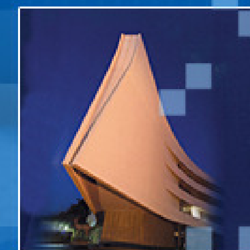
ERP 420

Research Project

Packet loss and delay

Dr A. De Freitas

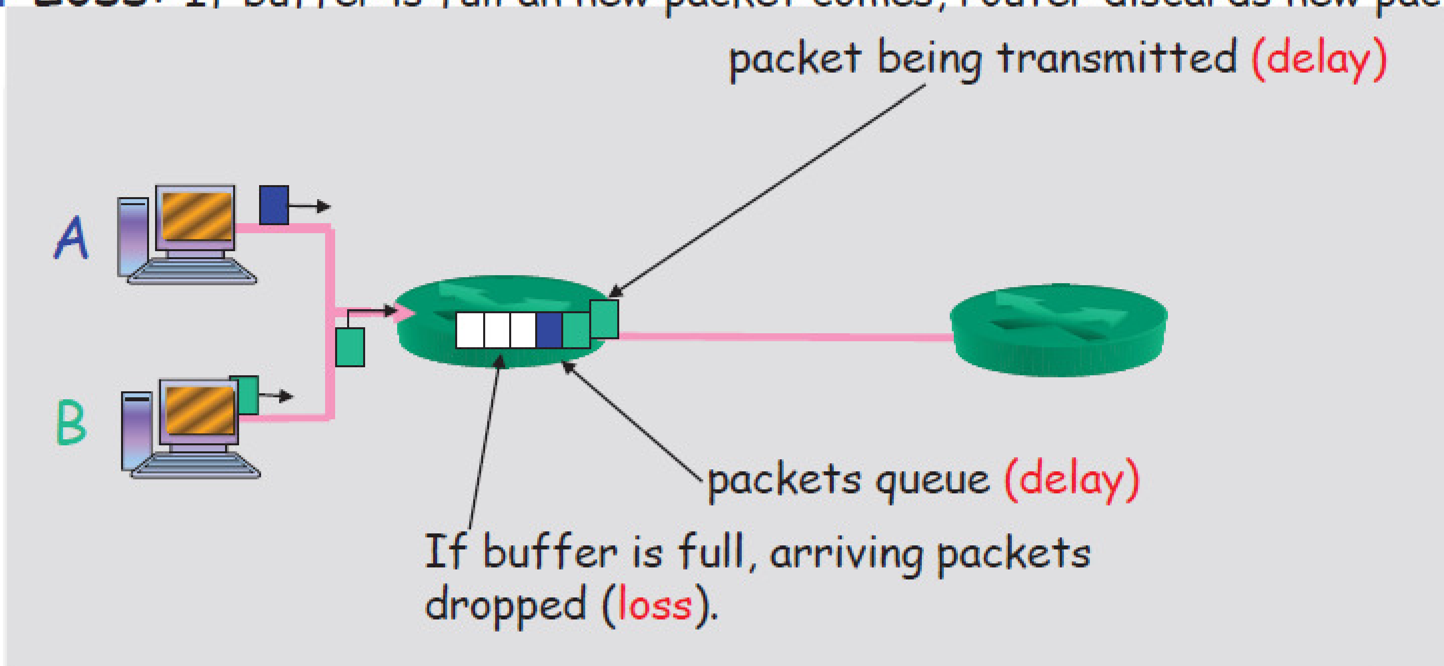


UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Denkleiers • Leading Minds • Dikgopolo tša Dihlalefi

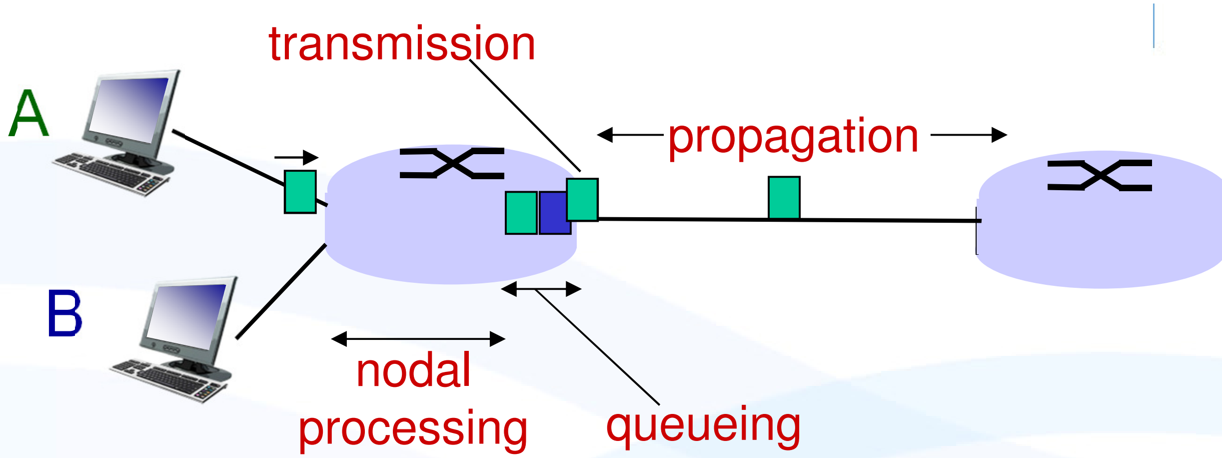
packet loss and delay

packets *queue* in router buffers

- **Delay:** if packet arrives to buffer, while, there are other packets in queue, then the new arrived packet experience DELAY.
- **Loss:** If buffer is full an new packet comes, router discards new packet.



