# Computer Networks - Throughput Problems

1. Hosts Alice and Bob are connected to each other via a router. The bandwidth of each link between Alice and the router is 15Mbps. If the efficiency of data transfer in the entire network is 80%, what is the actual throughput of the network?

$$IdealThroughput = min\{15, 15\} = 15Mbps$$

$$Efficiency = \frac{\text{Amount of data transferred through the network per second}}{\text{Amount of data that could be transferred per second}}$$

$$\frac{80}{100} = \frac{x}{15}$$

$$Throughput(x) = 12Mbps$$

2. A network with a bandwidth of 10 Mbps can pass only an average of 30,000 frames per minute where each frame carries an average of 10,000 bits. What will be the throughput for this network?

$$Throughput = \frac{30,000 * 10,000}{60}$$

$$Throughput = 5Mbps$$

The throughput is nearly equal to half of the bandwidth.

3. Consider a 10 Mbps link being shared by 7 users. What is the maximum throughput if the network is using using circuit switching?

$$Throughput = \frac{\text{Total link capacity}}{\text{No of users}}$$

$$Throughput = \frac{10}{7}$$

$$Throughput = 1.4Mbps$$

The throughput is nearly equal to half of the bandwidth.

4. Consider a 10 Mbps link college network link, and this link is being shared by 5 users. Suppose packet switching is used. What is the network throughput if the users are using 20% of the network bandwidth?

$$Throughput = 10Mbps$$

The network throughput is the maximum because 5 users using for 20% of the time is 100% usage.

5. Alice and Bob are connected to each other via a router. The bandwidth of each link between the router and Bob is 20Mbps. If the network allows for the actual transmission of data at 20Mbps, then what is the time taken for a packet of size 1000 bits to enter the network?

$$LetR = \text{bandwidth for the link between Alice and the router}$$

$$Throughput = min\{20, x\}$$

$$Throughput = 20Mbps$$

$$Timetaken = \text{Transmission delay} = \frac{\text{Packet Length}}{R}$$

$$Timetaken = \frac{1000}{20 * 106} = 50microseconds$$

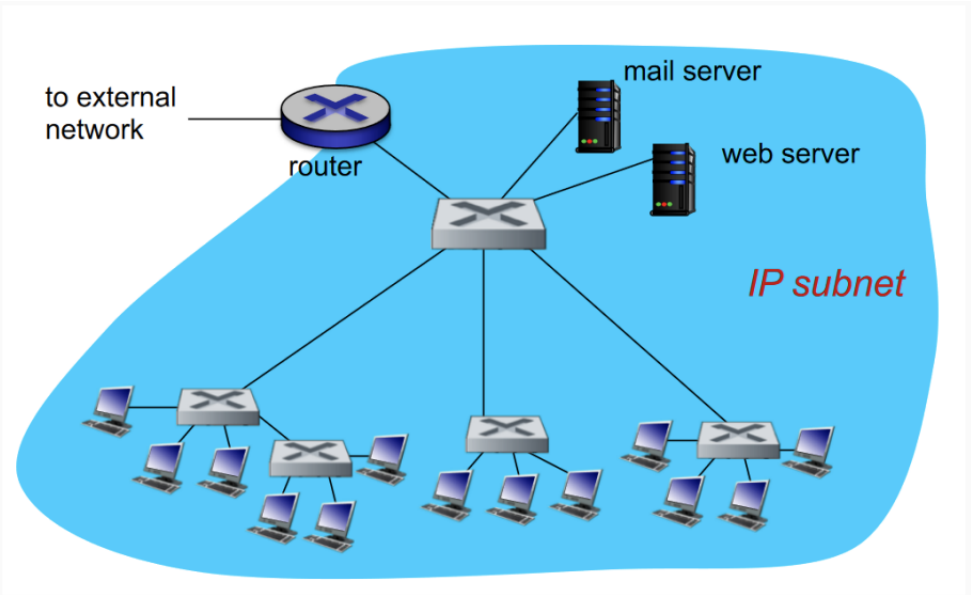
6. Your laptop is connected to the University WiFi network, you are downloading a 100kb file from the university file server. The WiFi link speed is 10Mbps and the server is connected to the network with a 100Mbps ethernet cable. What is the throughput while downloading the file onto your computer?

$$Throughput = min\{Rwifi, Rrouter\}$$

$$Throughput = min\{10, 100\}$$

$$Throughput = 10Mbps$$

7. What is the network throughput among the hosts and users of the below network, assuming that all the links are 150 Mbps?




