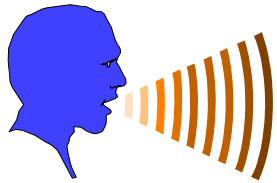





# EEL 6935

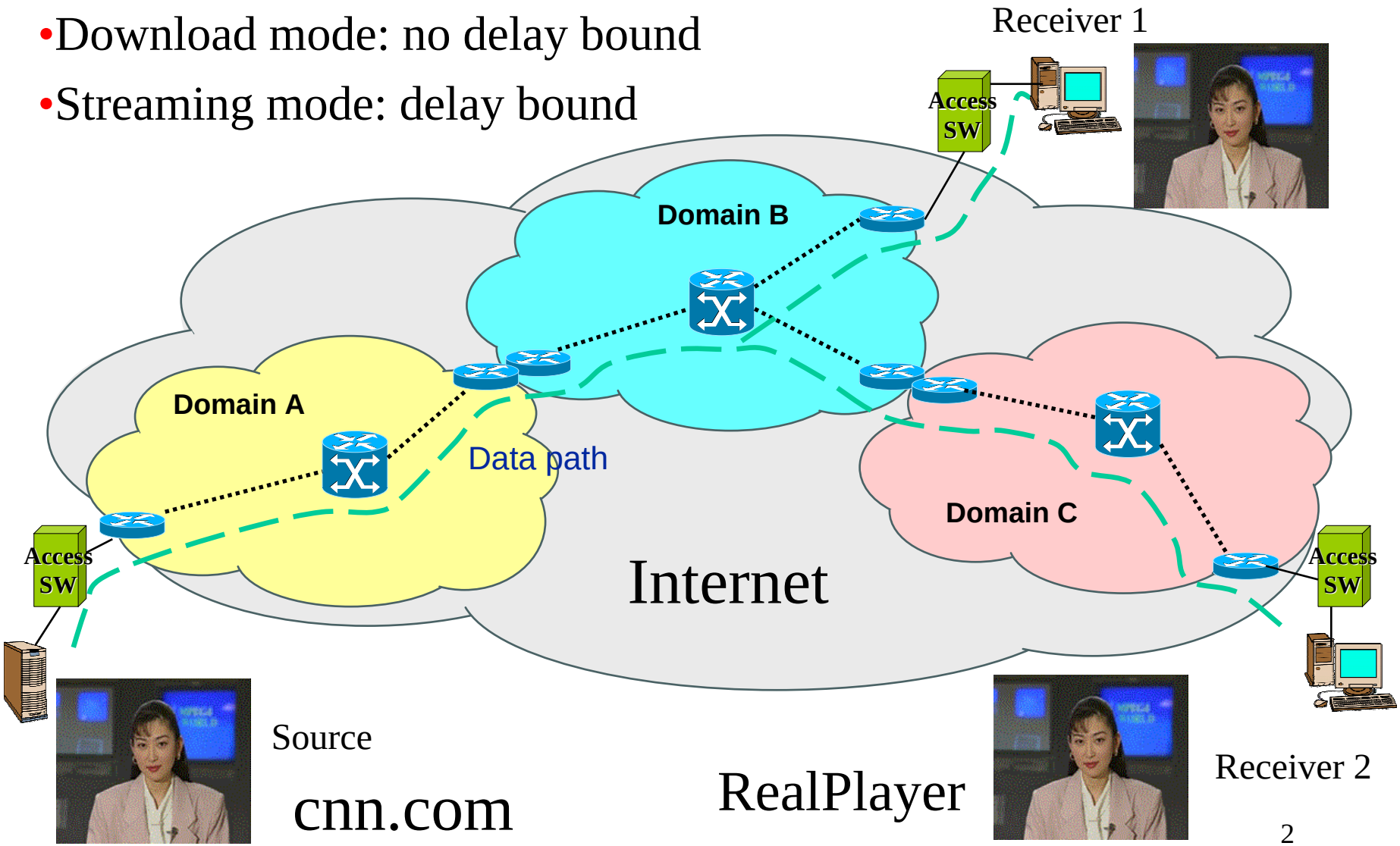
# Special Topics in Multimedia Communications and Networking

## Streaming Video over the Internet


**Dr. Dapeng Wu**
**University of Florida**
**Department of Electrical and Computer Engineering**

# What is Streaming Video?

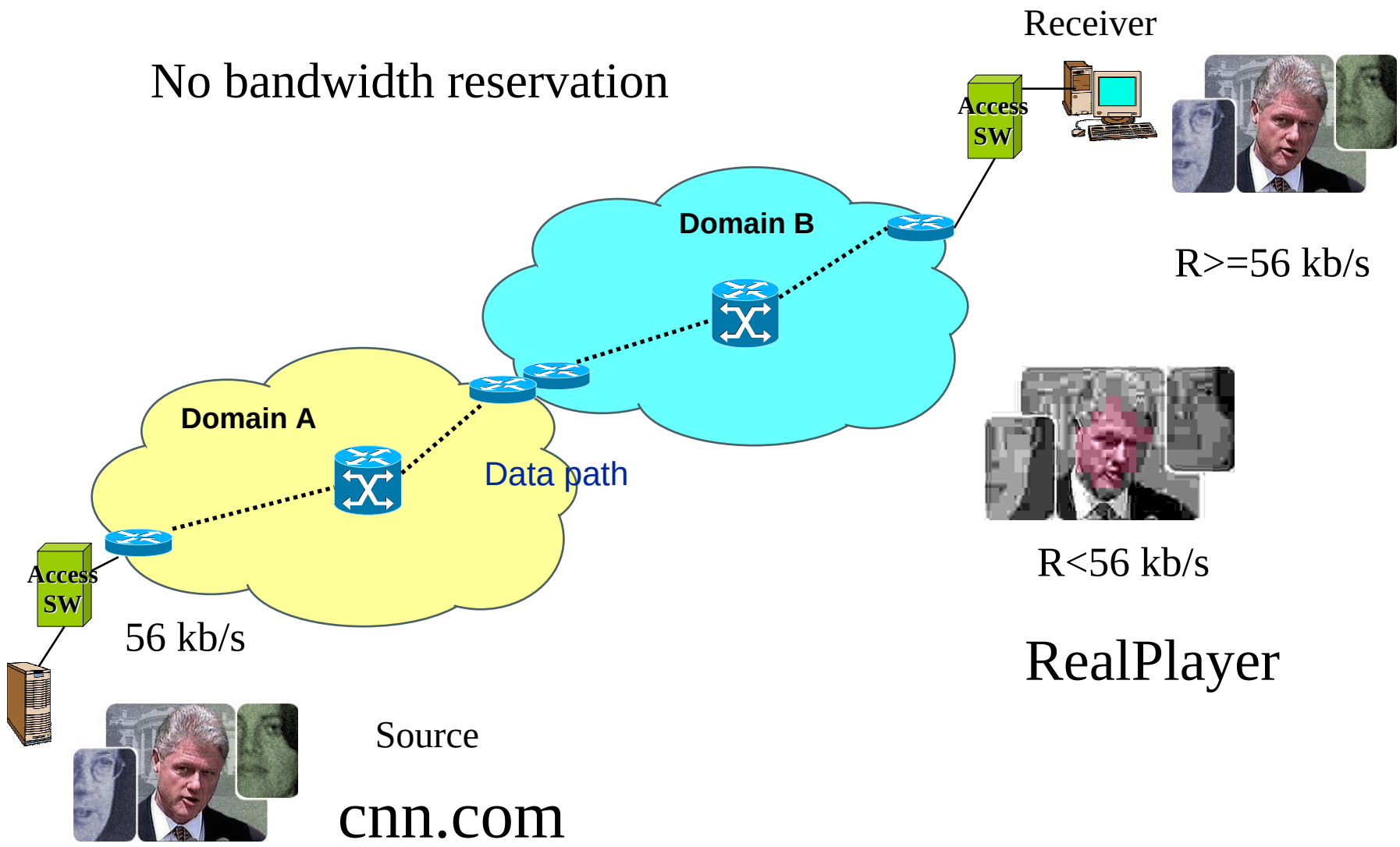
- Download mode: no delay bound
- Streaming mode: delay bound



