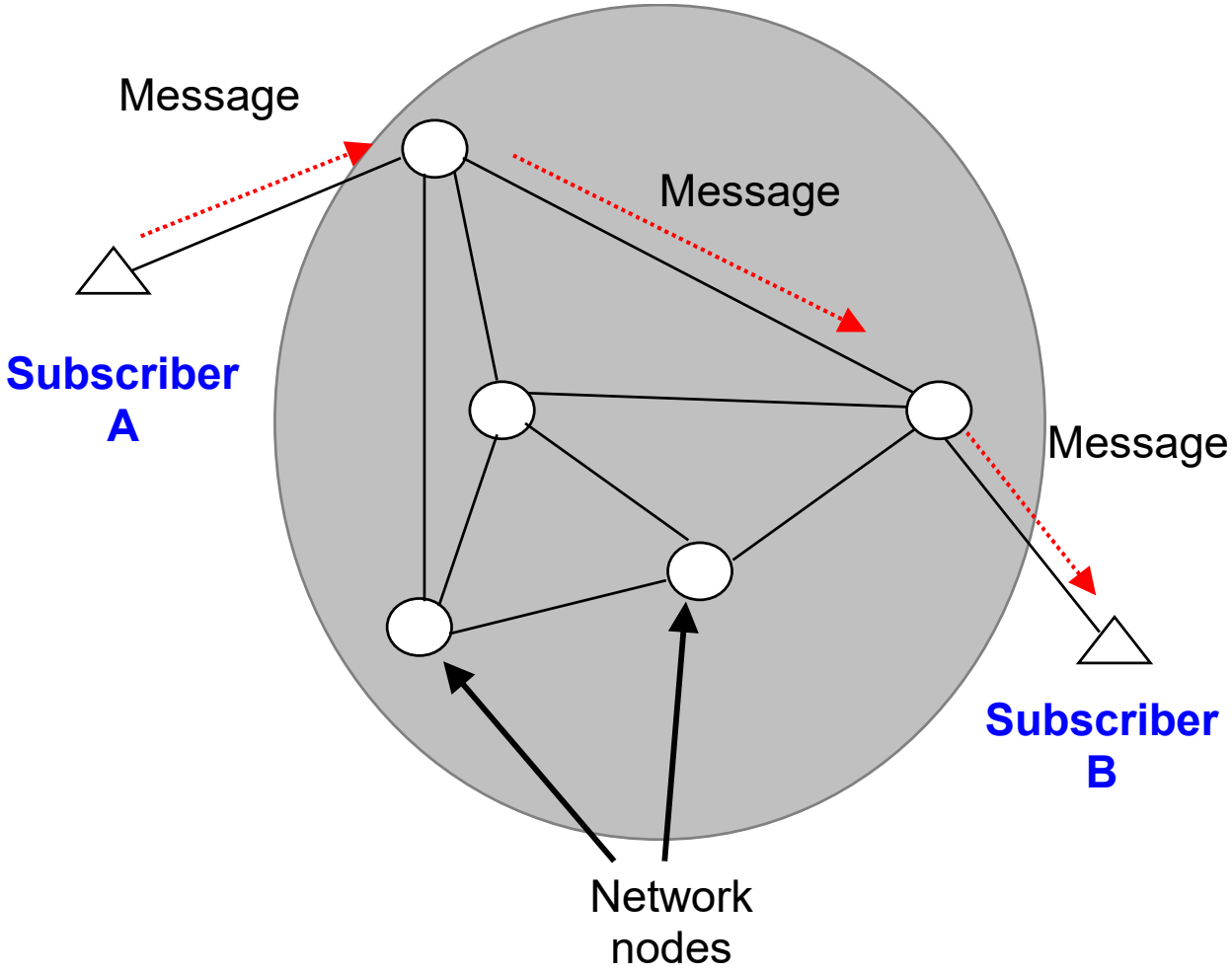
Delay in Packet Switched Networks

Required reading:
Kurose § 1.4

EECS 3214, Winter 2020
Instructor: N. Vlajic



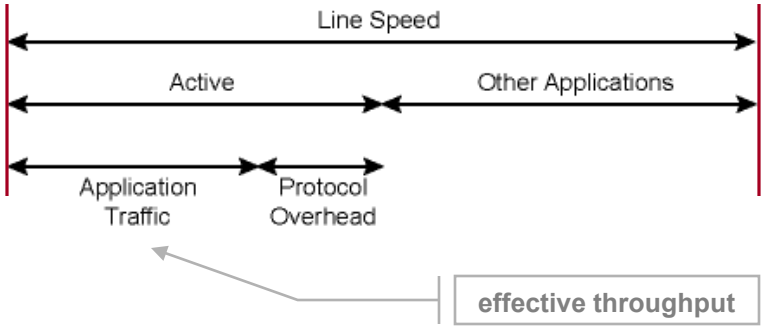
How do we characterize the performance of a network?!

Delay in Packet-Switched Networks

Link/Network Performance Measures: throughput and delay

Link Throughput – capacity potentially available for an application – generally expressed in "bit per second" [bps]

- effective capacity my be reduced by application multiplexing and protocol overhead (header bits, acknowledgments, etc.)

