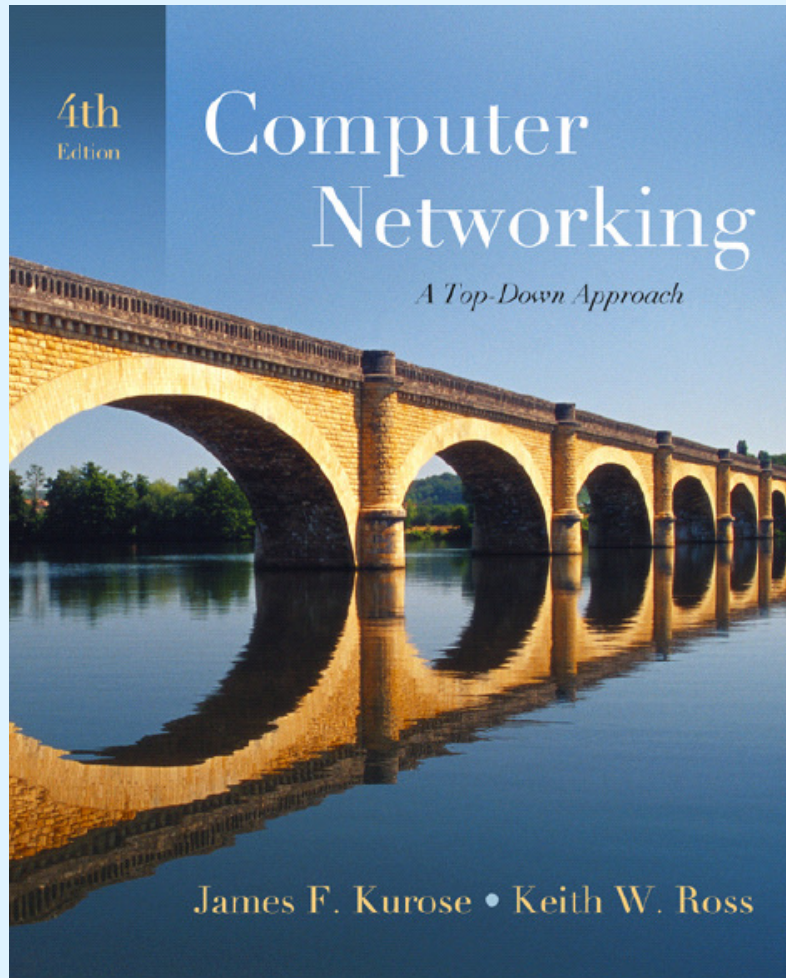# Wireless and Mobile Networks

Multimedia Networks

Bildspelet omfattar till stor del bilder som hör till följande bok:

A note on the use of these ppt slides:

We're making these slides freely available to all (faculty, students, readers). They're in PowerPoint form so you can add, modify, and delete slides (including this one) and slide content to suit your needs. They obviously represent a *lot* of work on our part. In return for use, we only ask the following:

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Thanks and enjoy! JFK/KWR

Computer Networking: A Top Down Approach , 4th edition.
Jim Kurose, Keith Ross, Addison-Wesley, July 2007.

"Komponenter" i trådlösa nät

❒ Trådlösa värdar

❒ Basstationer

❒ Trådlösa länkar

❒ Infrastruktur

mobil nod och en och samma basstation

mobil nod och olika basstationer

"ad hoc" – nät utan basstationer

IEEE 802.11 Wireless LAN (WLAN)

- 802.11b
  - up to 11 (5) Mbps

- 802.11g
  - up to 54 (23) Mbps

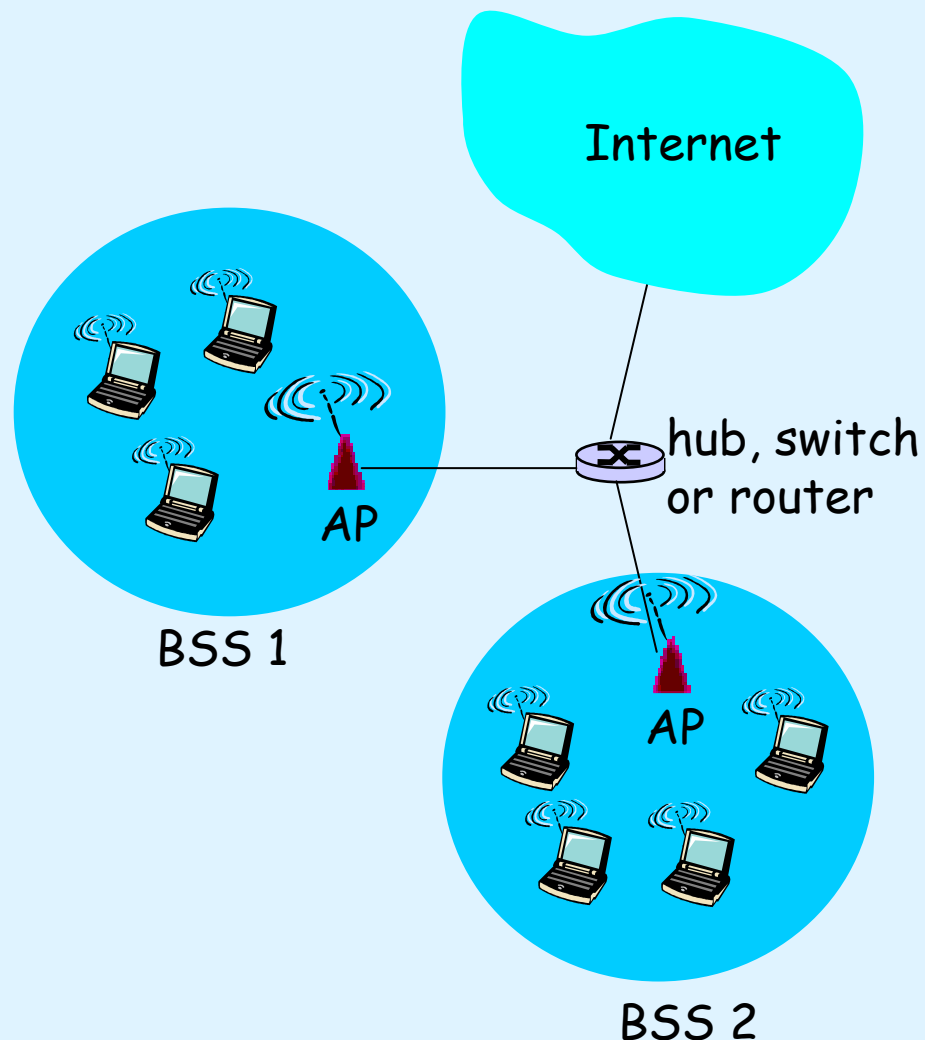- 802.11a
  - up to 54 (21) Mbps
  - low traffic band

