

Punkt-till-punkt-access

- HDLC
(High-level Data Link Control)
- PPP
(Point-to-Point Protocol)

HDLC

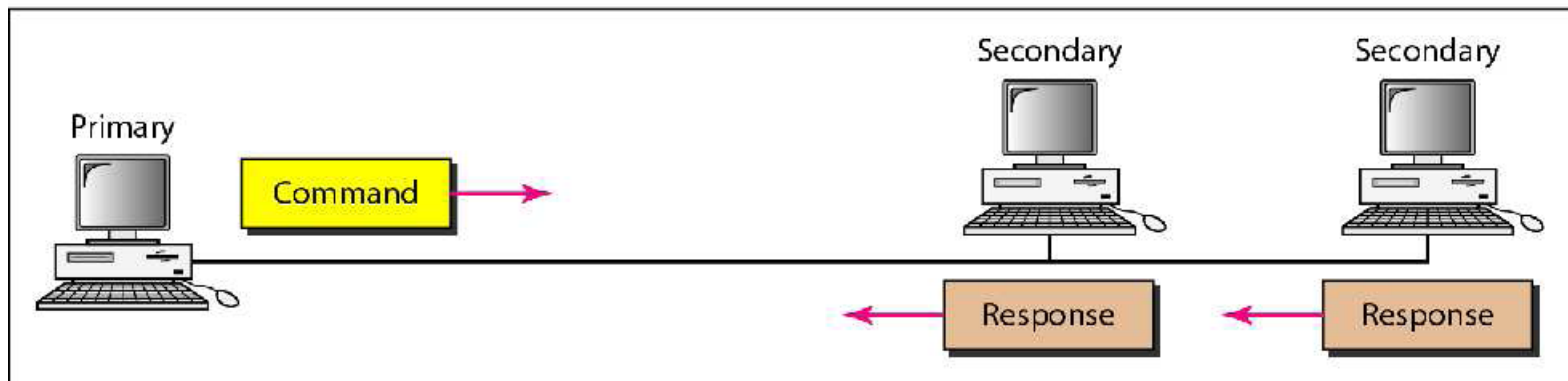
- HDLC (High-level Data Link Control)
 - Används både till punkt-till-punkt och till multi-punkt-förbindelser
 - Använder ARQ (Automatic Repeat reQuest)

HDLC

- NRM (Normal Response Mode)



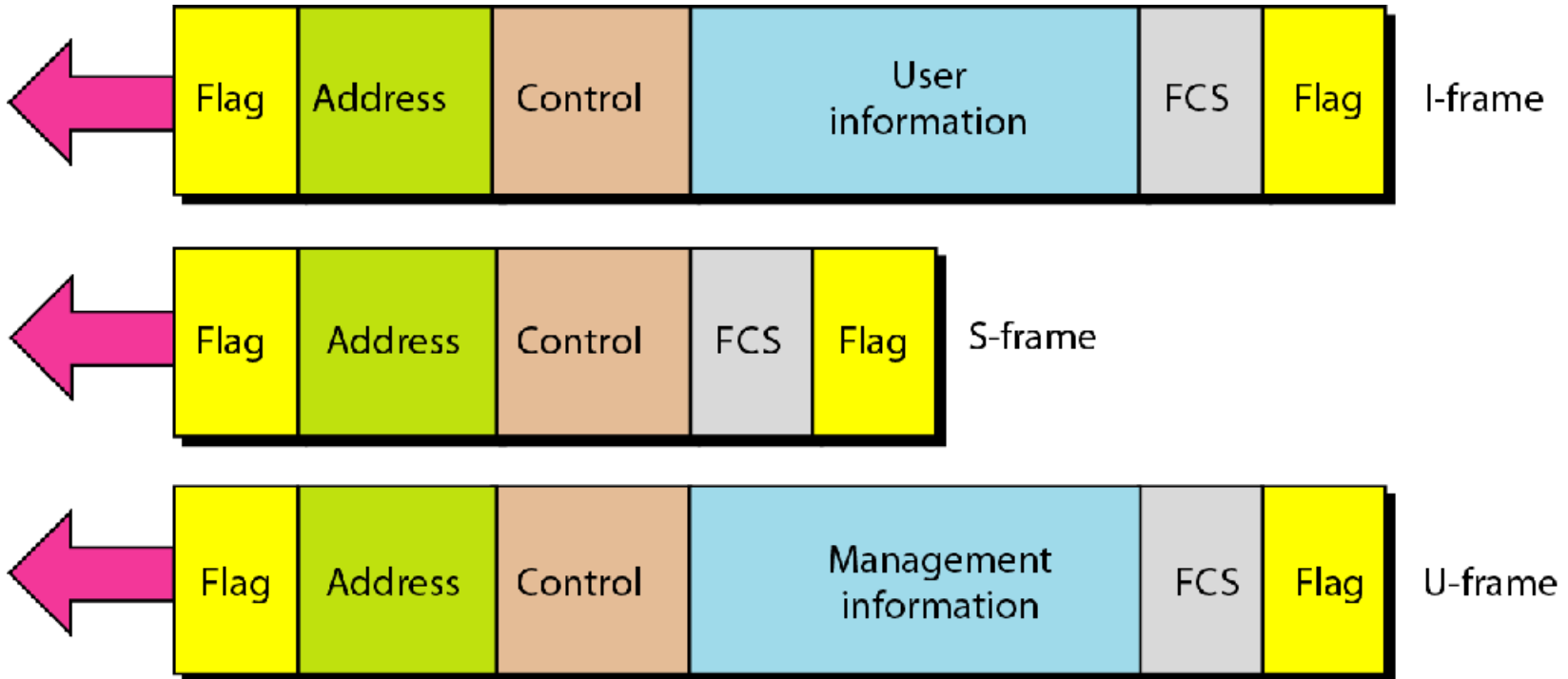
a. Point-to-point



b. Multipoint

HDLC

- De tre olika ramtyperna i HDLC



HDLC

- Flaggfält (Flag Field)
 - 8 bitar för synkronisering
- Adressfält (Address Field)
- Styrfält (Control Field)
- Informationsfält (Information Field)
 - Användar- eller systeminformation
- Ramkontrollfält (Frame Check Sequence Field)

HDLC

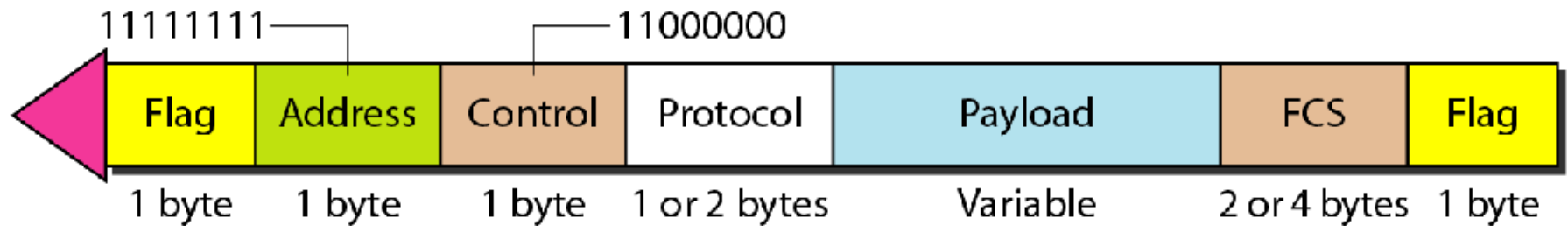
- I-frames (Information frames)
 - Förmedlar användardata från nätverkslagret
 - Kan innehålla information om flödes- och felkontroll (piggybacking)
- S-frames (Supervisor frames)
 - För flödes- och felkontrollinformation
- U-frames (Unnumbered frames)
 - Förmedlar system- och styrinformation

