1. a. F need to send four request messages.

b. T This's two pages are from same server.

C. F For non-persistent connections, a single TCP connection can only carry one request message.

d. F It indicates when the request was created.

e. F Some response messages have an empty body.

example: Status-code: 204. 304.

2. time for getting IP:

$$t_1 = RTT_1 + RTT_2 + \cdots + RTT_n$$

time for getting HTML

$$t_2 = 2RTT_0$$

so. total time:

$$t = t_1 + t_2 = 2RTT_0 + RTT_1 + RTT_2 + \cdots + RTT_n$$

3. a. one request need $2RTT_0$

total: $(2+8\times2)RTT_0 + t_1 = 18RTT_0 + RTT_1 + \cdots + RTT_n$

b. $RTT_1 + \cdots RTT_n + 2RTT_0 + 2\cdot 2RTT_0$

$= 6RTT_0 + RTT_1 + \cdots + RTT_n$

c. $RTT_{(TCP)} + 2RTT_{(HTTP)} + t_1 = 3RTT_0 + RTT_1 + \cdots + RTT_n$

$u = u_1 + u_2 + \cdots u_N$

4. a. Divide file into N parts, with the i^{th} part having size $(u_i/u)F$. transmiting the i^{th} part into peer i at rate $r_i = (u_i/u)u_s$. peer i can transmit i^{th} part to other N-1 peers. at the rate r_i:

total rate $(N-1)r_i = (N-1)(u_i/u)u_s = (N-1)u_iu_s/u <= u_i$

thus: rate of peer i is less than u_i

Thus each peer receives the file in F/u_s.

b. $u = u_1 + u_2 + \cdots + u_N$ $\quad u_s \geq \frac{(u_s+u)}{N}$

transmission is divided into two part.

① for each i $\quad \frac{u_i}{N-1}$

② for each i $\quad \frac{u_s - \frac{u}{N-1}}{N}$

①+②: $\sum_{i=1}^{N} \frac{u_i}{N-1} + \frac{u_s - \frac{u}{N-1}}{N} = u_s$

For each peer i receives the bits:

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

Therefore, the time required to receive the complete file by each peer (client) is $\frac{NF}{u_s+u}$

c. when : $u_s \leq (u_s + u_1 + \cdots + u_N)/N$ $\quad t \geq \frac{F}{u_s}$

when : $u_s \geq (u_s + u_1 + \cdots + u_N)/N$ $\quad t \geq NF/(u_s+u_1+\cdots u_N)$

For all cases: $\quad t \geq \max\{F/u_s, NF/(u_s+u_1+\cdots+u_N)\}$

thus: minimum distribution time is $\max\{F/u_s, NF/(u_s+u_1+\cdots u_N)\}$