Computer Networks: Quality of Service

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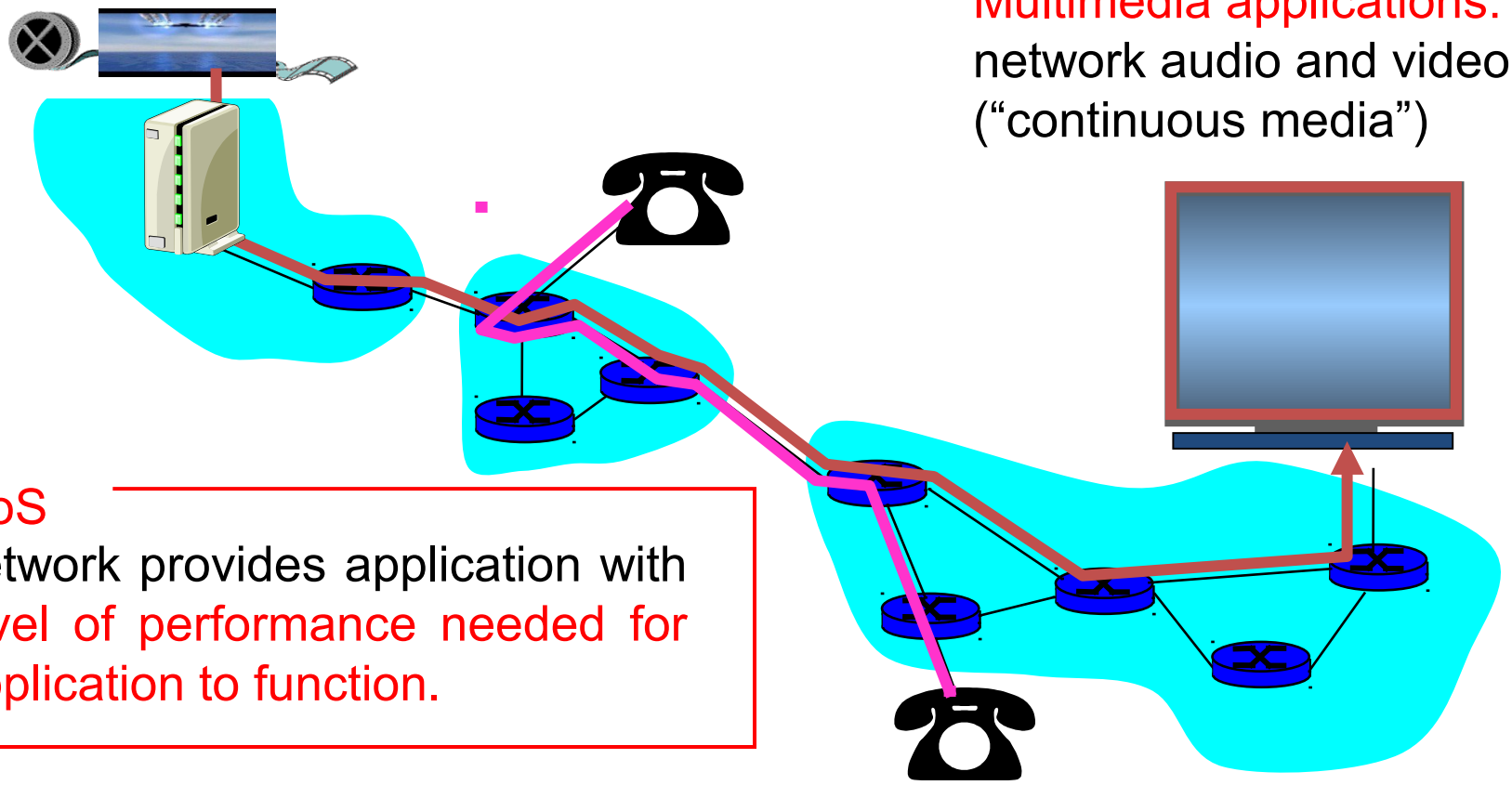
Outline

- What is QoS and it's requirements
- Higher Layer Protocols for QoS Guarantee
- Mechanisms to achieve Quality of Service
- QoS Protocols and Models for the Internet
  - Integrated Services (IntServ)
  - Differentiated Services (DiffServ)
  - Multiprotocol Label Switching (MPLS)

What is Quality of Service?

Multimedia applications:
network audio and video
("continuous media")



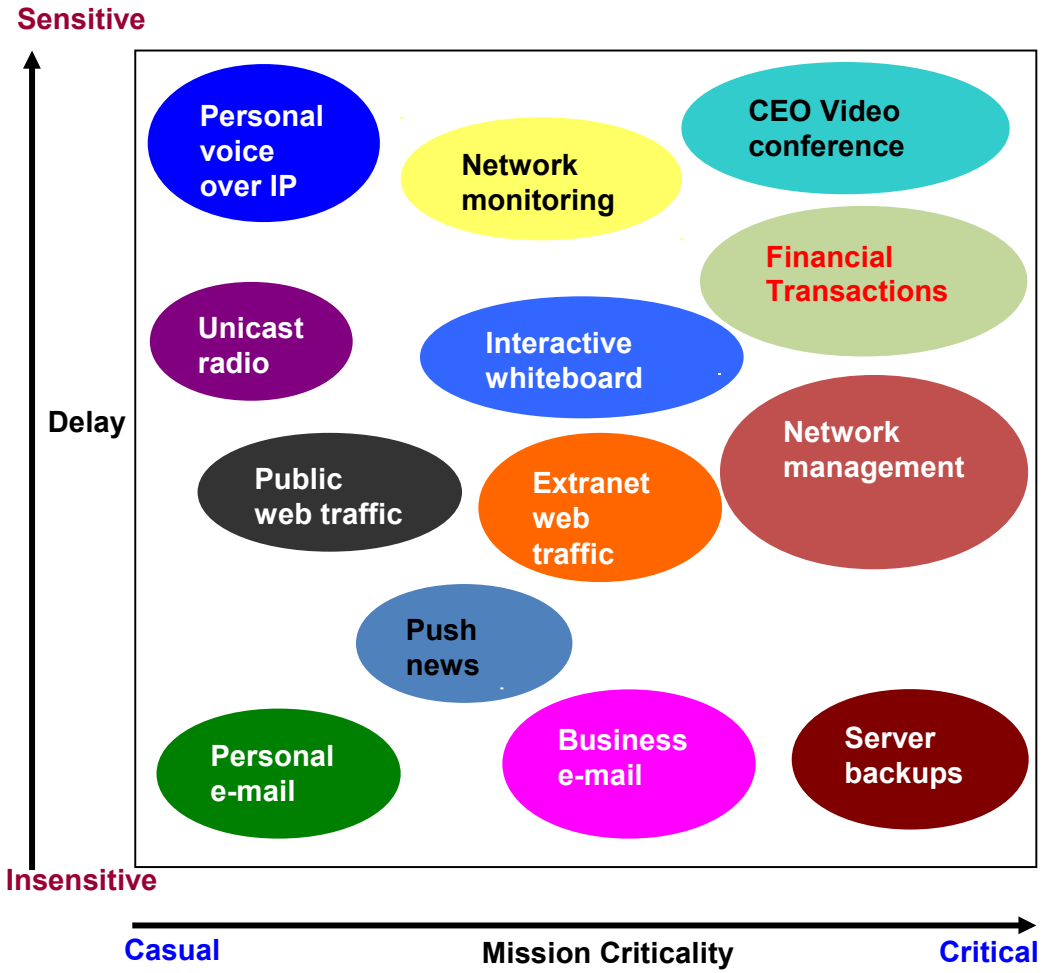
QoS
network provides application with level of performance needed for application to function.

