CS 414 – Multimedia Systems Design
Lecture 15 – Multimedia Transport Subsystem (Part 2)

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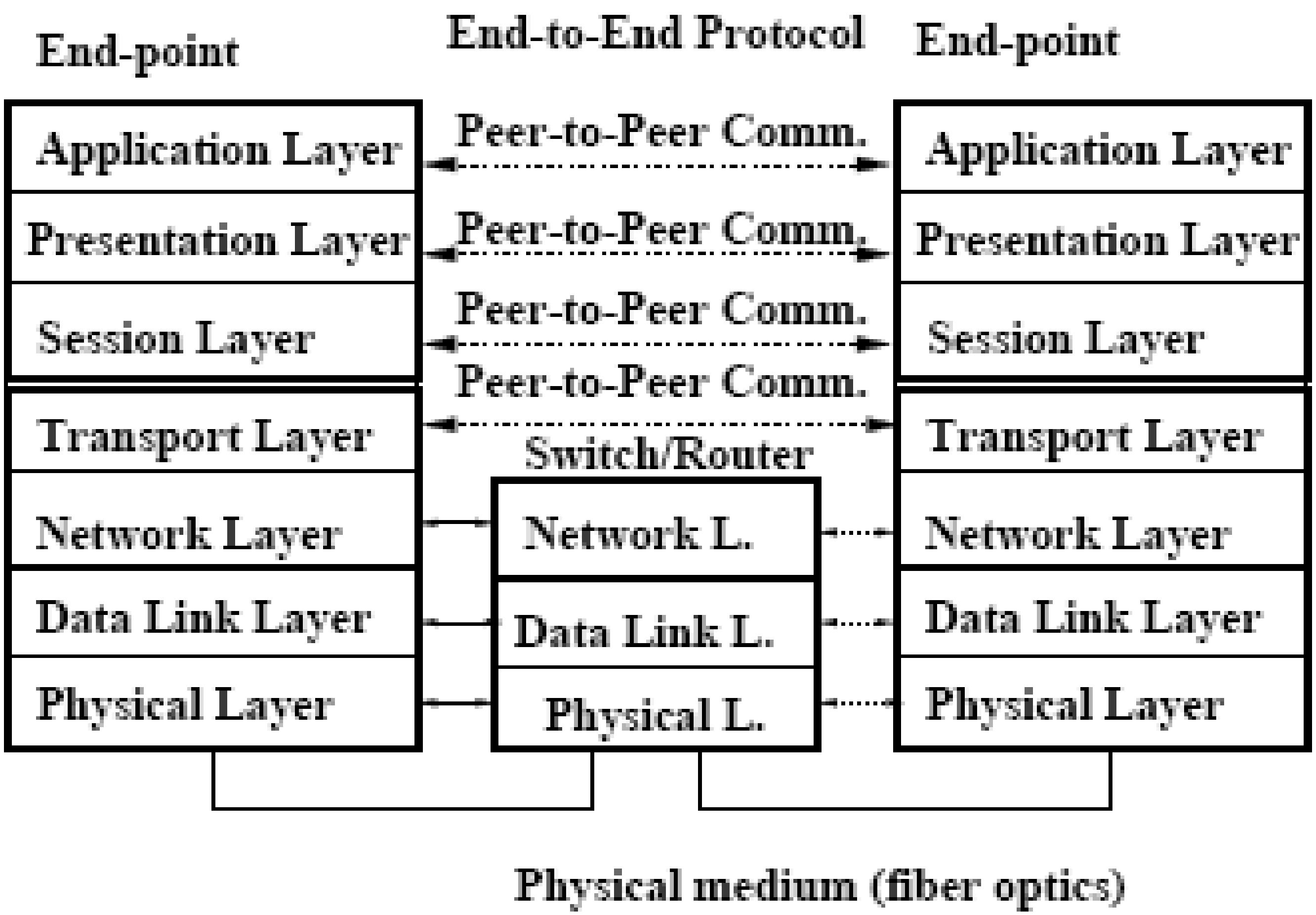
Administrative

