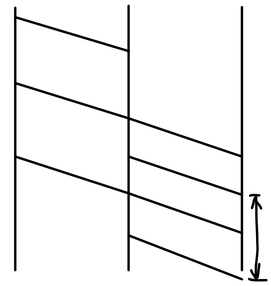
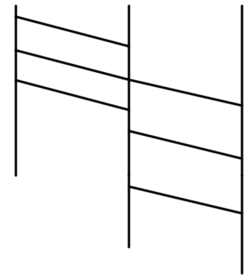
$R_s < R_c$



P23 (a) L/R_s

$R_s > R_c$

(b) Yes. due to $R_s > R_c$ Thus when packet 1 is transmit from router to client. Last bit of packet 2 is already in router



when $T = \frac{L}{R_c} - \frac{L}{R_s}$. Then when last bit of first packet was transmited, the last bit of second packet can also reach the router

P25 (a)

$$\frac{1 \cancel{000} \cancel{000}}{5\cancel{00} \cancel{0000}} = 0.2 \text{ seconds.}$$

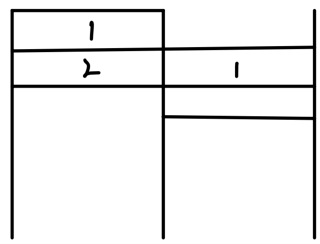
It takes 0.2 seconds from source to first packet switch.

$3 \times 0.2 = 0.6$ seconds

It takes 0.6 seconds

(b)

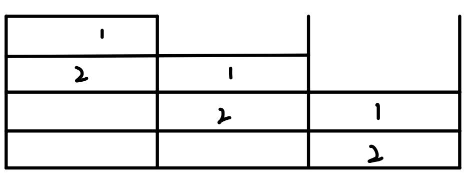
$$\frac{1\cancel{0000} \text{ bits}}{500 \cancel{0000} \text{ bit/s}} = \frac{1}{500} \text{ seconds.}$$



It take 1/500 seconds to move first packet from source to first switch

At 2/500 second. the second packet will be fully received at first switch

(c)



$$2 \times (1/500) + 100 \times (1/500)$$

$$= \frac{102}{500} = \frac{51}{250} \text{ seconds}$$

(d) If message has bit error. Saving resourse through resending message segmentation. Secondly. For long streaming data. such as video. big exe file. Saving time for loading beginning part of them. and reduce delay.

(e) More complex protocal for matcining the order of message segmentation.
Pay more resources for header. which will reduce the effecient of transmission.

P7 $\left(\sum_{i=1}^{n} RTT_i\right) + 2RTT_0$

P8

a $\sum_{i=1}^{n} RTT_i + 2RTT_0 + 8 \times 2RTT_0 = \sum_{i=1}^{n} RTT_i + 18RTT_0$

b 8 objects, but only 6 connections. Thus 2 times transmission

$\sum_{i=1}^{n} RTT_i + 2RTT_0 + 2 \times 2RTT_0 = \sum_{i=1}^{n} RTT_i + 6RTT_0$

c with pipeline

$\sum_{i=1}^{n} RTT_i + 2RTT_0 + RTT_0 = \sum_{i=1}^{n} RTT_i + 3RTT_0$

without pipeline.

$\sum_{i=1}^{n} RTT_i + 2RTT_0 + 8RTT_0 = \sum_{i=1}^{n} RTT_i + 10RTT_0$

P10 Nonpersistent with parallel

Handshake + initial object + 10 objects.

$$= \frac{200}{150} + T_p + \frac{200}{150} + T_p$$
$$+ \frac{200}{150} + T_p + \frac{100000}{150} + T_p$$
$$+ \frac{200}{15} + T_p + \frac{200}{15} + T_p + \frac{200}{15} + T_p + \frac{100000}{15} + T_p$$

$= 7377$ seconds $+ 8T_p$

persistent HTTP without pipeline.

Handshake + initial object + 10 objects

$$= \frac{200}{150} + T_p + \frac{200}{150} + T_p$$
$$+ \frac{200}{150} + T_p + \frac{100000}{150} + T_p$$
$$+ \left(\frac{200}{150} + T_p + \frac{100000}{150} + T_p\right) \times 10$$

$= 7351$ seconds $+ 24T_p$

persistent HTTP with pipeline.

$$= \frac{200}{150} + T_p + \frac{200}{150} + T_p$$

$$+ \frac{200}{150} + T_p + \frac{100000}{150} + T_p$$

$$+ \frac{200}{15} + T_p + \frac{100000}{15} + T_p$$

$= 7351$ seconds $+ 6T_p$

$$\frac{200\times3 + 100000}{150} + \frac{1002000}{150}$$

$T_p = 10/3\times10^8 = 0.03$ micro sec.

$\therefore$ persistent HTTP is not faster than non-persistent significantly.

R7 (a) $\frac{L \times 8}{128000} \times 1000 = \frac{L}{16}$ mseconds.

(b) $L = 1500$ bytes $\quad 1500/16 = 93.75$ mseconds

$L = 50$ byts $\quad 50/16 = 3.13$ mseconds.

(c) $T_t = \frac{(L+5)\times8}{622000}$

$L = 1500 \quad T_t \approx 0.019$ sec

$L = 50 \quad T_t \approx 7.07\times10^{-4}$ sec

(d) Small package decrease the delay and keep the voice relyable.