Client-Server, Distribution, and Streaming

These exercises are intended to help you master and remember the material discussed in lectures and explored in labs. In future semesters, we may make some or all of these exercises required, but for now they remain optional. We suggest that you do them as we go over the material, but you may also want to use them to review concepts before the exam.

Please note also that some of the exercises are meant to be done with a calculator, while in exams, we just want you to be able to set up the equations correctly. Also, some of the exercises (such as #2) are meant to help you to explore a topic and learn more about it using sources from the Internet and thus won't appear on exams.

Rather than using this version directly, we suggest that you use the version without solutions to solve the problems before looking at the answers. Many studies have shown that people often trick themselves into believing that they know how to solve a problem if they are presented with the answer before they try to solve the problem themselves.

1. [L7] In the Internet, a computer can act both as a client and as a server, depending on the service in question. For each scenario below, describe the service being provided over the Internet and state whether the computer mentioned is acting as a client, as a server, or as both.
   A. a computer accepting responses for the Google Form service
      a server, as it provides the Google Form service.
   B. a self-service kiosk at the airport
      a client, as it communicates to airlines' servers to process passenger's requests.
   C. a point-of-sale device to receive a payment from credit cards.
      a client, as it communicates to payment companies' servers to process customers' payments.
   D. a computer receiving the photos to be stored in Apple Photos
      a server, a storage server to be specific, as it provides the storage service.
   E. a computer that routes the requests from the Illinois mobile app to UIUC's central data server
      both client and server, as it provides service to Illinois mobile app, while receives the service from the central data server
   F. web browser (Chrome, Safari, and so forth)
      a client, as it receives the internet services from the web servers.

2. [L7] Glitches/mistakes in software programs are typically referred as 'bugs'.

   A. How was the term "bug" coined? Try to search on the Internet to track the origins of the word. It indeed is an interesting story.
      From Wikipedia: The term "bug" was used in an account by computer pioneer Grace Hopper, who publicized the cause of a malfunction in an early electromechanical computer. A typical version of the story is: In 1946, when Hopper was released from active duty, she joined the Harvard Faculty at the Computation Laboratory where she continued her work on the Mark II and Mark III. Operators traced an error in the Mark II to a moth trapped in a relay, coining the term bug. This bug was carefully removed and taped to the log book. Stemming from the first bug, today we call errors or glitches in a program a bug. This log book, complete with attached moth, is part of the collection of the Smithsonian National Museum of American History.

   B. As mentioned in class, commercial software typically has a bug for every 100 to 1,000 lines of code. The latest version of Microsoft Windows has roughly 50 million lines of code. Using these numbers, estimate how many bugs are likely to be present in Windows.
      An OS such as Windows has approximately 50,000 to 5,000,000 bugs. Not all of them are severe, though.

C. Can you recall any famous story where a software bug led to a major problem worldwide? *(Hint: search on the Internet to read some of them.)*
An interesting story of a software bug that affected the lives of people around the world is of Millennium bug or Y2K bug. Y2K refers to potential computer errors related to the formatting and storage of calendar data for dates in and after the year 2000. Many programs represented four-digit years with only the final two digits, making the year 2000 indistinguishable from 1900. Computer systems' inability to distinguish dates correctly had the potential to bring down worldwide infrastructures for industries ranging from banking to air travel [From Wikipedia].

If interested in reading more, please refer to: https://medium.com/swlh/some-of-the-most-famous-bugs-in-software-history-bb16a2ee3f8e

D. In the early era of computers, what was the main challenge that kept engineers from working on bugs in the OS?
The biggest challenge with early computer usage was that there weren't enough computers for everyone. It was considered a luxury item, and only a few families owned a computer at their home. On the other hand, universities had many computers in their possession. This can be resolved if we have a model where someone could use a computer for a little while, whenever they needed one. Cloud computing aims to do exactly that: allowing users to use someone else's computer as a service.

3. [L7] What are the two major challenges that cloud computing tries to overcome? Discuss some of the major issues with cloud computing and their remedies.

Major issues with cloud computing, and remedies:

A. Trust: trust is the biggest hurdle, since the users may not trust the service provider with their personal data; or service provider may not trust the users with their software. Such issue can be tackled with technological solutions such as sandboxing, and data encryption.

B. Compatibility: Users' programs may need certain specific computing configuration, which may not be available with the service provider. As a solution, many cloud computing companies are coming up with virtual machines where the user can select the hardware and software configurations in advance.

4. [L8] A student at the UIUC campus came up with the ambitious idea of launching an emergency service system that is based on smartphone messaging apps such as WhatsApp or Messenger. In case of an emergency, instead of dialing 911, users can now send a message to the local police department through WhatsApp. What are some major concerns/challenges in the above plan? Remember that WhatsApp and Messenger use Internet services internally.

One major challenge in the above plan is the reliability of the service. WhatsApp and Messenger use the Internet to connect the police department, but the Internet is not always reliable. The Internet only tries to deliver the packet but doesn't guarantee delivery. In general, the Internet doesn't make a good substitute for emergency services such as 911.

5. [L8] Consider the picture shown below, in which three pairs of users are trying to send videos simultaneously through a part of the Internet.
   - Jan wants to send a 800 MB video to Pat (along the BLUE line),
   - Alice wants to send a 400 MB video to Bob (along the GREEN line), and
   - Erato wants to send a 400 MB video to Denes (along the RED line).

Their routes share links as shown.