- Discussion Section II for MP2 on Monday, 2/18, 2008 (3405 SC), 6pm

OSI (Open System Internconnection) Layering Standard



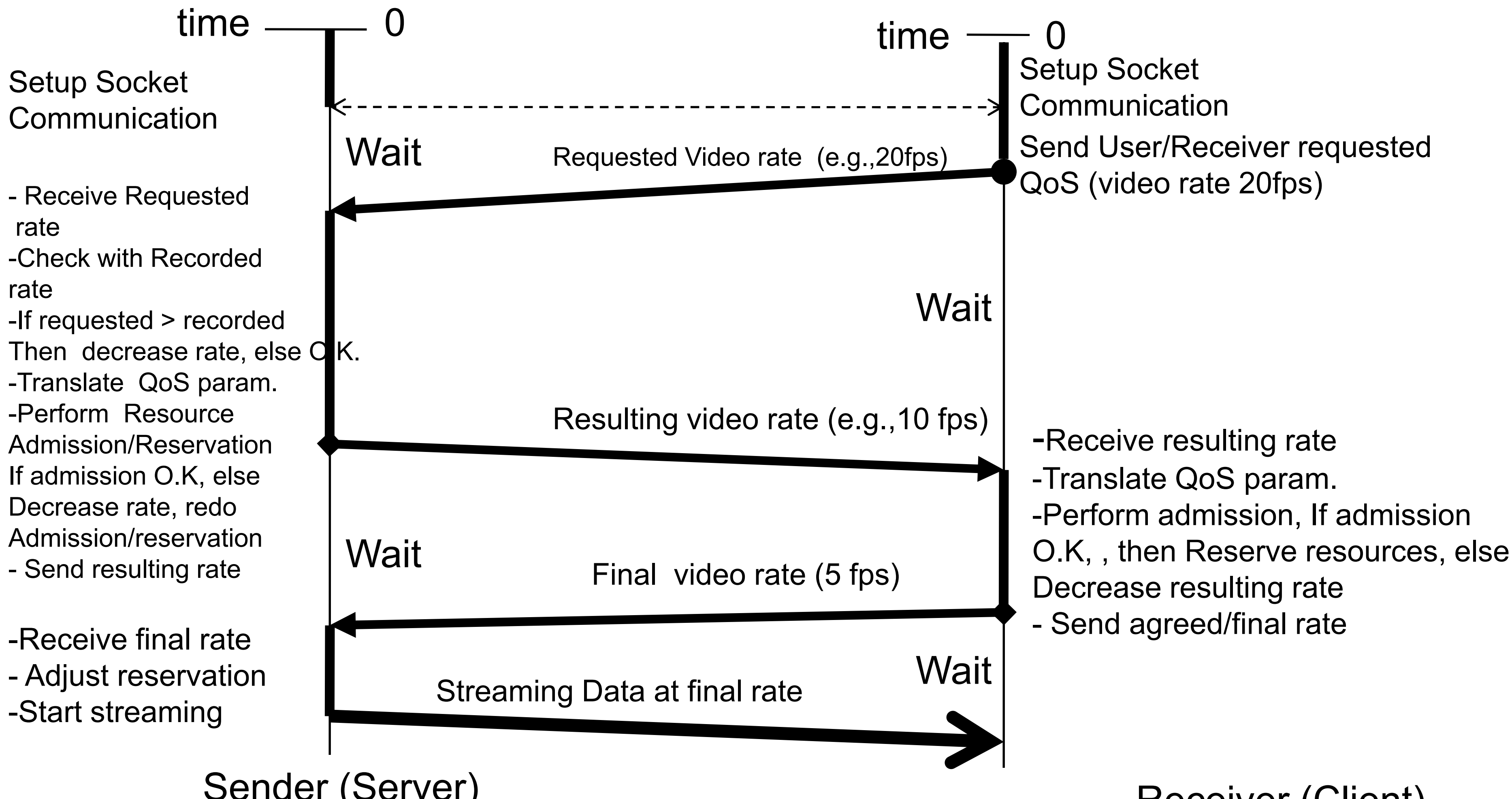
Network QoS and Resource Management

- Network QoS parameters:
  - End-to-end delay, jitter, packet rate, burst, throughput, packet loss
- Establishment Phase Protocol to establish **Multimedia Call**:
  1. Application/user defines QoS parameters
  2. QoS parameters are distributed and negotiated among participating parties
  3. QoS parameters are translated between different layers
  4. QoS parameters are mapped to resource requirements
  5. Required resources are admitted, reserved and allocated along the path between sender and receiver(s)

