalitet videa.
- VBR saobraćaj je nepovoljan u mreži,
- CBR saobraćaj se formira uvođenjem kontrole protoka.

# Kontrola protoka



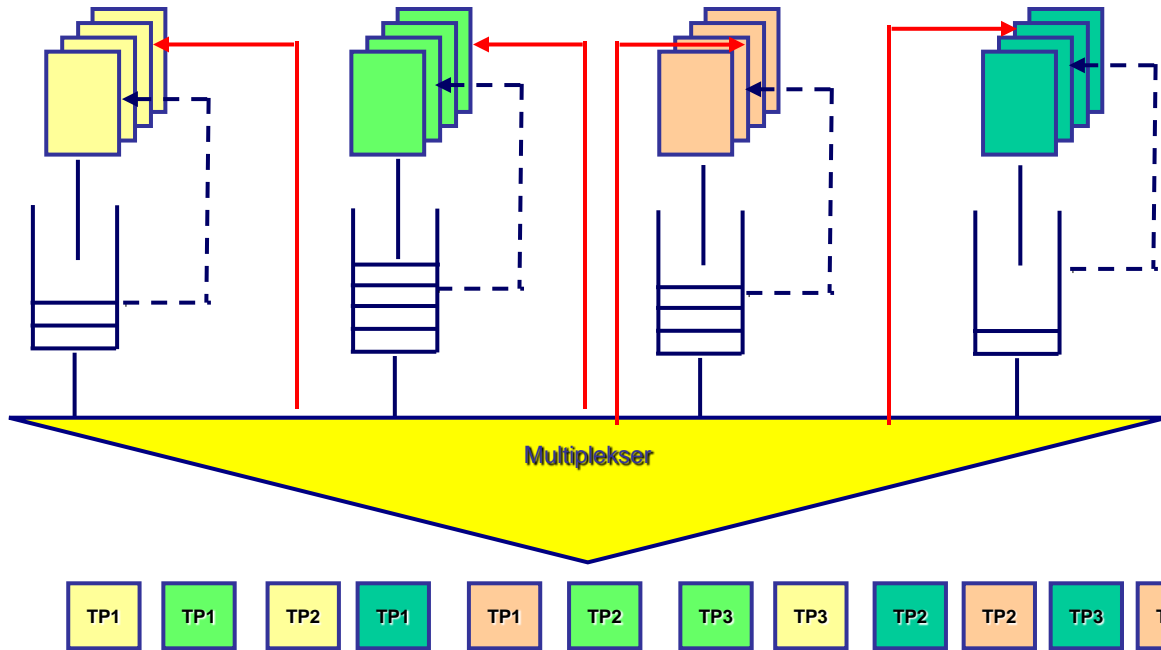
Kontrolom se ograničava protok na unapred definisanu vrednost.