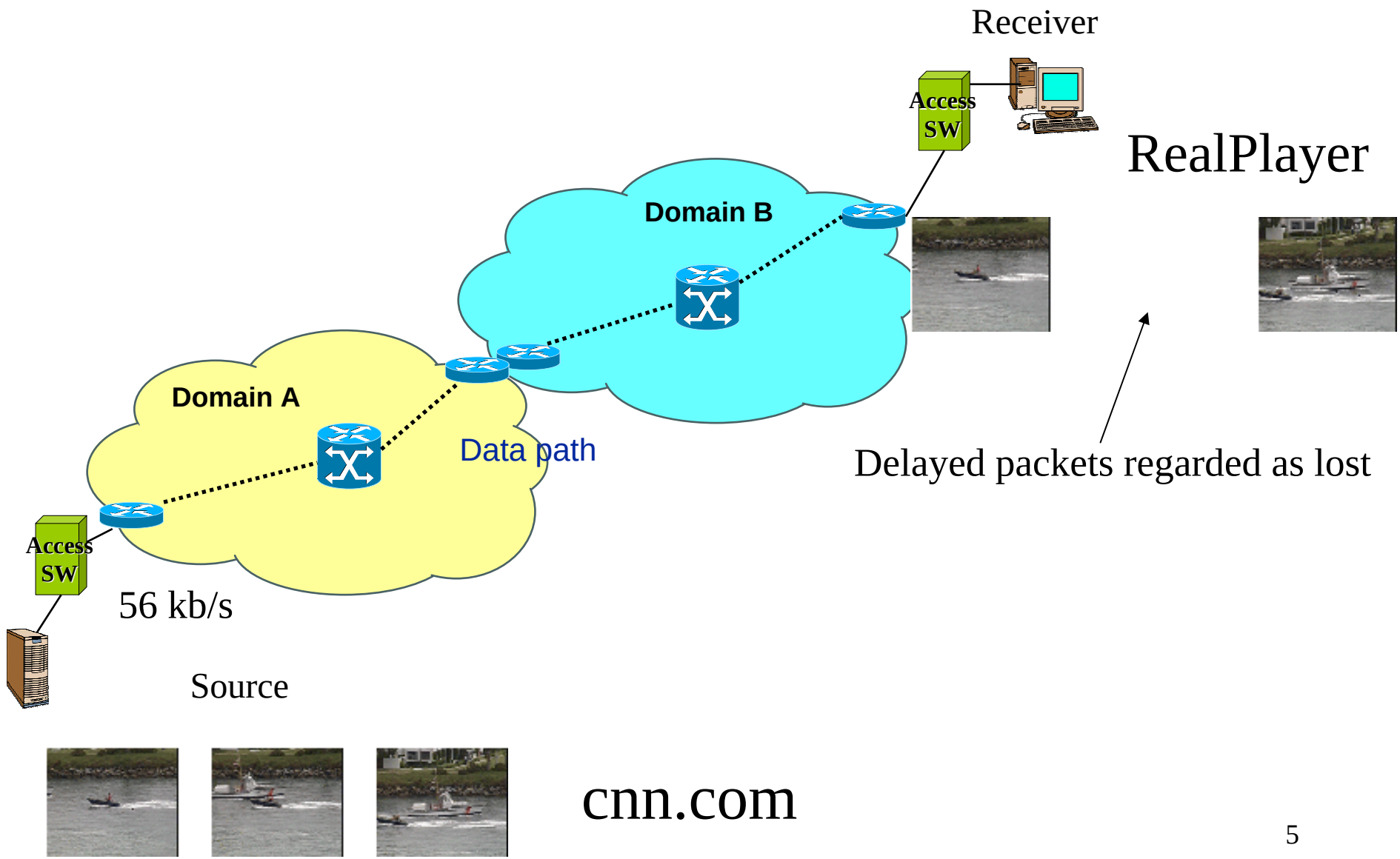
# Outline

- Challenges for quality video transport
- An architecture for video streaming
  - Video compression
  - Application-layer QoS control
  - Continuous media distribution services
  - Streaming server
  - Media synchronization mechanisms
  - Protocols for streaming media
- Summary