PPP

- PPP (Point-to-Point Protocol)
 - Vanligaste protokollet för punkt-till-punkt-förbindelser
 - Används för kontakt mellan användare och internetleverantör
 - Använder en variant av HDLC

PPP

- Formatet på en PPP-ram

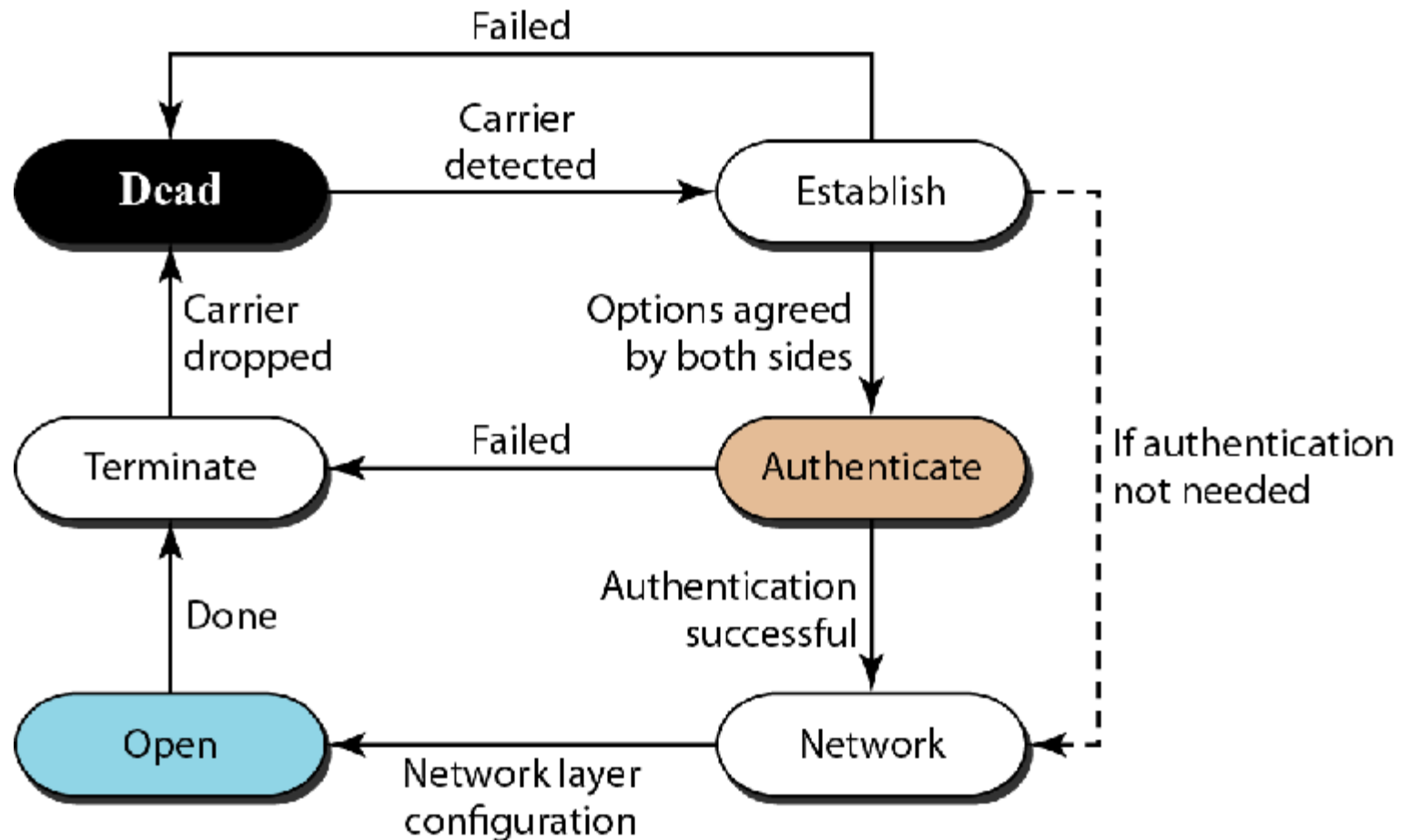


PPP

- Fälten i en PPP-ram
 - Flaggfälten för avgränsning (alltid 01111110 i PPP)
 - Adressfältet (HDLC:s broadcast 11111111)
 - Styrfältet (alltid 11000000)
 - Protokollfältet
 - Datafältet
 - FCS-fältet (CRC)