Capability of a network to provide better service (high bandwidth, less delay, low jitter, and low loss probability) to a selected set of network traffic.

QoS Requirements

(With QoS)

(Without QoS)



Sensitivity of applications

Audio end-to-end delay : < 150 msec good, < 400 msec OK

Application	*Reliability*	*Delay*	*Jitter*	*Bandwidth*
FTP	High	Low	Low	Medium
HTTP	High	Medium	Low	Medium
Audio-on-demand	Low	Low	High	Medium
Video-on-demand	Low	Low	High	High
Voice over IP	Low	High	High	Low
Video over IP	Low	High	High	High

Internet QoS

TCP/UDP/IP: “best-effort service”

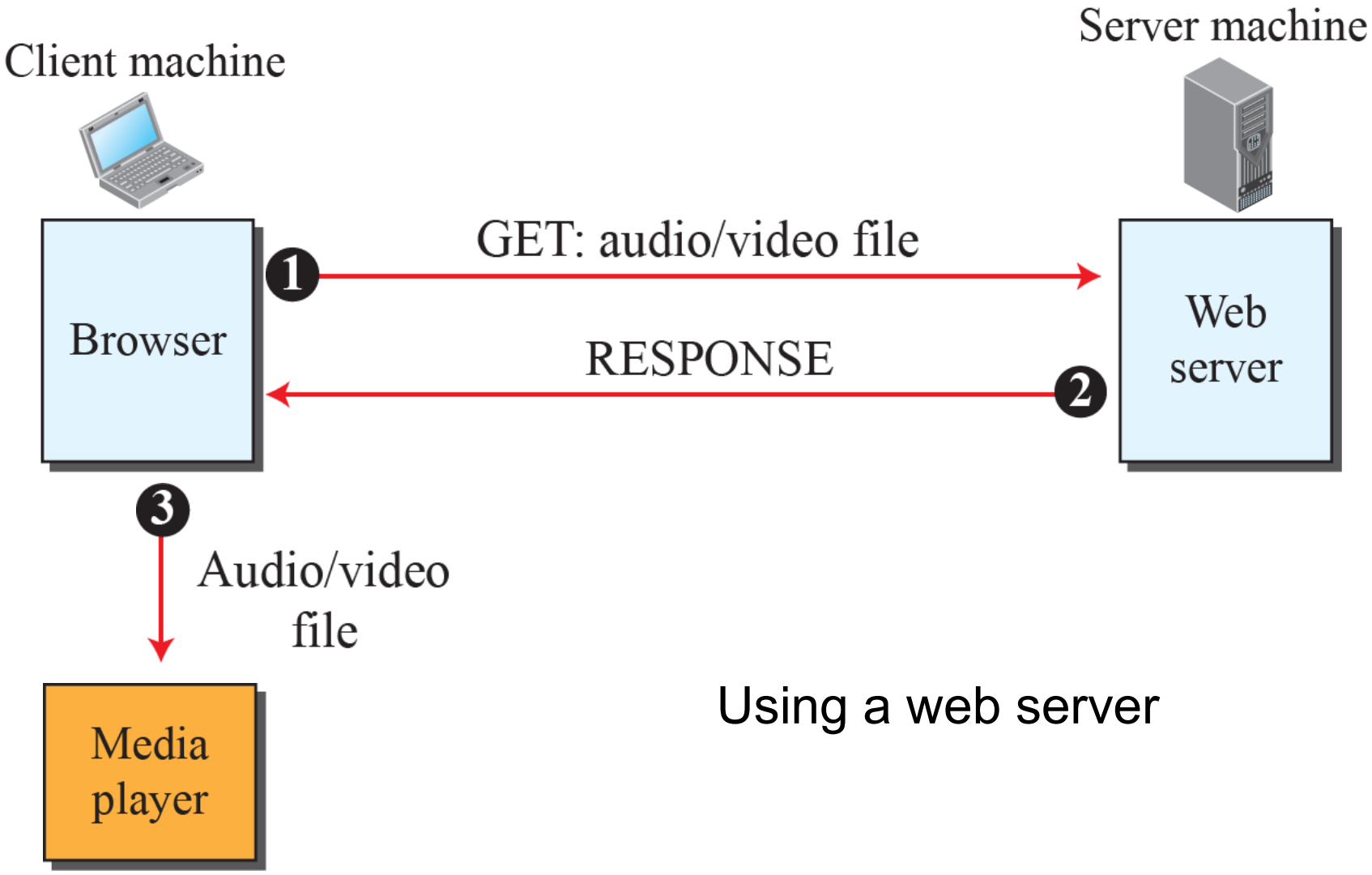
no guarantees on delay, loss

? ? ? ? ? ? ? ? ? ? ? ?

But you said multimedia apps require QoS and level of performance to be effective!

Today’s Internet multimedia applications use application-level techniques to mitigate (as best possible) effects of delay, loss etc.