- 802.11n: Mimo multiple antennae
  - up to ~~200~~ 600 Mbps
  - HDTV

- all use CSMA/CA for multiple access
- all have base-station and ad-hoc network versions
- more versions available (e.g. c, d, e, f, h, i, j, ad, ac)

802.11 LAN architecture

Internet

hub, switch or router

AP

BSS 1

AP

BSS 2

Basic Service Set (BSS) (aka "cell") in infrastructure mode contains:

❍ wireless hosts

❍ access point (AP): base station

❍ ad hoc mode: hosts only

802.11: Channels, association

❑ host: must *associate* with an AP

  ❍ scans channels, listening for *beacon frames* containing AP's name (SSID) and MAC address

  ❍ selects AP to associate with

  ❍ may perform authentication

  ❍ will typically run DHCP to get IP address in AP's subnet

802.11: passive/active scanning
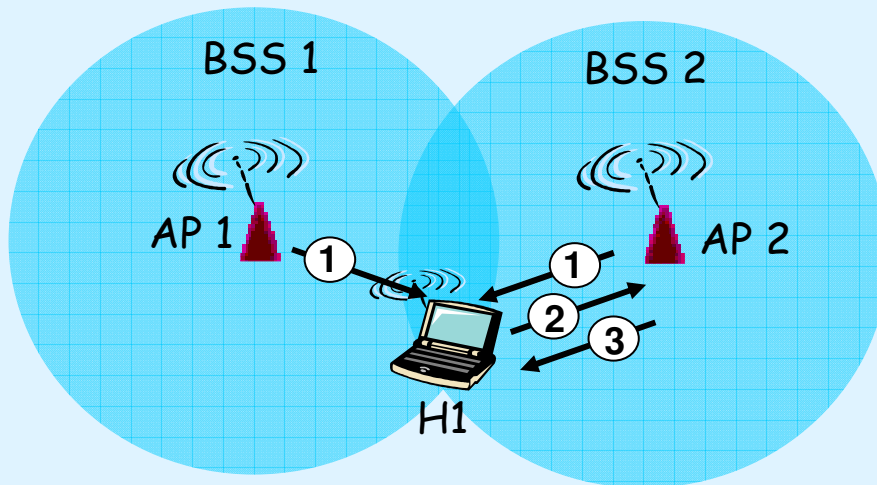
Passive Scanning:
(1) beacon frames sent from APs
(2) association Request frame sent:
    H1 to selected AP
(3) association Response frame sent:
    H1 to selected AP
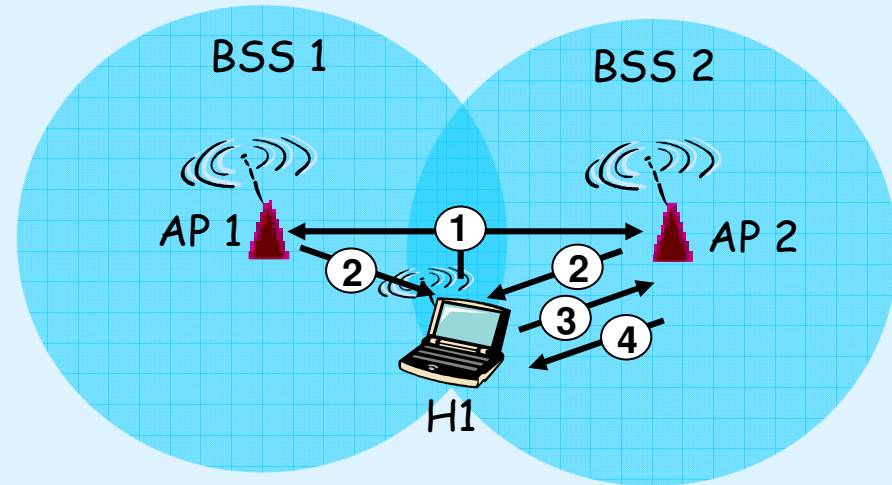
Active Scanning:
(1) Probe Request frame broadcast
    from H1
(2) Probes response frame sent from
    APs
(3) Association Request frame sent:
    H1 to selected AP
(4) Association Response frame
    sent: H1 to selected AP

IEEE 802.11: multiple access

- avoid collisions: 2+ nodes transmitting at same time
- 802.11: CSMA - sense before transmitting
  - don't collide with ongoing transmission by other node
- 802.11: *no* collision detection!
  - difficult to receive (sense collisions) when transmitting due to weak received signals (fading)
  - can't sense all collisions in any case: hidden terminal, fading
  - goal: *avoid collisions:* CSMA/C(ollision)A(voidance)

A's signal strength

C's signal strength

space
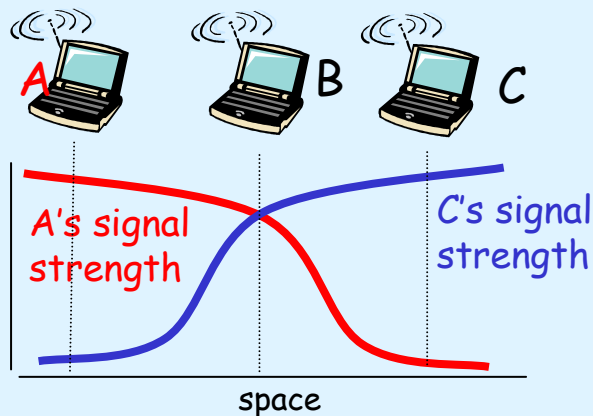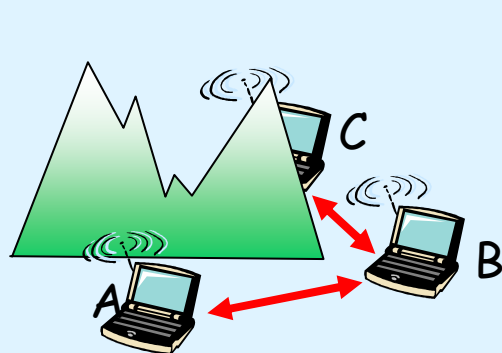
IEEE 802.11 MAC Protocol: CSMA/CA

