CS3200: Computer Networks

Lecture 26

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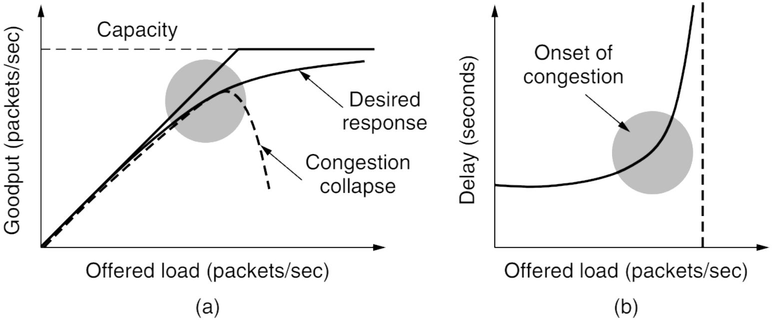
Efficiency and Power

An efficient allocation of bandwidth across transport entities will use all of the network capacity that is available.



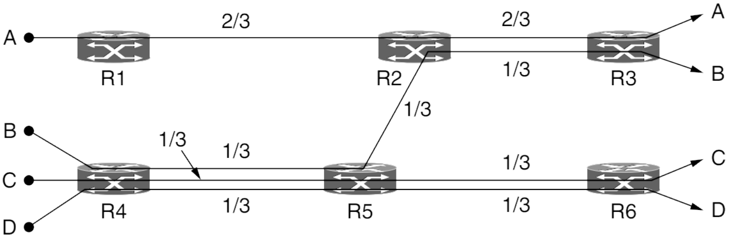
Kleinrock (1979) proposed the metric of **power**, where

$$\text{power} = \frac{\text{load}}{\text{delay}}$$

Max-Min Fairness

How to divide bandwidth between different transport senders? Give all senders an equal fraction of the bandwidth? But what happens if the flows have different, but overlapping, network paths?

An allocation is **max-min fair** if the bandwidth given to one flow cannot be increased without decreasing the bandwidth given to another flow with an allocation that is no larger.

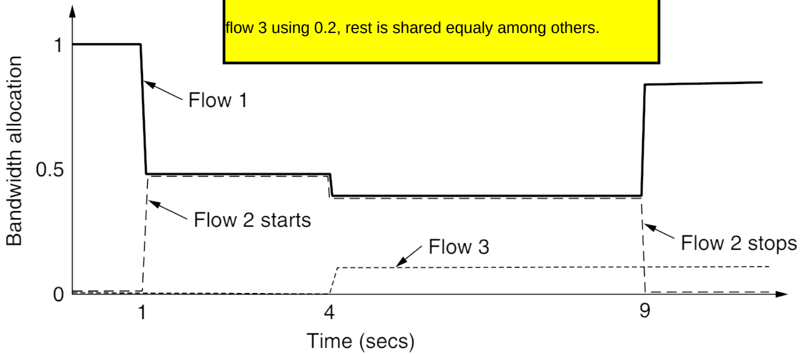


for router in_A = out_A, sum_{f in F_r \subseteq F} <= 1, max(min_{f in F} x_f).

Convergence

Congestion control algorithm converge quickly to a fair and efficient allocation of bandwidth. A good congestion control algorithm should rapidly converge to the ideal operating point, and it should track that point as it changes over time.

flow 3 using 0.2, rest is shared equaly among others.



Regulating the Sending Rate

- How do we regulate the sending rates to obtain a desirable bandwidth allocation?
- The sending rate may be limited by two factors. The first is flow control, in the case that there is insufficient buffering at the receiver. The second is congestion, in the case that there is insufficient capacity in the network.
- FAST TCP measures the roundtrip delay and uses that metric as a signal to avoid congestion (Wei et al., 2006).
- TCP with drop-tail or RED routers, packet loss is inferred and used to signal that the network has become congested.

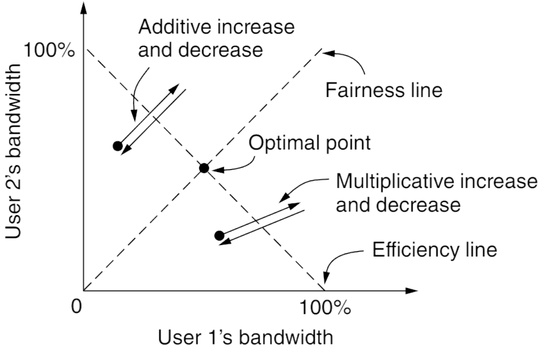
XCP = eXplicit Control Protocol. Precise = rate at which sender sho

- There are many variants of this form of TCP, including CUBIC TCP, which is used in Linux (Ha et al., 2008).
- Combinations are also possible. For example, Windows includes Compound TCP that uses both packet loss and delay as feedback signals (Tan et al., 2006).

Protocol	Signal	Explicit?	Precise?
XCP	Rate to use	Yes	Yes
TCP with ECN	Congestion warning	Yes	No
FAST TCP	End-to-end delay	No	Yes
Compound TCP	Packet loss & end-to-end delay	No	Yes
CUBIC TCP	Packet loss	No	No
TCP	Packet loss	No	No

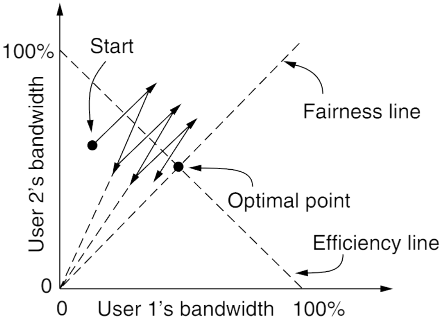
Additive Increase Multiplicative Decrease (AIMD)

What is users increase their sending rate by $1 Mbps$ every second? What is user increase their rate by 10% every second?



Additive Increase Multiplicative Decrease (AIMD)

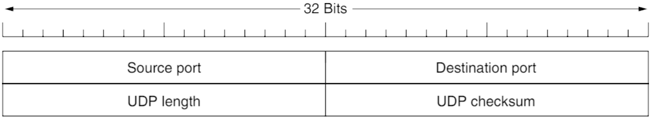
Increase rate by $1 Mbps$ every second, and decrease rate by 10% every second.



What would happen with multiplicative increase and additive decrease?

User Datagram Protocol (UDP)

UDP provides a way for applications to send encapsulated IP datagrams without having to establish a connection.



- UDP transmits segments consisting of an 8-byte header followed by the payload.
- The two ports serve to identify the endpoints within the source and destination machines.
- An optional Checksum is also provided for extra reliability.

User Datagram Protocol (UDP)

- For applications that need to have precise control over the packet flow, error control, or timing, UDP provides just what the doctor ordered.
- Often, the client sends a short request to the server and expects a short reply back. If either the request or the reply is lost, the client can just time out and try again.
- An application that uses UDP this way is DNS (Domain Name System).
- Read Section 6.4.2 on Remote Procedure Calls in Tanenbaum.