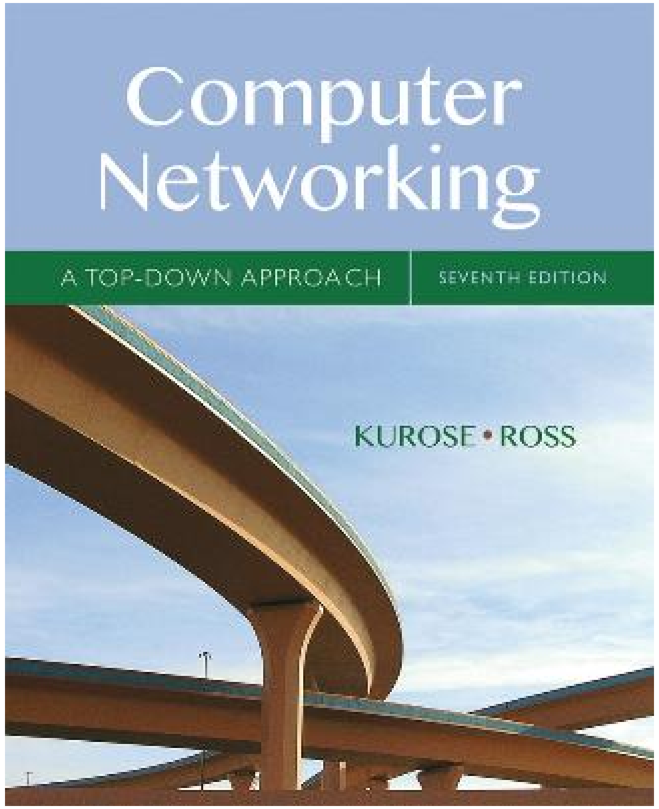
شبکه های کامپیوتری ۲

جلسه ۱۶ فصل ۹

Scheduling and Policing Mechanisms

دانشگاه صنعتی اصفهان
دانشکده مهندسی برق و کامپیوتر

Chapter 9
Multimedia Networking



Computer Networking: A Top Down Approach

7th edition
Jim Kurose, Keith Ross
Pearson/Addison Wesley
April 2016

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Thanks and enjoy! JFK/KWR

Multimedia networking: outline

9.1 multimedia networking applications

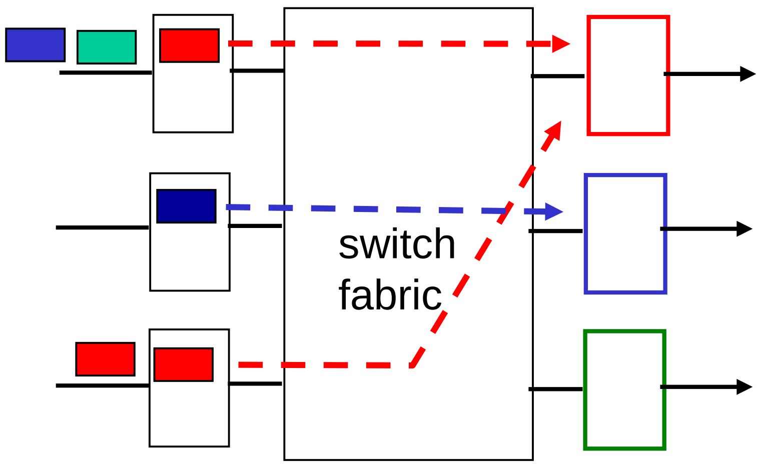
9.2 streaming *stored* video

9.3 voice-over-IP

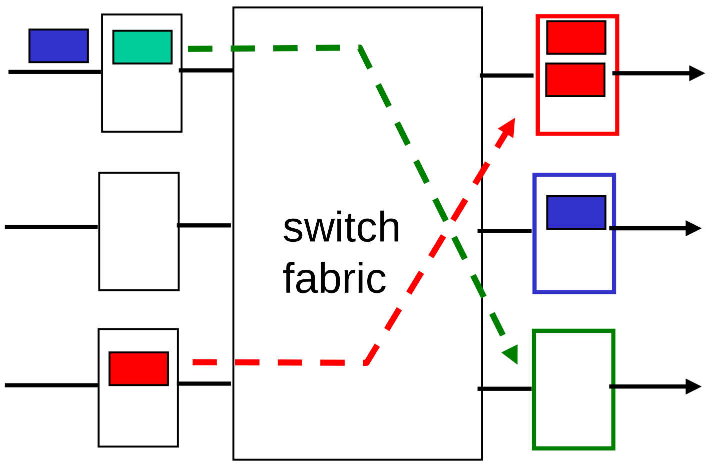
9.4 protocols for *real-time* conversational applications