802.11 sender

1. If sense channel idle for **DIFS** then
    transmit entire frame (no CD)
2. If sense channel busy then
    start random backoff time
    timer counts down while channel idle
    transmit when timer expires
    if no ACK, increase random backoff
        interval, repeat 2

802.11 receiver

– if frame received OK
    return ACK after **SIFS** (ACK needed due
    to hidden terminal problem)
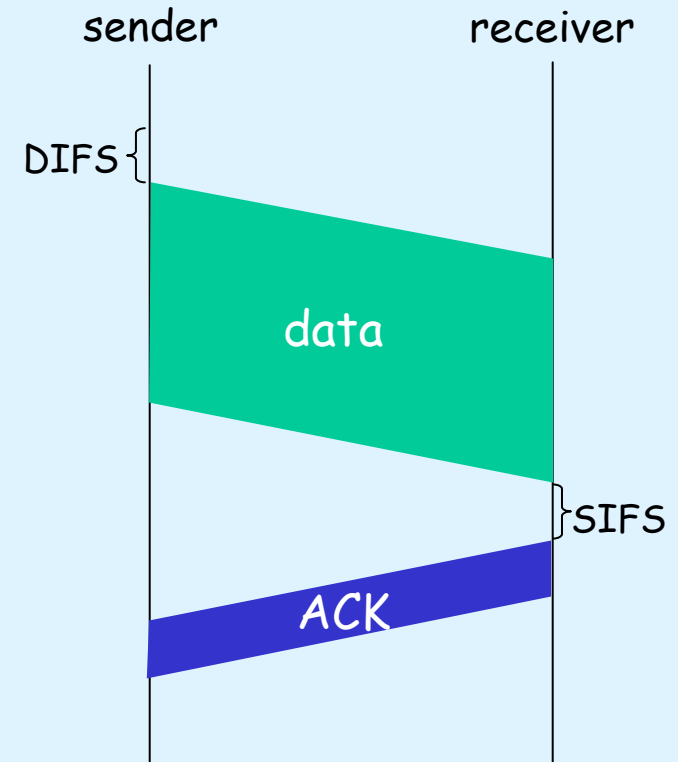
Collision Avoidance: RTS-CTS exchange
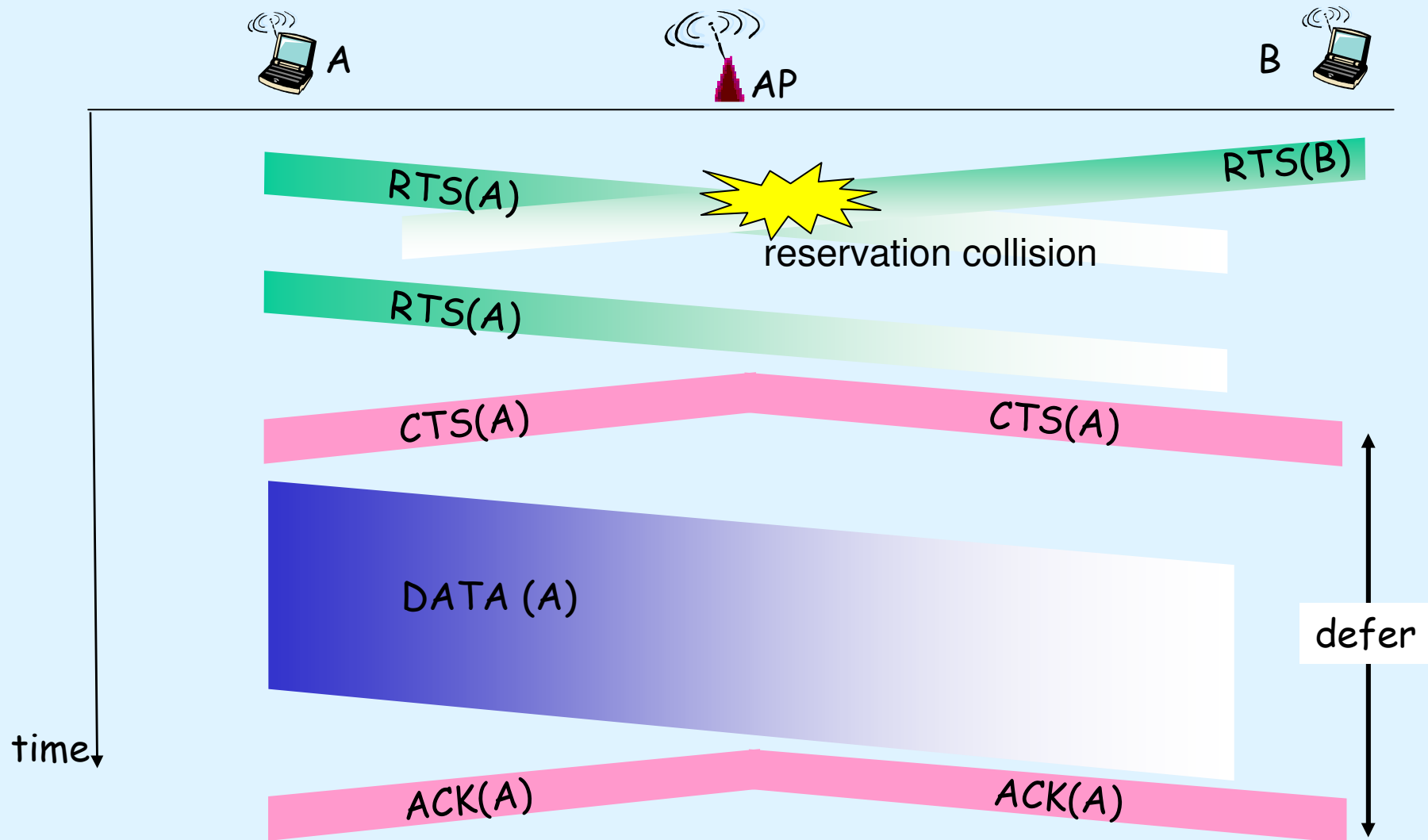
802.15: Personal Area Network (PAN)

❒ less than 10 m diameter

❒ replacement for cables (mouse, keyboard, headphones)

❒ ad hoc: no infrastructure

❒ master/slaves:
  ○ slaves request permission to send (to master)
  ○ master grants requests