# Formiranje Transport Stream-a



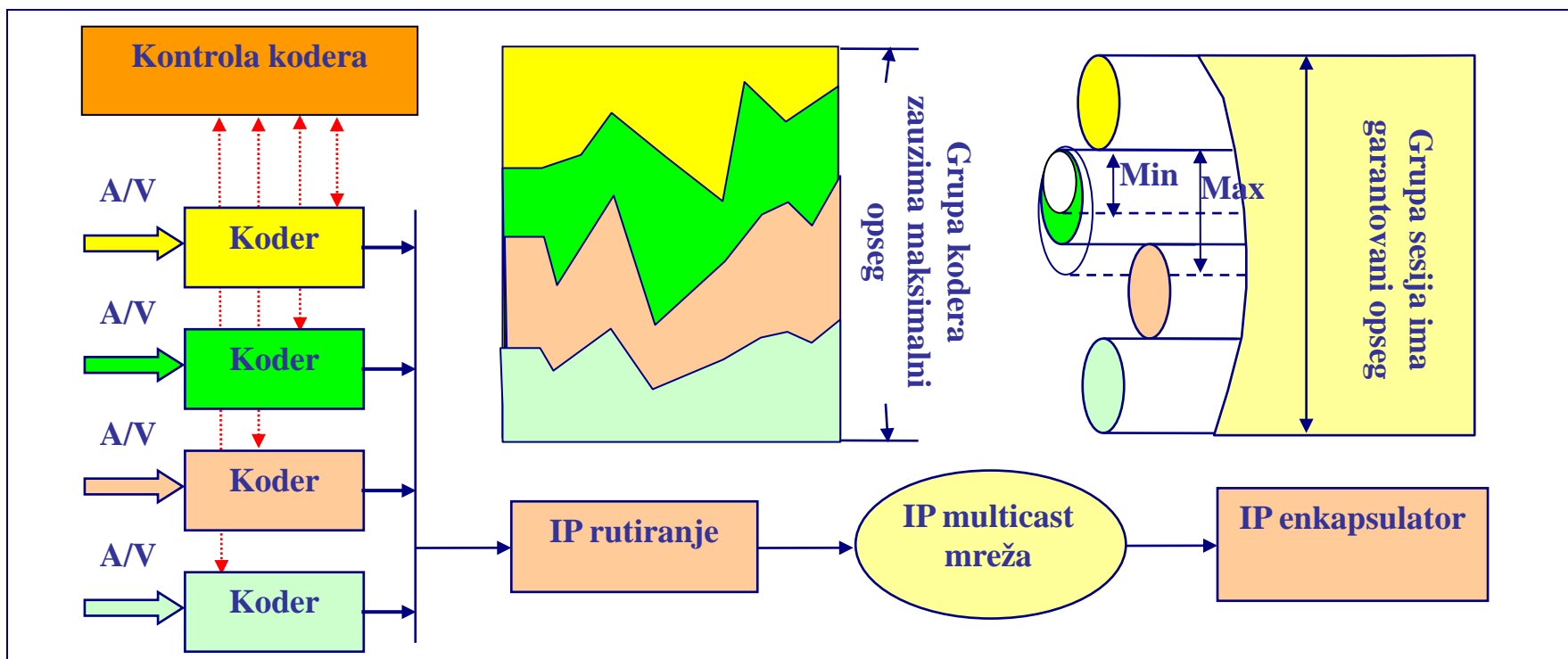
Transportni multiplex različitih kanala.

# Koder+statistički multiplekser



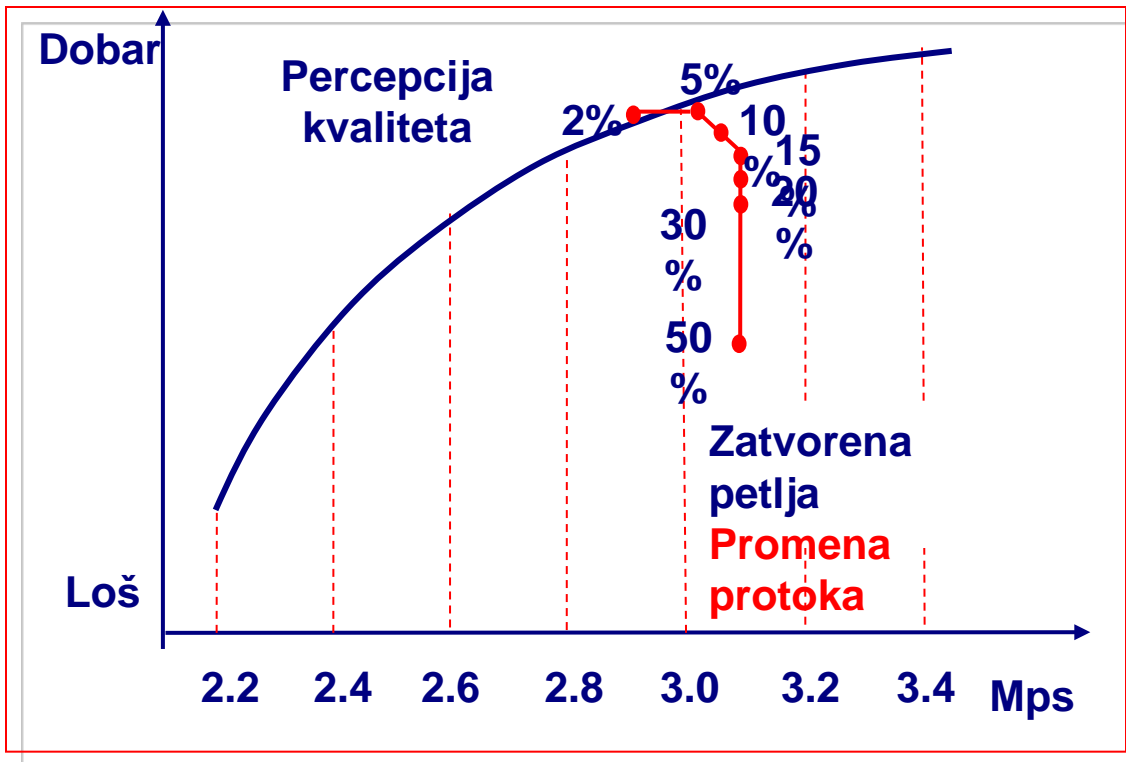
Optimalno iskorišćenje resursa – daje svakome prema potrebi.