9.5 network support for multimedia

Output port queueing



at *t,* packets more from input to output

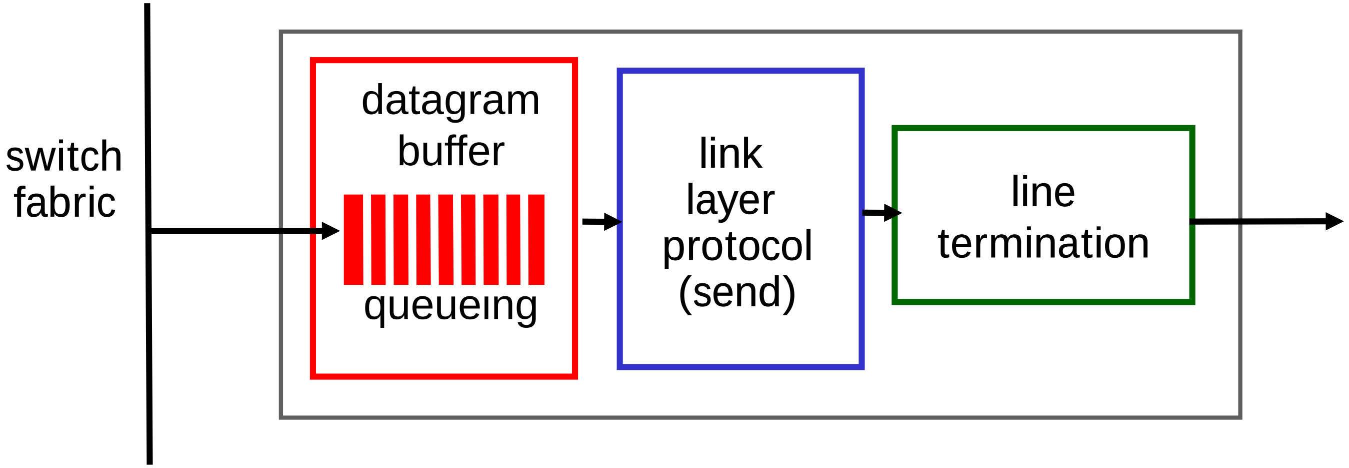


one packet time later

- buffering when arrival rate via switch exceeds output line speed
- *queueing (delay) and loss due to output port buffer overflow!*

Output ports

This slide in HUGELY important!



- *buffering* required when datagrams arrive from fabric faster than the transmission rate

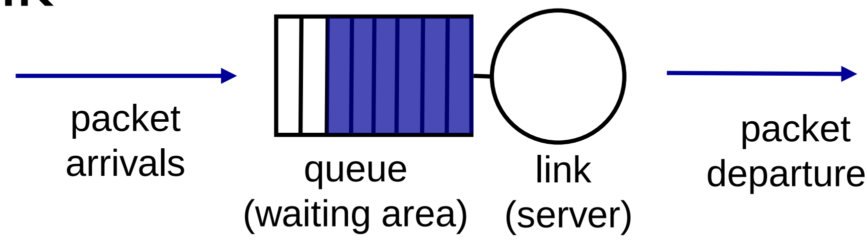
Datagram (packets) can be lost due to congestion, lack of buffers

- *scheduling discipline* chooses among queued datagrams for transmission

Priority scheduling – who gets best performance, network neutrality

Scheduling and policing mechanisms

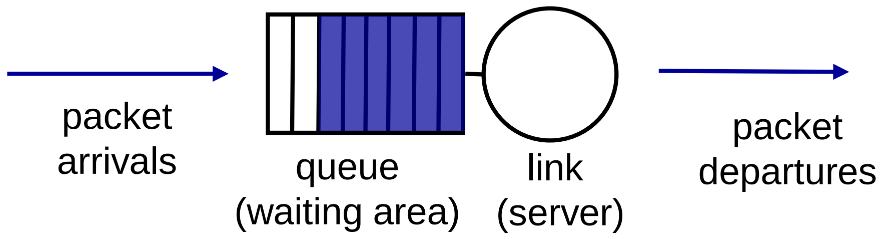
- *packet scheduling:* choose next queued packet to send on outgoing link



