Computer Network hw1

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1

packet switch

The transmission delay

$$d_t = \frac{x}{p} \cdot \frac{p}{b} = \frac{x}{b}$$

The store and forward delay

$$d_{sf} = (k-1) \cdot \frac{p}{b}$$

The propagation delay

$$d_p = kd$$

The total delay is

$$d_{pw} = d_t + d_{sf} + d_p = \frac{x}{b} + kd + (k-1) \cdot \frac{p}{b}$$

circuit switch

The transmission delay

$$d_t = \frac{x}{b}$$

The propagation delay

$$d_p = kd$$

The setup delay is s.

The total delay is

$$d_{cs} = \frac{x}{b} + kd + s$$

If packet switch is smaller:

$$\begin{gathered} d_p < d_c \\ \text{i.e.} \\ \frac{x}{b} + kd + (k-1) \cdot \frac{p}{b} < \frac{x}{b} + kd + s \\ \implies s > \frac{p(k-1)}{b} \end{gathered}$$

2

Since in the description it says that *The handshaking process costs 2RTT before transmitting the file.*, we don't consider transmitting file during the handshaking.

In my solution, I consider `Mb` as `10**6 bits`.

And in my solution, `0.5RTT` means in the final transmission, I just send the file, regardless of the return message from the receiver.

1)

$$d = 2\text{RTT} + 0.5\text{RTT} + \frac{1000KB}{1KB} \cdot \frac{1024 \cdot 8\ b}{1.5 \cdot 10^6 b/s} = 5711ms$$

2)

$$d = 2\text{RTT} + (\frac{1000KB}{1KB} - 1) \cdot \text{RTT} + 0.5RTT + \frac{1000KB}{1KB} \cdot \frac{1024 \cdot 8\ b}{1.5 \cdot 10^6 b/s} = 105611ms$$

3)

$$d = 2\text{RTT} + \text{RTT} \cdot (\frac{1000KB}{1KB \cdot 20} - 1) + 0.5\text{RTT} = 5150ms$$

3

home access

DSL using telephone line, cable internet access using HFC, Fiber to the home

enterprise access

100Mbps switched Ethernet switch, WiFi (802.11)

wide-area mobile access

3G, 4G

4

1)

In the ***textbook*** pp.96, I get these

Internet applications	Application-layer protocol
The web	HTTP
The email	SMTP
File transfer	FTP
Remote login	Telnet
Streaming multimedia	HTTP

2)

The IP address of the destination host and the port number of the socket of the process in the destination host.

5

In ***textbook*** pp.92, I get these

- Reliable data transfer (rdt)
    - TCP
- Guaranteed available throughput at some specified rate
    - Neither
- Guaranteed data delivered within specified time
    - Neither
- Security
    - Neither

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The time to get IP address:

$$t_1 = \sum_{i=1}^{n} RTT_i$$

The time to establish TCP connection and get HTML object

$$t_2 = RTT_0 + RTT_0 = 2RTT_0$$

a)

Adding 8 more files, so the total time is

$$t_a = t_1 + t_2 + 2 \cdot 8 \cdot RTT_0 = \sum_{i=1}^{n} RTT_i + 18RTT_0$$

b)

For this question, it needs 2 connections more.

$$t_b = t_1 + t_2 + 2 \cdot \lceil \frac{8}{5} \rceil RTT_0 = \sum_{i=1}^{n} RTT_i + 6RTT_0$$

c)

I consider this question as parallelism, so the 8 more files needs only one RTT_0.

$$t_c = t_1 + t_2 + RTT_0 = \sum_{i=1}^{n} RTT_i + 3RTT_0$$

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a)

Distribution scheme:

The server sends the file to each client at the same rate $\frac{u_s}{N}$ simultaneously, which is slower than the downloading rate, d_{min}, of each client (according to the assumption). Then the downloading rate becomes the same as uploading rate $\frac{u_s}{N}$, and the time cost on downloading the file of each client is $\frac{F}{\frac{u_s}{N}} = \frac{NF}{u_s}$. Since parallelism, the total distribution time is $\frac{NF}{u_s}$.

b)

Distribution scheme:

The server sends the file to each client at the same rate d_{min} parallel, because $\frac{u_s}{N} \geq d_{min}$, we cannot make it faster. Each client receives the file at the rate d_{min}, the time cost on receiving the whole file is $\frac{F}{d_{min}}$, and the total time is $\frac{F}{d_{min}}$.

c)

From the book we can get

$$D_{cs} \geq \max\{\frac{NF}{u_s}, \frac{F}{d_{min}}\}$$

When $\frac{u_s}{N} \leq d_{min}$, we can get $D_{cs} \geq NF/u_s$, however in a) we have $D_{cs} \leq NF/u_s$. Then we get $D_{cs} = NF/u_s$.

