Homework 2

Due: Sunday 11:59 PM, September 29, 2024

1. (12 points) Answer the following:
    a. Identify the architecture where a server with a permanent IP address has always-on host capability to provide service. Provide an example of the application of this model.
    b. Identify the architecture where a server with temporary IP address host file services does not have the always-on-host capability to share files. Provide an example application of this model.
    c. Which architecture do you find ideal in your day-to-day application usage? Give some examples.

2. (8 points) Differentiate between inter-process communication (IPC) in multi-machines versus the single machine using examples. What programming interface do you use for IPC between two hosts?

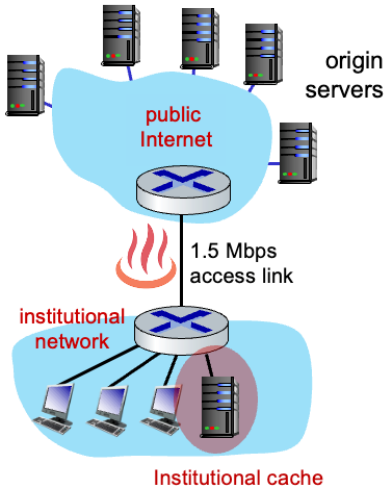
3. (10 points) You are designing a communication system for a real-time online gaming application. Players need to exchange information about their current positions, actions, and updates in the game environment. Additionally, the system should prioritize low latency to ensure a smooth gaming experience.

    Based on the given scenario, analyze the requirements of the online gaming application and propose the most suitable transport protocol for the communication between players. Justify your choice by considering factors such as reliability, latency, and the nature of the data being transmitted.

4. (10 points) Suppose that you have two browser applications open and active at the same time and that both applications are accessing the same server to retrieve HTTP documents at the same time. How does the server know how to tell the difference between the two applications (to send the correct document(s) to the correct application)?

5. (20 points) You are assigned a task to analyze the distribution of a file with a size of $F = 12$ Gbits to $N = 100$ clients or peers. The server supports an upload rate of $u_s = 15$ Mbps while each client/peer has a download rate of $d_i = 3$ Mbps and an upload rate of u, where $u =$ 500 Kbps or 800 Kbps. Show your calculations. [You can use conversion of the forms 1Kbps $=10^3$ bps, 1Mbps = 10^6 bps, 1Gb = 10^9 bits, in the exam you must remember the conversions]
    a. Calculate the minimum distribution time for a client-server distribution using the two values of u given above.
    b. Calculate the minimum distribution time for a peer-to-peer distribution using the two values of u given above.

6. (20 Points) Consider the following simplified network diagram where there is an institutional network connected to the Internet:



Suppose that the average object size is 60,000 bits and that the average request rate from the institution's browsers to the origin server is 23 requests per second. Also, suppose that the amount of time it takes from when the router on the Internet side of the access link forwards an HTTP request until it receives the response is two seconds on average. Model the total average response time as the sum of the average access delay and the average Internet delay. For the average access delay, use $\Delta/(1-\Delta\beta)$, where Δ is the average time required to send an object over the access link and β is the arrival rate of objects to the access link. You can assume that the HTTP request messages are negligibly small and thus create no realized traffic on the network or the access link. Show your calculations.

a. Find the total average response time.

b. Now, suppose a cache is installed in the institutional LAN (see figure). Suppose the miss rate is 0.4. Find the total response time.

7. (10 points) Suppose that you join BitTorrent as a new peer without possessing any chunks. Unfortunately, you cannot become a top-4 uploader for any of your peers since you do not have anything to upload. Describe how you will be able to get your first chunk. Be specific.

8. (10 points) Identify at least one reason why DNS uses UDP instead of TCP for its query and response messages. Justify your answer.