# Statistički multiplekser uključen u koder



Efikasnost dobra – problem nastaje pri razdvajanju komponenata i eventualnom transkodovanju.

# Poređenje statističkih multipleksera



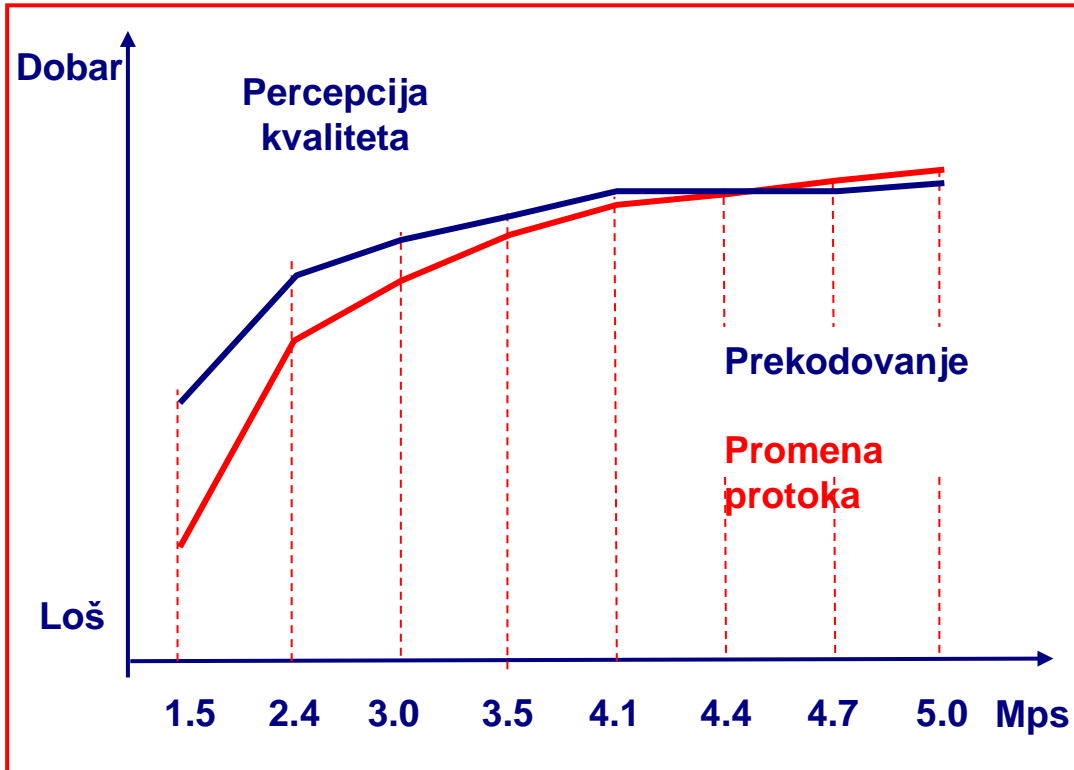
Statistički multiplekser:  
šest sekvenci  
(sa prosečno 3Mbps)  
se multipleksira.

Postupnom promenom  
protoka u  
koder+statistički multiplekser,  
postupno se menja i kvalitet.

Ako se u sistemu sa otvorenom petljom menja protok neznatno oko 3Mps, zbog ograničenja ukupnog kapaciteta, promena kvaliteta videa je od 2% do 50%.