Similarly, when $u_s/N \geq d_{min}$, we can get $D_{cs} = F/d_{min}$.

Hence, the minimum distribution time is in general given by $\max\{\frac{NF}{u_s}, \frac{F}{d_{min}}\}$.

8

a)

The description gives

$$u_s \leq \frac{u_s + \sum_{i=1}^{N} u_i}{N} \implies u_s \leq \frac{\sum_{i=1}^{N} u_i}{N-1}$$

Suppose that the file uploaded is divided into N parts, and every part has $\frac{u_i}{\sum_{i=1}^{N} u_i} F$ bits, and the server uploading each parts at the rate of $\frac{u_i}{\sum_{i=1}^{N} u_i} u_s$. Since $\sum_{i=1}^{N} \frac{u_i}{\sum_{i=1}^{N} u_i} u_s = u_s$, so the total rate does not exceed the limit. In the same way, each peer uploads the bits it receives to another N-1 peers at the rate $\frac{u_i}{\sum_{i=1}^{N} u_i} u_s$, so the total rate is $\frac{u_i(N-1)}{\sum_{i=1}^{N} u_i} u_s \leq u_i$, which is not exceeding the limit.

So every peer receives bits at the rate of (from server and from peers)

$$\sum_{i=1}^{N} \frac{u_i}{\sum_{i=1}^{N} u_i} u_s = u_s$$

Therefore, the time cost is F/u_s.

b)

In this part I have referred to Google for some help.

The description gives

$$u_s \geq \frac{u_s + \sum_{i=1}^{N} u_i}{N} \implies u_s \geq \frac{\sum_{i=1}^{N} u_i}{N-1}$$

Suppose that the file uploaded is divided into N+1 parts. The server sends the i$^{\text{th}}$ part to the i$^{\text{th}}$ peer at the rate of $\frac{u_i}{N-1}$, and then the i$^{\text{th}}$ peer sends the i$^{\text{th}}$ part of the file to other N-1 peers. The server alone sends N+1 part of the file to each of the peer at the rate of $\frac{u_s - \frac{\sum_{i=1}^{N} u_i}{N-1}}{N}$.

The total sending rate of the server is

$$N \cdot \frac{u_s - \frac{\sum_{i=1}^{N} u_i}{N-1}}{N} + \sum_{i=1}^{N} \frac{u_i}{N-1} = u_s \leq u_s$$

So the total rate is under the limit.

And the exact rate of the peer sending the corresponding part of the file is

$$(N-1)\frac{u_i}{N-1} = u_i \leq u_i$$

Thus, the i$^{\text{th}}$ peer uploading rate is under the limit.

Under such circumstance, the i$^{\text{th}}$ peer receving rate is

$$\frac{u_s - \frac{\sum_{i=1}^{N} u_i}{N-1}}{N} + \sum_{i=1}^{N} \frac{u_i}{N-1} = \frac{u_s + \sum_{i=1}^{N} u_i}{N}$$

So the time is

$$\frac{NF}{u_s + \sum_{i=1}^{N} u_i}$$

c)

From the book we know that

$$D_{P2P} \geq \max\{\frac{F}{u_s}, \frac{NF}{u_s + \sum_{i=1}^{N} u_i}\}$$

The prove is similar to the 8 c)

When $u_s \leq \frac{u_s + \sum_{i=1}^{N} u_i}{N}$, from above we get $D_{P2P} \geq \frac{F}{u_s}$, and from a) we get $D_{P2P} \leq \frac{F}{u_s}$, so the time is $D_{P2P} = \frac{F}{u_s}$.

Similarly, when $u_s \geq \frac{u_s + \sum_{i=1}^{N} u_i}{N}$, $D_{P2P} = \frac{NF}{u_s + \sum_{i=1}^{N} u_i}$.

Therefore, the minimum distribution time is in general given by

$$D_{P2P} = \max\{\frac{F}{u_s}, \frac{NF}{u_s + \sum_{i=1}^{N} u_i}\}$$

9

a)

Since N audio can be mixed in the N video,

Server needs to store

$$N \cdot N = N^2$$

files.

b)

Server needs to store

$$N + N = 2N$$

files.