1/23/2018

ORGANIZATION

ASes (http://bgp.he.net)

- > 50K ASes
- http://bgp.he.net/AS3676

Part 1: Multiplexing

Multiplexing (how multiple users can share the infrastructure)

packet switching vs. circuit switching

Packet Switching

Store-and-Forward Transmission

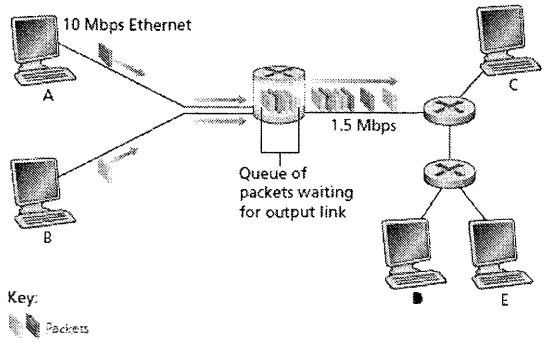
- Notion of packets (size of packet = 1500 bytes; 1 byte = 8 bits)
- Transmission time = L (size of packet) / R (Transmission rate)
- Suppose R = 100 Mbps, L = 1500 bytes; L/R = 1500*8/100000000 = 0.00012 = 0.12 ms

d(transmission) = N L/R (N links)

- Input port: store and forward packet transmission
- Output port: buffers (act as queues)

Best-effort: delays and packet loss

- How to mitigate packet loss?



Is it suitable for real-time communication?

- Compare to circuit switching used by telephone networks
- Need to establish dedicated connection before 2 users can communicate
- But guaranteed data transmission

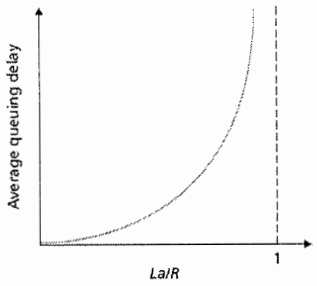
Part 2: Internet Performance Metrics

Delay

- processing delay (examine headers), order of microseconds
- transmission delay (time required to transmit a packet from head of queue), order of microseconds (L/R)
- propagation delay (length of link), determined by speed of light: distance/speed
    - Speed of light = 3*10^8 m/s in space, can be little slower in solids
    - hongkong new york 10K miles, 33 milliseconds
    - earth and moon: 1.26 seconds
    - earth and mars: 3 minutes
- queueing delay (wait in queues of infinite size), can be very large or negligible
    - Can vary from packet to packet
    - Depends on queuing strategy (FIFO)

Traffic intensity: a (packet arrival rate) L (size of packet)
aL/R (transmission rate)

aL/R >1 (queueing delay will increase indefinitely)
aL<=1 (if packets are equally spaced then no delay)
(if random then non-zero delay)



(nodal) = d(processing) + d(queue) + d(transmission) + d(propagation)

Packet Loss

- packet loss happens due to full queueing buffers
- Is it okay to have a packet loss?
    - Can we detect a lost packet?
    - Can we recover a lost packet?
- If we have large queues/buffers, we can reduce packet loss
    - Why not make buffer (almost infinite)
    - Is that a good idea? bufferbloat

Tools to measure delay and loss
- ping (ping /4 www.google.com)
- traceroute (tracert /4 www.google.com)

1/25/2018

Part 1: Internet Performance Metrics

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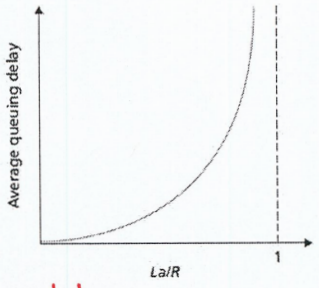

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burst: what if N packets arrive at the same time: 1st packet = no delay,
2nd packet = $\frac{L}{R}$
3rd packet = $\frac{2L}{R}$
;
Nth packet = $\frac{(N-1)L}{R}$

(nodal) = d(processing) + d(queue) + d(transmission) + d(propagation)

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- probability of packet loss

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How trace-route work