HW #2, Chapter 2

He Tianyang, 3022001441

October 5, 2024

Problem 2. Chapter 2 P8.

Referring to Problem P7, suppose the HTML file references eight very small objects on the same server. Neglecting transmission times, how much time elapses with

a. Non-persistent HTTP with no parallel TCP connections?

b. Non-persistent HTTP with the browser configured for 6 parallel connections?

c. Persistent HTTP?

Solution

a. Non-persistent HTTP with no parallel TCP connections

For non-persistent HTTP without parallel connections, each object (including the initial HTML file and the eight small objects) requires a separate TCP connection established sequentially.

1. **Initial HTML file:**
   - **1 RTT** for the TCP connection establishment (three-way handshake).
   - **1 RTT** for the HTTP request and the reception of the HTML file.

   Total time for initial HTML file: 1 RTT + 1 RTT = 2 RTTs.
2. **Eight small objects:**
   - For each object:
     - **1 RTT** for the TCP connection establishment.

  - **1 RTT** for the HTTP request and response.
- Time per object: 1 RTT + 1 RTT = 2 RTTs.
- Total time for eight objects: 8×2 RTTs = 16 RTTs.

Total elapsed time:

$$\text{Total time} = 2 \text{ RTTs (initial file)} + 16 \text{ RTTs (objects)} = \boxed{18 \text{ RTTs}}$$

b. Non-persistent HTTP with the browser configured for 6 parallel connections

With 6 parallel connections, the browser can fetch up to 6 objects simultaneously.

1. **Initial HTML file:**
   - Same as before: 1 RTT (connection) + 1 RTT (request/response) = 2 RTTs.
2. **First batch of objects (6 objects):**
   - **1 RTT** for TCP connection establishments (simultaneously for all 6 connections).
   - **1 RTT** for HTTP requests and responses (also simultaneous).
   - Total time for first batch: 1 RTT + 1 RTT = 2 RTTs.
3. **Second batch of objects (2 objects):**
   - After the first batch completes, the browser uses available connections to fetch the remaining 2 objects.
   - **1 RTT** for TCP connection establishments.
   - **1 RTT** for HTTP requests and responses.
   - Total time for second batch: 1 RTT + 1 RTT = 2 RTTs.

Total elapsed time:

$$\text{Total time} = 2 \text{ RTTs (initial file)} + 2 \text{ RTTs (first batch)} + 2 \text{ RTTs (second batch)} = \boxed{6 \text{ RTTs}}$$

c. Persistent HTTP

With persistent HTTP, a single TCP connection is used to transfer the initial HTML file and all subsequent objects.

1. **TCP Connection Establishment:**

- **1 RTT** for the initial TCP connection establishment.

2. **Initial HTML file:**
   - **1 RTT** for the HTTP request and response.

   Total time for initial HTML file: 1 RTT (connection)+1 RTT (request/response) = 2 RTTs.

3. **Eight small objects:**
   - Since the connection is persistent, no additional RTTs are needed for connection establishments.
   - Without pipelining (requests are sent one after another):
     - Each object requires **1 RTT** for its HTTP request and response.
     - Total time for eight objects: 8×1 RTT = 8 RTTs.

Total elapsed time:

$$\text{Total time} = 2 \text{ RTTs (initial file)} + 8 \text{ RTTs (objects)} = \boxed{10 \text{ RTTs}}$$

Note: If HTTP pipelining were used (allowing multiple requests to be sent without waiting for responses), the eight objects could be requested back-to-back, potentially reducing the time further. However, since pipelining is not specified, we assume it is not used.