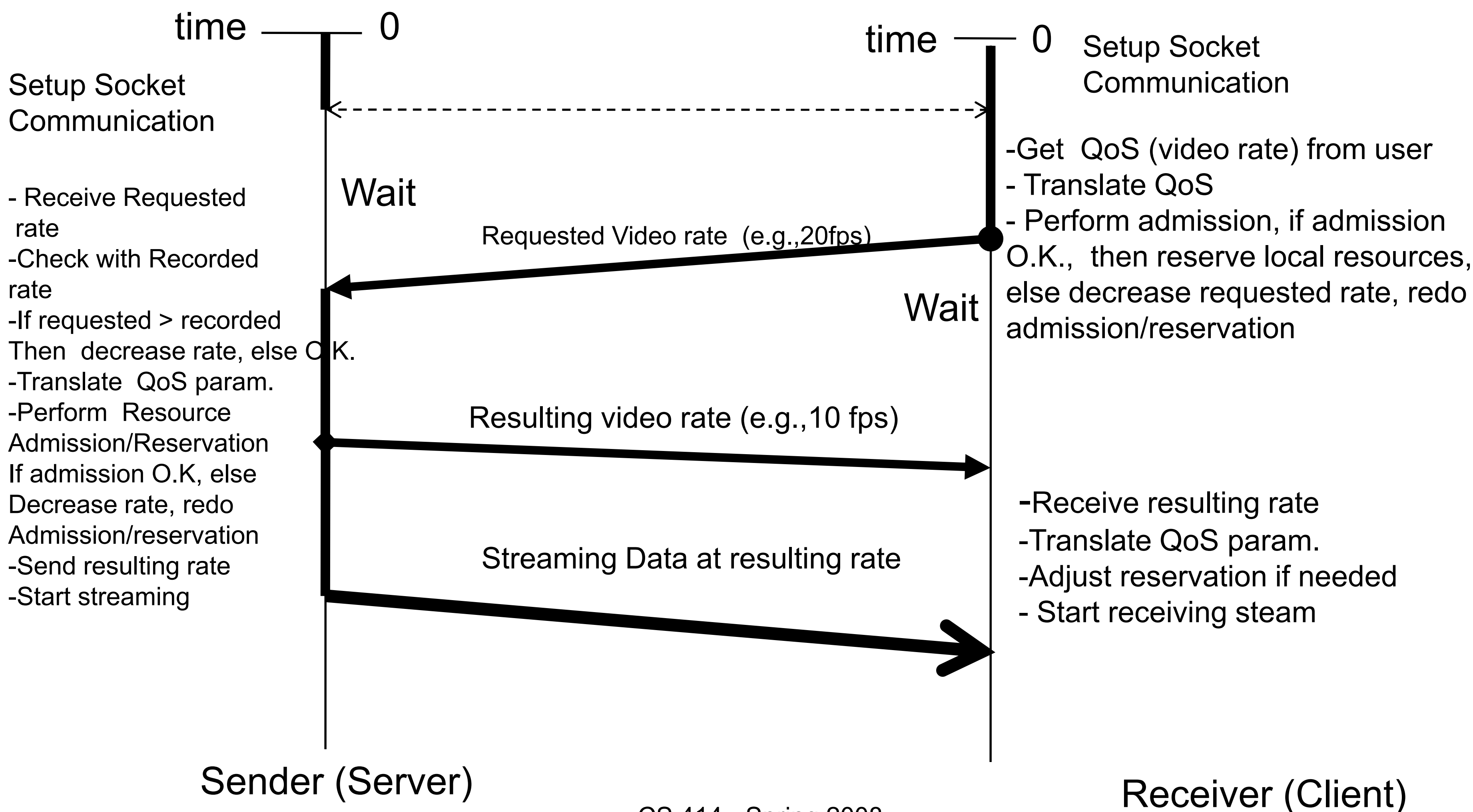
Negotiation and Translation

- For negotiation of network QoS we may use
  - Peer-to-peer negotiation and triangular negotiation (if service provider allows for negotiation)
- Translation between network and application QoS

Negotiation Protocol
(P2P Receiver-Initiated Negotiation – Example1)