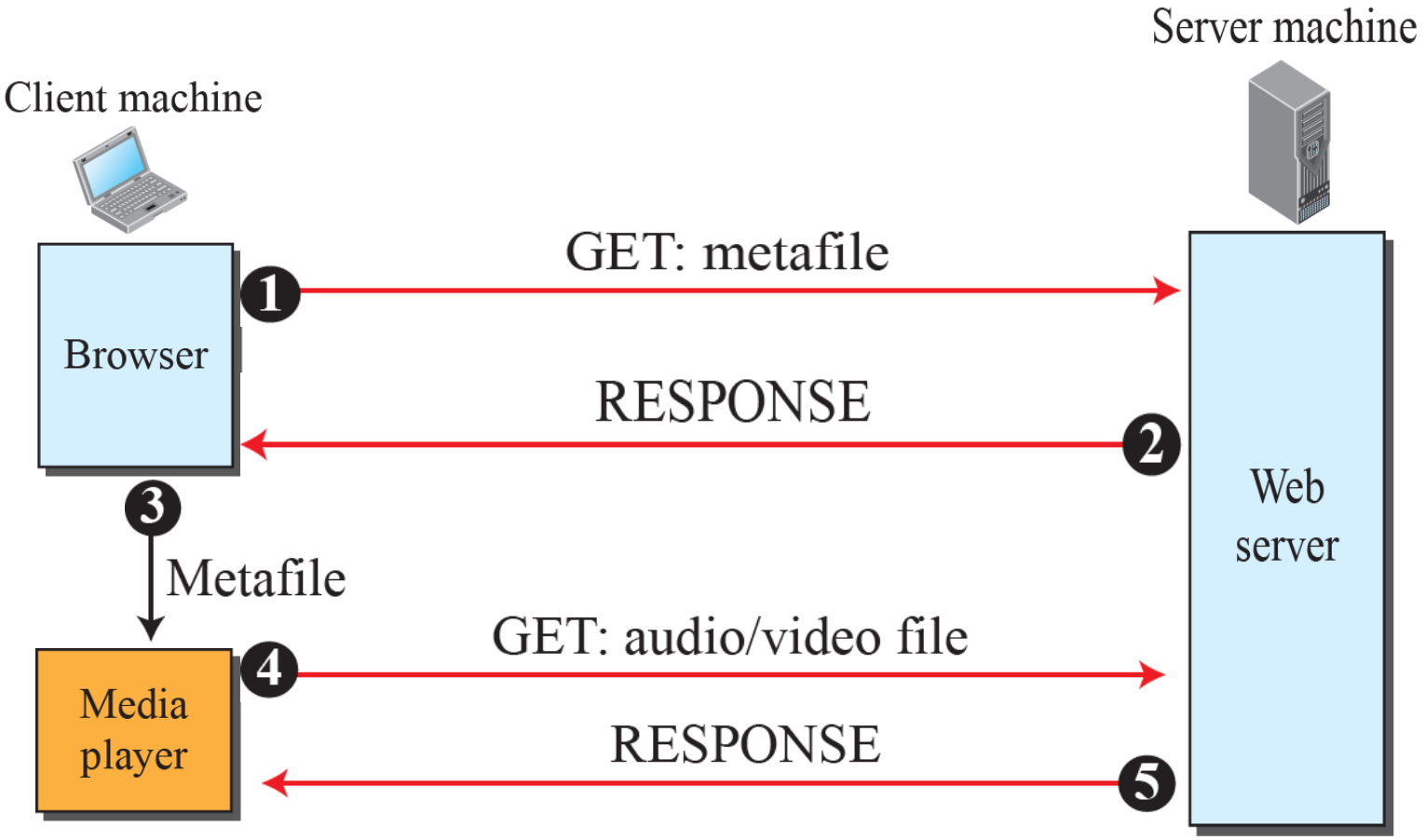
Application layer protocols



Using a web server

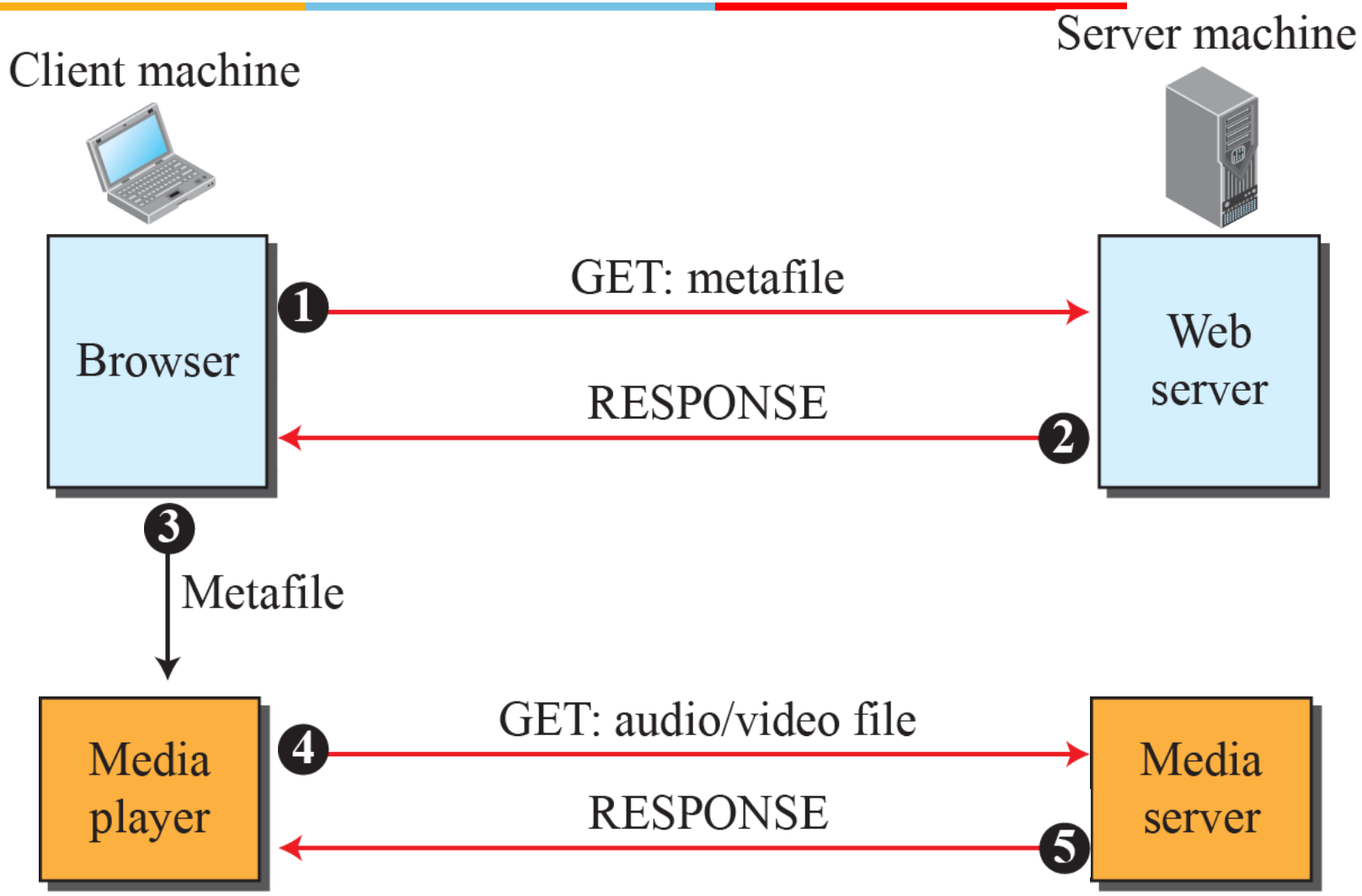
[Source: McGH, Computer Networks, Forouzan, and Mosharraf]

