

Q1)

$$\text{Estimate RTT} = \alpha \text{ Sample RTT} + (1-\alpha) \text{ Est. RTT}$$

After first sample

$$\begin{aligned} &= 0.125 \times 106 + 0.875 \times 100 \\ &= 100.75 \text{ms} \end{aligned}$$

2nd sample

$$\begin{aligned} &= 0.125 \times 120 + 0.875 \times 100.75 \\ &= 103.15625 \approx 103.156 \end{aligned}$$

3rd sample

$$\begin{aligned} &= 0.125 \times 140 + 0.875 \times 103.156 \\ &= 107.7615 \approx 107.762 \end{aligned}$$

4th sample

$$\begin{aligned} &= 0.125 \times 90 + 0.875 \times 107.762 \\ &= 105.54175 \approx 105.542 \end{aligned}$$

5th sample

$$\begin{aligned} &= 0.125 \times 115 + 0.875 \times 105.542 \\ &= 106.7245 \approx 106.724 \end{aligned}$$

Q2) $\text{Dev RTT} = \beta |\text{Sample RTT} - \text{Est. RTT}| + (1-\beta) \text{Dev RTT}$

$$\begin{aligned} \text{first} &= 0.25 \times (106 - 100.75) + 0.75 \times 5 \\ &= 5.0625 \approx 5.062 \end{aligned}$$

$$\begin{aligned} \text{second} &= 0.25 \times (120 - 103.156) + 0.75 \times 5.063 \\ &= 8.0095 \approx 8.010 \end{aligned}$$

$$\begin{aligned} \text{3rd} &= 0.25 \times (140 - 107.762) + 0.75 \times 8.010 \end{aligned}$$

$$= 14.067$$

$$\begin{aligned} w^{th} &= 0.25(90 - 105.542) + 0.75 \times 14.067 \\ &= 14.43575 \approx 14.436 \end{aligned}$$

$$\begin{aligned} s^{th} &= 0.25 \times (115 - 106.725) + 0.75 \times 14.436 \\ &= 12.89575 \approx 12.896 \end{aligned}$$

Q3)

Timeout Interval

$$RTO = Est.RTT + 4 \times DevRTT$$

$$0^{th} = 100 + 4 \times 5 = 120$$

$$1^{st} = 100.75 + 4 \times 5.062 = 120.99$$

$$2^{nd} = 103.156 + 4 \times 8.010 = 135.196$$

$$3^{rd} = 107.762 + 4 \times 14.067 = 164.03$$

$$4^{th} = 105.542 + 4 \times 14.436 = 163.286$$

$$5^{th} = 106.725 + 4 \times 12.896 = 158.309$$

Q4) Max file size is irrelevant to

MSS size $2^{32} = 4294967296 = 2$

Q5) (MTU Limit) 1500 - 40 (IP + TCP header)
 $\Rightarrow 1460$

$$\left\lceil \frac{2^{32}}{1460} \right\rceil = 2941759 = n$$

Q6)

IP + TCP header

$$n \times 40 = 117670360 \text{ bytes} = y$$

Q7)

$$\text{Time} = (y + 2)^B / 64 \text{ Mbps}$$

$$= (y+2) \times 8 \text{ b} / 64 \text{ Mbps}$$

$$= 526.027 \text{ s} \approx 526$$