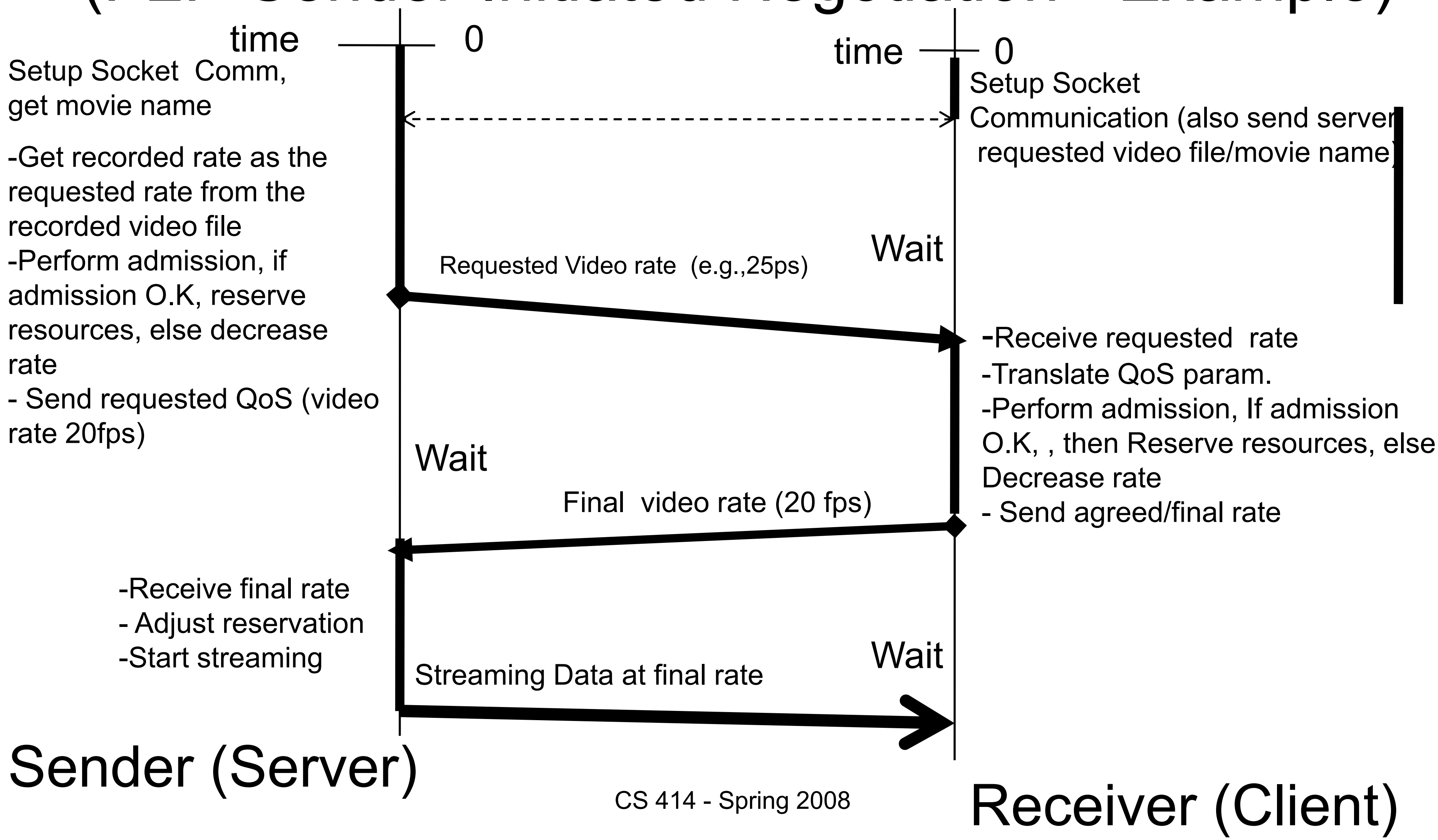


Negotiation Protocol
(P2P Receiver-Initiated Negotiation – Example2)



Negotiation Protocol

(P2P Sender-Initiated Negotiation - Example)



Example of Translation

- Consider application QoS (frame size M_A, frame rate R_A) and network QoS (throughput B_N, packet rate R_N)
- Assume
  - M_A = (320x240 pixels, 1 pixel = 8 bits),
  - R_A = 10 fps, packet size
  - M_N = 4KBytes
- Application Throughput:
  - $B_A = M_A \times R_A$ = (320 x 240 x 8) x 10 = 6,144,000 bps
- Packet rate:
  - $R_N = (\lceil M_A / M_N \rceil) \times R_A$ = 190 packets per second
- Network Throughput:
  - $B_N = M_N \times R_N$ = 6,225,920 bps