  - FCFS: first come first served
  - simply multi-class priority
  - round robin
  - weighted fair queueing (WFQ)

Scheduling mechanisms

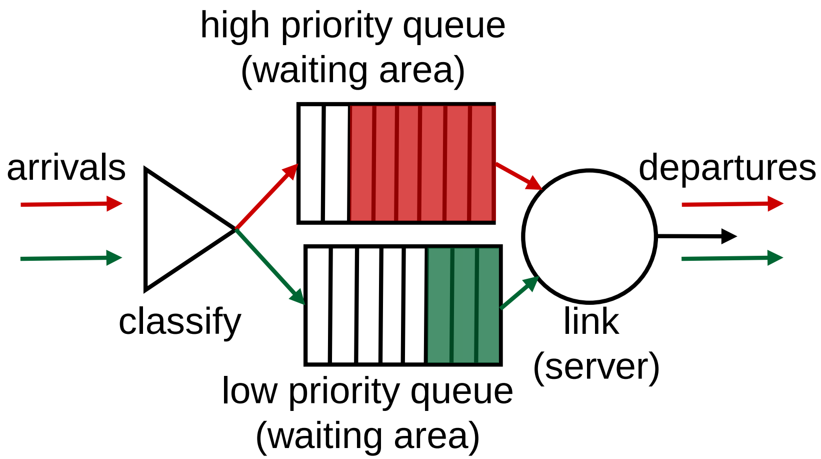
- *scheduling:* choose next packet to send on link
- *FIFO (first in first out) scheduling:* send in order of arrival to queue
  - real-world example?
  - *discard policy:* if packet arrives to full queue: who to discard?
    - *tail drop:* drop arriving packet
    - *priority:* drop/remove on priority basis
    - *random:* drop/remove randomly

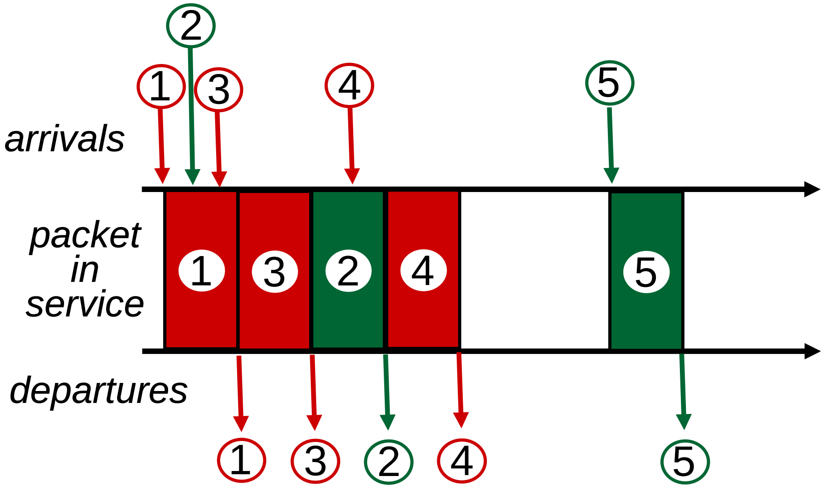


Scheduling policies: priority

priority scheduling: send highest priority queued packet

- multiple *classes*, with different priorities
  - class may depend on marking or other header info, e.g. IP source/dest, port numbers, etc.
  - real world example?

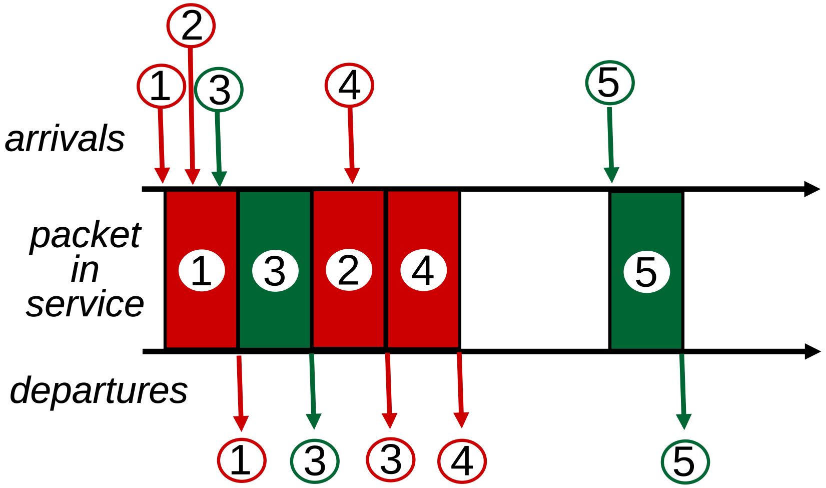




Scheduling policies: still more

Round Robin (RR) scheduling:

