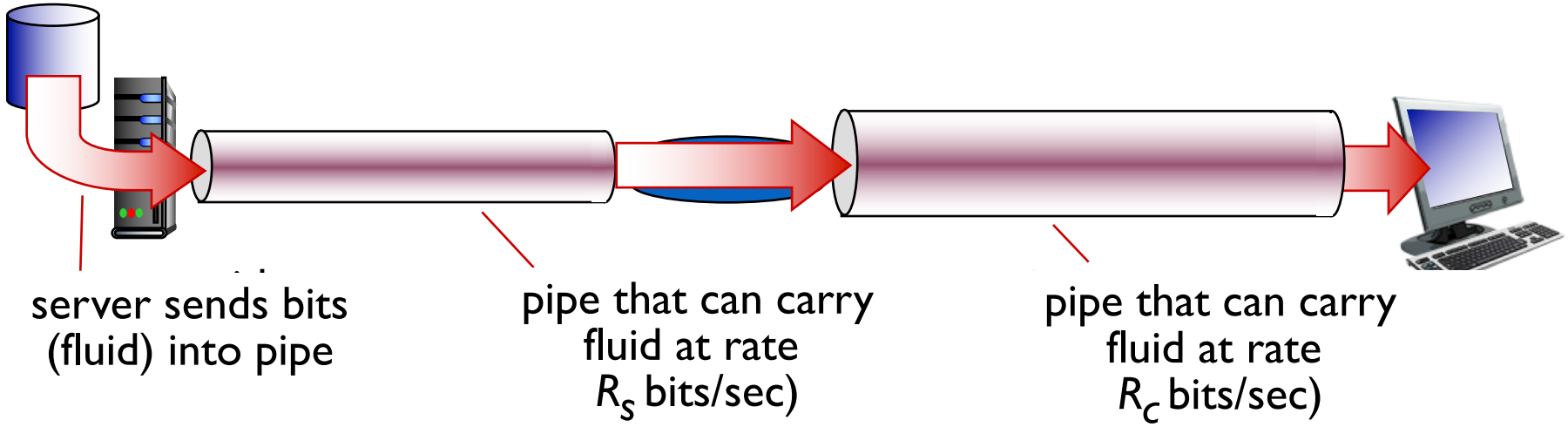
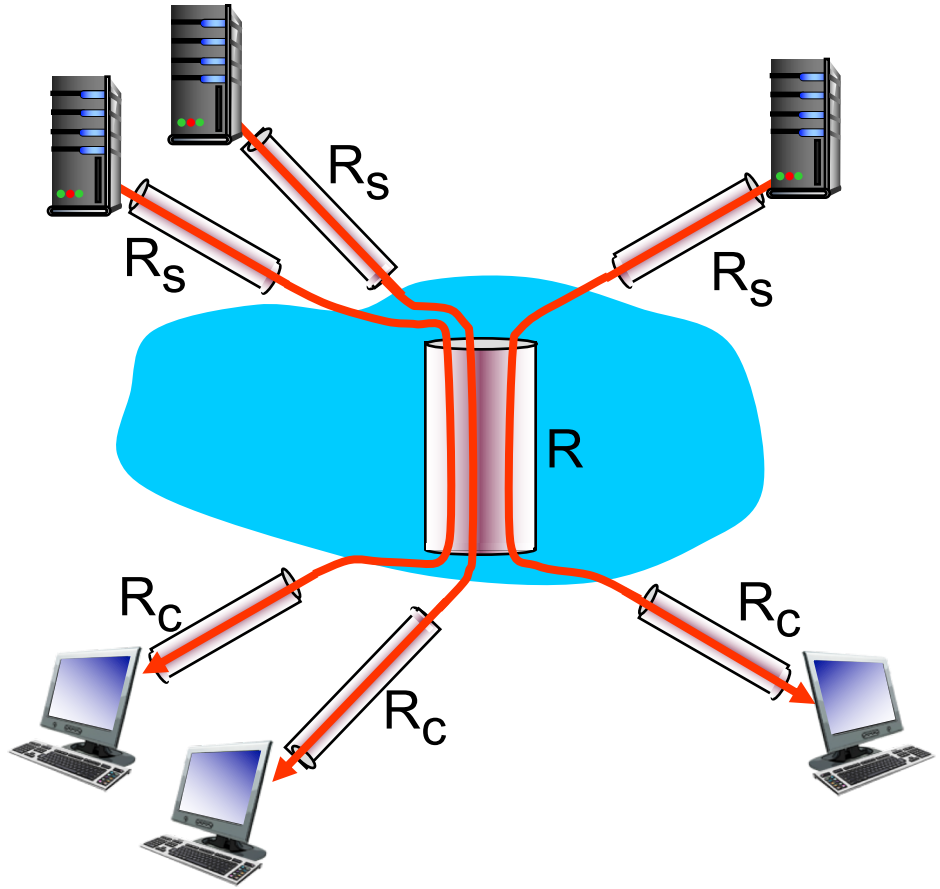
Throughput

- *throughput:* rate (bits/time unit) at which bits transferred between sender/receiver
  - *instantaneous:* rate at given point in time
  - *average:* rate over longer period of time



Throughput: Internet scenario

- per-connection end-end throughput: *min(R_c,R_s,R/10)*
- in practice: R_c or R_s is often bottleneck



10 connections (fairly) share backbone bottleneck link *R* bits/sec

* Check out the online interactive exercises for more examples: http://gaia.cs.umass.edu/kurose_ross/interactive/

Delay versus Throughput

Suppose:

A link, call it T3, has capacity/bandwidth = 45 million bits per sec

A CD, compact disc, has capacity 500 megabytes of data.

A file of size = 500*2^20*8*1000 bits ≈ 4 terabytes of data

Time to transfer file on the T3 link = (500*2^20*8*1000)/(45 million bits per sec) = 93206 s = 25 hours

Throughput of T3 = 45 million bits per sec

Time to transfer file using 1000 CDs with overnight shipment = 24 hours

Throughput of 1000 CDs = (500*2^20*8*1000)/(24*60*60) = 48545185.1852 = 48.5 million

Suppose Host A wants to send a large file to Host B. The path from Host A to Host B has three links, of rates $R_1 = 500$ kbps, $R_2 = 2$ Mbps, and $R_3 = 1$ Mbps.

a. Assuming no other traffic in the network, what is the throughput for the file transfer?

b. Suppose the file is 4 million bytes. Dividing the file size by the throughput, roughly how long will it take to transfer the file to Host B?

c. Repeat (a) and (b), but now with R_2 reduced to 100 kbps.