❒ 802.15: evolved from Bluetooth specification
  ○ V.1.x up to 1 Mbps (723 kbps)
  ○ V.2 up to 3 Mbps (2.1 Mbps)
  ○ V.3/V.4 up to 24 Mbps

radius of coverage
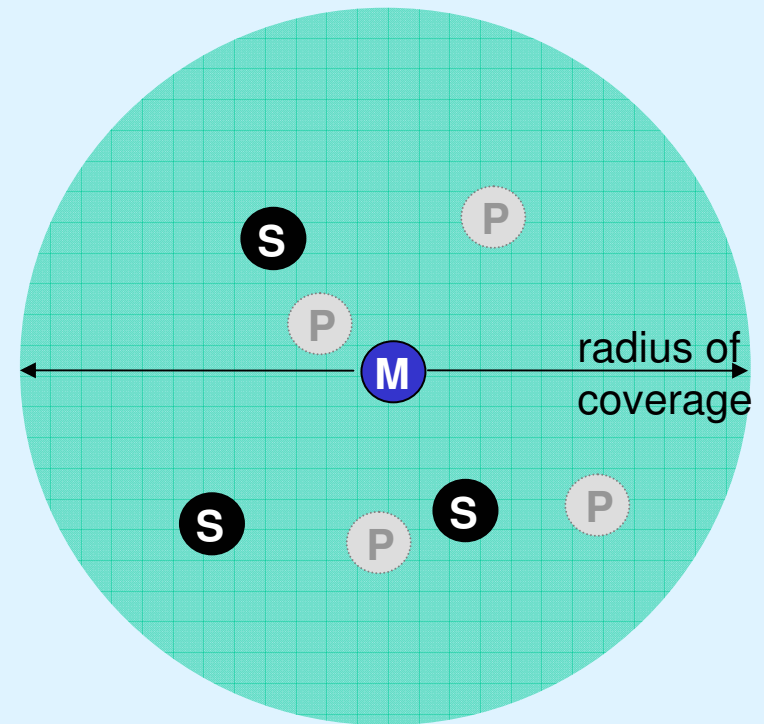
Ⓜ Master device

Ⓢ Slave device

Ⓟ Parked device (inactive)

Mobilitet på Internet

A. Publik IP-adress kompletterad med C/O-adress

    1. Indirect routing

    2. Direct routing

B. Lån av IP-adress (DHCP)

C. Byte av basstation/accesspunkt under pågående uppkoppling

Multimedia på nät, 3 typer

❐ Streaming <u>Stored</u> Audio and Video)

❐ <u>Conversational</u> Voice- and Video-over-IP
(Konversera med ljud och video över IP)

❐ Streaming <u>Live</u> Audio and Video

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
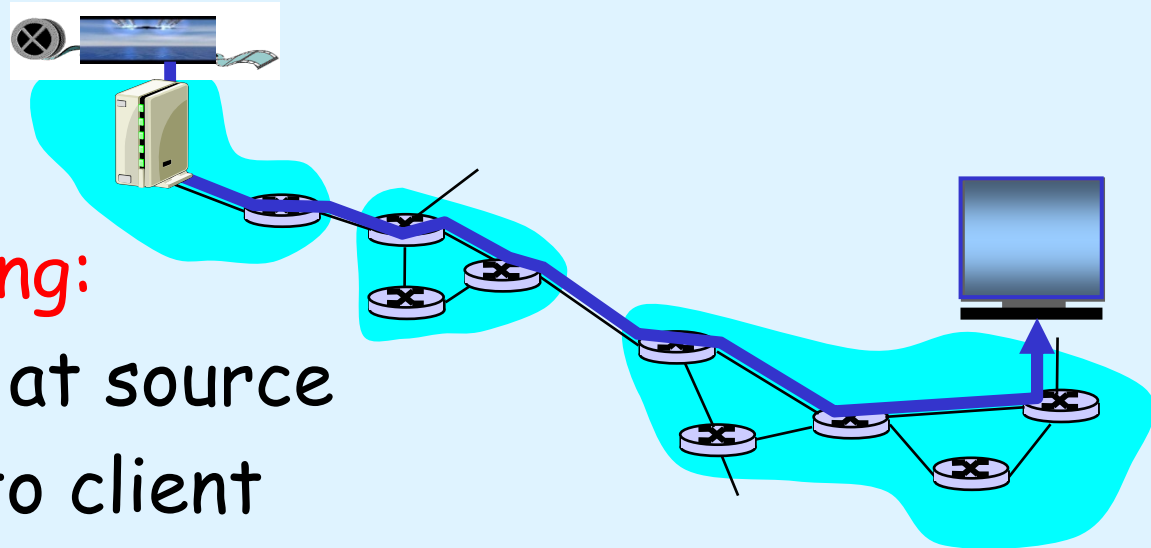
Internet multimedia: streaming approach
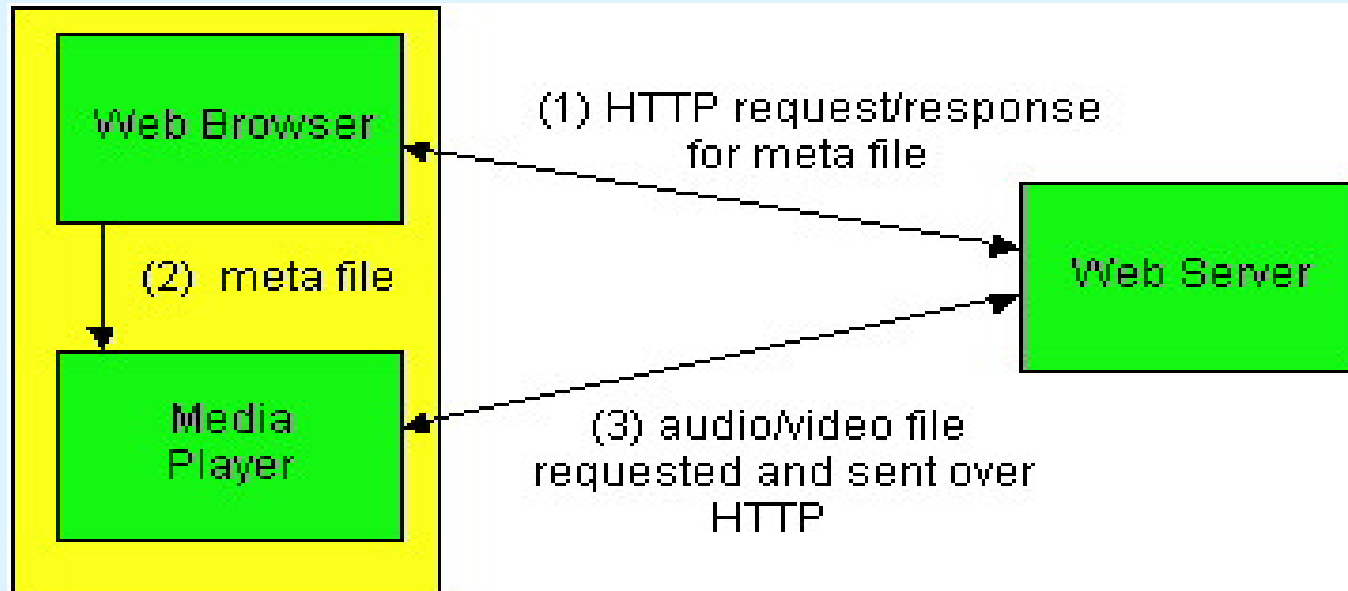
❐ browser GETs **metafile**
❐ browser launches player, passing metafile
❐ player contacts server
❐ server **streams** audio/video to player