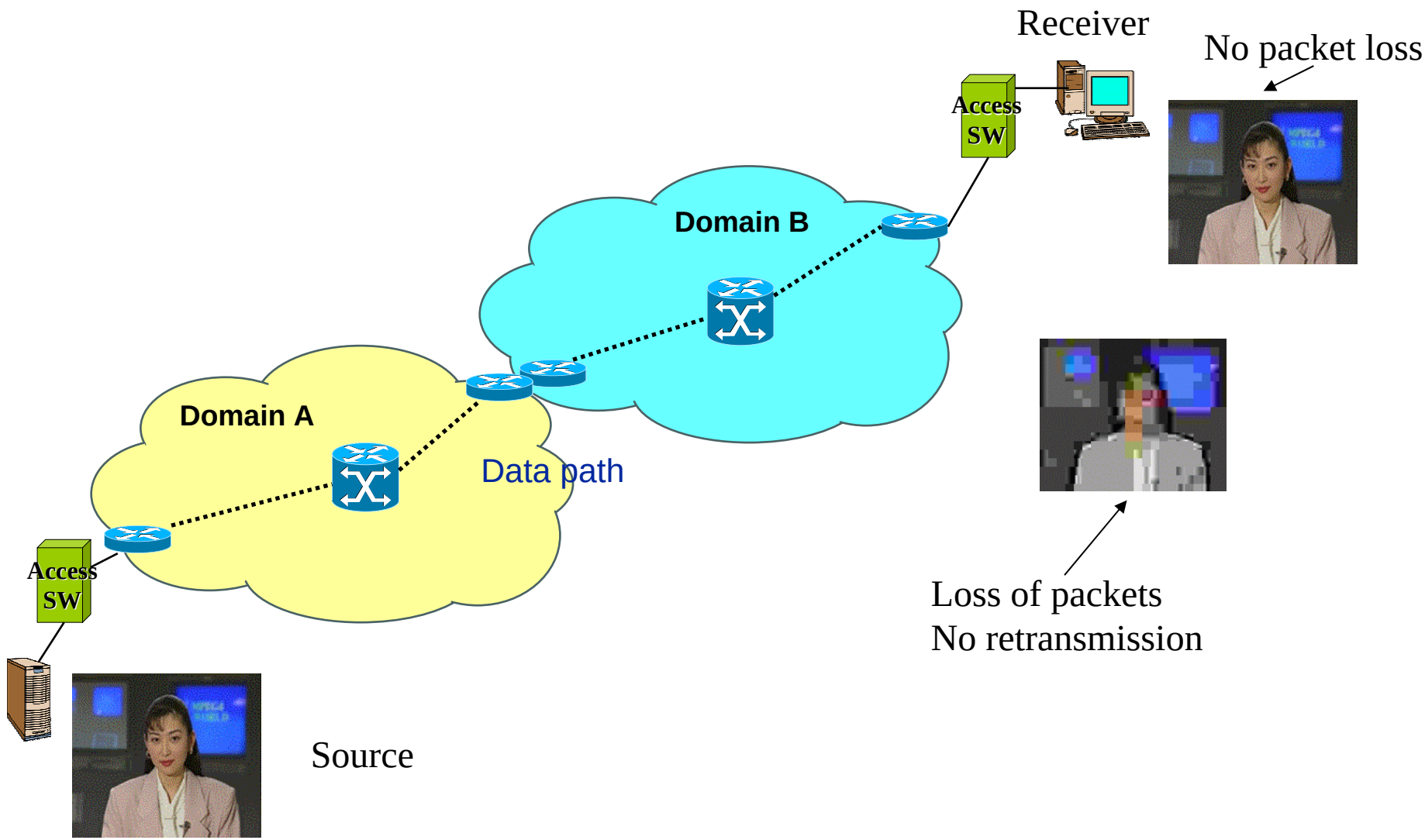
# Time-varying Available Bandwidth



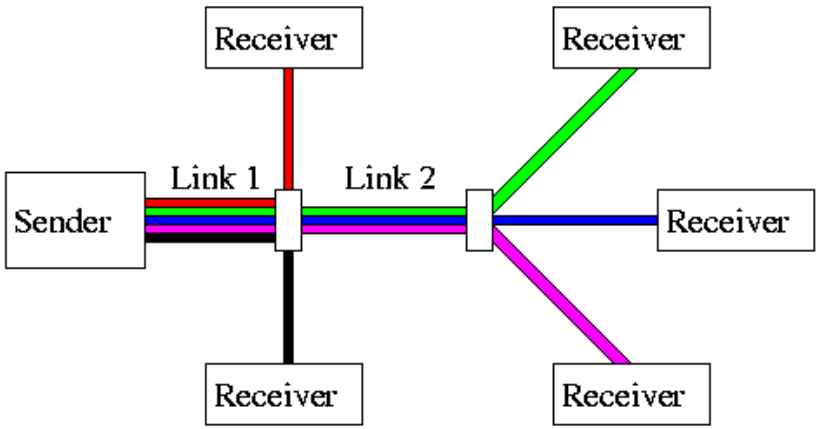
# Time-varying Delay



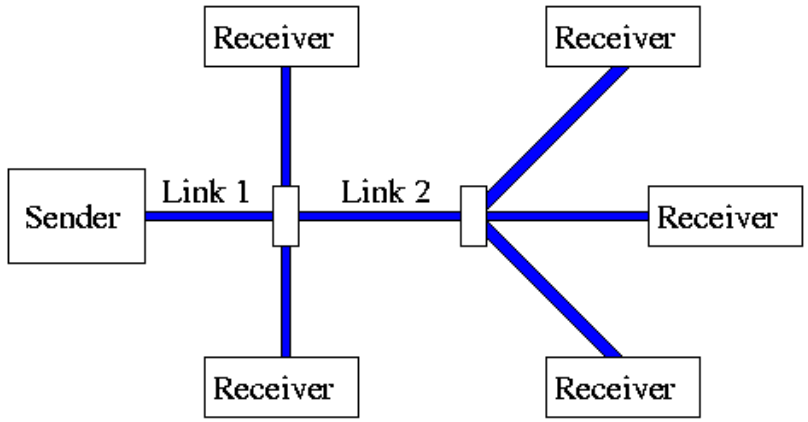
# Effect of Packet Loss



# Unicast vs. Multicast




Unicast

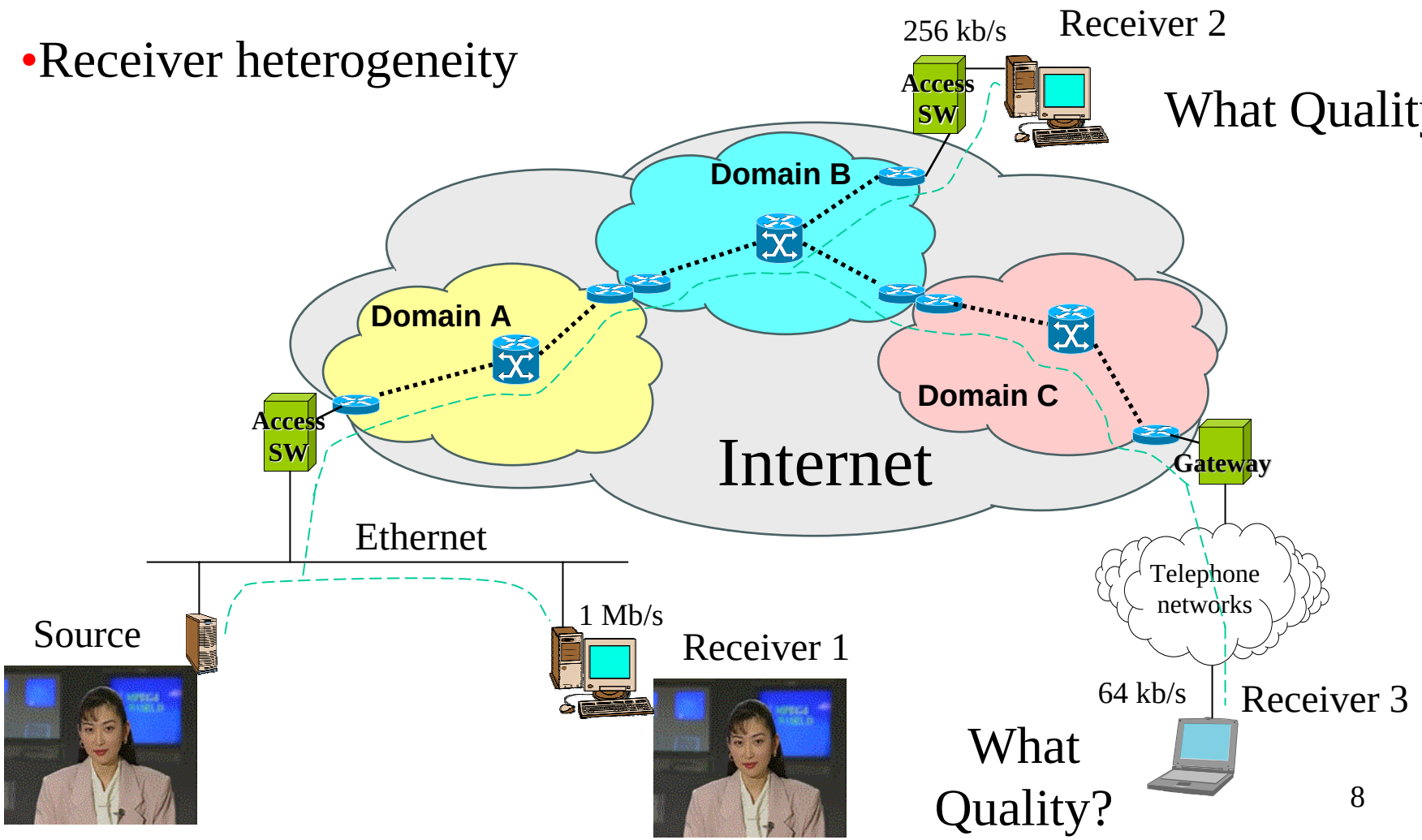



Multicast

Pros and cons?