Admission Control

- Throughput QoS parameter maps to bandwidth resource
- Packet rate maps to scheduling resource
- Error rate maps to buffer resources

Bandwidth Admission Test

- Consider
  - b_i – reserved bandwidth for the 'i' connection
  - B_{max} – maximal bandwidth at the network interface
- Admission test (if all connections declare their bandwidth requirements b_i at the same time):
  - $\sum_{(i=1,\ldots n)} b_i \leq B_{max}$

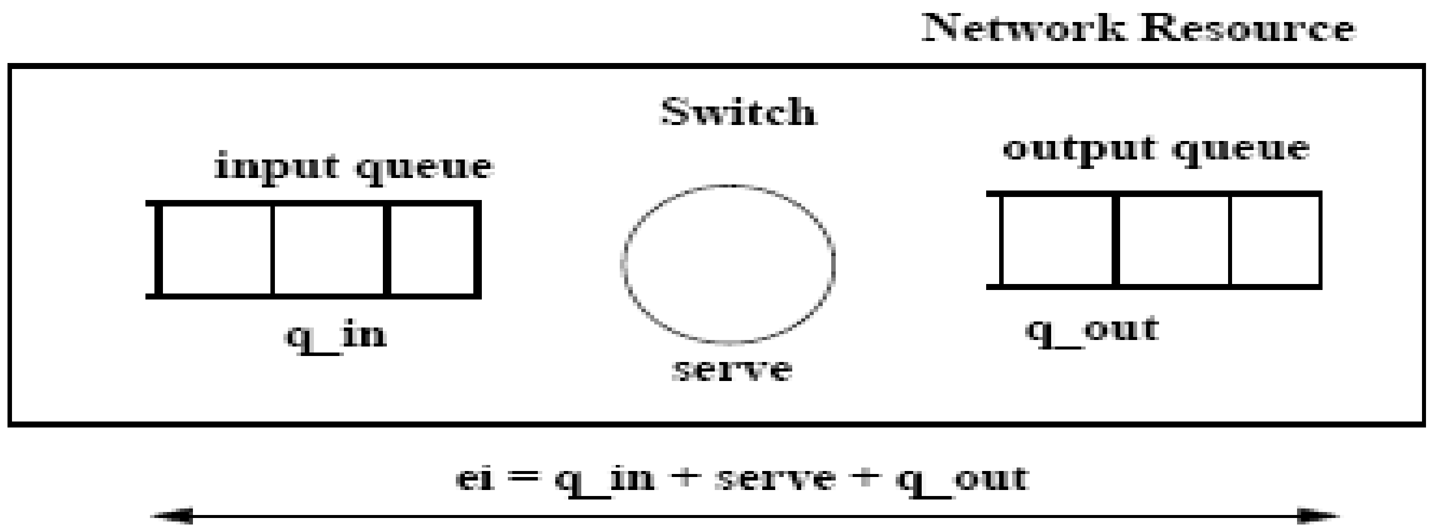
Bandwidth Admission

- Admission Test (if requests come in iterative fashion) :
- Consider
  - b_i^{alloc} – bandwidth already admitted, allocated and promised to connection *'i'*
  - b_j^{req} – bandwidth requested by connection *'j'*
  - $B_{avail} = B_{max} - \sum_{(i=1,..n)} b_i^{alloc}$, where $i \neq j$
- Admission Test:
  - $b_j^{req} \leq B_{avail}$

Packet Scheduling Admission

- At switches/routers – packet scheduling decision needs to be made when admitting new streams of packets
- Need packet schedulability tests
  - Note that in networking only NON-PREEMPTIVE scheduling exists!!!