Streaming from a streaming server


```
┌─────────────────────────────────────────────────┐
│ ┌──────────────────┐                             │
│ │                  │   (1) HTTP request/response │  ┌──────────────┐
│ │   Web Browser    │◄──for presentation descripton file──►│  Web Server  │
│ │                  │                             │  │              │
│ └──────────────────┘                             │  └──────────────┘
│   │ (2) presentation                             │
│   │ description file                             │
│   ▼                                              │
│ ┌──────────────────┐                             │  ┌──────────────┐
│ │                  │                             │  │  Streaming   │
│ │   Media          │◄──(3) audio/video file──────│  │  Server      │
│ │   Player         │      requested and sent     │  │              │
│ └──────────────────┘                             │  └──────────────┘
└─────────────────────────────────────────────────┘
    client                                             servers
```
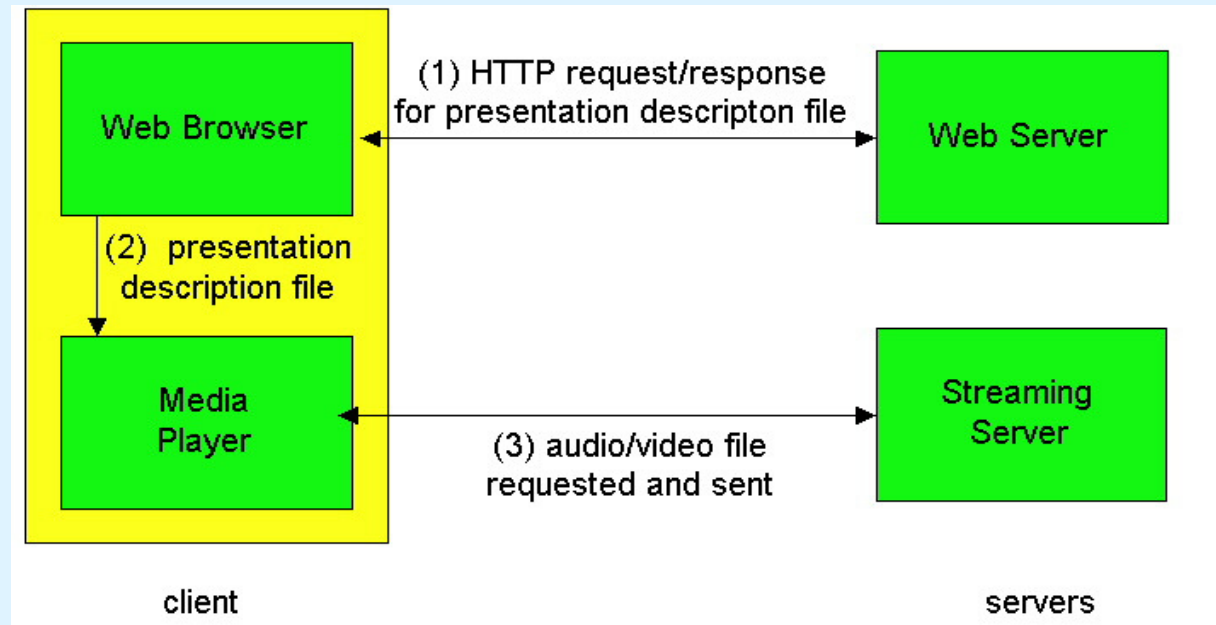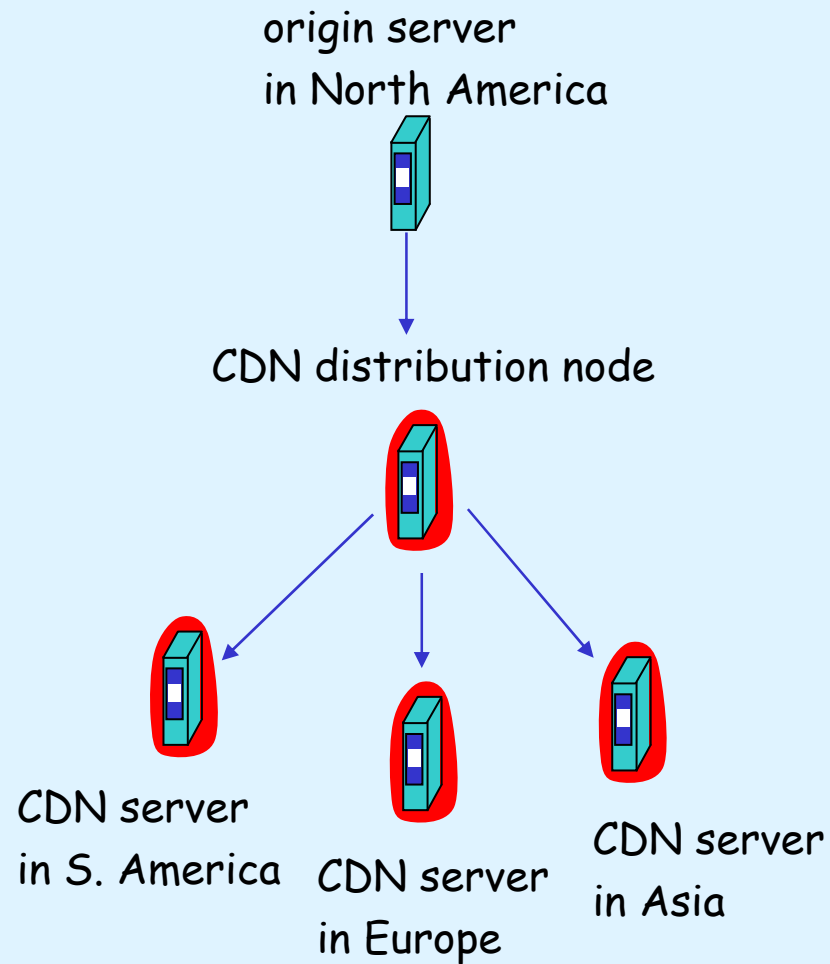
□ allows for non-HTTP protocol between server, media player