# Heterogeneity For Multicast

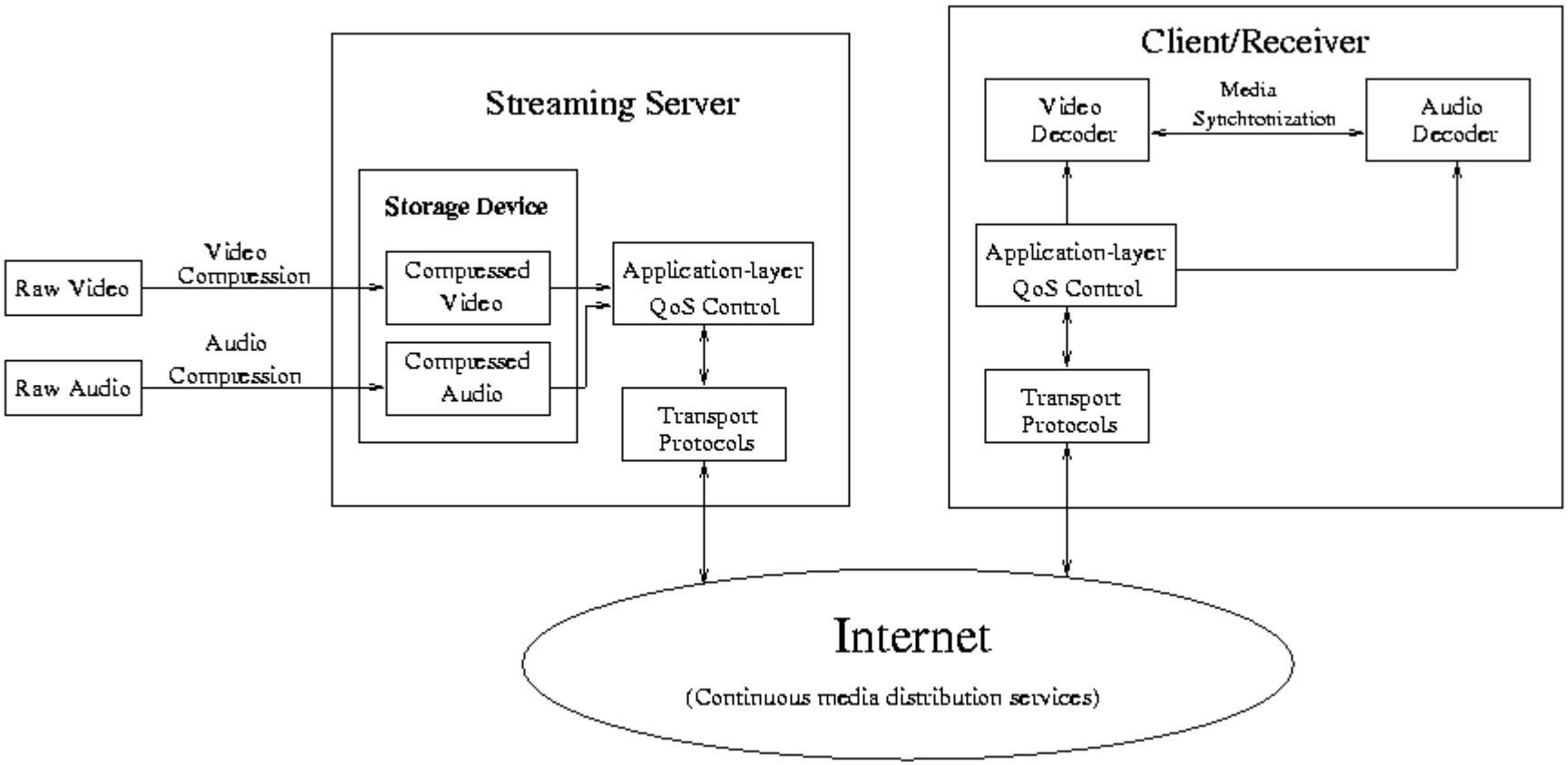
- Network heterogeneity
- Receiver heterogeneity



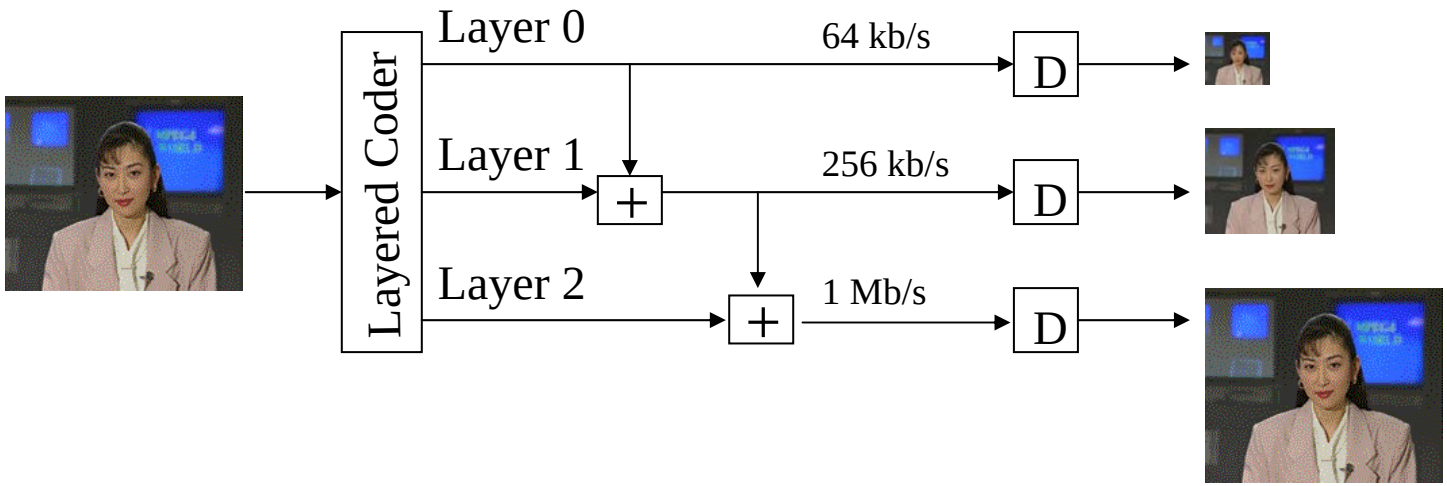
# Outline

- Challenges for quality video transport
- An architecture for video streaming
  - Video compression
  - Application-layer QoS control
  - Continuous media distribution services
  - Streaming server
  - Media synchronization mechanisms
  - Protocols for streaming media
- Summary

# Architecture for Video Streaming



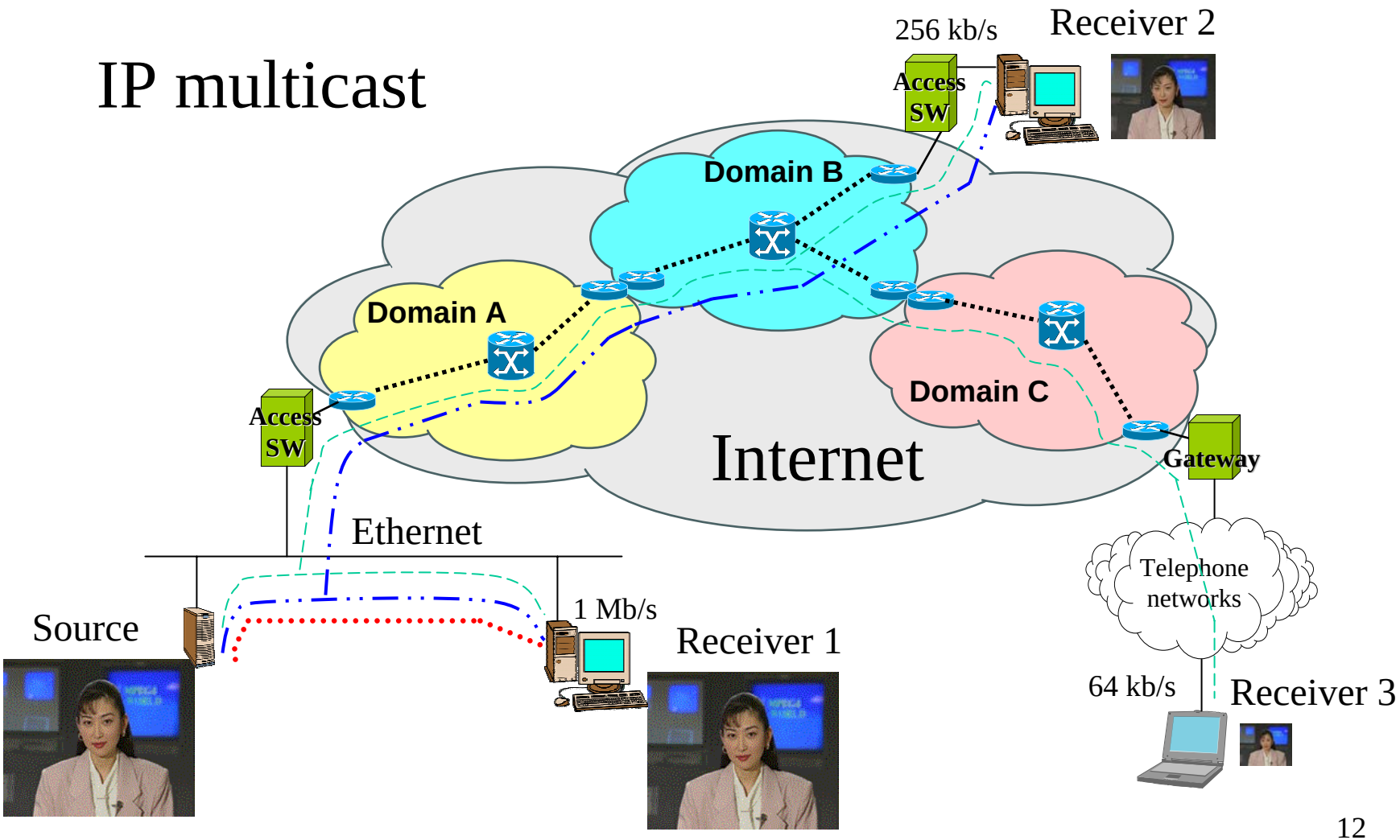
# Video Compression




Layered video encoding/decoding.