Webserver with a metafile



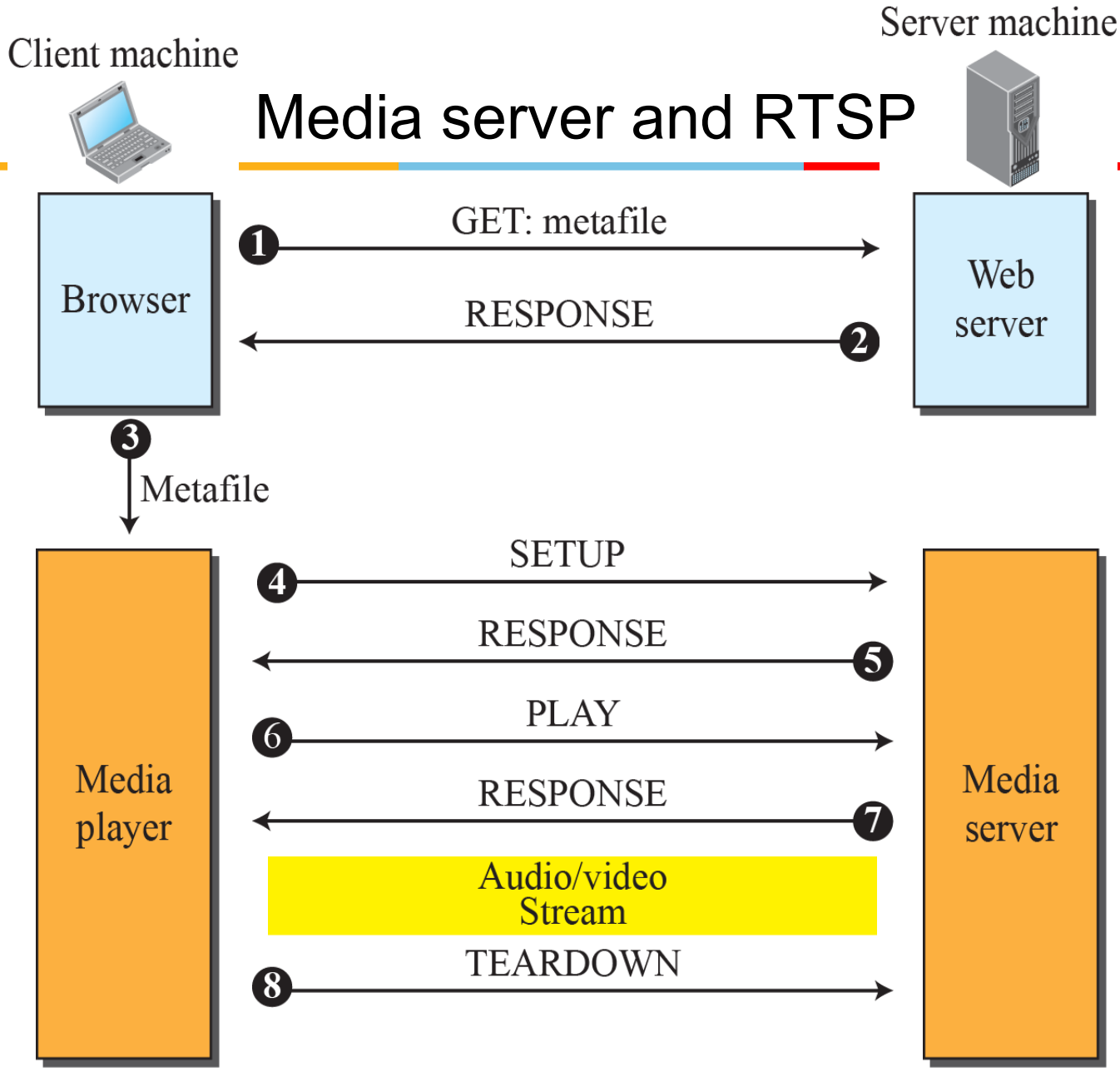
[Source: McGH, Computer Networks, Forouzan, and Mosharraf]

Webserver and media server



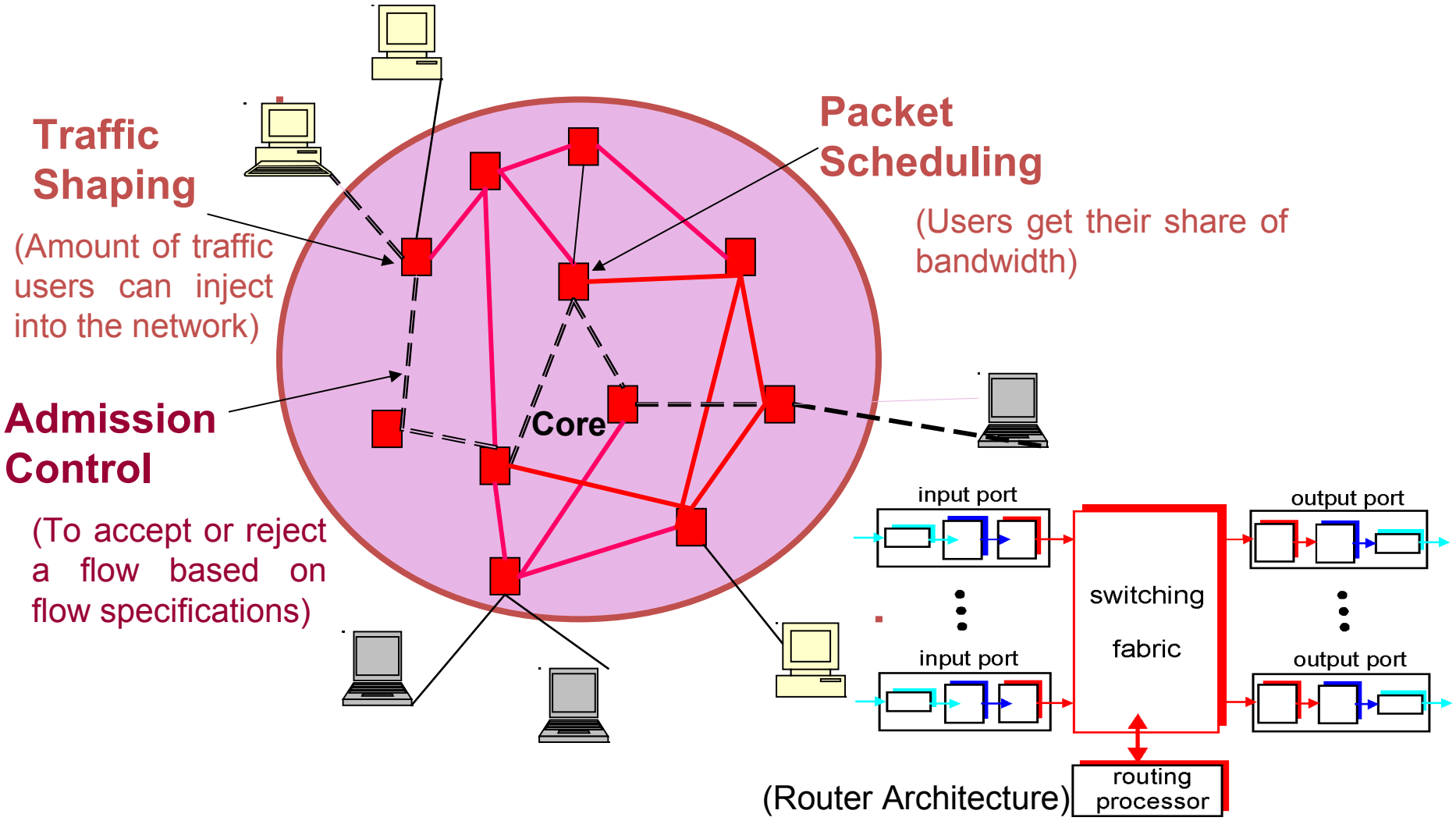
[Source: McGH, Computer Networks, Forouzan, and Mosharraf]