□ UDP or TCP for step (3)

Strömmande lagrad video, 3 klasser

- UDP-ström

- HTTP-ström

- Adaptiv HTTP-ström

Content distribution networks (CDNs)

origin server
in North America

CDN distribution node

CDN server
in S. America

CDN server
in Europe

CDN server
in Asia

Real-Time Transport Protocol (RTP)   (1)

- RFC 3550

- Streaming Stored Multimedia

- Typiskt med socket över UDP/IP

- Garanterar inte Quality-of-Service (QoS)

Real-Time Transport Protocol (RTP)   (2)

Payload Type	Sequence Number	Timestamp	Synchronization Source Identifer	Miscellaneous Fields

RTP Header

☐ Payload type:

Audio/video-format

Samplingsfrekvens

Bithastighet

Session Initiation Protocol (SIP)

❒ IP-telefoni

❒ Mekanismer

  o upprätta/ta ned ljudförbindelser

  o call management

    UNDER SAMTAL tillföra nya mediaströmmar, byta kod, bjuda in fler parter, etc.

❒ Medger kodförhandlingar

❒ SIP kombineras med RTP, audio codec och video codec

❒ Den anropande kan få fram den anropades IP-adress

  o DHCP kan användas

Protokoll för strömmar

- ☐ Real-Time Transport Protocol (RTP)

- ☐ Real-Time Streaming Protocol (RTSP)

- ☐ Real-Time Control Protocol (RTCP)

- ☐ Session Initiation Protocol (SIP)

- ☐ H.323

Typiskt för multimedia över nät

□ **Känsligt för fördröjningar**
  - från ände till ände
  - jitter (variationen i fördröjning inom en paket-
    ström)

□ **Tolerant mot förluster**

Tjänstekvalité (1)

□ Quality-of-Service (QoS)

- o Värd-till-nät + Internet-skiktet

- o Kan förbättras av transportskiktet.

□ Best-effort Service

- o Routrar distribuerar paket så snabbt som möjligt.