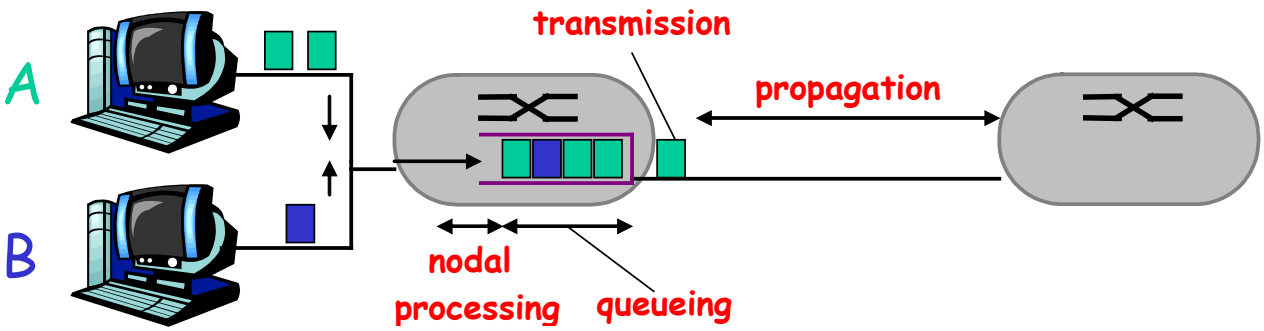


Network Delay – average time for a block of data to go from an application on one system to corresponding application on another system

- 4 types of delay contribute to overall delay:

$$d_{total} = d_{processing} + d_{queueing} + d_{propagation} + d_{transmission}$$

Delay in Packet-Switched Networks (cont.)



Processing Delay: time required to process a packet – to check for bit errors, to determine output links, etc.

(a) at source prior to sending,

(b) at any intermediate router, and

(c) at destination prior to delivering to application

- on the order of 10^{-6}·seconds or less – often negligible

Queueing Delay: time spent waiting in a queue at any point along the route

- depends on intensity and nature of traffic arriving at queue(s)
- on the order of 10^{-6}·seconds to 10^{-3}·seconds

Delay in Packet-Switched Networks (cont.)

Propagation Delay: time for one bit to propagate from source to destination at propagation speed of the link

- depends on physical medium of the link
- on the order of 10^{-6}·seconds
- negligible for two routers on the same LAN; significant for two geostationary satellites

$$d_{propagation}\ [sec] = \frac{d\ [m]}{s\ [m/sec]}$$

d [m]: distance between source and destination [m]

s [m/sec]: propagation speed of medium [m/s]

Transmission Delay: time to send out / absorb all of the packet bits

- also known as "store-and-forward" delay
- on the order of 10^{-6}·seconds to 10^{-3}·seconds
- negligible for transmission rates ≥ 10 Mbps; significant for large packets sent over low-speed links

$$d_{transmission}\ [sec] = \frac{L\ [bit]}{R\ [bps]}$$

L [bit]: packet size [bits]

R [bps]: link transmission rate [bps]

distance: d

destination

How long does it take for the parcels/load to arrive to the destination ?!

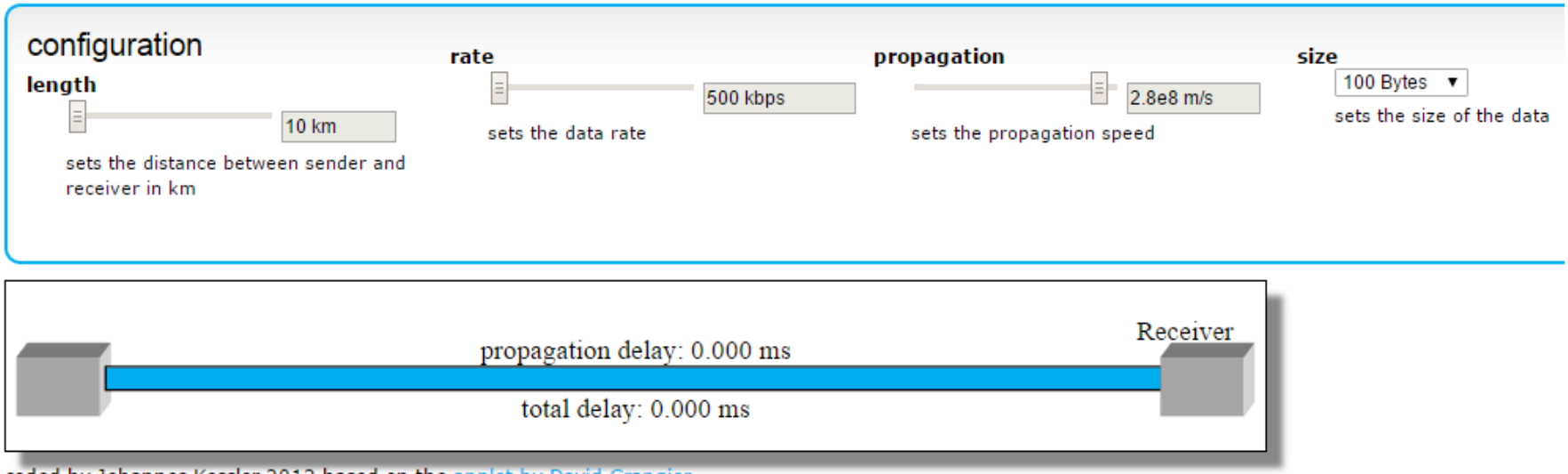
Step 1: drive truck to the destination (propagation delay)

Step 2: remove parcels off the track (transmission delay)

Transmission vs Propagation Delay

This animation illustrates the difference between transmission and propagation delay.

You can set the length of the link, the packet size, the transmission speed, the propagation speed of the link; The animation shows the packet being sent from senc
Note that for many combinations, the head of the packet reaches the receiver before transmission is finished at the sender.



coded by Johannes Kessler 2012 based on the applet by David Grangier

http://www.ccs-labs.org/teaching/rn/animations/propagation/