Media server and RTSP

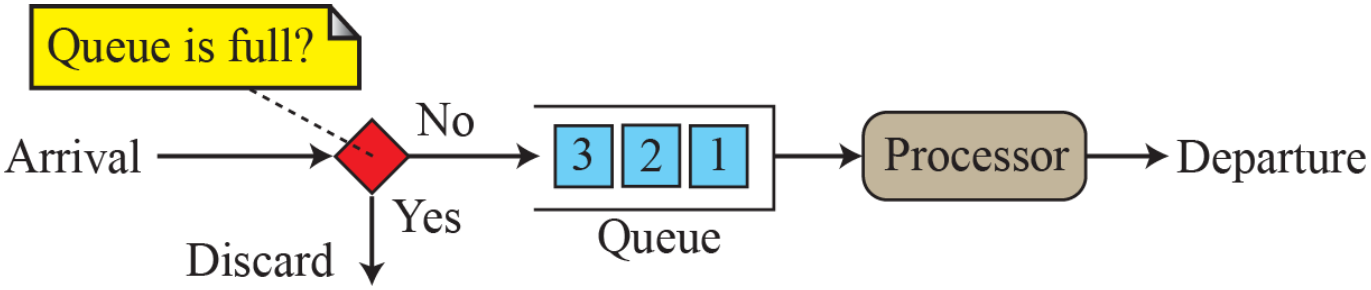


[Source: McGH, Computer Networks, Forouzan, and Mosharraf]

QoS at Network layer

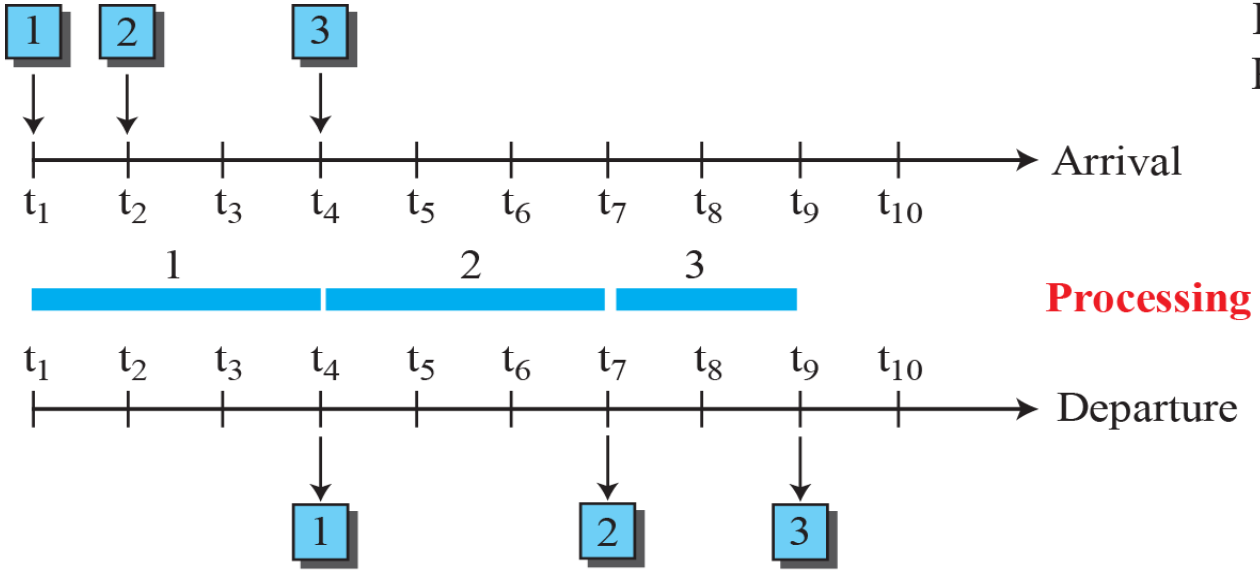


Scheduling: FIFO Queuing



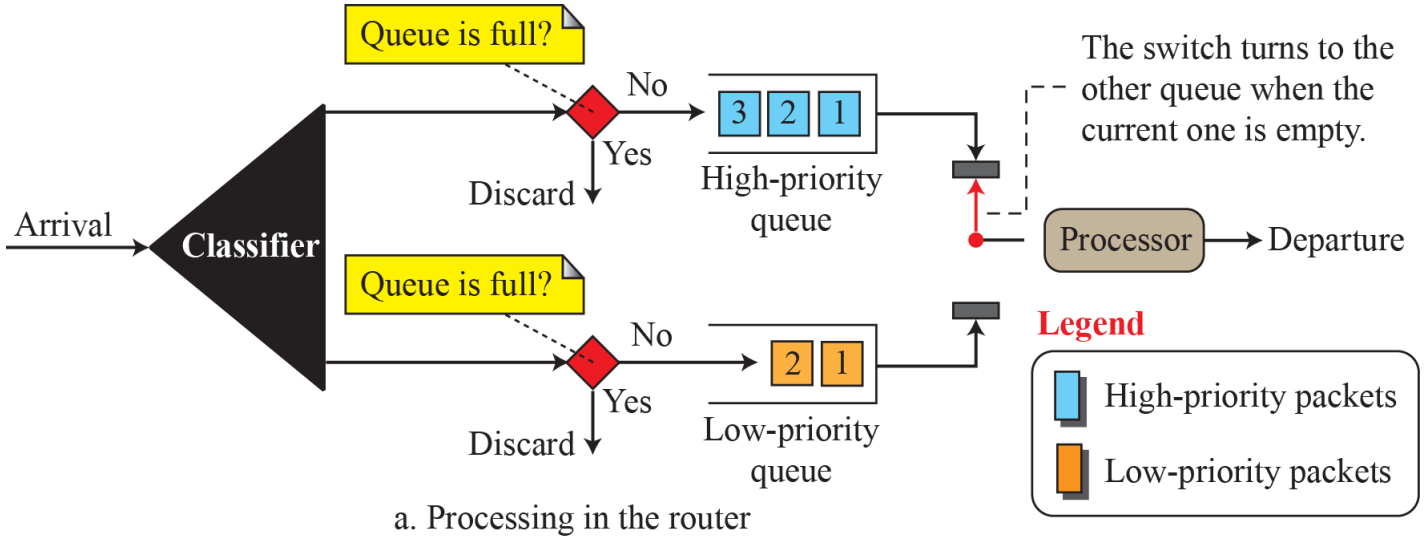
a. Processing in the router

Required processing time
Packet 1: three time units
Packet 2: three time units
Packet 3: two time units

