

CS 640 Introduction to Computer Networks

Lecture 26

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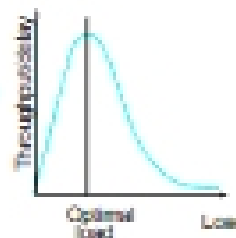
Today's lecture

- Congestion in networks
- TCP congestion control
 - Additive Increase Multiplicative Decrease
 - Slow start
 - Fast retransmit and fast recovery

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Congestion in the Internet

- Checksums are effective for detecting bit errors but they are not the only problem...
- We know that traffic is bursty
 - Statistical multiplexing of ON/OFF sources
 - Heavy-tailed file sizes
 - Routers have limited buffer capacity
 - Packets dropped when buffers full
 - Buffers do protect from short bursts
- Congestion lengthens delays and lowers throughput
 - Standard throughput/load curve



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How can we deal with congestion?

- **Over-provision networks**
 - Very expensive
 - Commonly done
 - Networks designed to normally operate at 5-50% capacity
- **Call admission control (phone networks)**
- **Develop protocols to respond to congestion**
 - Route away from congestion
 - Good idea - how can we do it?
 - Retransmit in the face of loss
 - This is the state of the art

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Congestion Control Basics

- **UDP will send packets at any specified rate**
 - Does not have mechanisms to handle congestion
- **Issues:**
 - Detecting congestion
 - Reacting to congestion
 - Avoiding congestion
 - Shaping traffic
 - QoS mechanisms
- **Transport protocol will deal with congestion...**

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Congestion control in the Internet

- **TCP implements congestion control**
 - Detects congestion through packet losses
 - Reduces rate aggressively in response to congestion
 - Increases rate cautiously to use up available bandwidth
 - Works well for large flows
- **Why the Internet doesn't experience congestion collapse**
 - Backbones overprovisioned
 - TCP congestion control
 - Sources' rate limited by nearest bottleneck link

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TCP RENO Overview

- Standard TCP functions in last lecture
 - Connections, reliability, RTT calculation, etc.
- Congestion control/management
 - Additive Increase/ Multiplicative Decrease (AIMD)
 - Fast Retransmit/Fast Recovery
 - Slow Start

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TCP Congestion Control

- Idea
 - Assumes best effort network (FIFO or FQ routers) each source determines network capacity for itself
 - Uses implicit feedback
 - ACKs pace transmission (*self-clocking*)
- Challenge
 - Determining the available capacity in the first place
 - Adjusting to changes in the available capacity

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