*D* denotes the decoder.

# Application of Layered Video

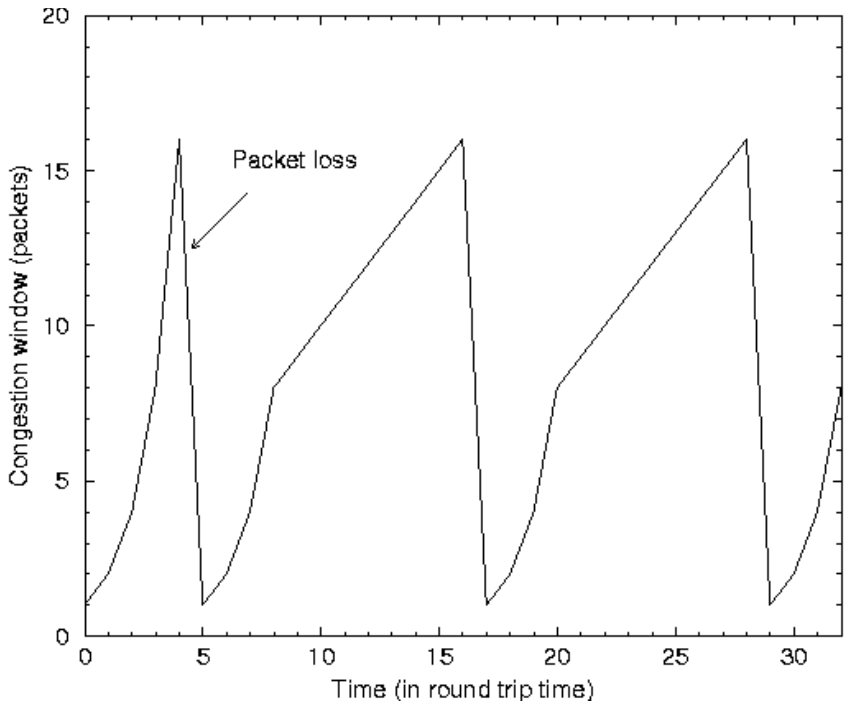


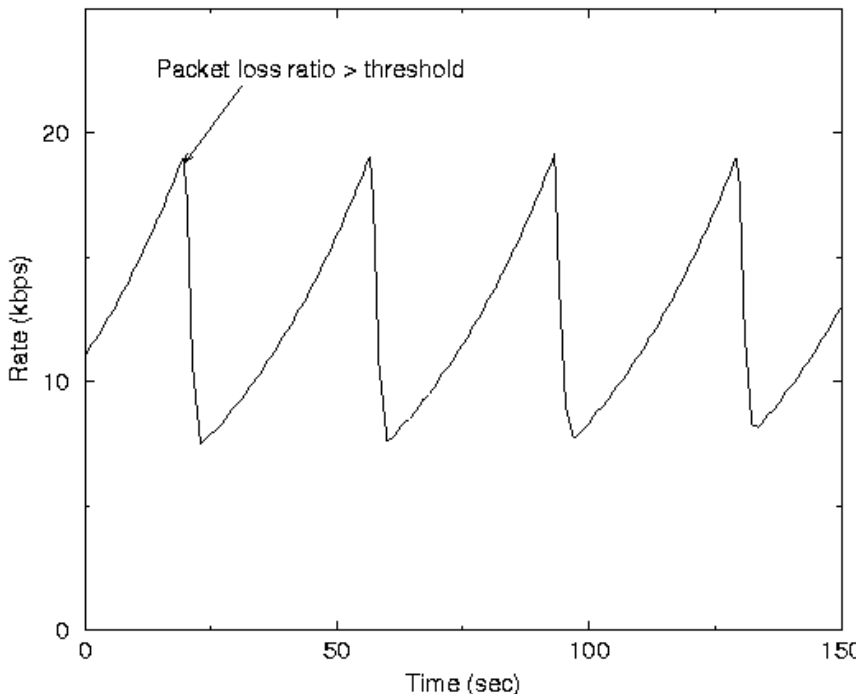
# Application-layer QoS Control

- Congestion control (using rate control):
  - Source-based, requires
    - rate-adaptive compression or
    - rate shaping
  - Receiver-based
  - Hybrid
- Error control:
  - Forward error correction (FEC)
  - Retransmission
  - Error resilient compression
  - Error concealment

# Congestion Control

- Window-based vs. rate control (pros and cons?)