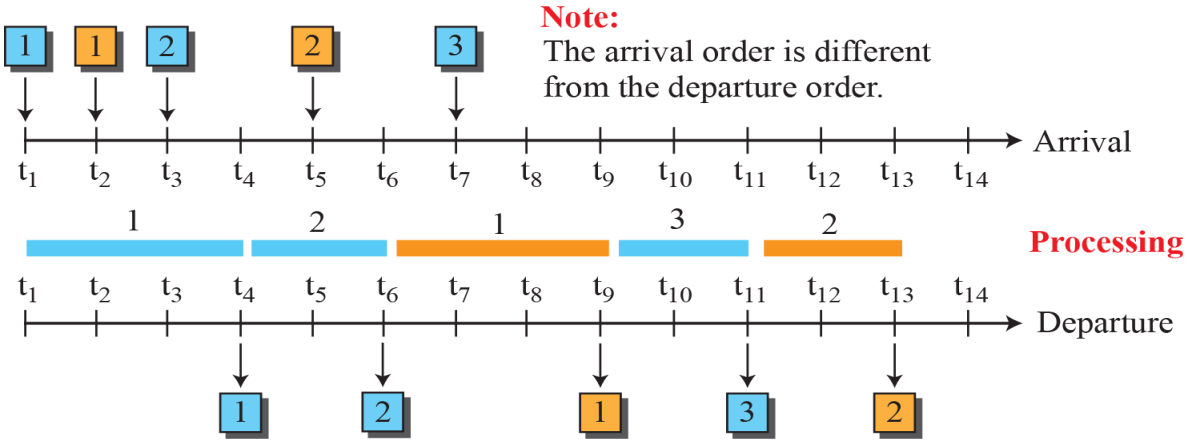


b. Arrival and departure time

Scheduling: Priority Queuing

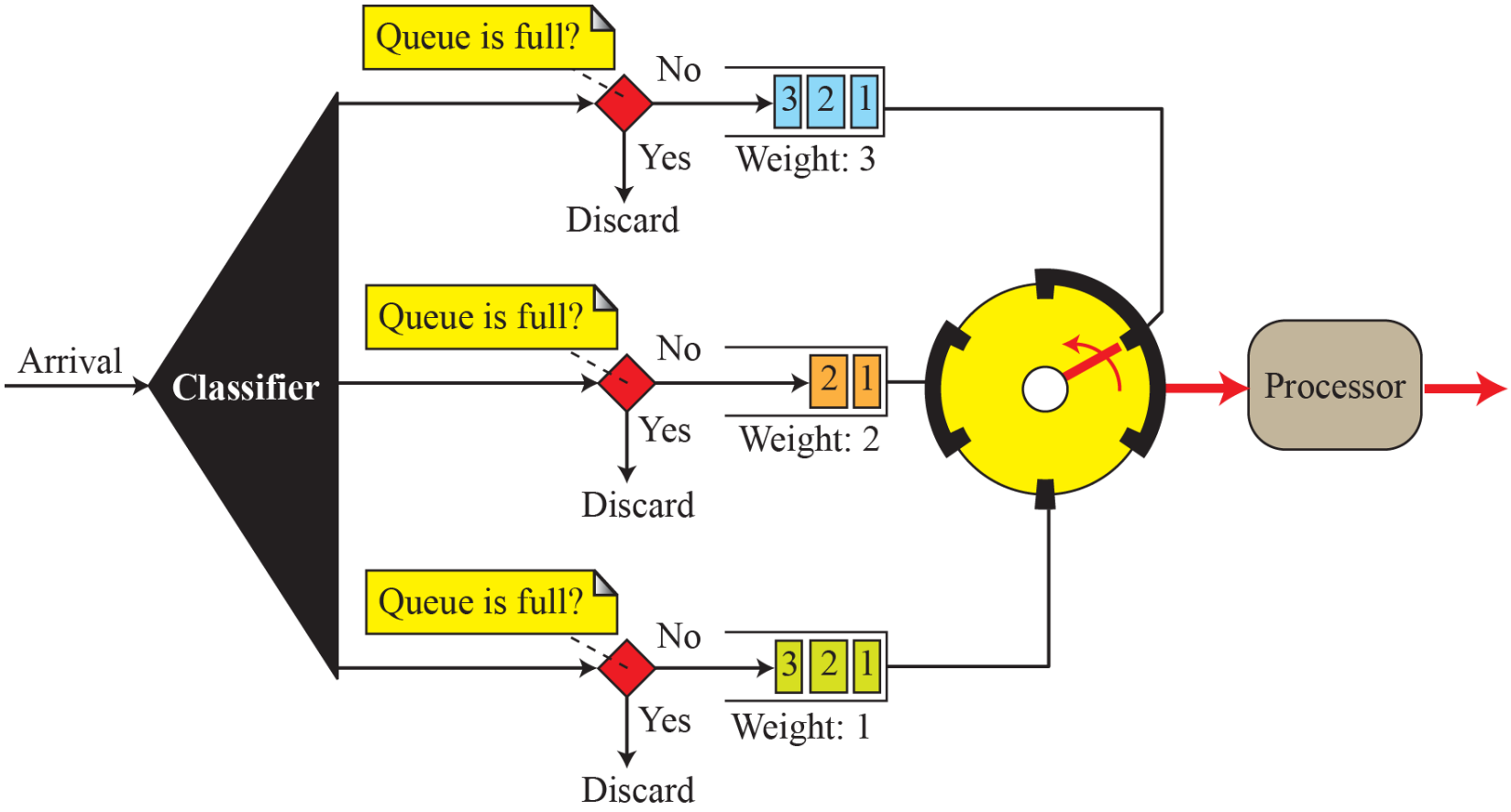


a. Processing in the router

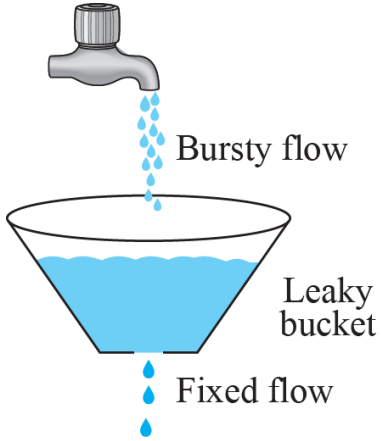


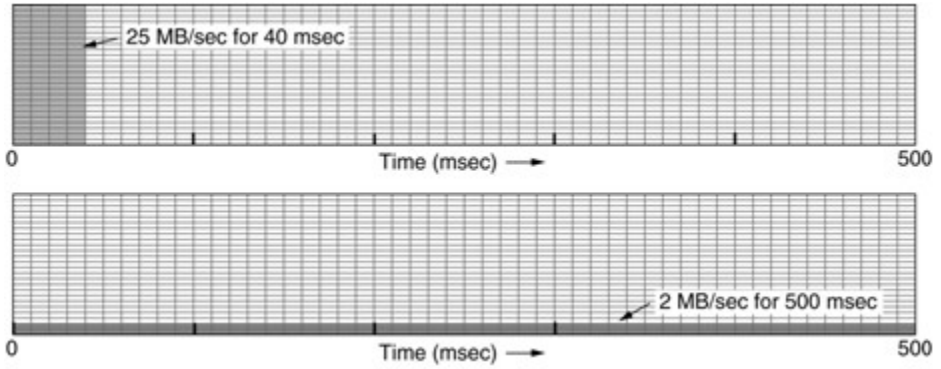
