Link Scheduling & Queuing

COS 461: Computer Networks

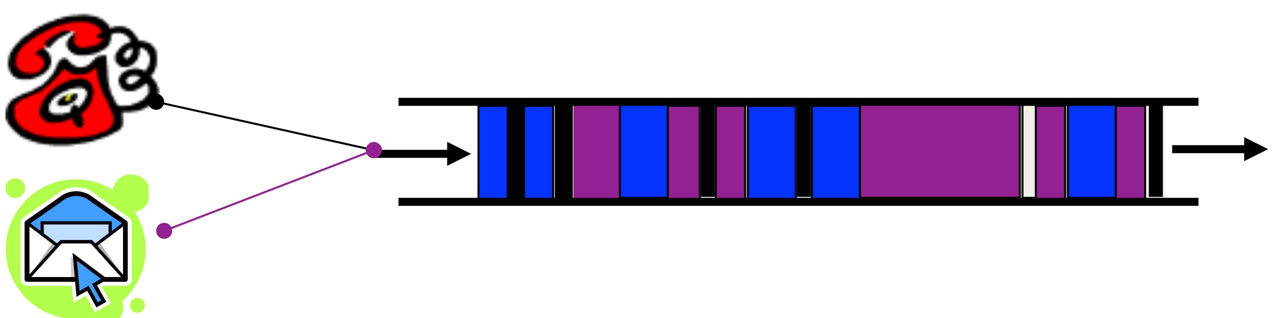
http://www.cs.princeton.edu/courses/archive/spr14/cos461/

Outline

- Link scheduling (not covered on Monday)
- Queuing practice questions
- Miscellanea

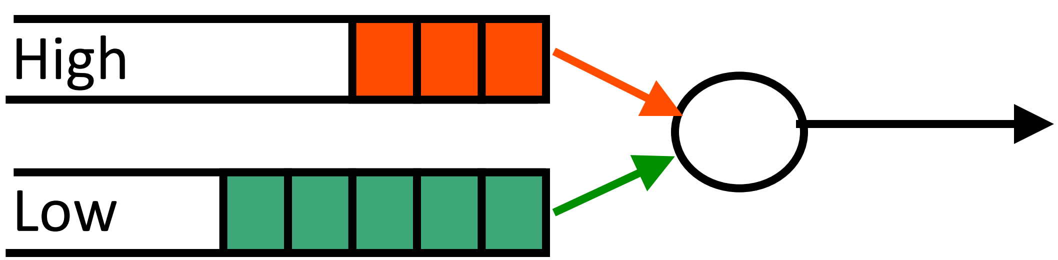
First-In First-Out Scheduling

- First-in first-out scheduling
  - Simple, but restrictive
- Example: two kinds of traffic
  - Voice over IP needs low delay
  - E-mail is not that sensitive about delay
- Voice traffic waits behind e-mail



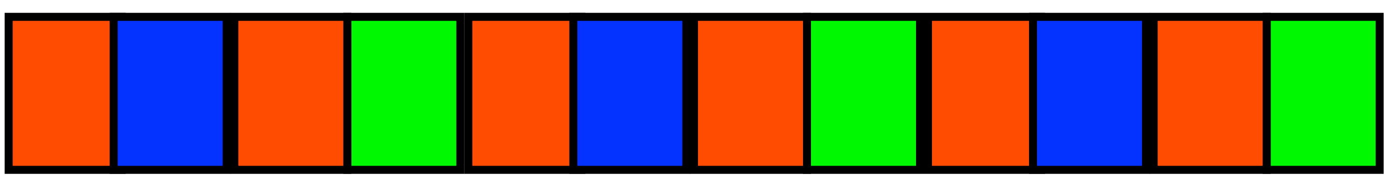
Strict Priority

- Multiple levels of priority
  - Always transmit high-priority traffic when present
- Isolation for the high-priority traffic
  - Almost like it has a dedicated link
    - Except for (small) delay for transmission
- Possible starvation



Weighted Fair Queuing

- Each queue gets a fraction of the link bandwidth
- Rotate across queues on a small time scale
- What if a queue is empty during its time slice?
  - Move on to next queue if *work conserving*



50% red, 25% blue, 25% green

Weighted Fair Queuing

- If non-work conserving
  - Flows get at *most* their allocated weight
- If work-conserving
  - Send extra traffic from one queue if others are idle
  - Bytes, not packets
  - Higher or lower utilization than non-work conserving?
- Results in max-min fairness
  - Maximize the minimum rate of each flow

Implementation Trade-Offs

- FIFO
  - One queue, trivial scheduler
- Strict priority
  - One queue per priority level, simple scheduler
- Weighted fair scheduling
  - One queue per class, and more complex scheduler

For the following questions, assume that these are always coupled with a FIFO scheduling policy.