- o Ingen garanti för $d_{end-end}$ och jitter.
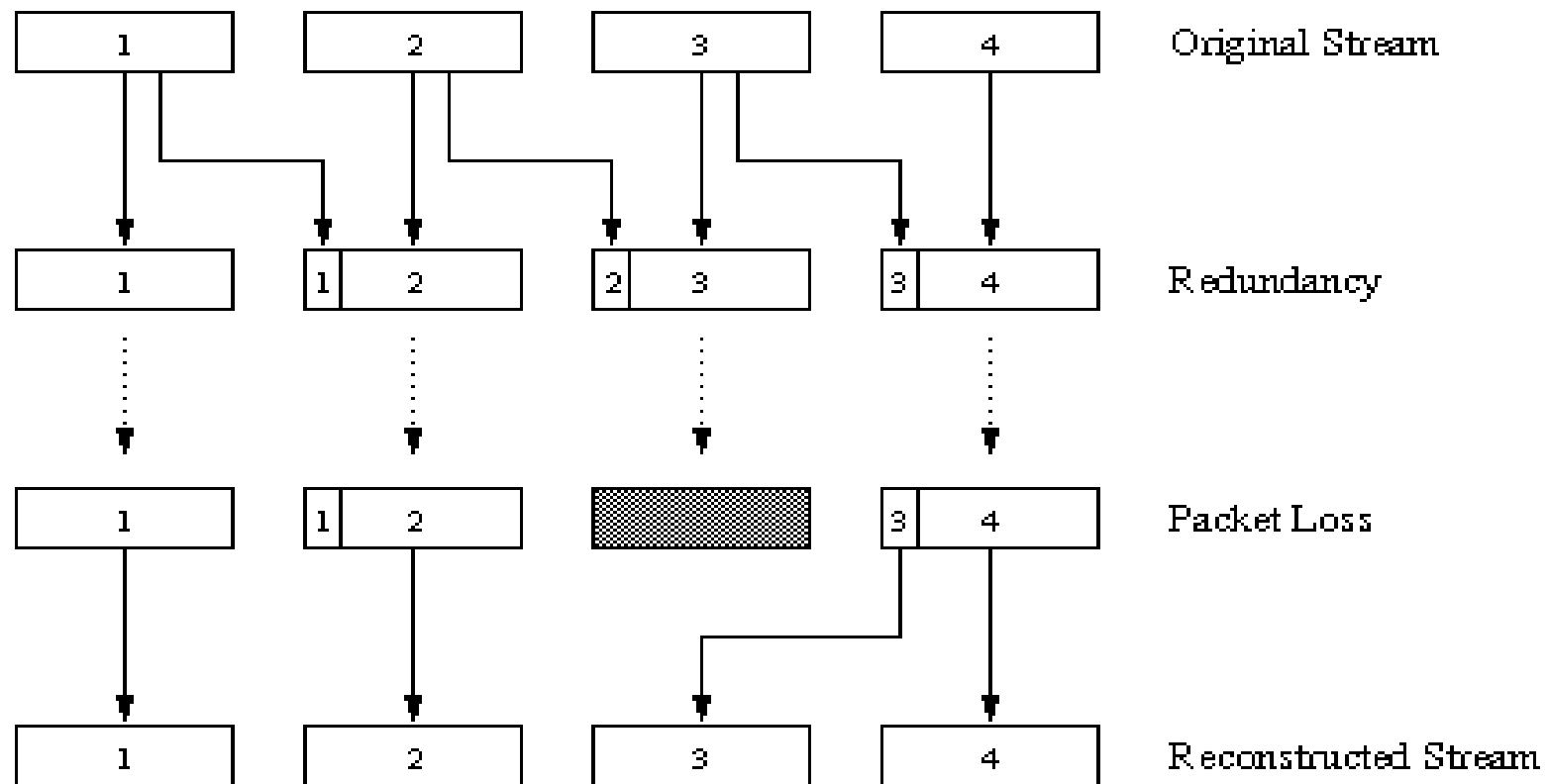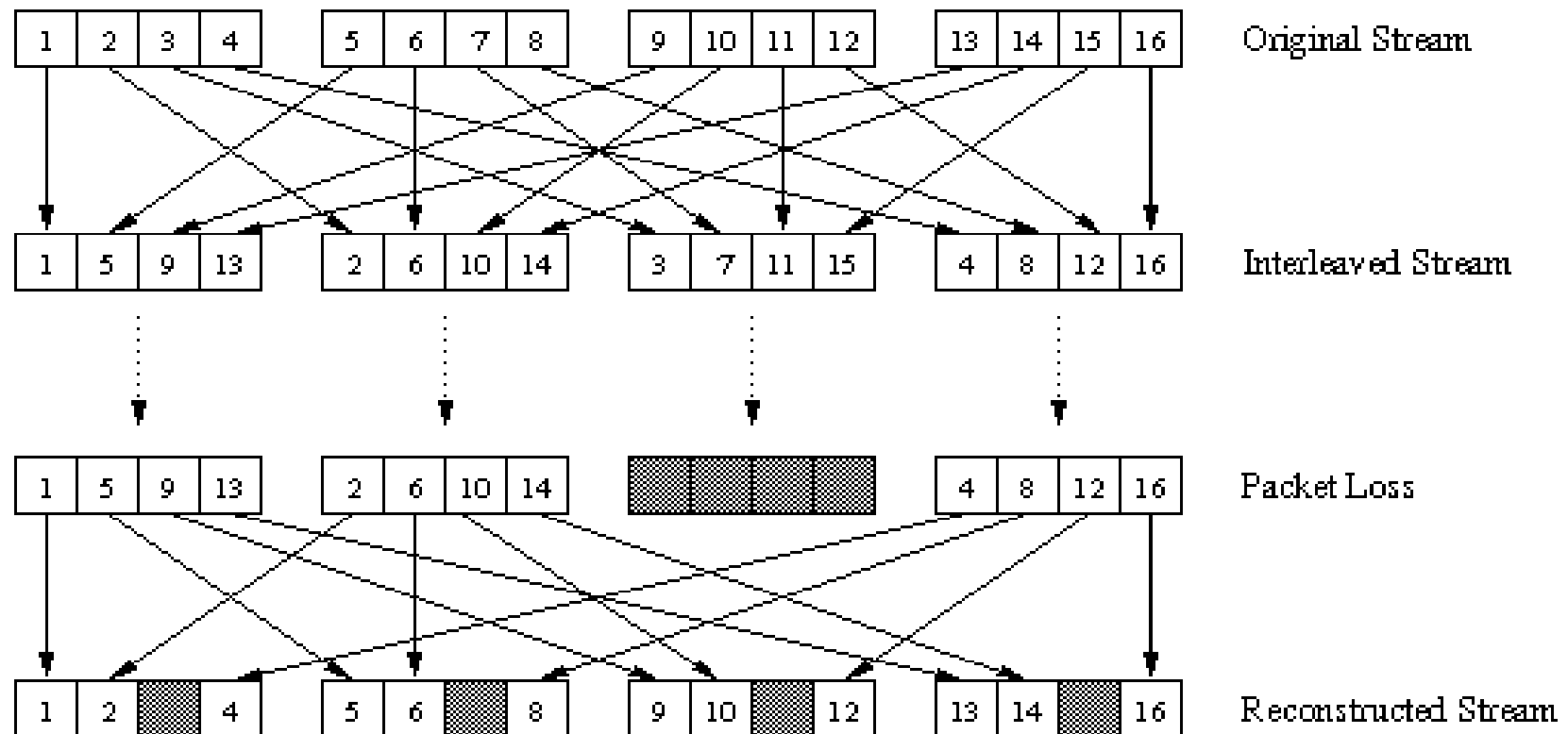
Tjänstekvalité   (2)

□ Förebygga problem p.g.a. multimediajitter

   o Sekvensnummer och tidsstämpel

   o Fördröjd avspelning (konstant eller adaptiv)

□ Förebygga problem p.g.a. paketförlust

   o FEC

   o Piggyback FEC

   o Interleaving

Piggyback FEC

Interleaving

Förbättringar för multimedia

- Differentiated services (Diffserv)

- Per-connection QoS Quarantees
  Integrated services (Intserv)

Diffserv-modellen

□ Kantfunktioner

  Paketklassificering och uppsättning av trafikvillkor.

  Informationen skrivs in i paketets huvud av en diffservkapabel värd eller den första diffservroutern längs vägen.

□ Kärnfunktioner

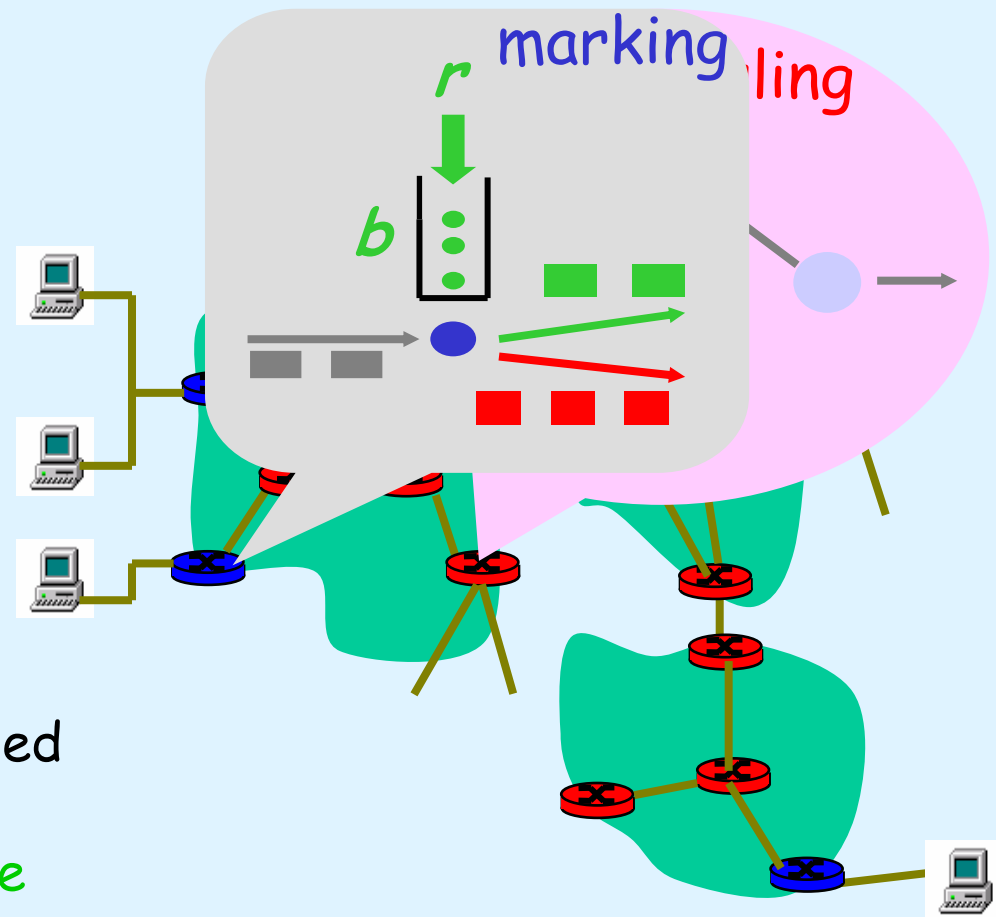 Vidarebefordring enligt paketklassens "per-hop behavior".