Packet Scheduling Admission



e_i – processing of a packet 'i' in network node

Admission Test:

$e_i \leq$ deadline (within a switch)

$\sum_{(i=1,\ldots,n)} serve_i / (1/r) \leq 1$

serve – packet service time at the processors – constant time due to hardware implementation

q_in and *q_out* are variable

$q = N/\lambda$ (Little Theorem)

r – service rate of the switch

Network Resource Reservation/Allocation

- Bandwidth reservation
  - Pessimistic reservation with maximal bandwidth allocation: Given (M_N, R_A, *and* M_A)
    - if $M_A = \max_{i=1,..n}(M_A^i)$ then

$$B_N = M_N \times (\lceil M_A / M_N \rceil) \times R_A$$

Pessimistic Resource Reservation (Example)

- Example: Consider sequence of MPEG video frames of size 80KB, 60 KB, 20KB, 20 KB, 60KB, 20 KB, 20 KB (Group of Pictures I, P, B, B, P, B, B),
- Pessimistic frame size calculation:
  - M_A = max(80, 60, 20, 20, 60, 20, 20) = 80KB
- Given video frame rate RA = 20 fps
- If Given MN = 10 KB (network packet size, e.g., packet size for the transport layer like TCP/UDP), then need to consider bandwidth/ throughput reservation for
  - BN = 10KB x (8 network packets per application frame) x 20 application frames per second= 1600 KB/second = 12800 Kbps

Optimistic Resource Reservation/Allocation

- Optimistic reservation considers average bandwidth allocation
- Given MA, RA, MN, where

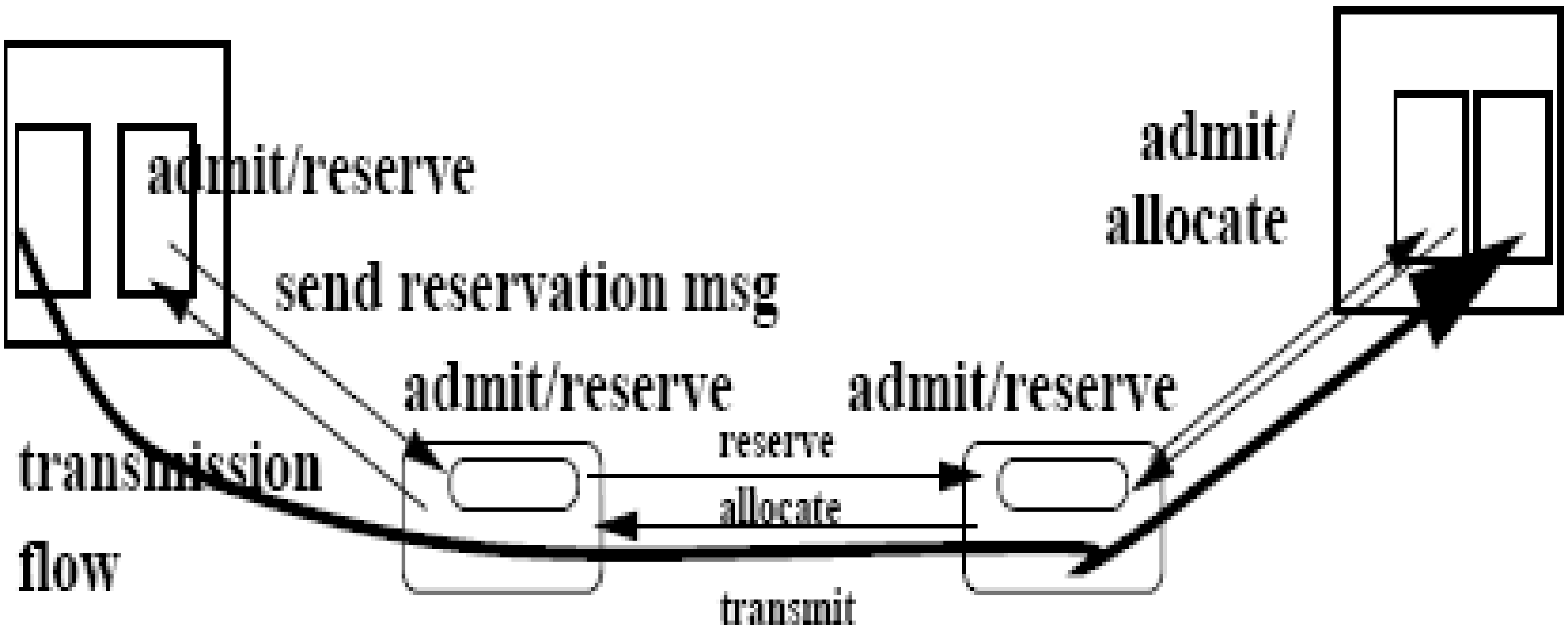
$$M_A = (1/n \times \sum_{i=1}^{n} M_A^i)$$

