ECE 463
Introduction to Computer Networks
Network Performance

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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 or Message Latency
  - How long it takes for a message to go across
  - Also called "Delay" (confusing)
- Message Transfer Time(Latency) =
  - Propagation Delay + Transmission Time + Queuing
- Propagation Delay => Distance/Speed-of-Light
- Transmission Time => Size/Bandwidth

Both network characteristics are important

- Message Transfer Time(Latency)=
  - 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.

Examples (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.

Examples (2)

- 1000Km,2.8*10^8m/s, 512Kbps,100bytes
  - Tx time: 1.56ms, PD: 3.57ms, total: 5.13ms
- Change Length=10Km:
  - total:1.6ms, dominated by Transmission time.

Examples (3)

- 1000Km,2.8*10^8m/s, 512Kbps,100bytes
  - Tx time: 1.56ms, PD: 3.57ms, total: 5.13ms
- Change BW=> 100Mbps: total:3.58ms, dominated by PD.
- “Wasted channel bw”

Bandwidth-Delay Product

- How many “bits” fit in the pipe.
- How much data can be transmitted before first bit is received.

- In Example:
  - (512 Kbps) * (3.57 s) = 1.827 Mbits.
  - (100 Mbps) * (3.57 s) = 357 Mbits

Today's trend

- Bandwidth keeps increasing.
- Propagation Delay does not
- Higher bandwidth-delay products:
  - Transfer Time: Becomes more propagation delay-bound than bandwidth bound

Round Trip Time

- Time for a packet to go from sender to destination and return.
- Typically for homework problems
  - 2 * Propagation Delay
- Strictly speaking:
  - 2 * Packet Latency
  - “Minimum RTT” => 2 * Propagation Delay
- This example: “minimum RTT” => 2 * 3.57 => 7.14 msecs

Caveat

- “Bandwidth-Delay”:
  - Typical usage: BW * Propagation-Delay
    - Use this unless otherwise mentioned
  - Sometimes BW * Propagation-Delay * 2
    - Use this only if textbook problem explicitly says so.