PPP

- Tillståndsgraf för PPP

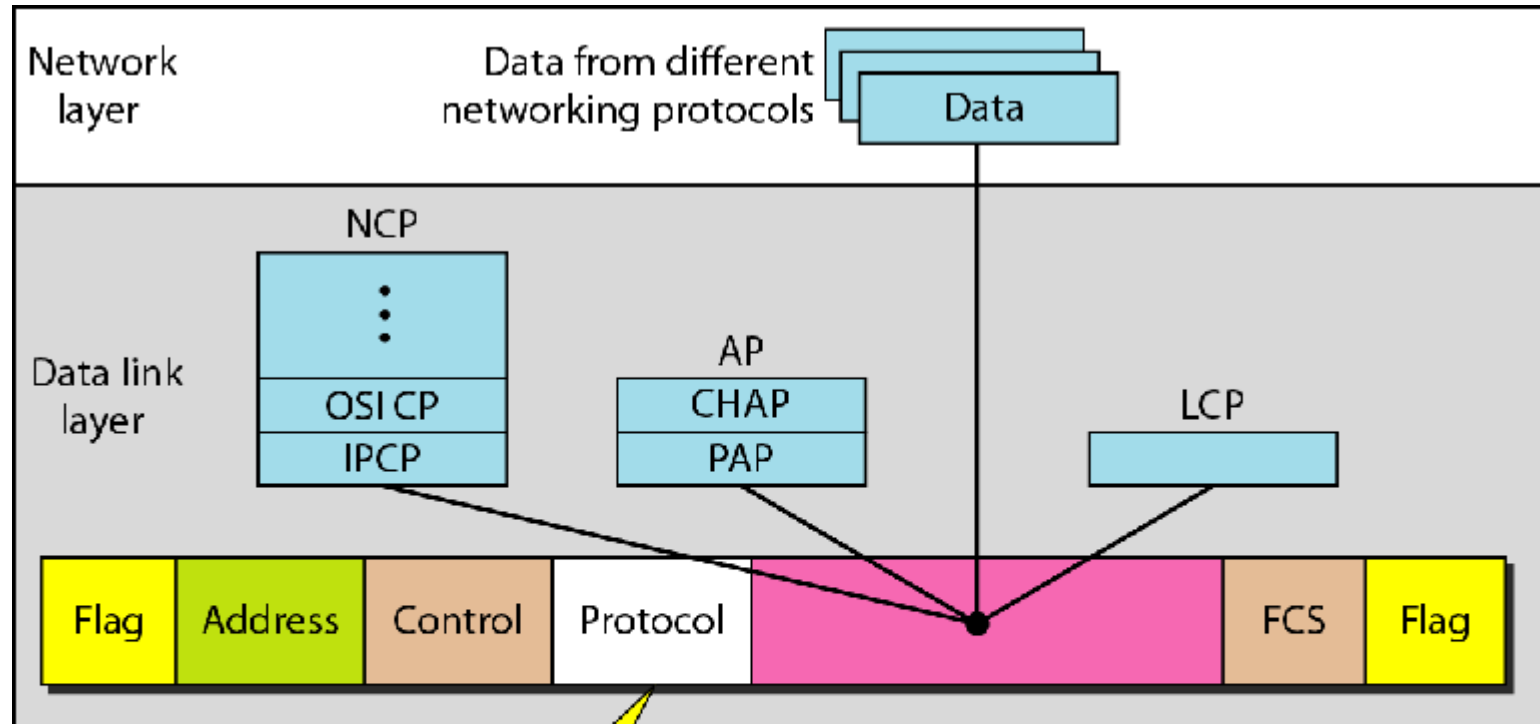


PPP

- Protokollstack för PPP
 - LCP (Link Control)
 - PAP (Password Authentication)
 - CHAP (Challenge Handshake Authentication)

PPP

- Flera lager av protokoll

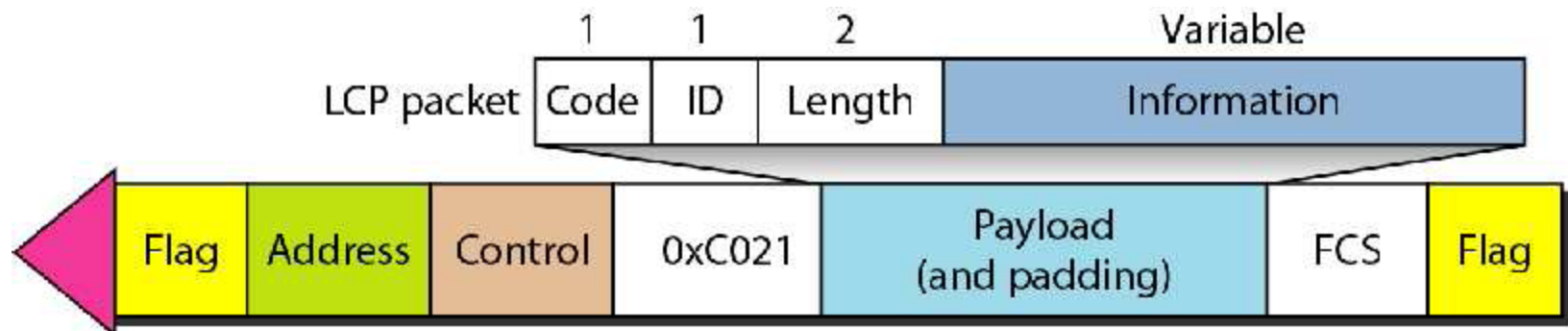


LCP: 0xC021
AP: 0xC023 and 0xC223
NCP: 0x8021 and
Data: 0x0021 and

LCP: Link Control Protocol
AP: Authentication Protocol
NCP: Network Control Protocol

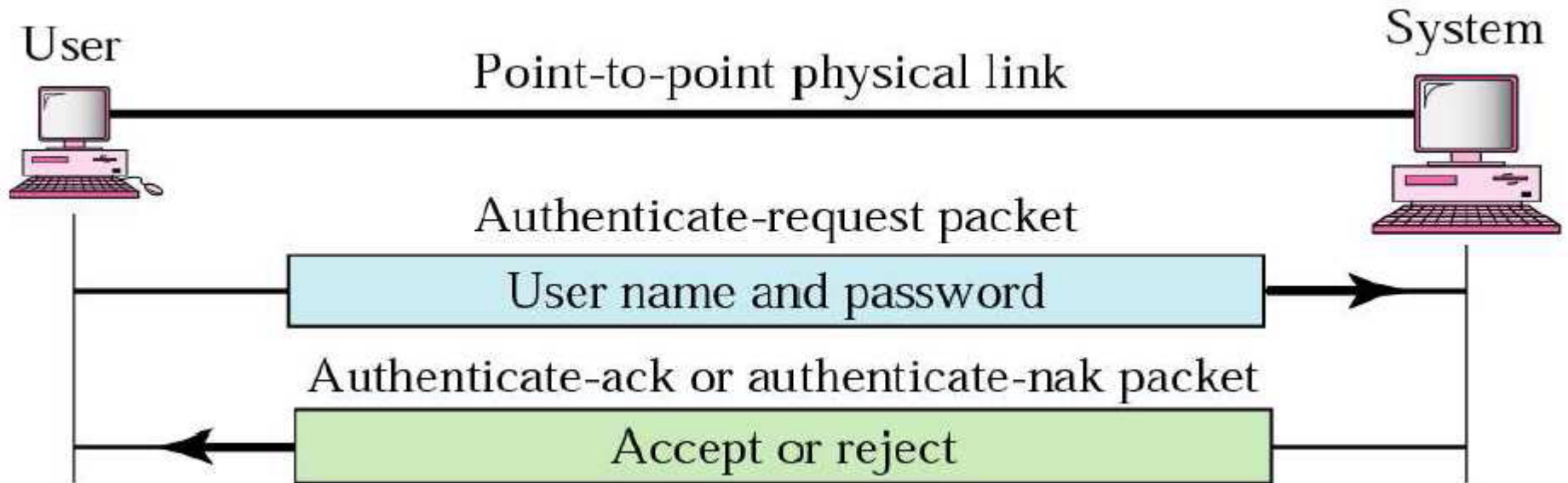
PPP

- LCP-paket i en PPP-ram
 - Kod (Code): typen av LCP-paket
 - ID: för matchning av förfrågan och svar
 - Längd (Length): Totala LCP-paketets längd
 - Information: extra informaton