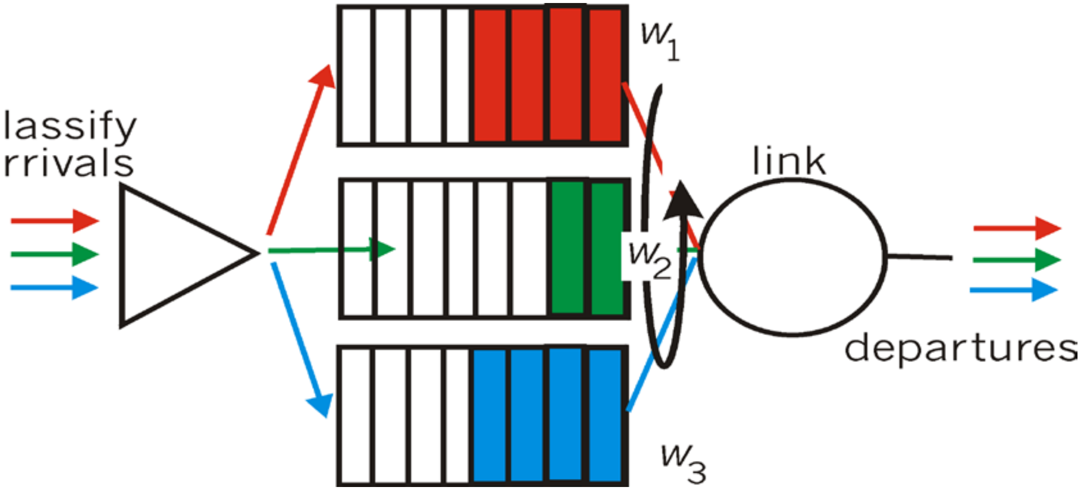
- multiple classes
- cyclically scan class queues, sending one complete packet from each class (if available)
- real world example?



Scheduling policies: still more

Weighted Fair Queuing (WFQ):

- generalized Round Robin
- each class gets weighted amount of service in each cycle
- real-world example?



Policing mechanisms

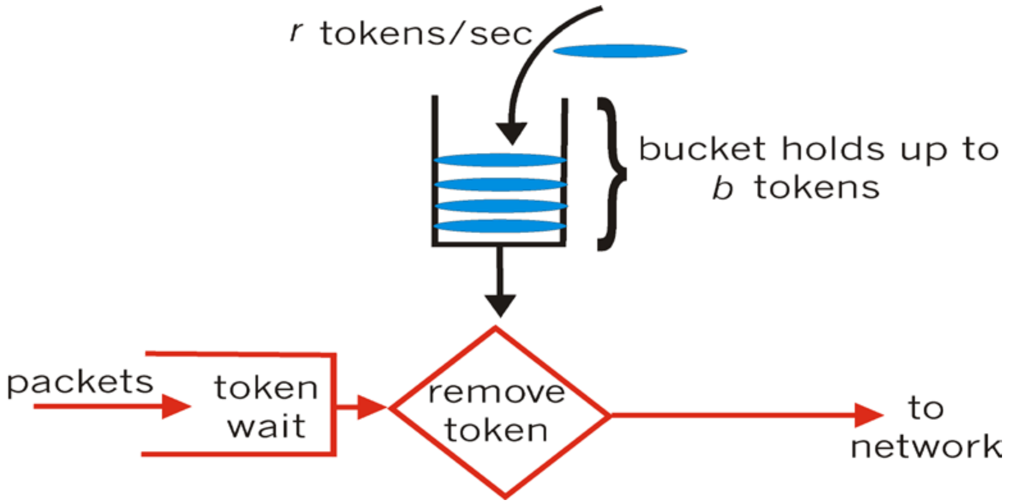
goal: limit traffic to not exceed declared parameters