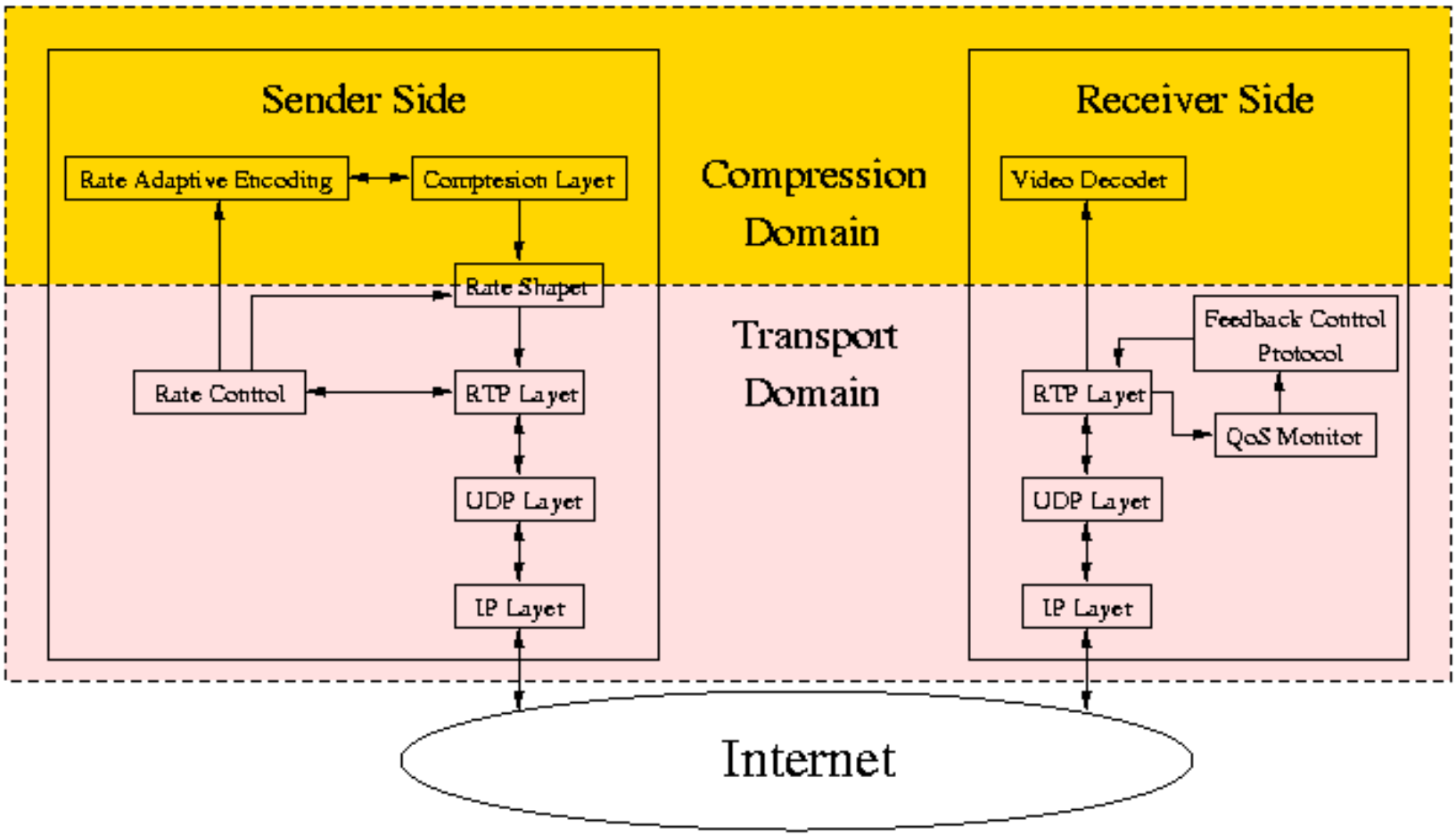



Window-based control

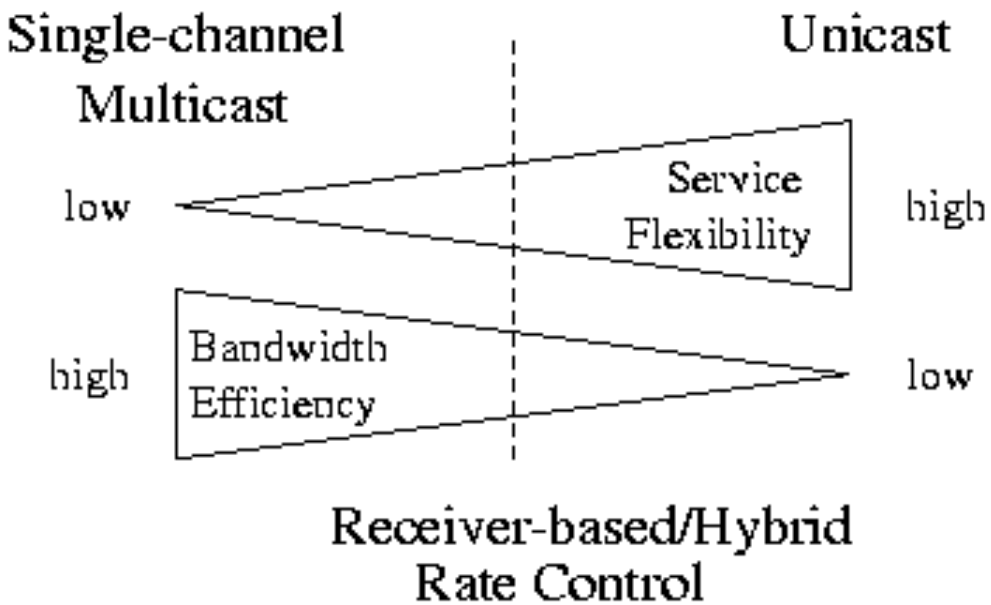
Rate control

# Source-based Rate Control



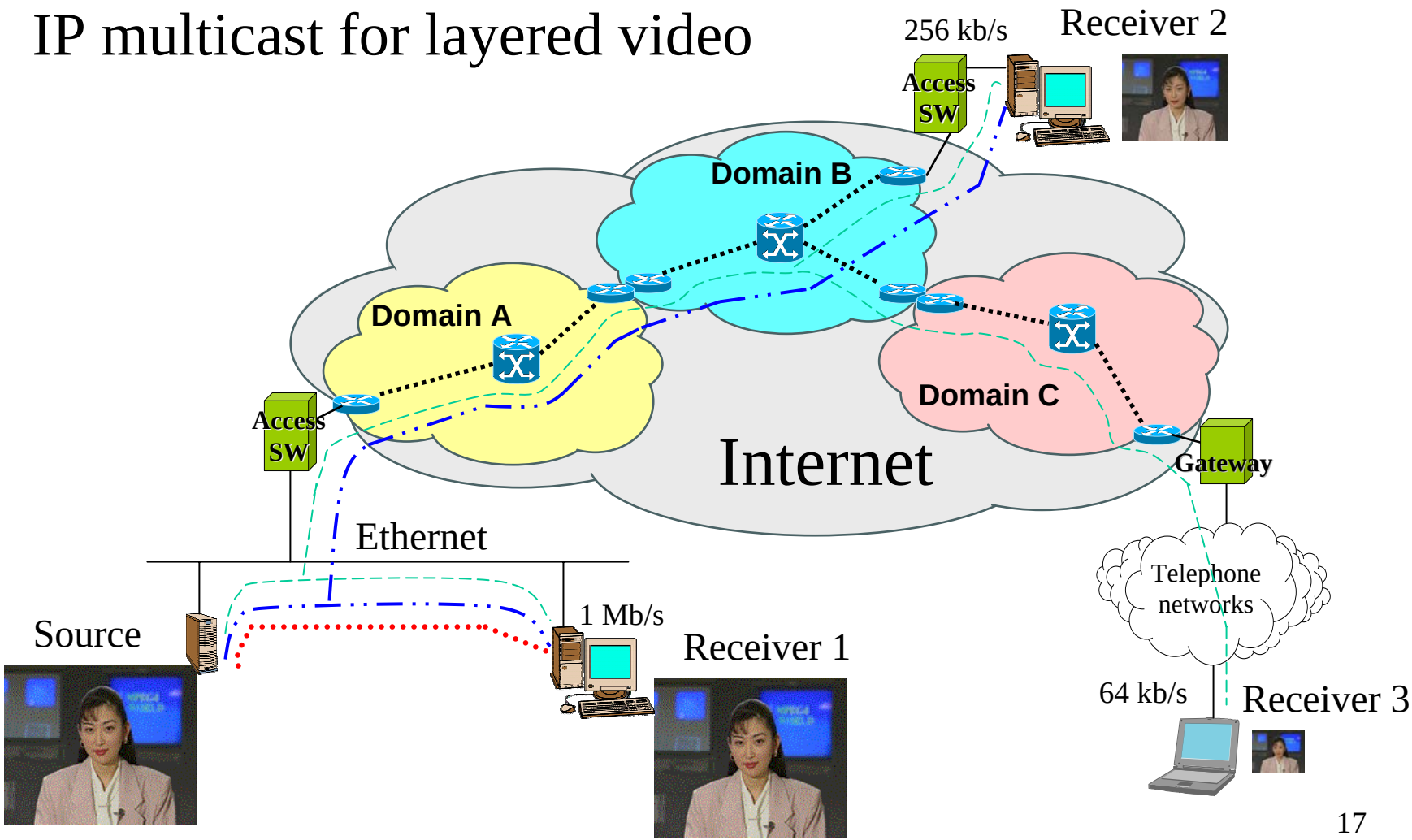
# Video Multicast

- How to extend source-based rate control to multicast?
- Limitation of source-based rate control in multicast
- Trade-off between bandwidth efficiency and service flexibility