- Then $$B_N = M_N \times (\left\lceil \frac{M_A}{M_N} \right\rceil) \times R_A$$

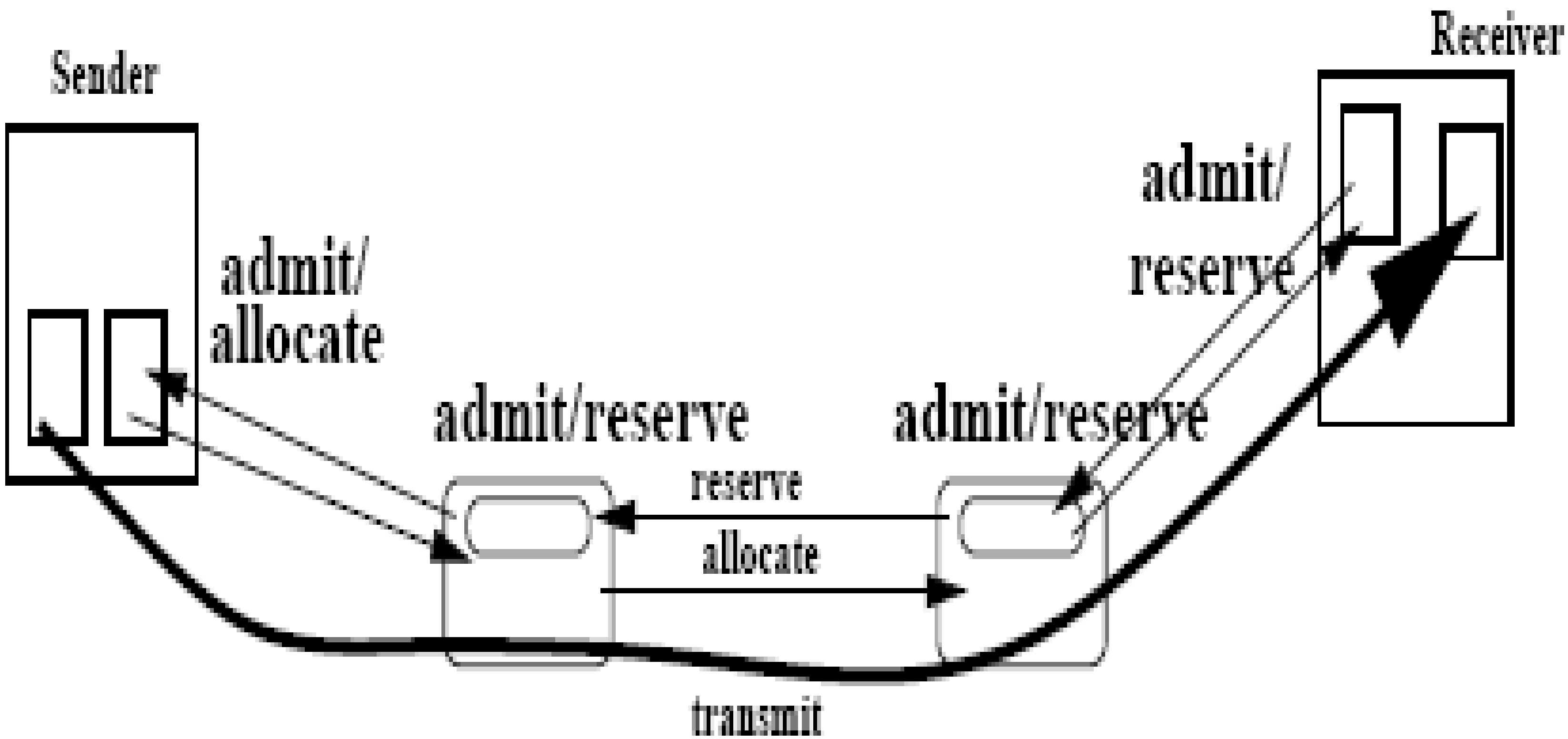
Optimistic Resource Reservation (Example)