Three common-used criteria:

- *(long term) average rate:* how many pkts can be sent per unit time (in the long run)
  - crucial question: what is the interval length: 100 packets per sec or 6000 packets per min have same average!
- *peak rate:* e.g., 6000 pkts per min (ppm) avg.; 1500 ppm peak rate
- *(max.) burst size:* max number of pkts sent consecutively (with no intervening idle)

Policing mechanisms: implementation

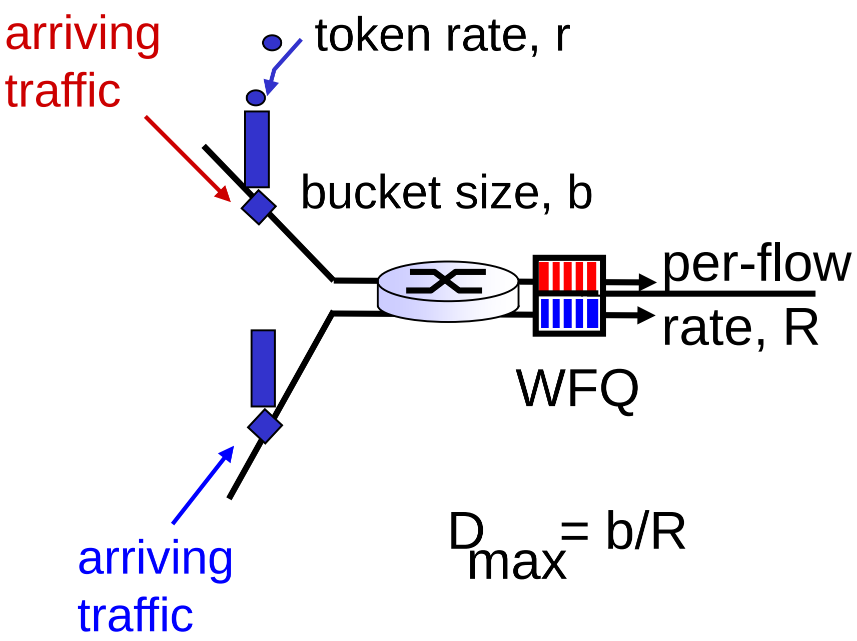
token bucket: limit input to specified *burst size* and *average rate*



- bucket can hold b tokens
- tokens generated at rate *r token/sec* unless bucket full
- *over interval of length t: number of packets admitted less than or equal to (r t + b)*

Policing and QoS guarantees

- token bucket, WFQ combine to provide guaranteed upper bound on delay, i.e., *QoS guarantee!*



arriving traffic

token rate, r

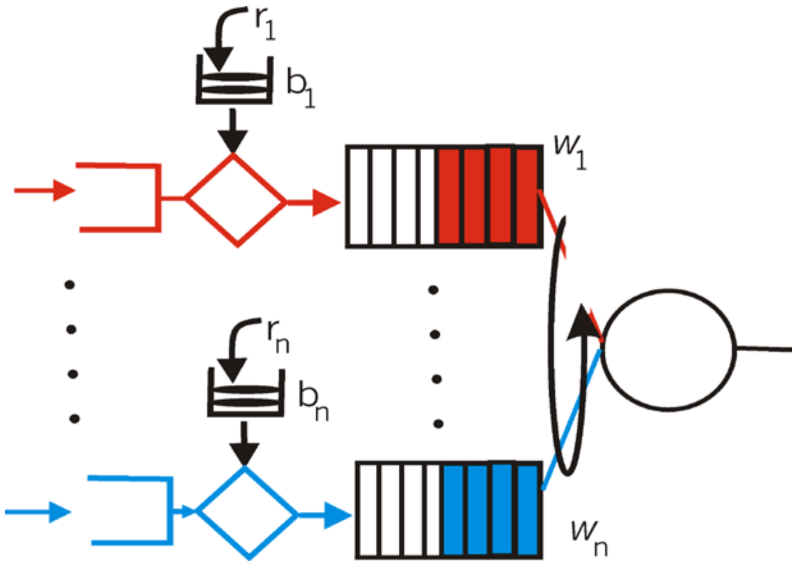
bucket size, b

per-flow rate, R

WFQ

arriving traffic

$D_{max} = b/R$



r_1
b_1
w_1
r_n
b_n
w_n