# Receiver-based Rate Control

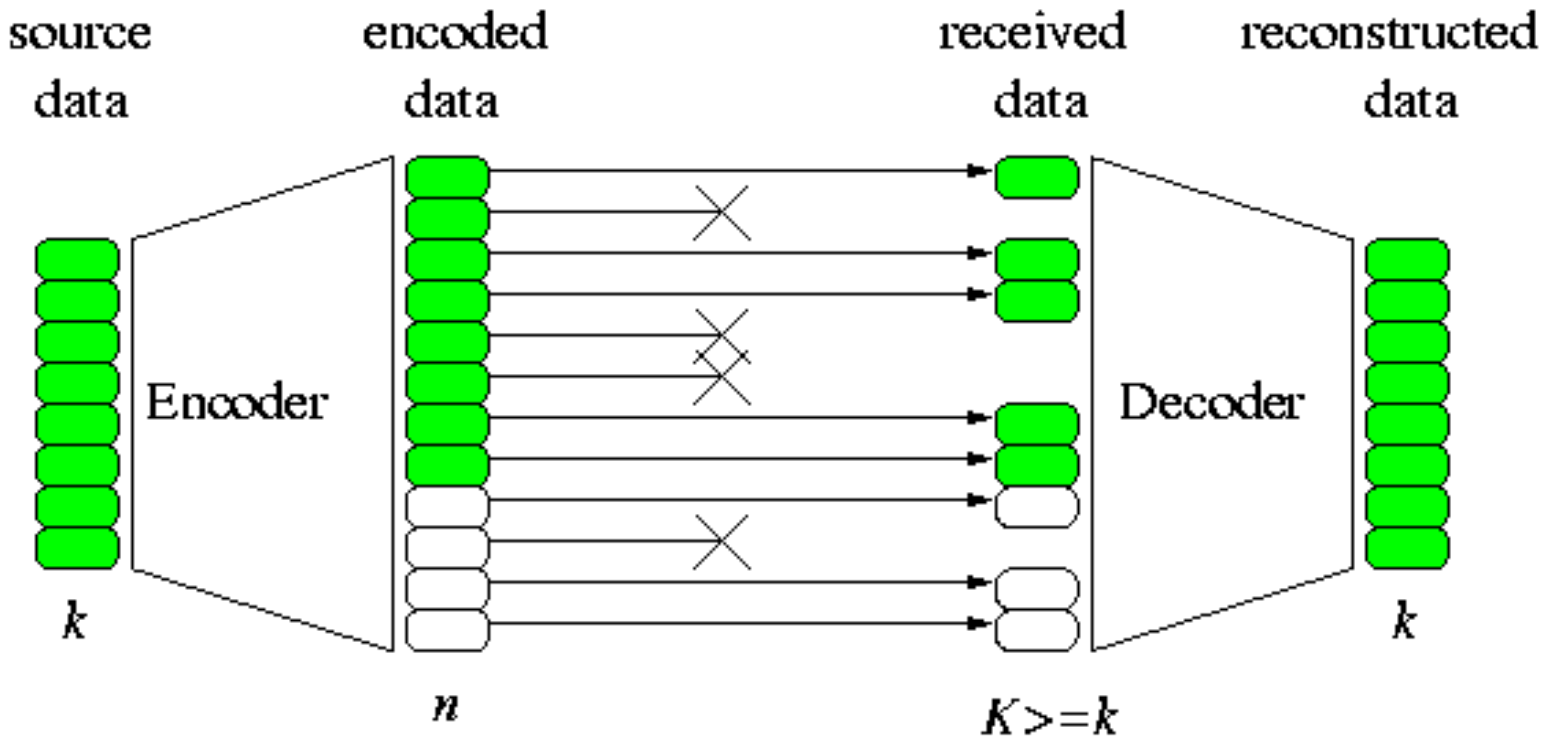
IP multicast for layered video



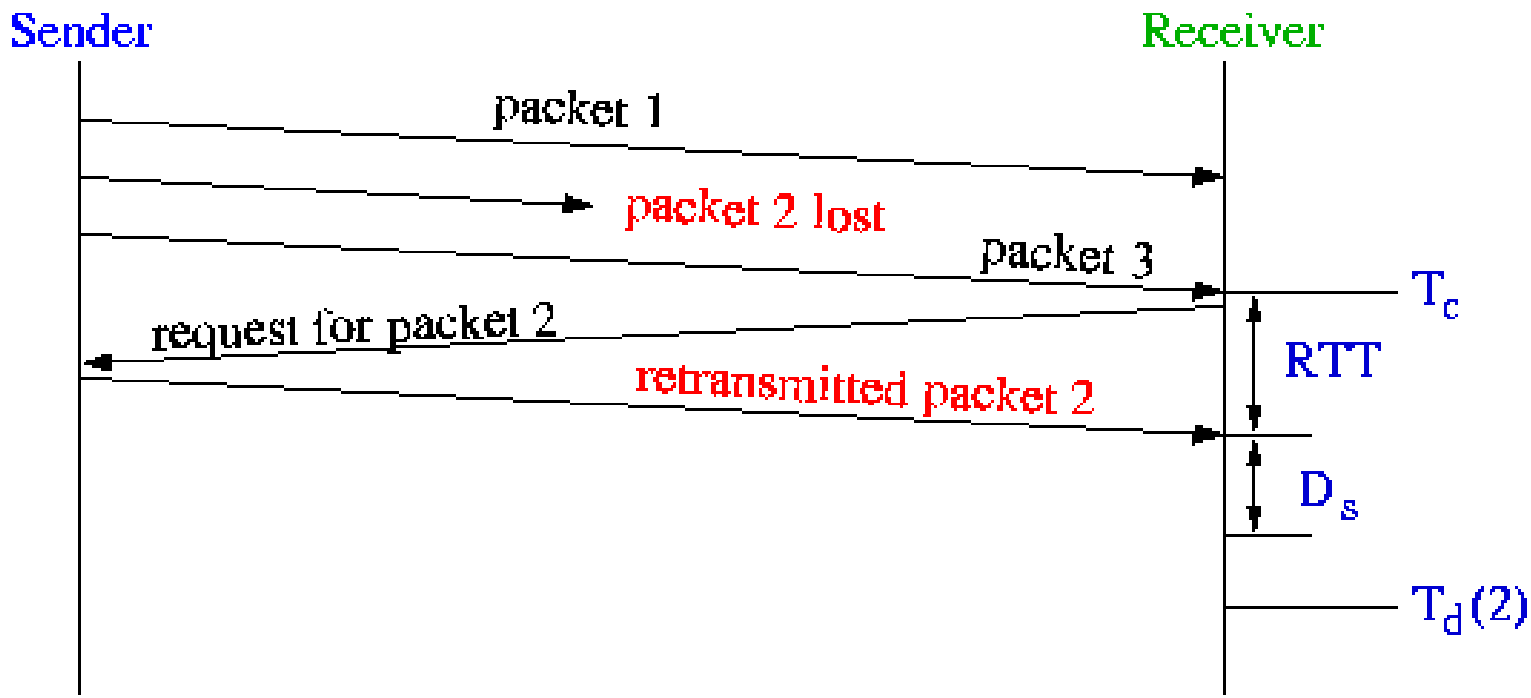
# Error Control

- FEC
  - Channel coding
  - Source coding-based FEC
  - Joint source/channel coding
- Delay-constrained retransmission
- Error resilient compression
- Error concealment

# Channel Coding



# Delay-constrained Retransmission



# Outline

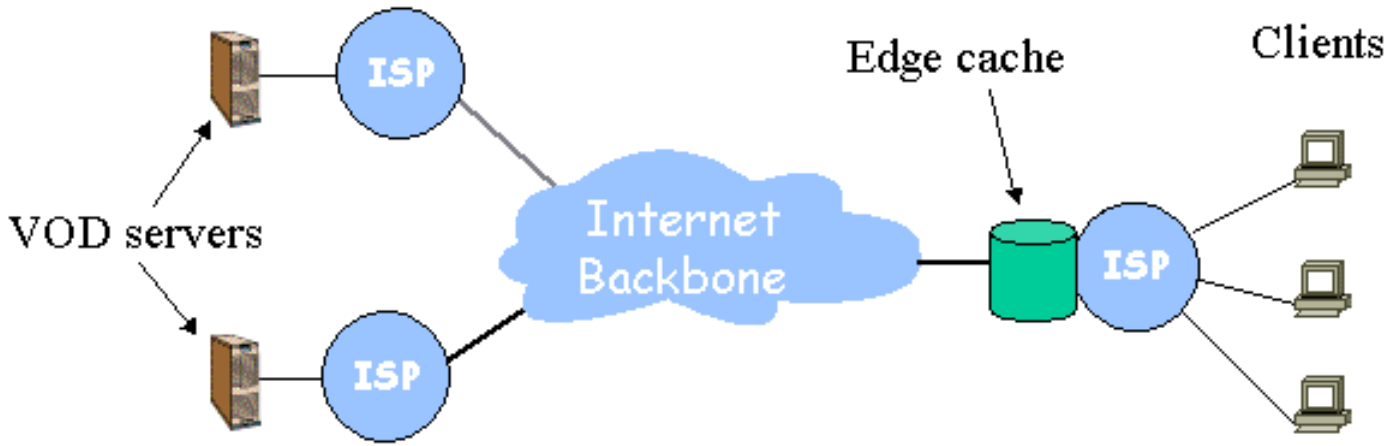
- Challenges for quality video transport
- An architecture for video streaming
  - Video compression
  - Application-layer QoS control
  - Continuous media distribution services
  - Streaming server
  - Media synchronization mechanisms
  - Protocols for streaming media
- Summary

# Continuous Media Distribution Services

- Content replication (caching & mirroring)
- Network filtering/shaping/thinning
- Application-level multicast (overlay networks)

# Caching

- What is caching?
- Why using caching? WWW means World Wide Wait?
- Pros and cons?