b. Arrival and departure time

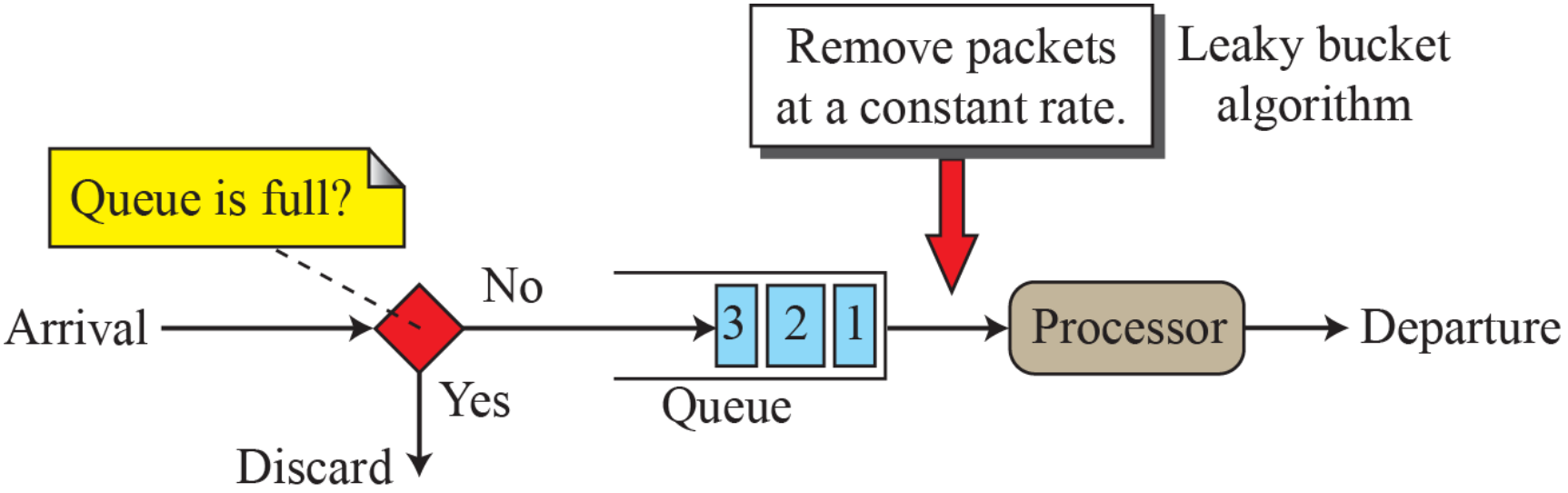
Scheduling: Waited fair queuing



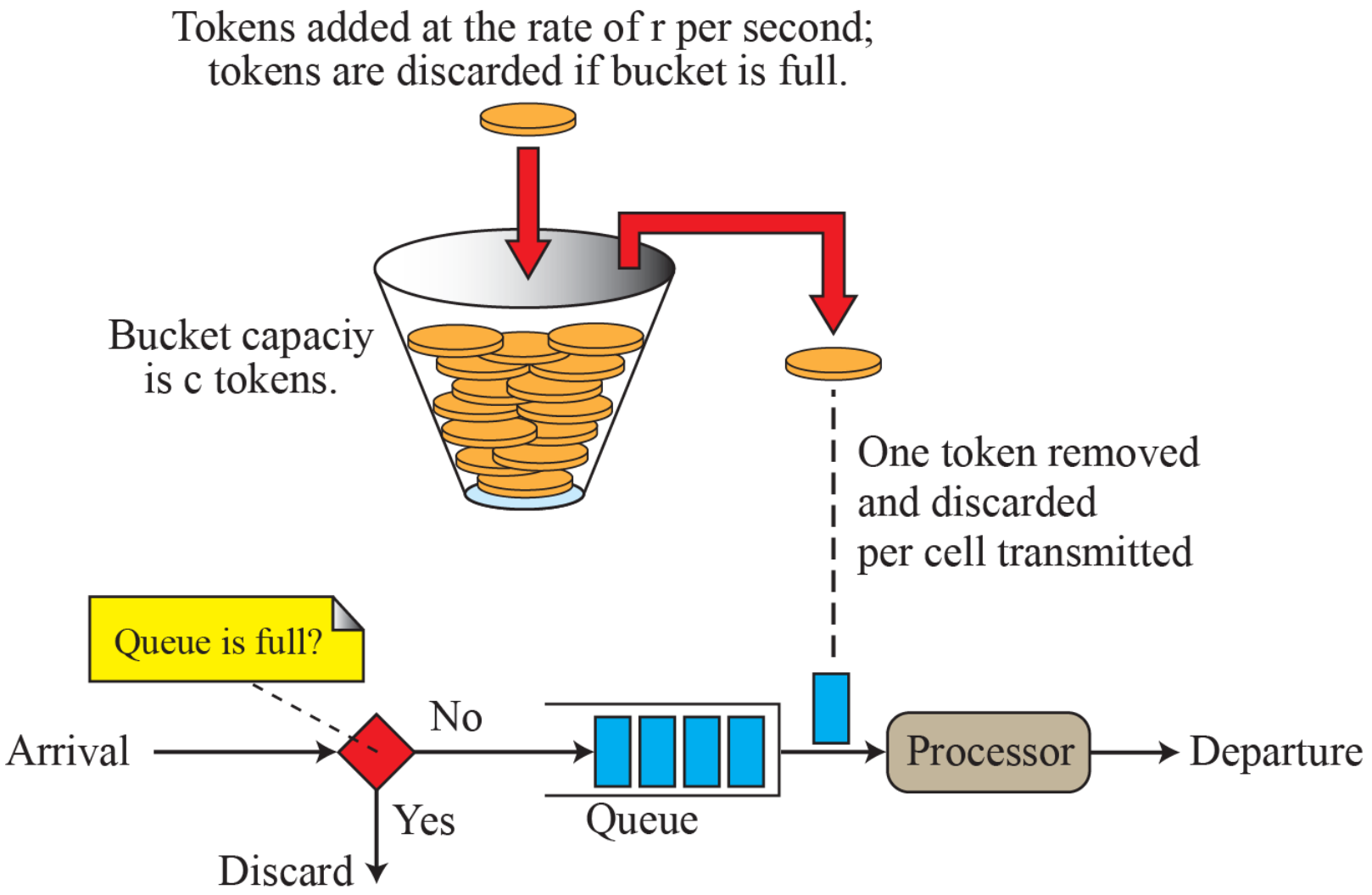
Traffic shaping: Leaky bucket



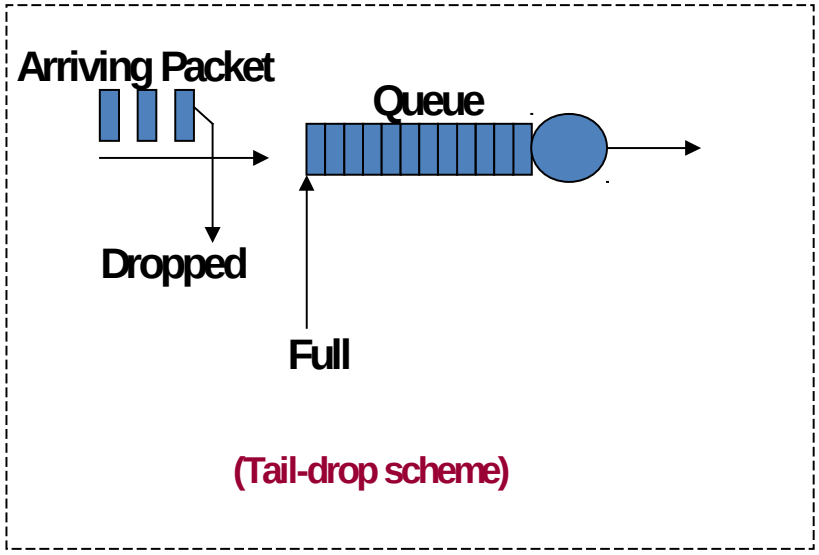