- Example: Consider sequence of MPEG video frames of size 80KB, 60 KB, 20KB, 20 KB, 60KB, 20 KB, 20 KB (Group of Pictures I, P, B, B, P, B, B,),
- Optimistic frame size calculation:
  - M_A = 280/7 = 40 KB
- Given video frame rate RA = 20 fps
- If Given MN = 10 KB (network packet size, e.g., packet size for the transport layer like TCP/UDP), then need to consider bandwidth/ throughput reservation for
  - BN = 10KB x (4 network packets per application frame) x 20 application frames per second= 800 KB/second = 6400 Kbps

Sender-Oriented Reservation Protocol



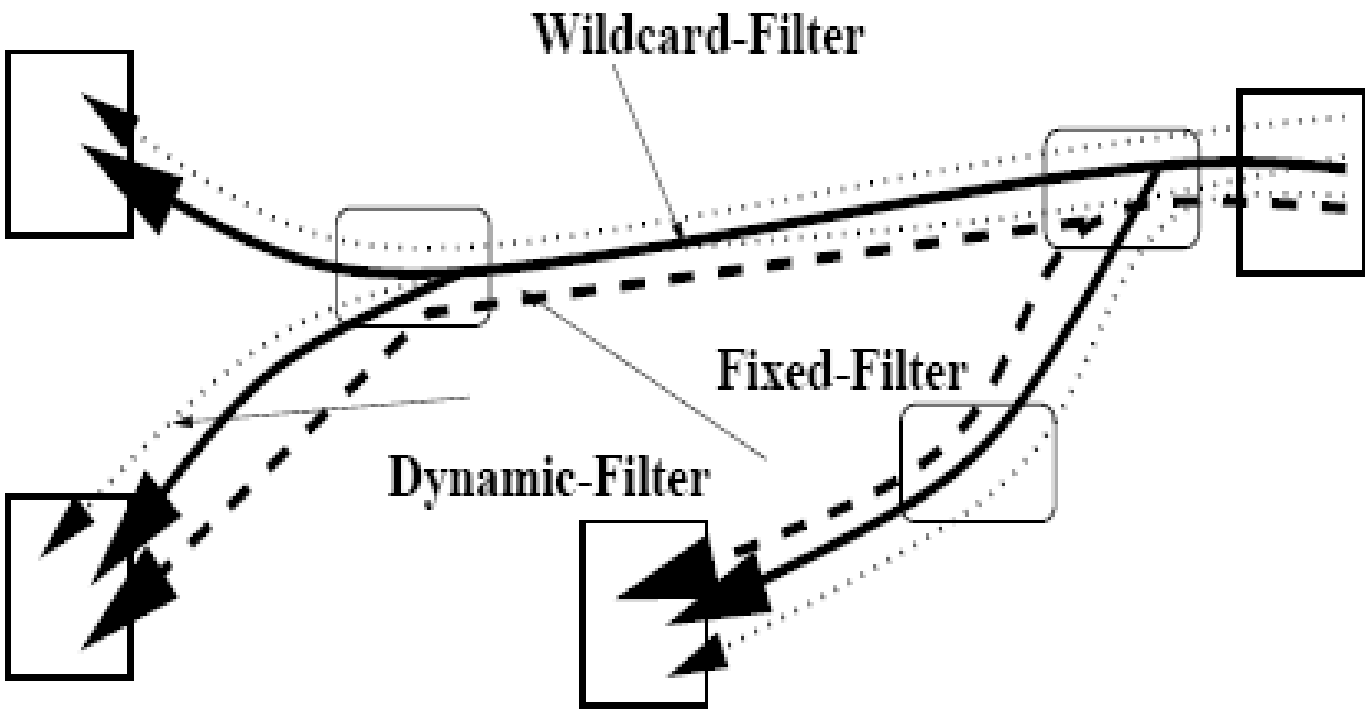
Receiver-Oriented Reservation Protocol



Reservation Styles

- IETF (Internet Engineering Task Force) standard defines three types of reservation styles
  - Wildcard
    - Allows receiver to create a single reservation along each link shared among all senders for the given session
  - Fixed filter
    - Allows each receiver to create a single reservation from a particular sender whose packets it wants to receive
  - Dynamic filter
    - Allows each receiver to create N reservations to carry flows from up to N different senders. This style allows the receiver to do channel switching (similar to TV channel switching)

Reservation Styles



Conclusion

- Important set of services and protocols for establishment of multimedia calls/sessions
- Different network technologies adopt different establishment approaches, so one has to dig into the standard protocol to see which
  - Negotiation and translation
  - Admission and reservation protocols/services the standard adopts