VOD: video-on-demand
ISP: Internet service provider

# Outline

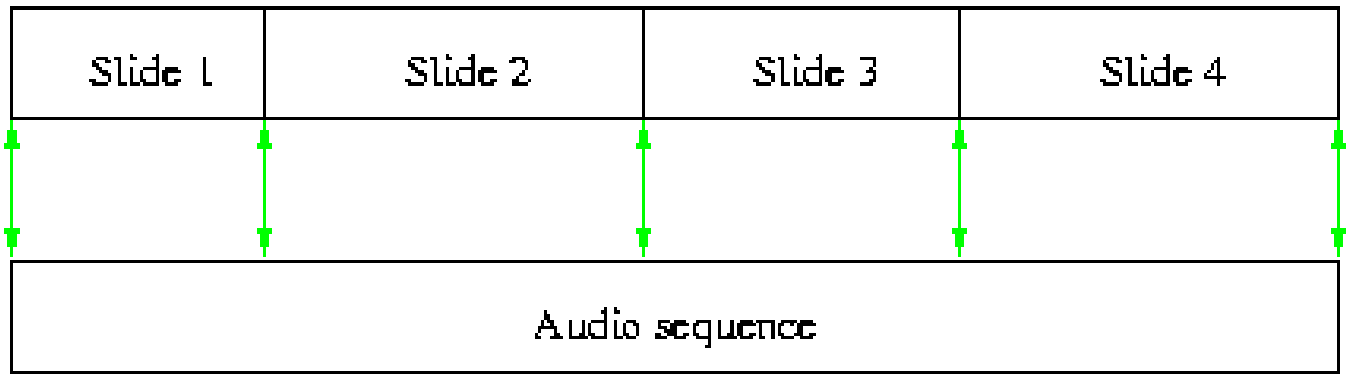
- Challenges for quality video transport
- An architecture for video streaming
  - Video compression
  - Application-layer QoS control
  - Continuous media distribution services
  - Streaming server
  - Media synchronization mechanisms
  - Protocols for streaming media
- Summary

# Streaming Server

- Different from a web server
  - Timing constraints
  - Video-cassette-recorder (VCR) functions (e.g., fast forward/backward, random access, and pause/resume).
- Design of streaming servers
  - Real-time operating system
  - Special disk scheduling schemes

# Media Synchronization

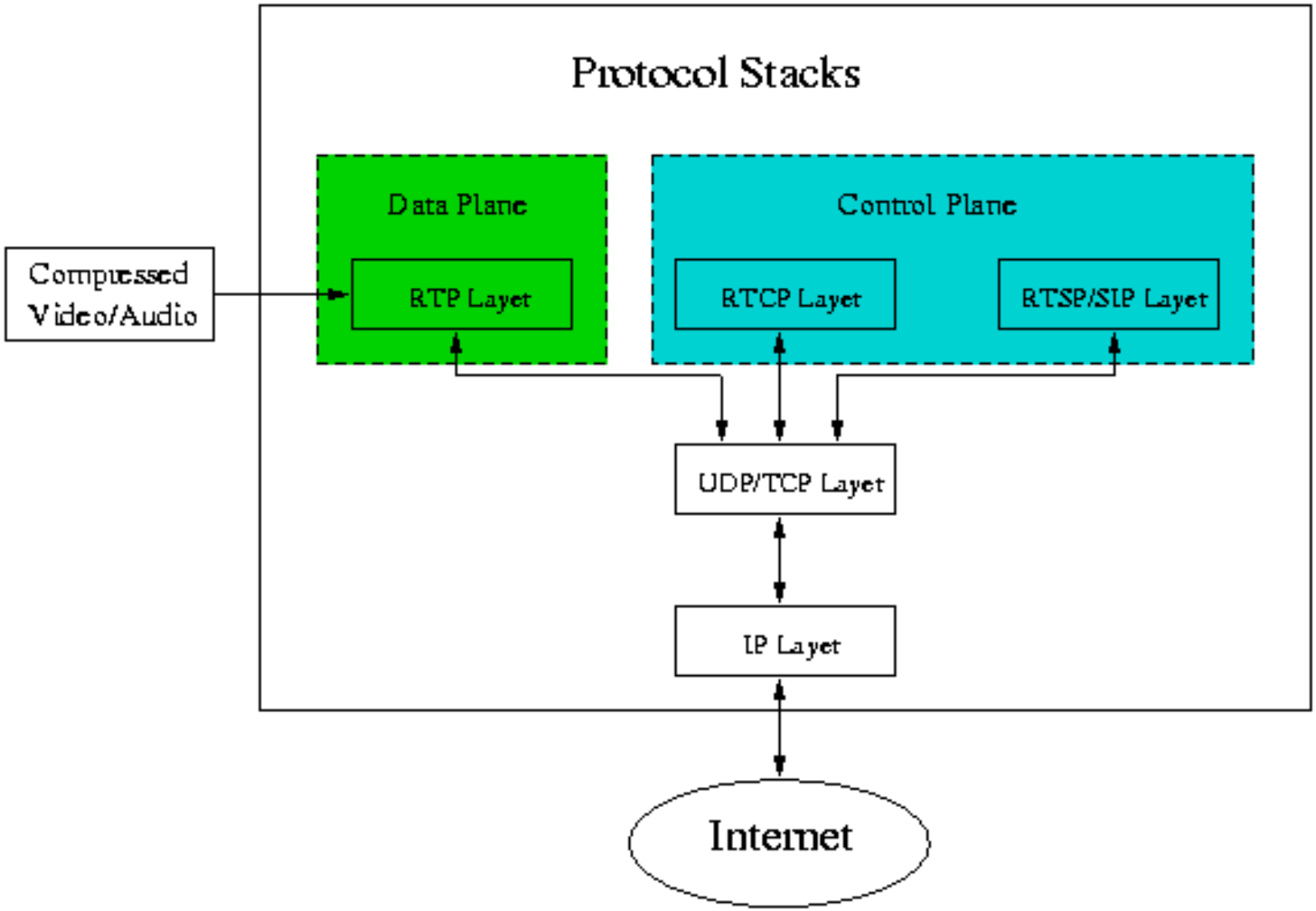
- Why media synchronization?
- Example: lip-synchronization (video/audio)



# Protocols for Streaming Video

- Network-layer protocol: Internet Protocol (IP)
- Transport protocol:
  - Lower layer: UDP & TCP
  - Upper layer: Real-time Transport Protocol (RTP) & Real-Time Control Protocol (RTCP)
- Session control protocol:
  - Real-Time Streaming Protocol (RTSP): RealPlayer
  - Session Initiation Protocol (SIP): Microsoft Windows MediaPlayer; Internet telephony

# Protocol Stacks



# Summary

- Challenges for quality video transport
  - Time-varying available bandwidth
  - Time-varying delay
  - Packet loss
- An architecture for video streaming
  - Video compression
  - Application-layer QoS control
  - Continuous media distribution services
  - Streaming server
  - Media synchronization mechanisms
  - Protocols for streaming media

# Homework

- Reading assignment: Chap. 15