# Prekodovanje – promena protoka



Prekodovanje:  
dekodovanje i  
ponovno kodovanje

Promena protoka:  
odbacivanje  
vršnih protoka

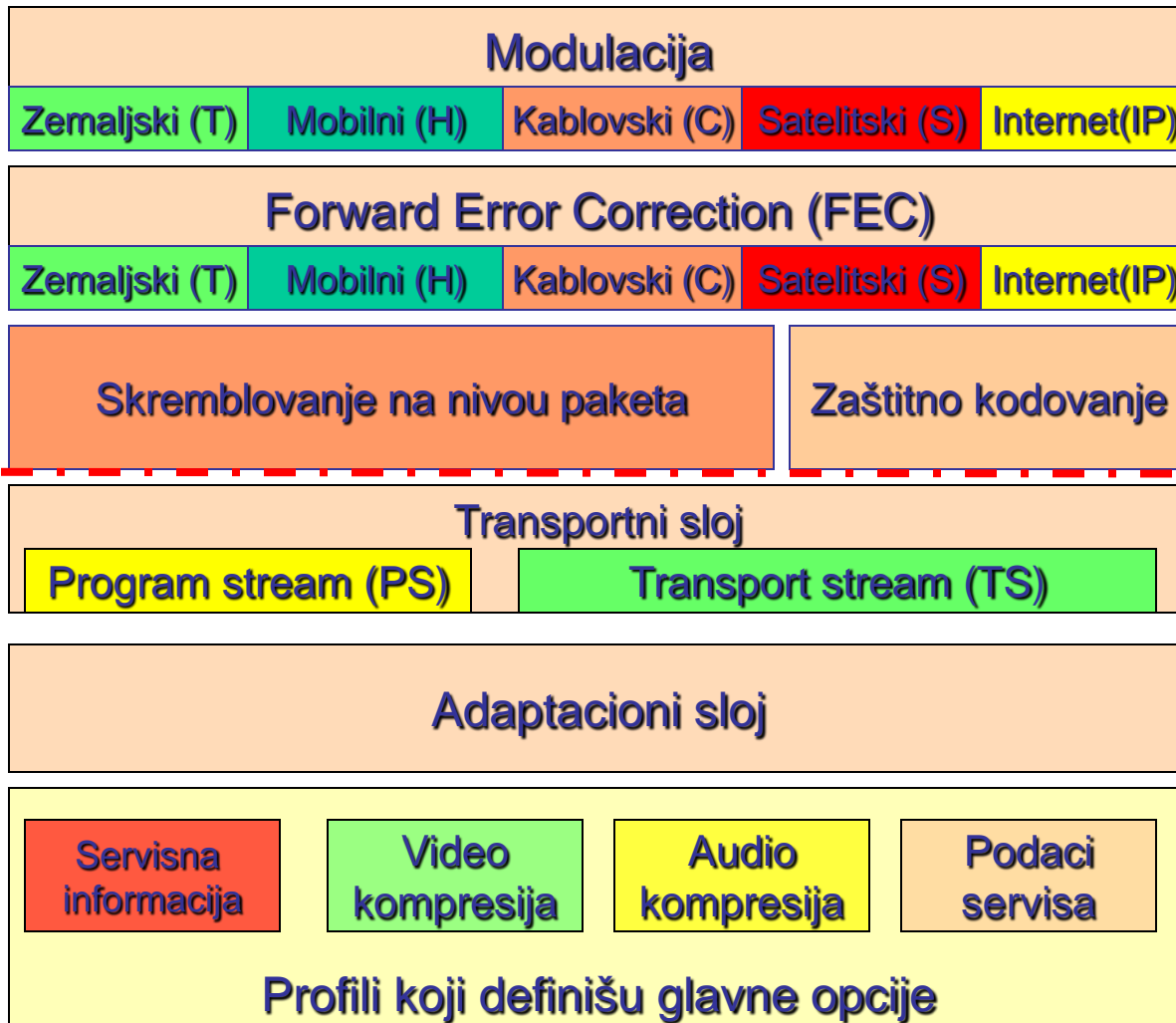
## “Koduj jednom – distribuiraj veliki broj puta”

- Niža cena uređaja (što manje kodera i multipleksera)
- Prekodovanje smanjuje odnos S/N za 3-5dB.
- Centralni headend: akvizicija sadržaja, kodovanje, multipleksiranje i modulacija.
- Kontribucioni sadržaji su CBR (50Mbps)
- Treba ih prebaciti do headend-a ASI interface-om, koji ne trpi velika rastojanja (do 200m).

# MPEG2 Transport Stream

## ISO/IEC 13818-1 International Standard

# MPEG aspekt



Bilo koje rešenje  
DVB-T, DVB-S,  
DVB-C, DVB-H,  
DVB-SI,...

Definisano  
u  
MPEG-u