Homework 2: Network Application Performance Analysis

CSE 4/589 - Modern Networking Concepts
Instructor: Yaxiong Xie

NOTES:

- **Academic integrity**: Print the following statement at the very beginning of your homework file: "*I have read and understood the course academic integrity policy in the syllabus of the class. I confirm that the work presented in this report is my own. Where information has been derived from other sources, I confirm that this has been indicated in the report.*" Your homework will NOT be graded if you didn't print the sentence.
- For the calculation, you need to write down how the results are derived and your final answer also should be correct to obtain the credits for that question. Please state any assumptions you are making while answering a question.
- Submit the homework through UBLearns as PDF files.

Instructions

- Show all necessary steps for calculations.
- Submit electronically in PDF format.

Question 1: HTTP Connection Performance Analysis

A webpage consists of:

- 1 HTML file (**0.04 Mbit**)
- 5 images (each **0.4 Mbit**)

The network characteristics are as follows:

- Link bandwidth: **10 Mbit/s**
- Round-trip time (RTT): **50 ms**
- Assume negligible processing delay at both the client and server.

Calculate the total webpage load time for three HTTP connection types:

1. **Non-Persistent HTTP (without pipelining)**: Each request requires a new TCP connection. (10 points)
2. **Persistent HTTP (without pipelining)**: A single TCP connection is used for all requests, but each request must be sent sequentially. (10 points)
3. **Persistent HTTP with Pipelining (HTTP/1.1)**: A single TCP connection is used, and multiple requests can be sent before waiting for responses. (10 points)

Question 2: Web Caching Performance Analysis

A university web server serves a **5 Mbit** webpage to students. A caching proxy is introduced with the following network parameters:

- **Client-to-Proxy RTT**: 20 ms
- **Proxy-to-Server RTT**: 60 ms
- **Web Server Bandwidth**: 50 Mbit/s
- **Proxy Server Bandwidth**: 200 Mbit/s
- **Cache Hit Ratio**: 80%

Calculate the total webpage load time for:

1. Direct retrieval from the web server (no caching). (10 points)
2. Cache hit (page served from the proxy). (10 points)
3. Cache miss (proxy retrieves from the web server). (10 points)
4. Expected average response time. (10 points)

DNS Performance Analysis

A client requests the resolution of `www.example.com`. The recursive DNS resolver queries external servers if the record is not cached. The network parameters are:

- **Client-to-Local Resolver RTT**: 10 ms
- **Local Resolver-to-Root DNS RTT**: 25 ms
- **Root DNS-to-TLD Server RTT**: 20 ms
- **TLD Server-to-Authoritative Server RTT**: 15 ms
- **Processing delay at each server**: 5 ms
- **Cache Hit Rate**: 70%
- **All queries use UDP (no TCP handshake).**

Calculate:

1. Cached resolution time. (10 points)
2. Uncached resolution time. (10 points)
3. Expected average resolution time. (10 points)