CS 456 Hao Pan
Salahuddin, Mohammad
Spring 2018

Chapter 1.4 - Delay, Loss, and Throughput in Networks

10/05/2018 [Th]

Loss and Delay

- **Loss and delay** can occur if packets arrive at a router faster than the router's output capacity.
- There are *four* sources of packet delay ($d_{nodal} = d_{proc} + d_{queue} + d_{trans} + d_{prop}$):
  - d_{proc} is the **nodal processing**. It checks the bits for errors and determines the output link. It is typically very fast ($<$ msec).
  - d_{queue} is the **queuing delay**. It is the time that must be waited at the output link *before transmission*. The delay depends on the router's congestion level.
  - d_{trans} is the **transmission delay**. It is equal to the packet length divided by the link bandwidth ($d_{trans} = L/R$).
  - d_{prop} is the **propagation delay**. It is equal to the length of the physical link divided by the propagation speed ($d_{prop} = d/s$).
- Car analogy: Slides 1-46 and 1-47.
- A closer look at *queuing delay*, where *a* equals *average arrival rate*. If:
  - La/R $\sim$ 0: the average queuing delay is very small.
  - La/R $\rightarrow$ 1: the average queuing delay grows larger.
  - La/R $>$ 1: the average queuing delay is infinite (more work arriving than can be serviced).
- **Packet loss** occurs when packets arrive at a link with a *finite buffer* and a *full queue*. When there is packet loss, additional packets are dropped.
- The lost packet *may or may not* be retransmitted by the previous node or by the source end system.

Throughput

Rate at which bits are transferred between the sender and receiver.

- **Instantaneous throughput** is the rate at a given point in time.
- **Average throughput** is the rate over a longer period of time.
- A **bottleneck link** is a link on the end of a path that constrains end-end throughput.
- The bottleneck link can be found by looking for the link that is at capacity even though a link further down/upstream is not.