The **full queue** problem occurs if routers' queues are often full.

The **lockout** problem refers to a situation where a small number of flows monopolize the available queue space on a router.

- Drop-tail solves the full queue problem T/F

For the following questions, assume that these are always coupled with a FIFO scheduling policy.

The **full queue** problem occurs if routers' queues are often full.

The **lockout** problem refers to a situation where a small number of flows monopolize the available queue space on a router.

- Drop-tail solves the full queue problem T/**F**

For the following questions, assume that these are always coupled with a FIFO scheduling policy.

The **full queue** problem occurs if routers' queues are often full.

The **lockout** problem refers to a situation where a small number of flows monopolize the available queue space on a router.

- Drop-tail solves the full queue problem T/**F**
- Random Early Detection (RED) solves the full queue problem T/F

For the following questions, assume that these are always coupled with a FIFO scheduling policy.

The **full queue** problem occurs if routers' queues are often full.

The **lockout** problem refers to a situation where a small number of flows monopolize the available queue space on a router.

- Drop-tail solves the full queue problem T/**F**
- Random Early Detection (RED) solves the full queue problem **T**/F

For the following questions, assume that these are always coupled with a FIFO scheduling policy.

The **full queue** problem occurs if routers' queues are often full.

The **lockout** problem refers to a situation where a small number of flows monopolize the available queue space on a router.

- Drop-tail solves the full queue problem T/**F**
- Random Early Detection (RED) solves the full queue problem **T**/F
- RED solves the lockout problem for TCP flows T/F

For the following questions, assume that these are always coupled with a FIFO scheduling policy.

The **full queue** problem occurs if routers' queues are often full.

The **lockout** problem refers to a situation where a small number of flows monopolize the available queue space on a router.

- Drop-tail solves the full queue problem T/**F**
- Random Early Detection (RED) solves the full queue problem **T**/F
- RED solves the lockout problem for TCP flows **T**/F

1 Drop-tail has fewer burst losses than RED

T/F

1 Drop-tail has fewer burst losses than RED

T/**F**

1 Drop-tail has fewer burst losses than RED

T/**F**

2 Both drop-tail and RED can be used with Explicit Congestion Notification (ECN), so the router can signal congestion to the sender without dropping a packet

T/F

1 Drop-tail has fewer burst losses than RED

T/**F**

2 Both drop-tail and RED can be used with Explicit Congestion Notification (ECN), so the router can signal congestion to the sender without dropping a packet

T/**F**

1 Drop-tail has fewer burst losses than RED

T/**F**

2 Both drop-tail and RED can be used with Explicit Congestion Notification (ECN), so the router can signal congestion to the sender without dropping a packet

T/**F**

3 RED drops every incoming packet with some probability P > 0

T/F

1 Drop-tail has fewer burst losses than RED

T/**F**

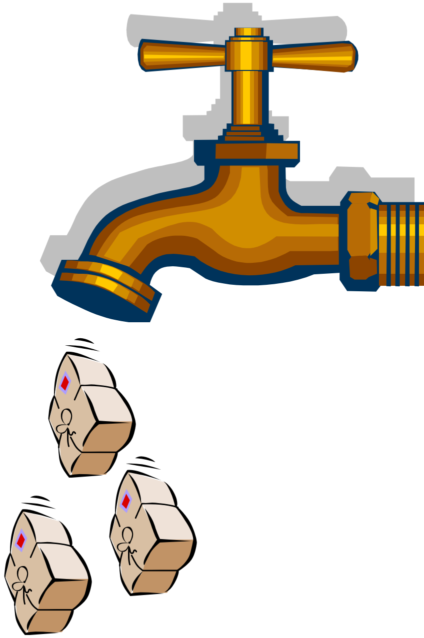
2 Both drop-tail and RED can be used with Explicit Congestion Notification (ECN), so the router can signal congestion to the sender without dropping a packet

T/**F**

3 RED drops every incoming packet with some probability P > 0

T/**F**

TCP Windows



- Receive *window*
  - flow control
- Congestion *window*
  - Additive increase / multiplicative decrease
  - Triple duplicate ACKs
  - Slow-start, fast retransmit, fast recovery, etc.