ICSI 516 Computer Communication Networks, Fall 2018 – Homework 1
Due September 12th, 2018 11:59PM via Blackboard – (20 points)

Requirements and policies

Students should complete this assignment individually. Your turn-in is due on Blackboard. **Late submissions will not be accepted.**

Part 1: Internet architecture

1. Give one example of the positive impact of the Internet on society.

2. Define network edge and network core. Which one connects client devices? Give one example of physical media used in edge networks.

3. Where do servers connect to the Internet: in edge or core networks?

4. What are the two common multiplexing techniques used in circuit switching? Briefly describe each of them.

5. Suppose that all clients in a network send data at a constant bit rate. Would packet-switching or circuit-switching be more desirable in this case? Why?

6. What are Tier-1 providers? Discuss their role in the Internet in light of network scalability.

Part 2: Packet loss, delay, throughput

1. Consider two packet switches directly connected by a link of *5,000 km*, propagation speed $2.5 * 10^8$ *m/s* and transmission rate *10 Mbps*. How long does it take to move a packet of length *100 Bytes* from one packet switch to the other packet switch? Generally, how long does it take to move a packet of length L *Bytes* over a link of distance d *km*, propagation speed s *m/s*, and transmission rate R *bps*?

2. Provide the definition of throughput. Imagine three client-server connections ($R_{S1} - R_{C1}$, $R_{S2} - R_{C2}$, $R_{S3} - R_{C3}$) sharing the same link R as illustrated in the figure below and with the indicated transmission speeds. What should be the minimum throughput of the shared link for it to not present a bottleneck to the three client-server links? Briefly describe your reasoning.

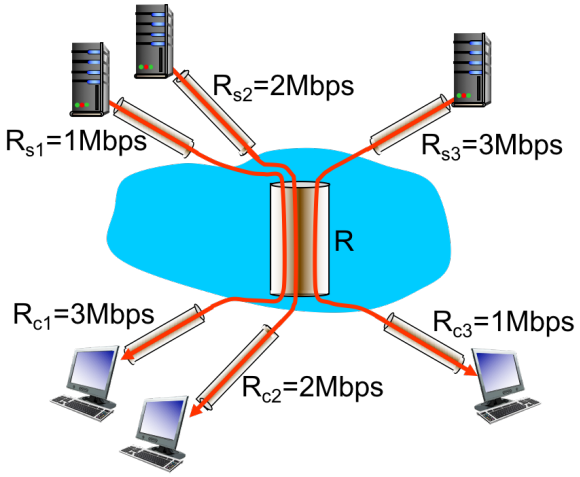

Figure 1: Three client-server streams sharing a common link R. What should be the minimum throughput of R, so that it does not present a bottleneck?

3. The Unix utility `traceroute` or its Windows counterpart `tracert` can be used to find the number of hops between two end stations and the delay incurred from the initiating host to each router along the way. Use `traceroute` to measure the number of hops and delay from our server[1] `csi516-fa18.arcc.albany.edu` to one host in Eastern Europe (the web server of Technical University Sofia at `www.tu-sofia.bg`) and one host on the East coast (the web server of Princeton at `www.princeton.edu`). Paste the outputs in your submission and answer the following questions.

   (a) What is the difference in hop count between UAlbany and TU-Sofia and between UAlbany and Princeton. How well does the number of hops correlate with the geographical distance?

[1] For detailed instructions on how to access our course server refer to `https://goo.gl/j7ta8n`

(b) What is the round-trip time (RTT) to each of the two hosts? How well does it correlate with the geographical distance?

(c) Do you see any sudden increases in the RTT between consecutive routers along the path? Why?

(d) What is the sequence of routers from our server to the edge of the UAlbany network?

(e) Run traceroute in two distinct parts of the day (say midday and late at night). Note the time of each run and comment on the differences you observe in number of hops and RTTs.

4. Where and when does packet loss occur?

1 Part 3: Protocol stack

1. Which are the five layers of the TCP/IP stack?

2. Up to which layer do end systems process TCP/IP packets?

3. Up to which layer do routers process packets?

Part 4: Research papers

1. [$Saltzer+84$] presents an argument about placement of functionality in network system design. Particularly, the article compares placement of functionality in the network core vs. the end hosts. Consider an example of reliable data transfer and talk about the benefits and drawbacks of implementing reliable data transfer in the end hosts.

2. One of the key design principles of the Internet architecture presented in [$Clark88$] is the ability of the Internet to accommodate variety of services. What functional changes had to be made to the then-integrated TCP/IP protocol in order to accommodate variety of services. Give two examples of services whose performance suffers when protocols impose stringent reliability requirements.