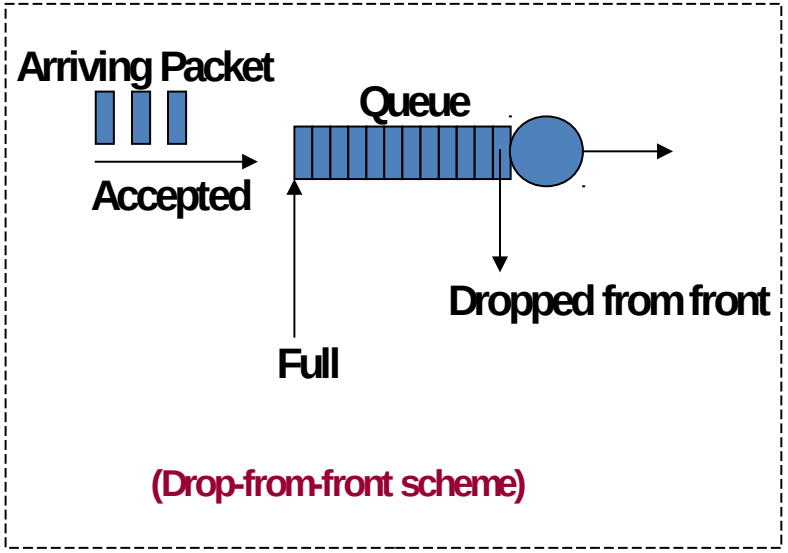


Traffic shaping: Token bucket



Queue Management





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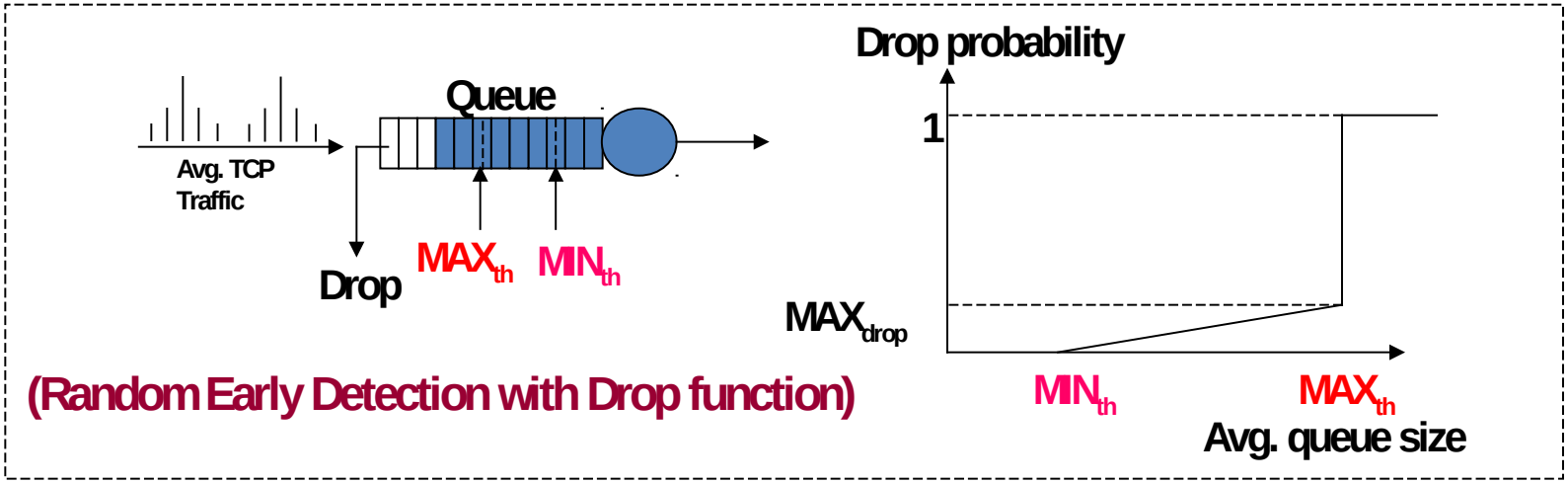

(Random Early Detection with Drop function)