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Chapter 3.7 TCP Congestion Control

3.7.1 Overview

- TCP's approach is to *increase the sender's transmission rate* (window size) until loss occurs.
- **Additive increase** is to increase *cwnd* by 1 MSS every RTT until loss is detected.
- **Multiplicative decrease** is to cut *cwnd* by half after loss is detected.

3.7.1.1 Details

- The sender limits transmission such that $LastByteSent - LastByteAcked \leq cwnd$.
- The TCP sending rate is roughly $\frac{cwnd}{RTT} bytes/sec$.

3.7.2 TCP Slow Start

- When a connection is established, increase output rate *exponentially* until loss is detected.
- Commonly, cwnd starts at 1 MSS and *doubles* every RTT (every time an ACK is received).
- Thus, the initial rate of transfer is low, but grows rapidly.

3.7.3 TCP: Detecting and Reacting to Loss

- If loss is indicated by **timeout**, set cwnd to 1 MSS and grow window exponentially until a threshold is reached. At that point, it will grow linearly. In other words, it repeats the *TCP Slow Start* method until a threshold is reached.
- If loss is indicated by 3 duplicate ACKs being received, it indicates that the network is capable of delivering at least *some* segments. Thus, cwnd is *cut in half* and then grows linearly. This method is known as **TCP RENO**.
- Assuming there is always data to send, the average window size is $\frac{3}{4}\frac{W}{RTT} bytes/sec$ where W is the window size where loss occurs.

3.7.4 Explicit Congestion Notification (ECN)

- If there is congestion in a router, the *router will mark two bits* in the IP header (ToS field) to indicate congestion.
- The congestion indication will be sent to the receiver, who, after seeing the indication, will set an *ECE bit* on the ACK back to sender to notify them of congestion.