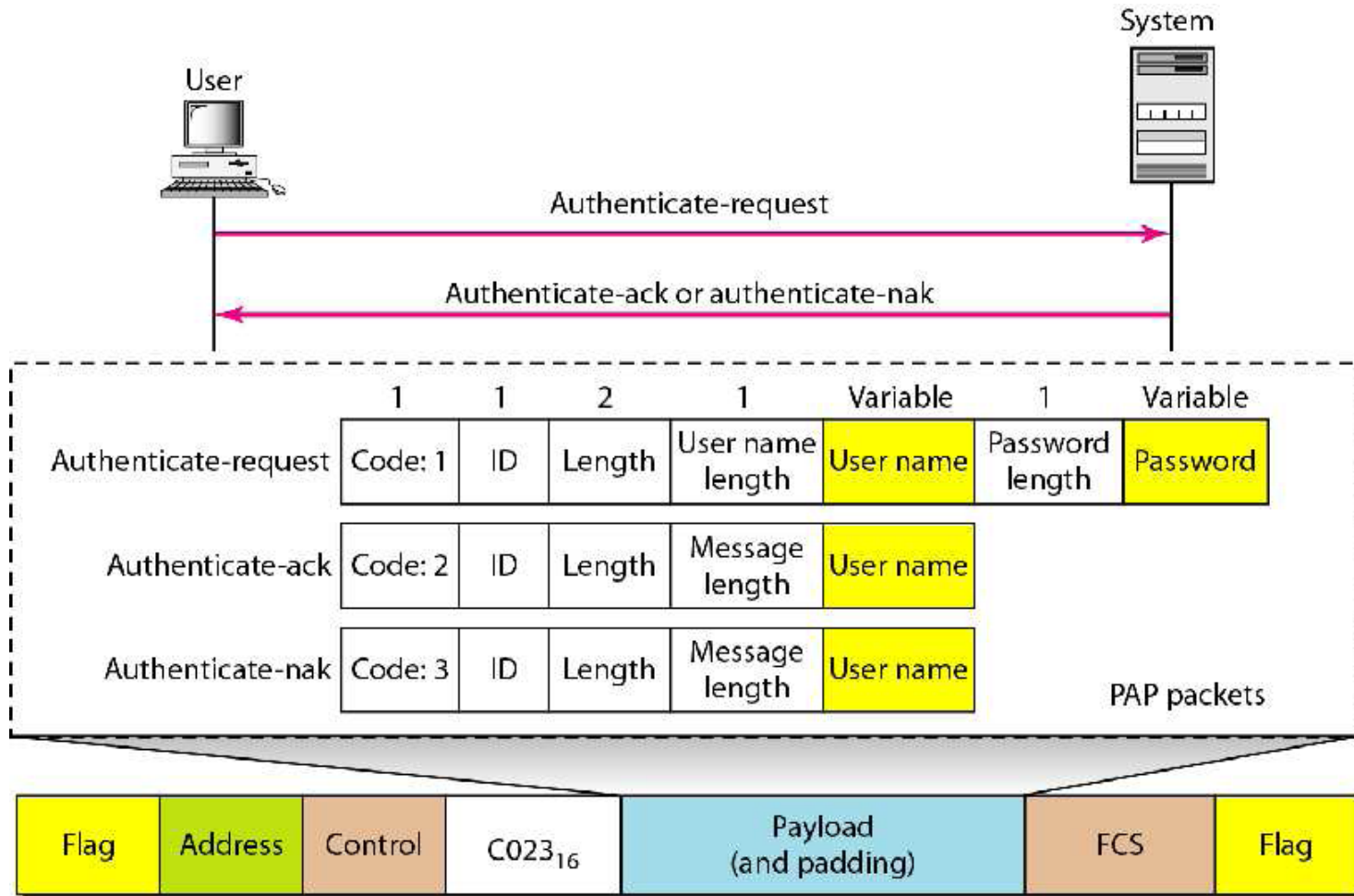
PPP

- PPP-kommunikation med PAP-autentisering



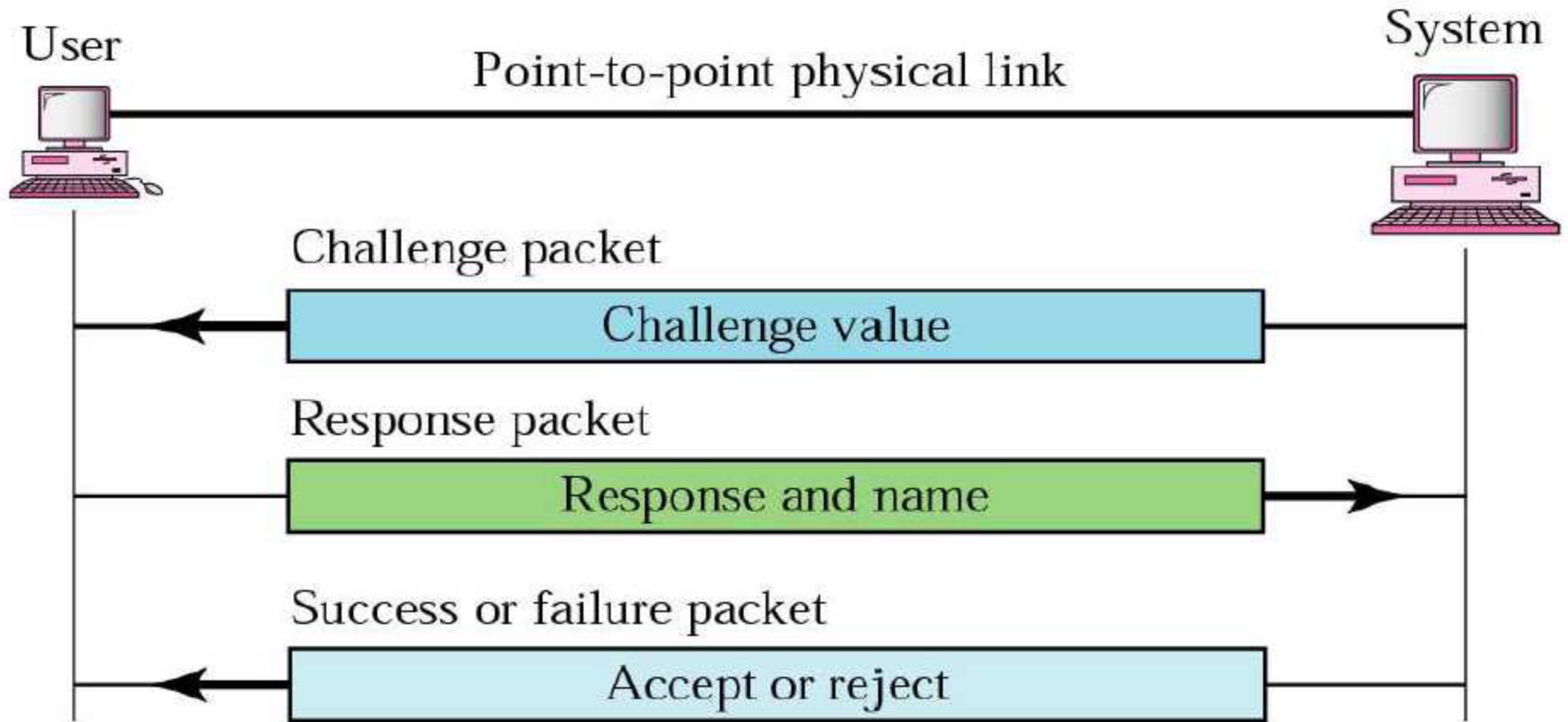
PPP

- PAP-paket i PPP-ram



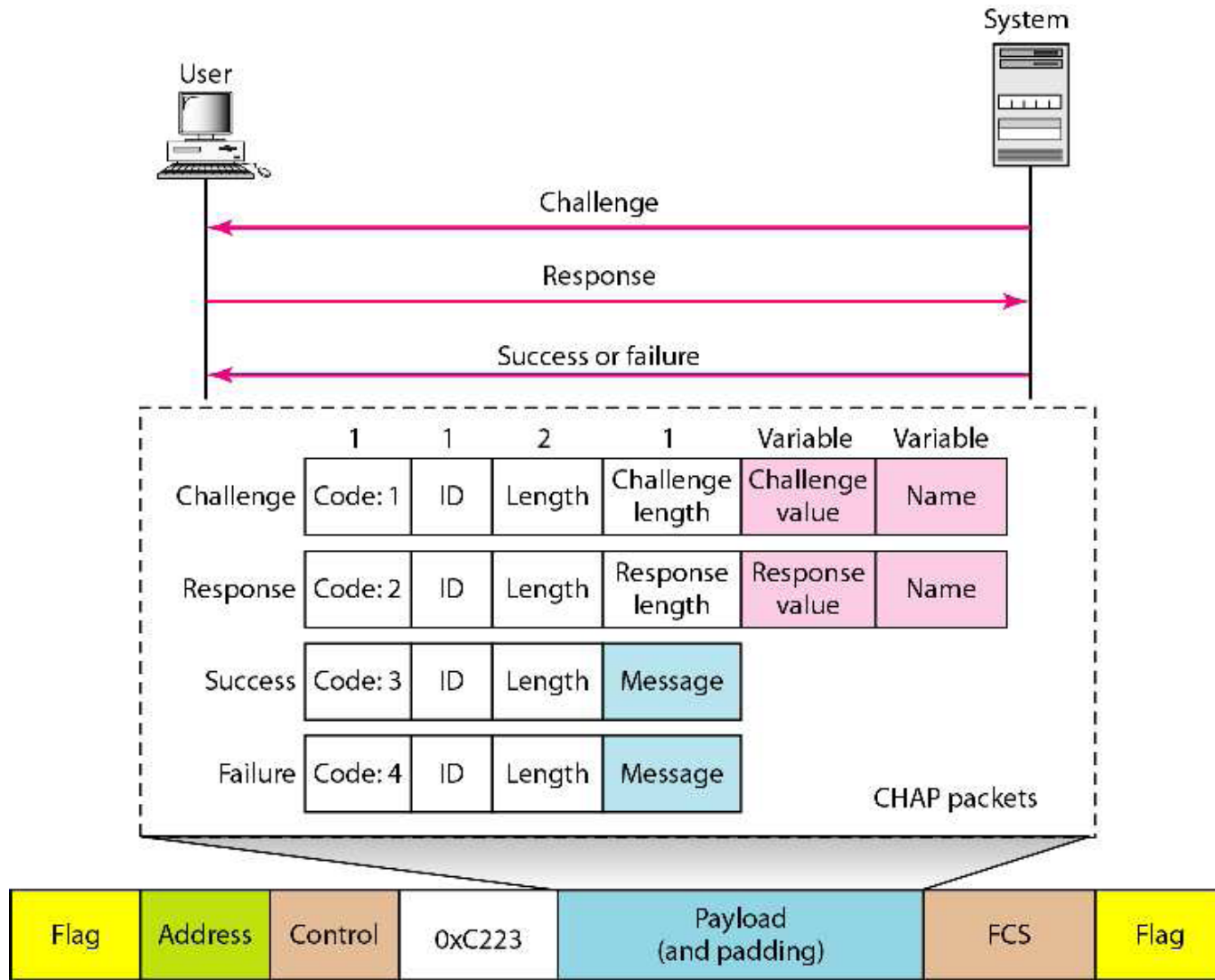
PPP

- PPP-kommunikation med CHAP-autentisering



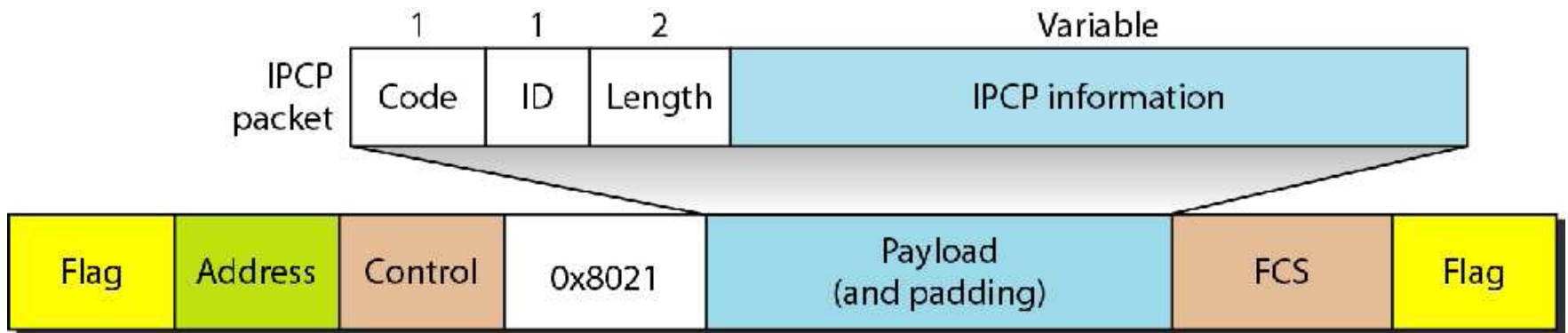
PPP

- CHAP-paket i PPP-ram



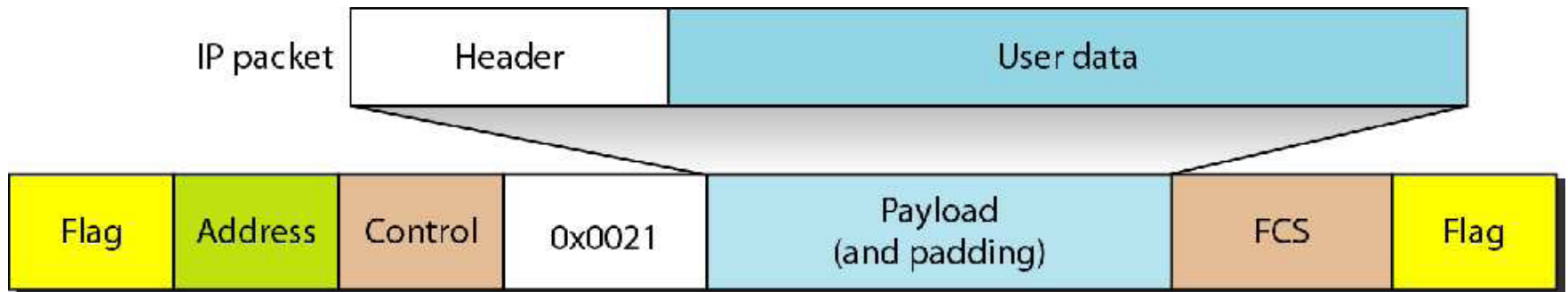
