Network Performance

ECE 50863 – Computer Network Systems

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Characterizing a Network

- Fundamental characteristics of a network:
  - Bandwidth
    - No of bits per second that can be transmitted on the link.
  - Propagation Delay:
    - Minimum time it would take to transmit a bit across due to speed-of-light considerations.
    - Distance/Speed-of-Light
- Note – these are independent of each other.

Message Transfer Time

- Message Transfer Time
  - How long it takes for a message to go across
- Message Transfer Time =
  - Propagation Delay + Transmission Time + Queuing
- Propagation Delay => Distance/Speed-of-Light
- Transmission Time => Size/Bandwidth

Both network characteristics are important

- Message Transfer Time =
  - Propagation Delay + Size/Bandwidth + Queuing
- If size very small: (e.g. text chat)
  - Bandwidth less important
  - Propagation Delay becomes important
- If size very large: (e.g. download 1 GB file)
  - Bandwidth becomes more critical.

Round Trip Time

- Time for a packet to go from sender to destination and return.
- If packet does not encounter queuing, and is sufficiently small,

Round Trip Time (RTT) =

2 * Propagation Delay

Example 1

- Applet
- 1000Km,2.8*10^8m/s, 512Kbps,100bytes
  - Tx time: 1.56ms, PD: 3.57ms, total: 5.13ms
- PD= (1000 * 10^3)/(2.8 * 10^8) sec=3.57ms
- Tx= (100 * 8)/(512 * 10^3) sec=1.56ms
- Around 1.56ms, last bit out of sender.
- Around 3.57ms, first bit reaches receiver.
- Around 5.13ms, last bit reaches receiver.

Today's trend

- Bandwidth keeps increasing.
- Propagation Delay does not
- Transfer time becomes more propagation delay bound than bandwidth bound

Example 2

- 1000Km,2.8*10^8m/s, 512Kbps,100bytes
  - Tx time: 1.56ms, PD: 3.57ms, total: 5.13ms
- Change BW=> 512 * 1000 Kbps:
  - Tx time: 1.56/1000 ms, PD: 3.57 ms,
  - Total: 3.5715 ms
    - Dominated by Propagation Delay

Bandwidth-Delay Product

- How many “bits” fit in the pipe.
- How much data can be transmitted before first bit is received.
- Technology trend: larger bandwidth delay products
- In Examples:
  - (512 Kbps) * (3.57 s) = 1.827 Mbits.
  - (512 * 1000 Kbps) * (3.57 s) = 1827 Mbits

Simple reliable transmission protocol

- Sender sends a packet
- Receiver sends an acknowledgement (ACK)
- How much more data could the sender transmit after it sends the packet, and before it gets an ACK for that packet?
- Answer:
  - (B) (2d) , i.e., twice Bandwidth-Delay product
  - Assuming size of ACK can be neglected