Four sources of packet delay



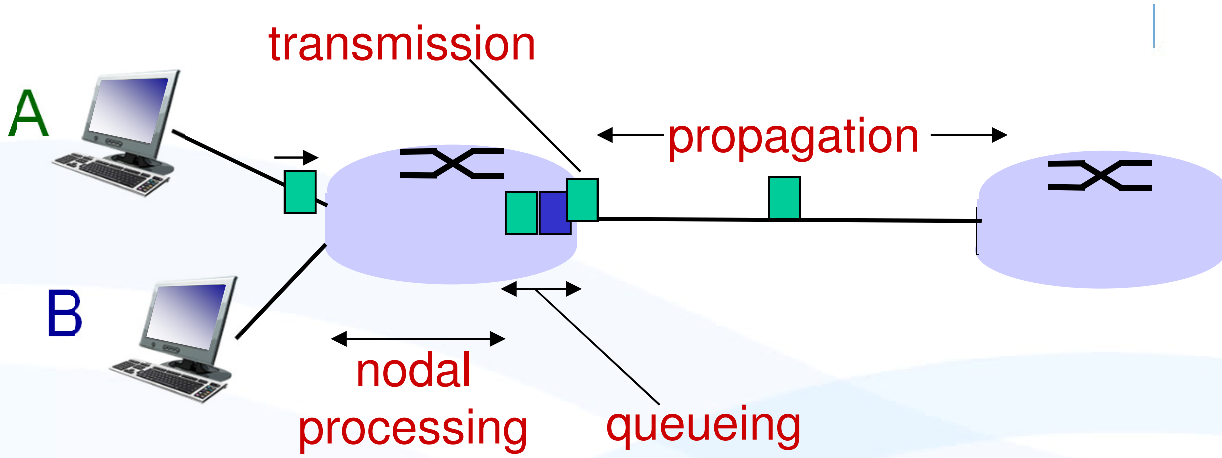
nodal processing

- check bit errors
- determine output link
- typically < msec

queueing delay

- time waiting at output link for transmission
- depends on congestion level of router

Four sources of packet delay



transmission delay:

- L: packet length (bits)
- R: link *bandwidth* (*bps*)
- $d_{trans} = L/R$

d_{trans} and d_{prop}
very different

propagation delay:

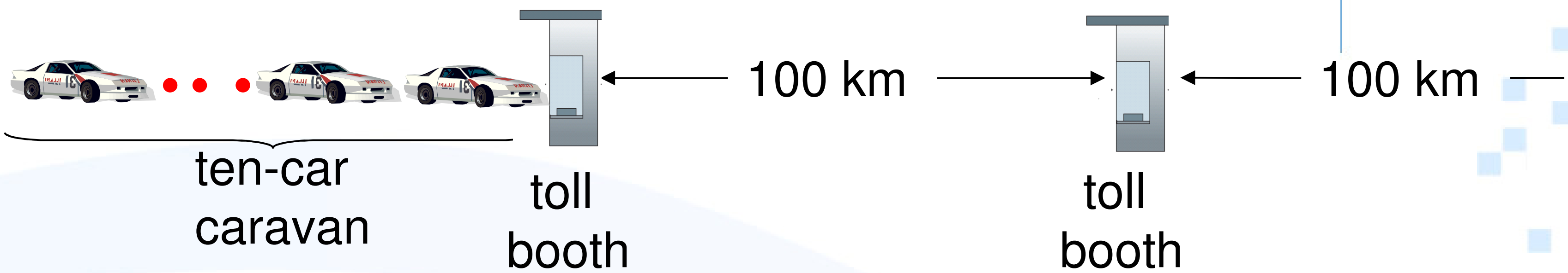
- d: length of physical link
- s: propagation speed in medium (~2×10^8 m/sec)
- $d_{prop} = d/s$

Nodal delay

$$d_{nodal} = d_{proc} + d_{queue} + d_{trans} + d_{propagation}$$

- d_{proc} = processing delay
  - typically a few msecs or less
- d_{queue} = queuing delay
  - depends on congestion
- d_{trans} = transmission delay= *L/R(packet length/bandwidth)*
  - , significant for low-speed links
- d_{prop} = propagation delay= *d/s (link length/propagation speed)*
  - a few microsecs to hundreds of msecs

Caravan Analogy



cars "propagate" at 100 km/hr

toll booth takes 12 sec to service car (bit transmission time)