PPP

- IPCP-paket i PPP-ram

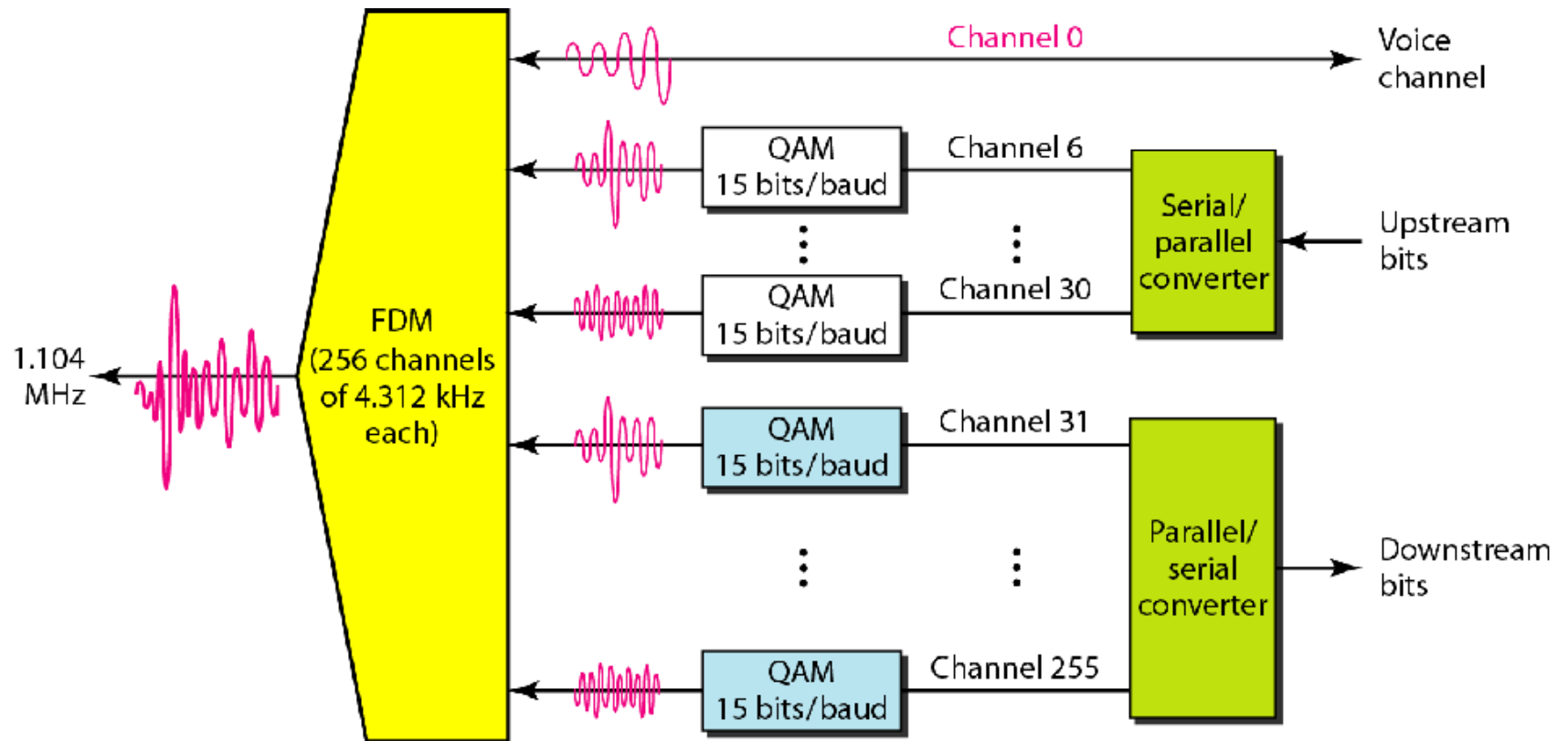


PPP

- IP-paket i PPP-ram

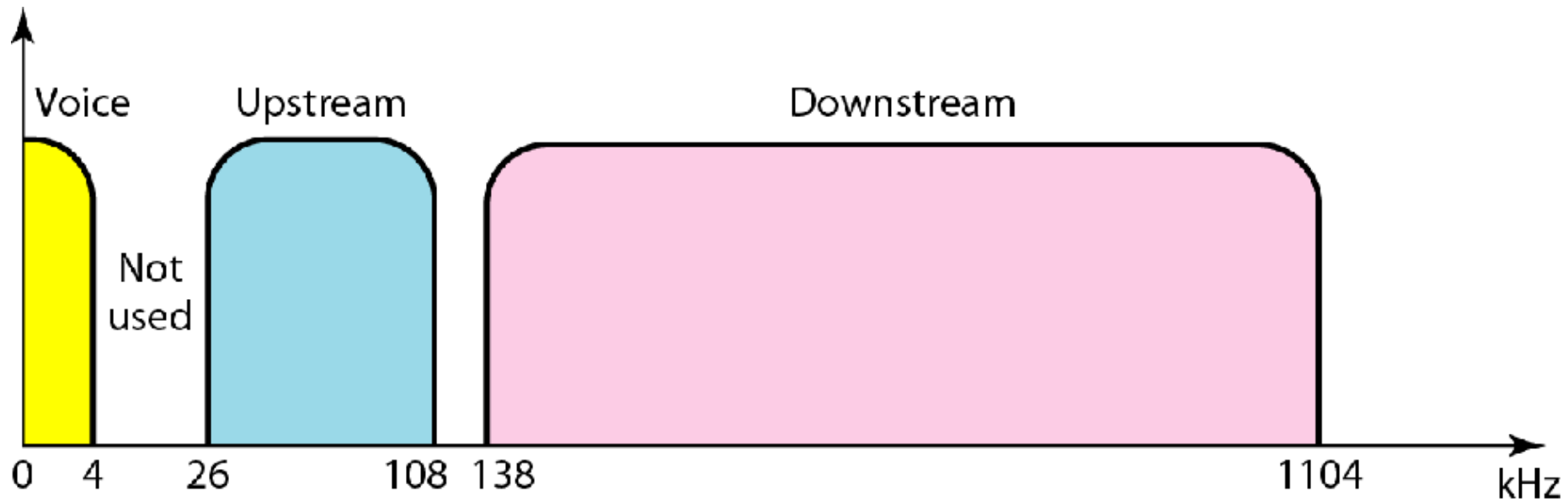


ADSL



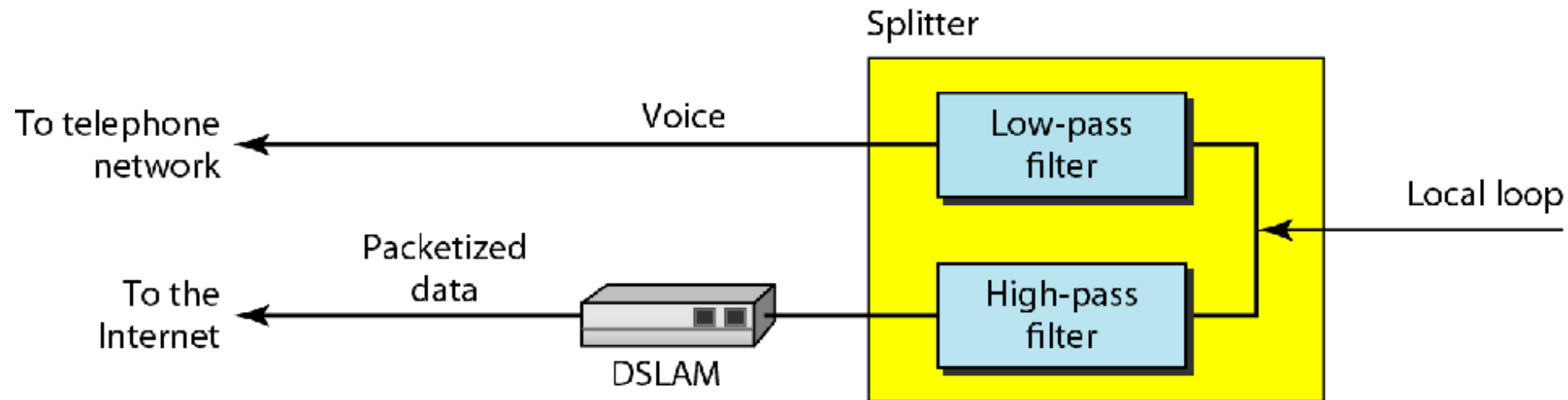
ADSL

- Bandbreddsutnyttjande vid ADSL
 - Assymmetri mellan uppströms och nedströms



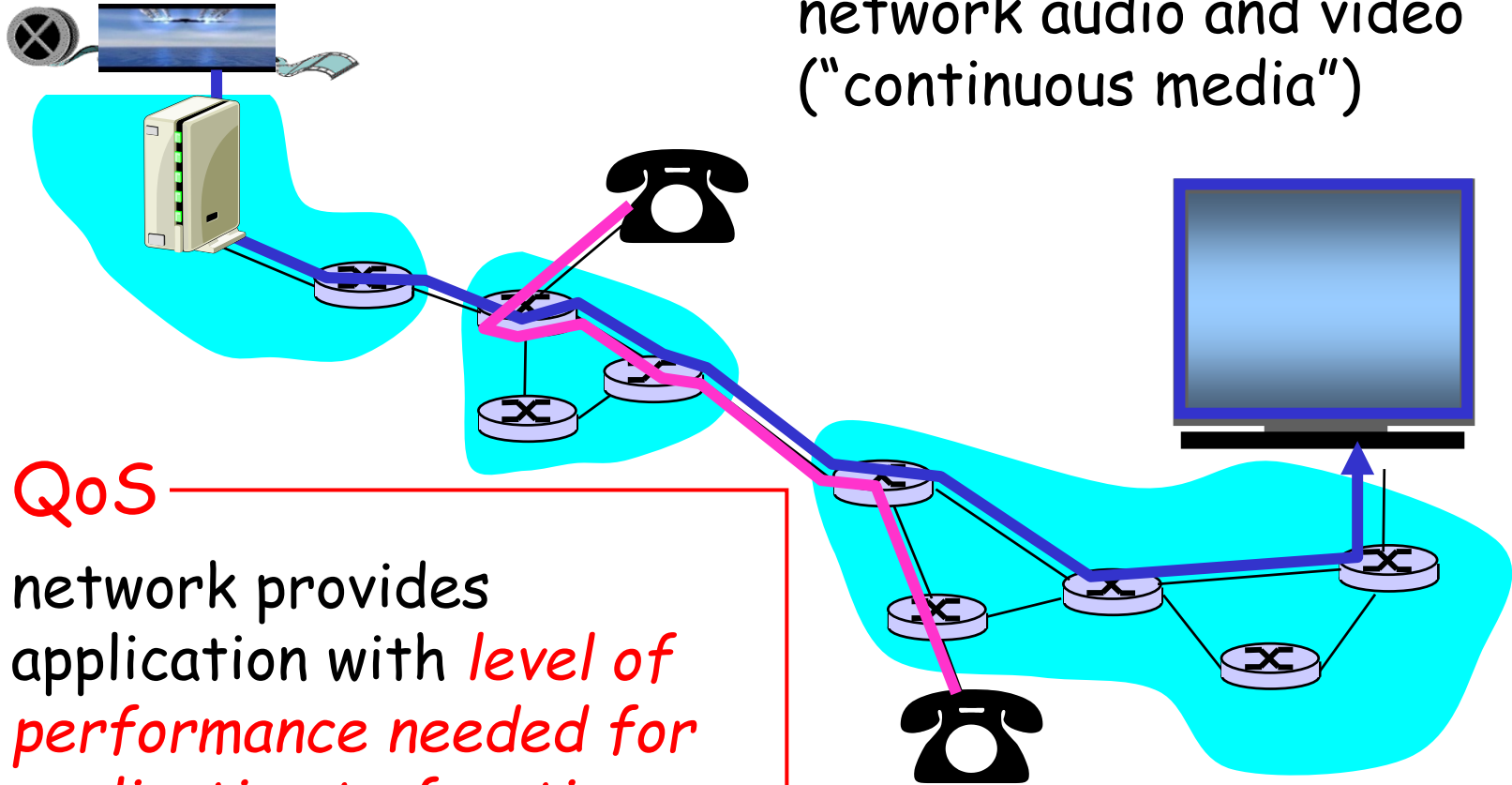
ADSL

- Användning av s.k. splitter för uppdelning mellan tal och data genom filtrering