Assume for all questions that TCP is able to reach the rates shown on the links, and that link sharing is fair unless one of the connections is limited by another link along its route.
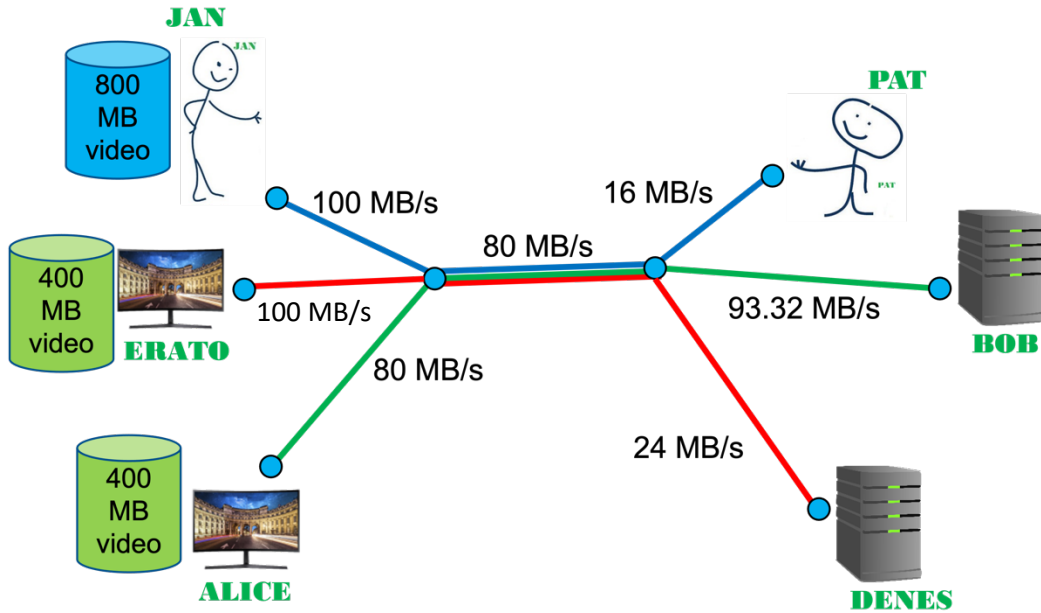
Calculating fractions is not required.

    A. At what rate can Jan send to Pat? _____ MB/s
       How long does it take? _____ seconds

    B. At what rate can Alice send to Bob? _____ MB/s
       How long does it take? _____ seconds

    C. At what rate can Erato send to Denes? _____ MB/s
       How long does it take? _____ seconds

The shared link will try to cater each three paths equally. However, we also need to consider other links on each path to identify the limiting link. In the following diagram, shared and limiting links are shown.
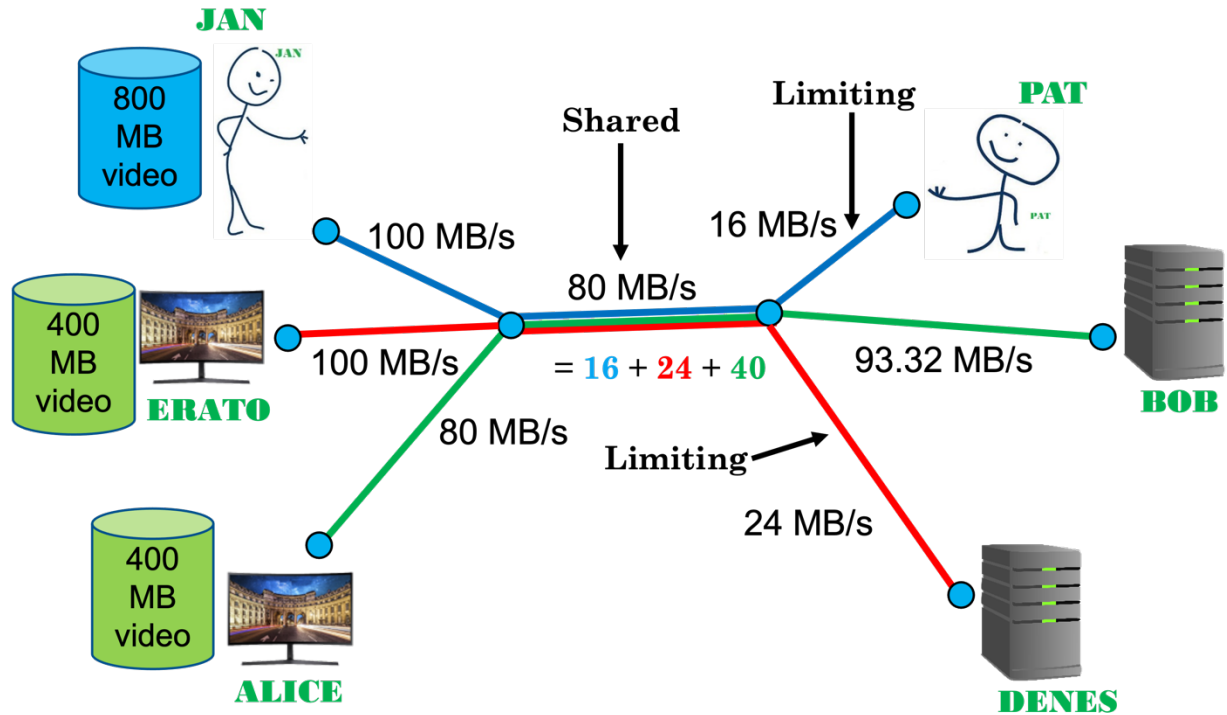
A. At what rate can Jan send to Pat? _____**16**_____ MB/s
   How long does it take? _____**800 / 16 = 50**_____ seconds

B. At what rate can Alice send to Bob? _____**40**_____ MB/s
   How long does it take? _____**400 / 10 = 40**_____ seconds

C. At what rate can Erato send to Denes? _____**24**_____ MB/s
   How long does it take? _____**400 / 24 = 16.67**_____ seconds