ICSI516 Fall17, Homework 1 – *20 points*

Due date: Wednesday, 9/20, by 11:59PM via Blackboard

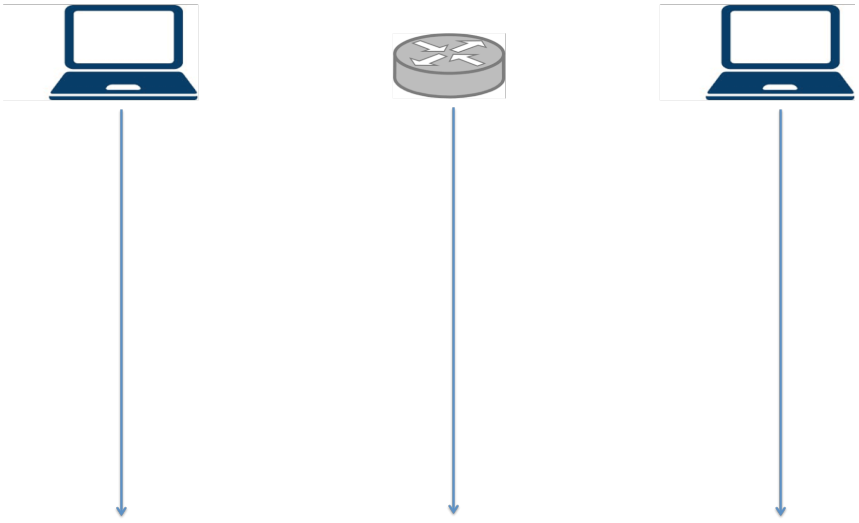
[Internet architecture]

1. ***[2 points]*** Circuit-switching provides certain guarantees such as fixed number of hops and fixed bandwidth, however, it is not the preferred way of handling traffic in today's Internet. What is the preferred way? Why?

[Packet loss, delay, throughput]

2. ***[2 points]*** Consider sending a packet from a source host to a destination host over a fixed route. List the delay components in the end-to-end delay. Which of these delays are constant and which are variable?

3. ***[2 points]*** On the diagram below, a packet begins from the host to the left and travels through a single router to the host on the right. Imagine that the vertical arrows below the devices are timelines and that the clocks of all machines are absolutely synchronized.
    a. What delay types will the packet experience in each machine?
    b. Draw the delay components on the diagram below as ranges on the timeline (if they happen within the device) or as lines connecting timelines (if they happened between two consecutive devices). Be sure to note what type of delays they are as you draw them.



4. ***[4 points]*** Consider a packet of length 1,000 bytes that propagates over a link of distance 2,500 km with propagation speed of $2.5 \cdot 10^8$ m/s, and transmission rate 2 Mbps?
    a. How long does the packet propagation take?
    b. Does this propagation delay depend on the packet length?
    c. Does this propagation delay depend on the transmission rate?

5. ***[4 points]*** 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 `itsunix` 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?
    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 `itsunix` 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.

    Note: You will need to use the full path to the binary (i.e. `/usr/sbin/traceroute`) when running `traceroute` on `itsunix`.

[Protocol stack]

6. ***[1 points]*** Which are the five layers in the Internet protocol stack? What are the principal responsibilities of each of these layers?

7. ***[1 points]*** Which layers from the Internet protocol stack does a router implement? Which layers does a link-layer switch implement? Which layers does a host implement?

[Research papers]

8. ***[2 points]*** [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.
9. ***[2 points]*** 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.