Multimedia and Quality of Service: What is it?

multimedia applications:
network audio and video
("continuous media")



QoS

network provides
application with *level of
performance needed for
application to function.*

MM Networking Applications

Classes of MM applications:

- 1) stored streaming
- 2) live streaming
- 3) interactive, real-time

Jitter is the variability of packet delays within the same packet stream

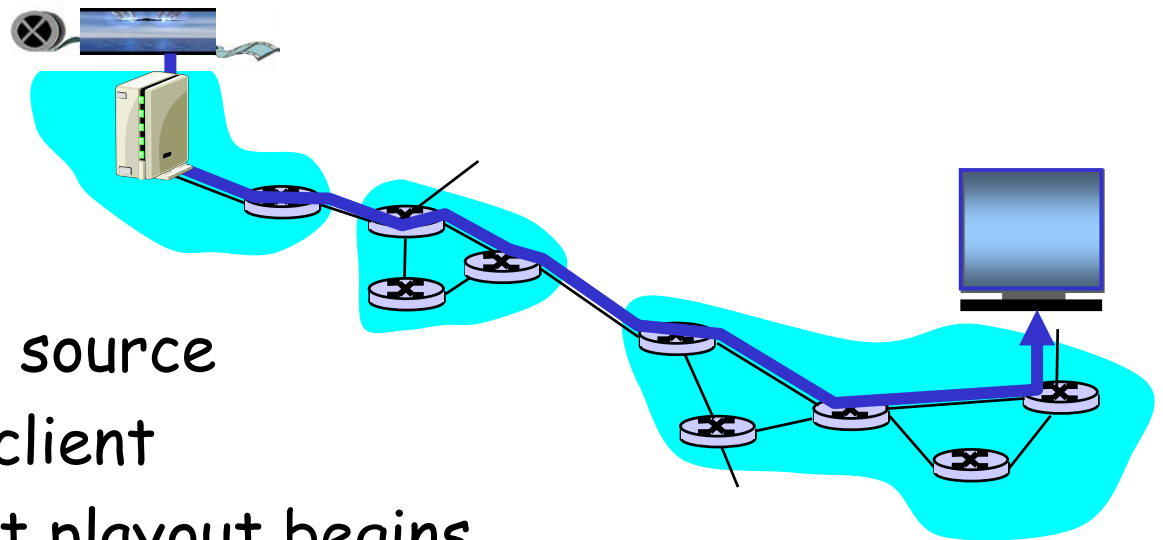
Fundamental characteristics:

- ❖ typically **delay sensitive**
 - end-to-end delay
 - delay jitter
- ❖ **loss tolerant**: infrequent losses cause minor glitches
- ❖ antithesis of data, which are loss *intolerant* but delay *tolerant*.