If all 15 nodes are using the entirety of their link's bandwidth

$$Throughput = 15 * 100 = 1500Mbps$$

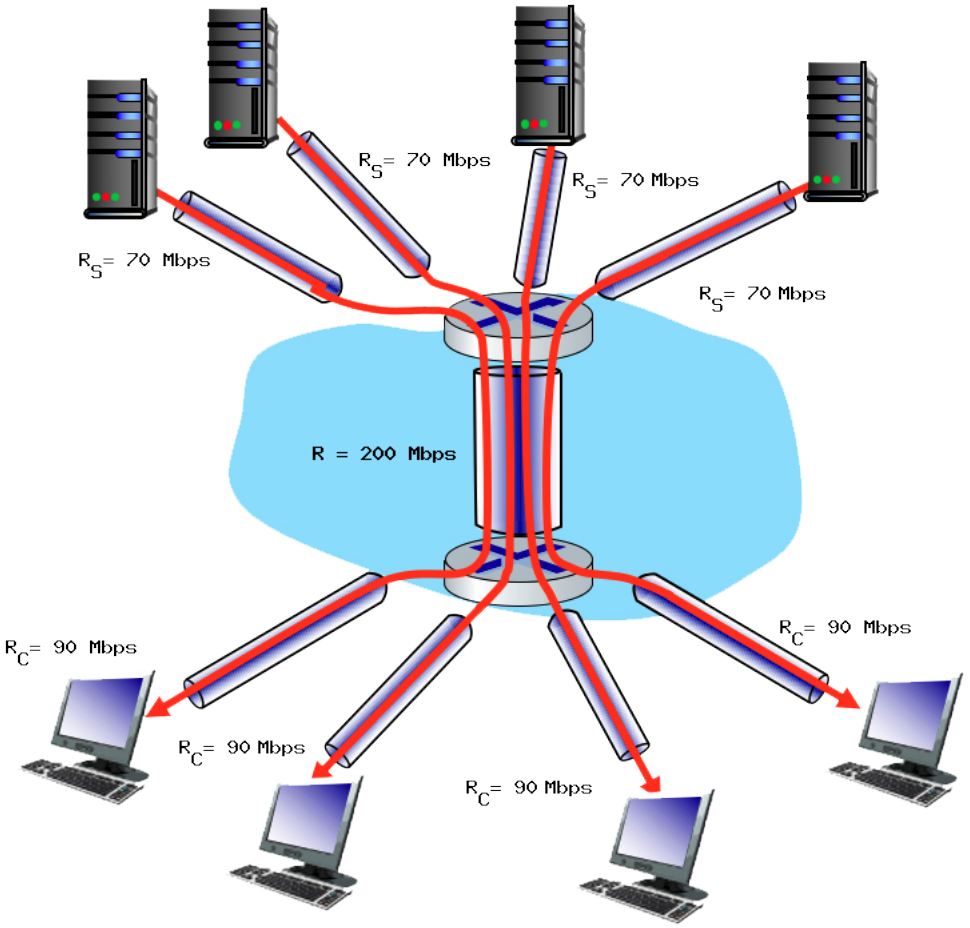
8. Consider the figure below where transmission delay is the only significant delay. Each link is 2Mbps. Suppose the number of links N is 3. Calculate the end to end delay if message of size 8 Mb is transferred and calculate the throughput for this scenario.

$$\text{Delay}$$
$$L = 8Mb$$
$$\text{End to end delay} = 3 * \frac{L}{R} = 3 * \frac{8}{2} = 12sec$$
$$Throughput = \frac{8Mb}{12sec} = 0.667Mbps$$

9. 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 R1 = 10 Mbps, R2 = 5 Mbps, and R3 = 30 Mbps. Assuming no other traffic in the network, what is the throughput for the file transfer?

$$Throughput = min\{R1, R2, R3\}$$
$$Throughput = min\{10, 5, 30\}$$
$$Throughput = 5Mbps$$

10. Consider the scenario shown below, with four different servers connected to four different clients over four three-hop paths. The four pairs share a common middle hop with a transmission capacity of R = 200 Mbps. The four links from the servers to the shared link have a transmission capacity of RS = 70 Mbps. Each of the four links from the shared middle link to a client has a transmission capacity of RC = 90 Mbps.



(a) What is the maximum achievable end-end throughput (in Mbps) for each of four client-to-server pairs, assuming that the middle link is fairly shared (divides its transmission rate equally)?

Bottleneck = min{Rc, Rs, R}
Bottleneck = R = 200 Mbps
Since there are 4 devices connected,
Maximum throughput = R/4 = 200/4 = 50Mbps

(b) Which link is the bottleneck link?

R, since 50Mbps is the highest the middle hop can offer.

(c) Assuming that the servers are sending at the maximum rate possible, what are the link utilization's for the server links (RS)? (In Percentage)

Assuming maximum rate at server as 70 Mbps, and bottleneck as 50 Mbps
Utilization = (50/70)*100 = 71

(d) Assuming that the servers are sending at the maximum rate possible, what are the link utilization's for the client links (RC)?

Assuming maximum rate at client as 90 Mbps, and bottleneck as 50 Mbps
Utilization = (50/90)*100 = 56

(e) Assuming that the servers are sending at the maximum rate possible, what is the link utilization's for the shared link (R)?

Assuming maximum rate at server as 70 Mbps, and bottleneck as 50 Mbps
Since there are 4 streams at the bottleneck, 50*4 = 200Mbps
Utilization = (200/200)*100 = 100