CIS 457 - Data Communications

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Images taken from Kurose and Ross book

End-to-End Throughput

Previously considered delay and packet loss

Studied on a node-by-node basis

Another metric of interest is **end-to-end throughput** -- how much information can get from host A to host B in a given amount of time

Unlike delay, which is measured in time (seconds), throughput is measured in bits/sec (or Mbps, etc.)

Throughput is a good measure of what user actually cares about in network

High throughput means that large files can be downloaded quickly

If you are trying to watch Netflix, you care about throughput

If you have ever tried an internet speed test, you know that throughput will vary somewhat over time

We consider average throughput

Effective network will have high average throughput (unlike delay, which should be low)

Physical analogy is amount of water flowing through a pipe

We are interested in how much information can flow through a network path

Information is like water, and each link in path is a pipe

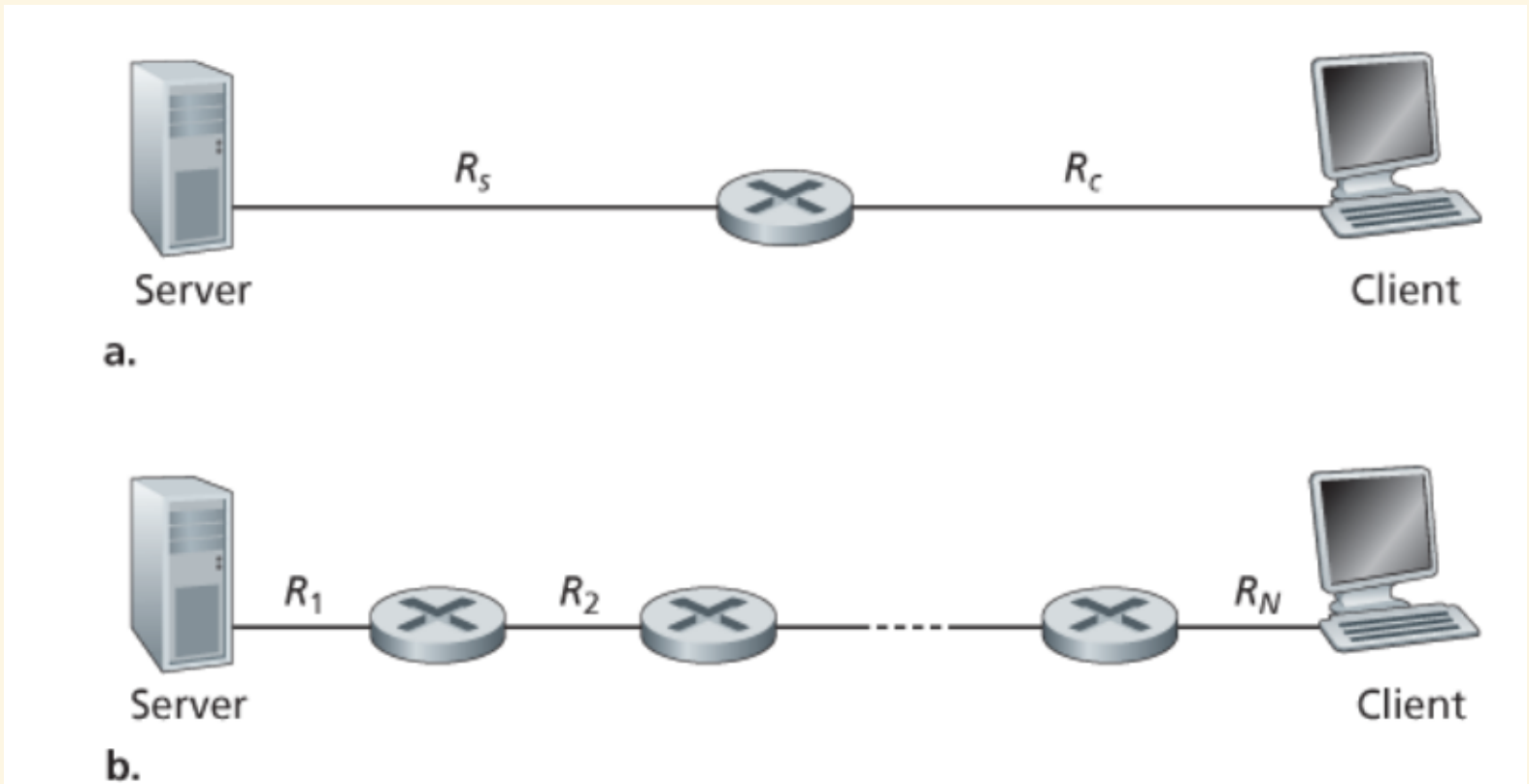
(As we all know, the internet is a series of tubes)

Path between two hosts consists of many links

Each link may have different transmission rate

Throughput can be only as large as link with lowest transmission rate

We call that link the **bottleneck link**


R_s
R_c
Server
Client
a.
R_1
R_2
R_N
Server
Client
b.