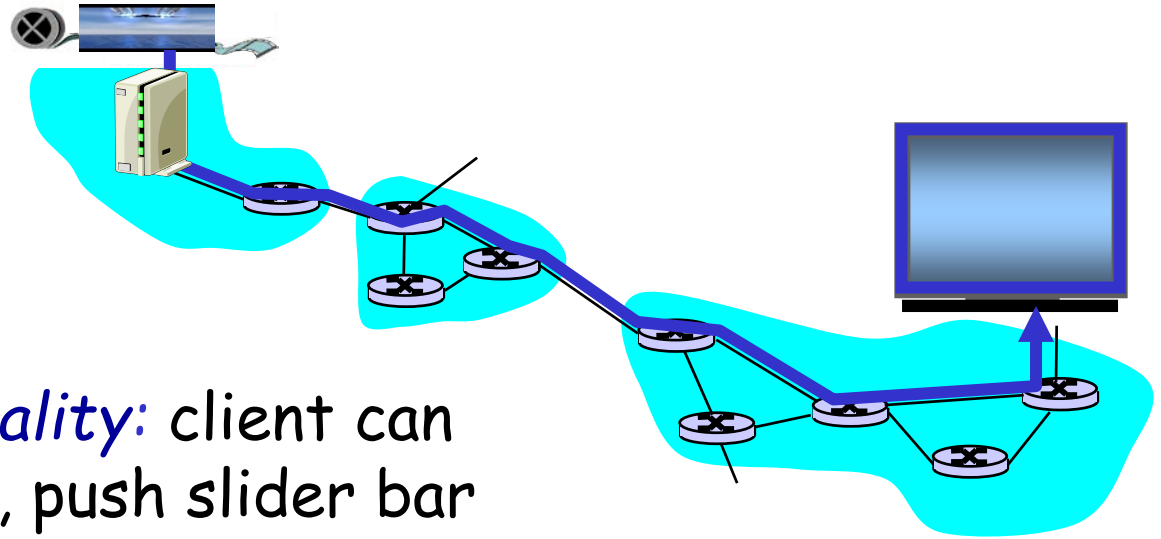
Streaming Stored Multimedia

Stored streaming:

- ❖ media stored at source
- ❖ transmitted to client
- ❖ streaming: client playout begins before all data has arrived
- ❖ timing constraint for still-to-be transmitted data: in time for playout



Streaming *Stored* Multimedia: Interactivity



- ❖ *VCR-like functionality*: client can pause, rewind, FF, push slider bar
 - 10 sec initial delay OK
 - 1-2 sec until command effect OK
- ❖ timing constraint for still-to-be transmitted data: in time for playout

Streaming *Live* Multimedia

Examples:

- ❖ Internet radio talk show
- ❖ live sporting event

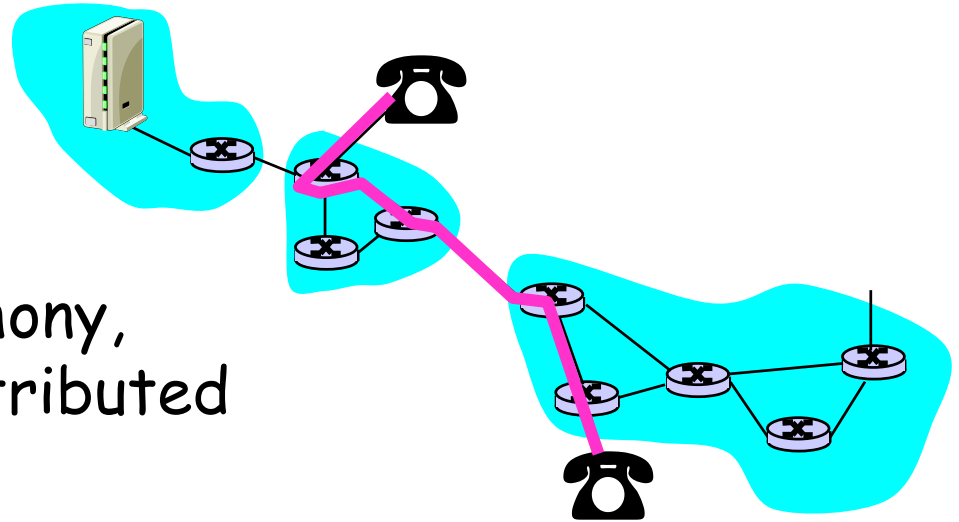
Streaming (as with streaming *stored* multimedia)

- ❖ playback buffer
- ❖ playback can lag tens of seconds after transmission
- ❖ still have timing constraint

Interactivity

- ❖ fast forward impossible
- ❖ rewind, pause possible!

Real-Time Interactive Multimedia



- ❖ **applications:** IP telephony, video conference, distributed interactive worlds
- ❖ **end-end delay requirements:**
 - audio: < 150 msec good, < 400 msec OK
 - includes application-level (packetization) and network delays
 - higher delays noticeable, impair interactivity
- ❖ **session initialization**
 - how does caller advertise its IP address, port number, encoding algorithms?

Multimedia Over Today's Internet

TCP/UDP/IP: "best-effort service"

❖ **no** guarantees on delay, loss



? ? ? ? ?
But you said multimedia apps requires ?
QoS and level of performance to be
? effective! ? ?



Today's Internet multimedia applications
use application-level techniques to mitigate
(as best possible) effects of delay, loss

A few words about video compression

- ❖ video: sequence of images displayed at constant rate
 - e.g. 24 images/sec
- ❖ digital image: array of pixels
 - each pixel represented by bits
- ❖ redundancy
 - spatial (within image)
 - temporal (from one image to next)

Examples:

- ❖ MPEG 1 (CD-ROM) 1.5 Mbps
- ❖ MPEG2 (DVD) 3-6 Mbps
- ❖ MPEG4 (often used in Internet, < 1 Mbps)

Research:

- ❖ layered (scalable) video
 - adapt layers to available bandwidth

Streaming Stored Multimedia

application-level streaming techniques for making the best out of best effort service:

- client-side buffering
- use of UDP versus TCP
- multiple encodings of multimedia

Media Player

- ❖ jitter removal
- ❖ decompression
- ❖ error concealment
- ❖ graphical user interface w/ controls for interactivity

Streaming Multimedia: UDP or TCP?

UDP

server sends at rate appropriate for client (oblivious to network congestion !)

often send rate = encoding rate = constant rate

then, fill rate = constant rate - packet loss

short playout delay (2-5 seconds) to remove network jitter

error recover: time permitting

TCP

send at maximum possible rate under TCP

fill rate fluctuates due to TCP congestion control

larger playout delay: smooth TCP delivery rate

HTTP/TCP passes more easily through firewalls

Summary: Internet Multimedia: bag of tricks

use **UDP** to avoid TCP congestion control (delays) for time-sensitive traffic

client-side **adaptive playout delay**: to compensate for delay

server side **matches stream bandwidth** to available client-to-server path bandwidth

chose among pre-encoded stream rates

dynamic server encoding rate

error recovery (on top of UDP)

FEC, interleaving, error concealment

retransmissions, time permitting

CDN (Content Distribution Network):

bring content closer to clients