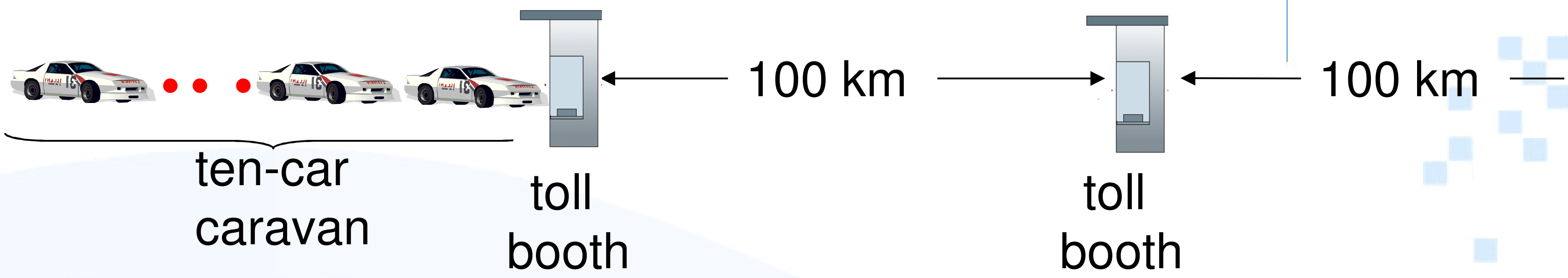
car~bit; caravan ~ packet

Q: How long until caravan is lined up before 2nd toll booth?

- time to "push" entire caravan through toll booth onto highway = 12*10 = 120 sec
- time for last car to propagate from 1st to 2nd toll both: 100km/(100km/hr)= 1 hr
- *A:* 62 minutes

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Denkleiers • Leading Minds • Dikgopolo tša Dihlalefi

Caravan Analogy



suppose cars now "propagate" at 1000 km/hr

and suppose toll booth now takes one min to service a car

Q: Will cars arrive to 2nd booth before all cars serviced at first booth?

- *A: Yes!* after 7 min, 1st car arrives at second booth; three cars still at 1st booth.

Example

- Consider two hosts, A and B, connected by a single link of rate R bps. Suppose that the two hosts are separated by m meters, and suppose the propagation speed along the link is s meters/sec. Host A is to send a packet of size L bits to Host B.
- a) Express the propagation delay, $d$prop, in terms of m and s.
- b) Determine the transmission time of the packet, $d$trans, in terms of L and R.
- c) Ignoring processing and queuing delays, obtain an expression for the end-to-end delay.
- d) Suppose Host A begins to transmit the packet at time $t = 0$. At time $t = d$trans, where is the last bit of the packet?
- e) Suppose $d$prop is greater than $d$trans. At time $t = d$trans, where is the first bit of the packet?
- f) Suppose $d$prop is less than $d$trans. At time $t = d$trans, where is the first bit of the packet?
- g) Suppose $s = 2.5 \cdot 10$^8, $L = 120$ bits, and $R = 56$ kbps. Find the distance m so that $d$prop equals $d$trans.

Example

a) $d_{prop} = m / s$ seconds.

b) $d_{trans} = L / R$ seconds.

c) $d_{end-to-end} = (m / s + L / R)$ seconds.

d) The bit is just leaving Host A.

e) The first bit is in the link and has not reached Host B.

f) The first bit has reached Host B.

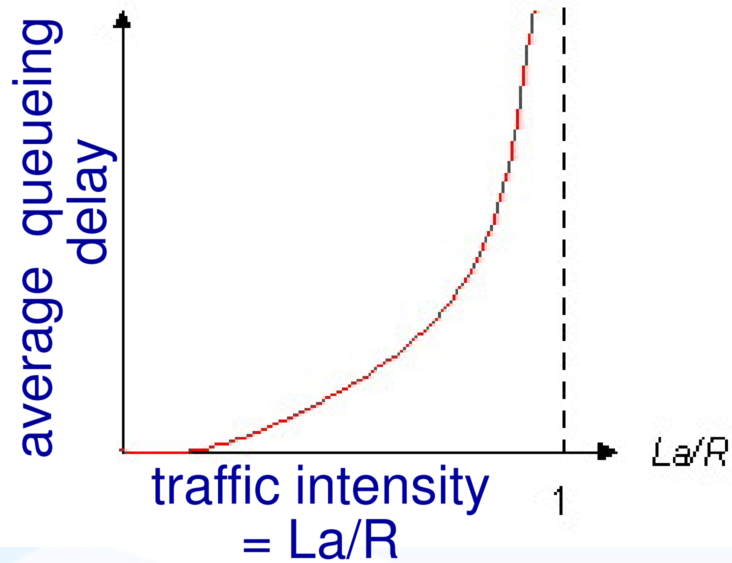
g) $m = \frac{L}{R} s = \frac{120}{56 \times 10^3} \left(2.5 \times 10^8\right) = 536$ km.

Queueing delay

R: link bandwidth (bps)

L: packet length (bits)

a: average packet arrival rate



- *La/R* > 1: more "work" arriving than can be serviced, average delay infinite
- *La/R* ~ 0: avg. queueing delay small
- *La/R* --> 1: avg. queueing delay large

La/R ~ 0

La/R --> 1