In example (a), throughput is `min(Rs, Rc)`

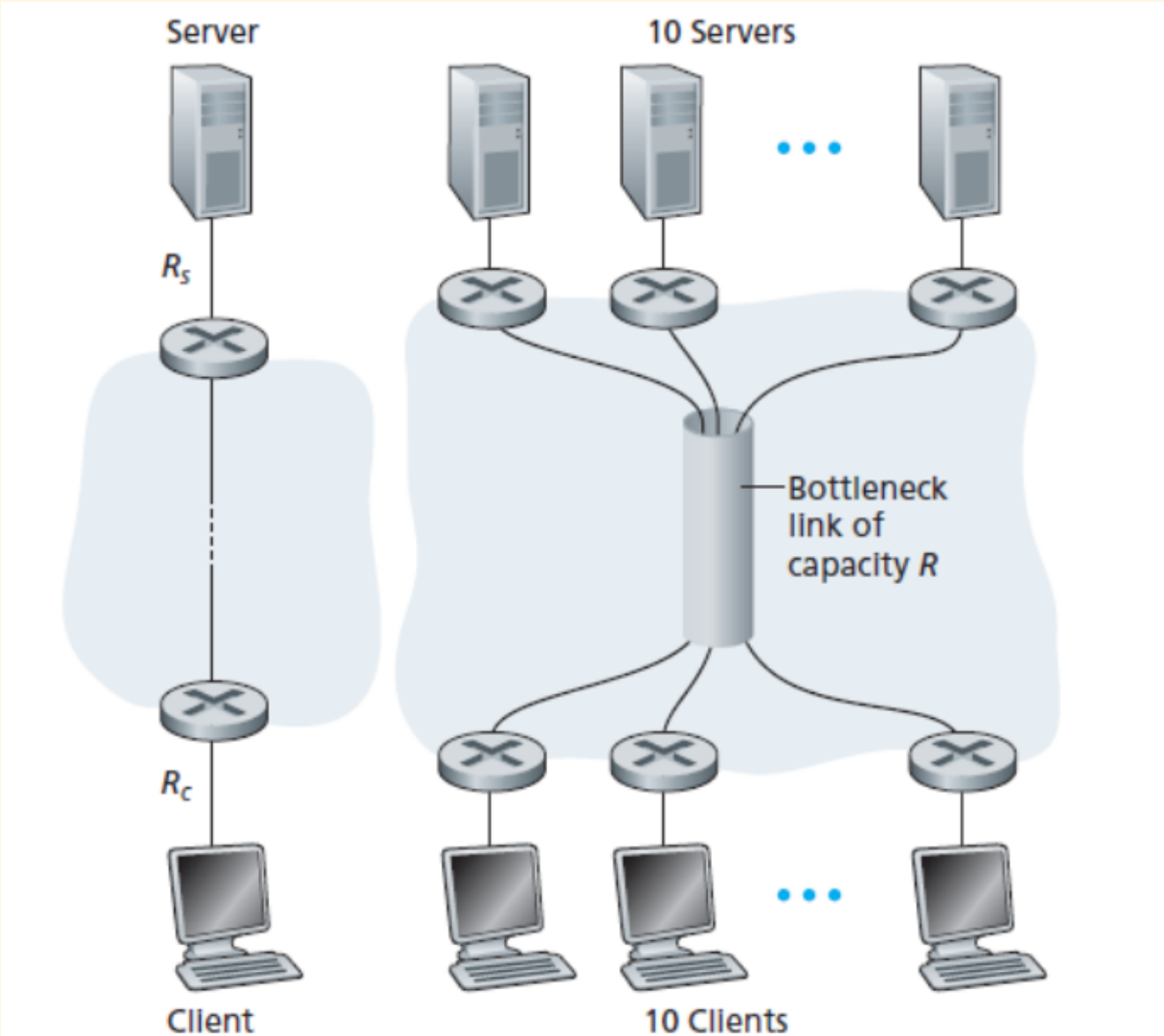
In example (b), throughput is `min(R1, R2, ..., RN)`

Consider transferring file of F bits between two hosts

Assume average throughput between those hosts is P

Total time to transfer is F/P

Throughput depends on link capacity, but also depends on traffic


Server
10 Servers
R_s
R_c
Bottleneck
link of
capacity R
Client
10 Clients

As number of connections using link goes up, effective bandwidth of link goes down because packets need to share

Increasing number of hosts using particular link by 10x means that each one can only use the link 1/10 as often (on average), so bandwidth for that connection has dropped by factor of 10

When bandwidth drops by 10x, total file download time goes up 10x