Diffserv Architecture

Edge router:

- per-flow traffic management
- marks packets as in-profile and out-profile

Core router:

- per class traffic management
- buffering and scheduling based on marking at edge
- preference given to in-profile packets

Intserv-modellen

□ Call setup för reservation

□ Varje router (längs vägen) känner till...

buffertstorlek
och
bandbredd
för pågående sessioner.

Call setup

❑ Viktiga routerparametrar

Rspec = reservation, QoS som en uppkoppling erfordrar

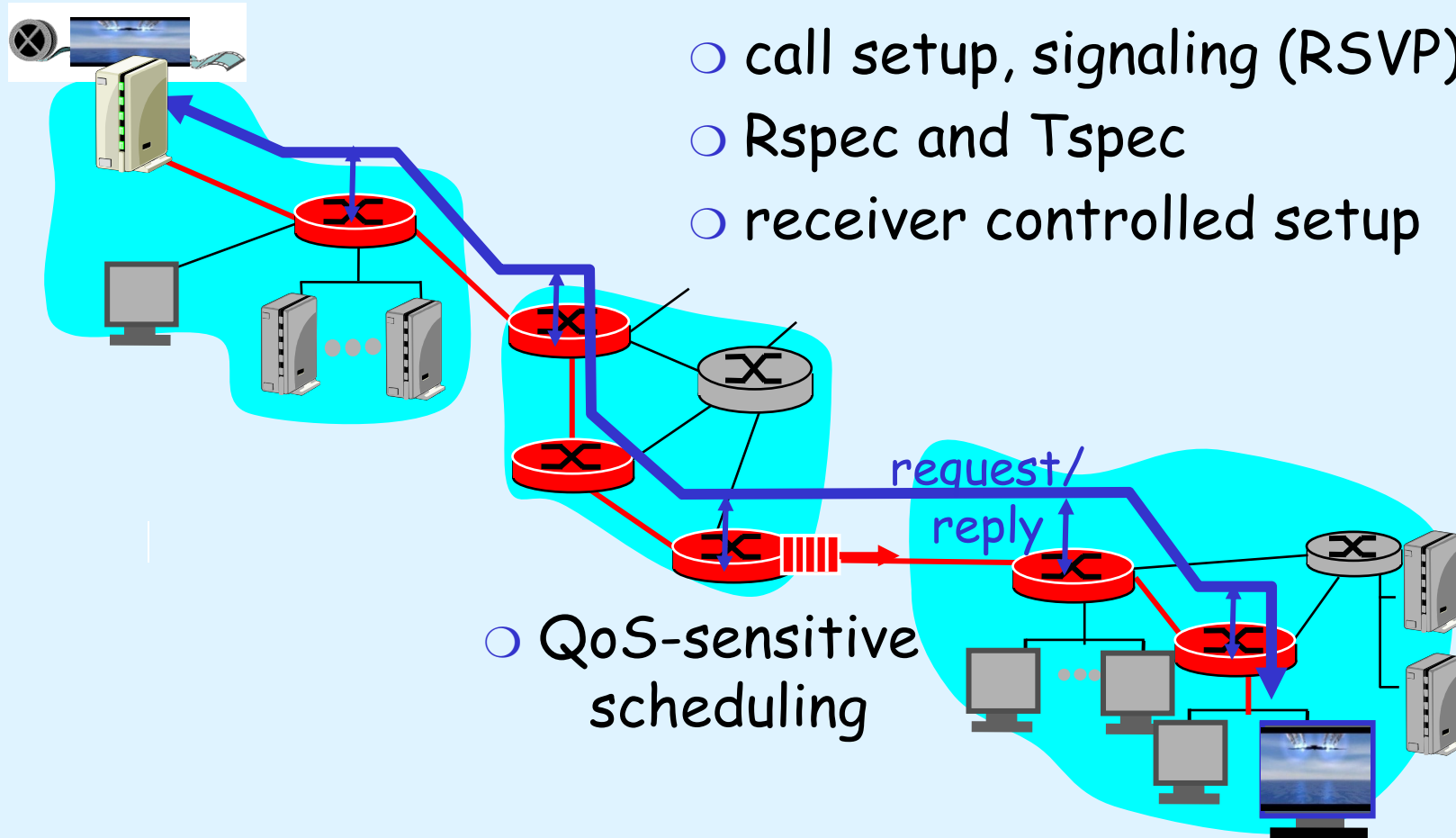Tspec = trafiken från sändaren eller till mottagaren

❑ ReSerVation Protocol (RSVP)

  o Ger reserverad bandbredd i multicast-träd

  o Mottagarorienterat, dvs. <u>mottagaren</u> upprätthåller resursreservationen (signalerar "setup").

QoS guarantee scenario

☐ **Resource reservation**
  - ○ call setup, signaling (RSVP)
  - ○ Rspec and Tspec
  - ○ receiver controlled setup

request/
reply

○ QoS-sensitive
scheduling