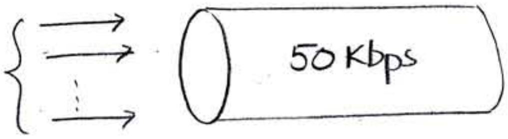
3.9

(a) 10 sessions

each session (150 pkt/min, Poisson)



pkt length $\sim$ exponential with mean = 1000 bits

① 10 TDM channels, 5 kbps each

for each channel:

service time = $\dfrac{\text{pkt length}}{5 \text{ kbps}}$ $\sim$ exponential with mean 0.2 sec

service rate $\mu = \dfrac{1}{0.2} = 5$ pkt/sec $= 300$ pkt/min

arrival rate $\lambda = 150$ pkt/min $= 2.5$ pkt/sec

$$\rho = \frac{\lambda}{\mu} = \frac{1}{2}$$

$$N = \frac{\rho}{1-\rho} = \frac{1/2}{1-1/2} = 1 \quad , \quad N_Q = \frac{\rho^2}{1-\rho} = \frac{1}{2}$$

$$T = \frac{N}{\lambda} = \frac{1}{2.5} = 0.4 \text{ sec}$$ (Little's thm)

$$\boxed{N=1, \; N_Q = 0.5, \; T = 0.4\text{ s}}$$

② Statistical multiplexing

service time = $\dfrac{\text{pkt length}}{50 \text{ kbps}}$ $\sim$ exponential with mean 0.02 sec

service rate $\mu = \dfrac{1}{0.02} = 50$ pkt/sec $= 3000$ pkt/min

arrival rate (aggregate) $\lambda = 10 \times 150 = 1500$ pkt/min $= 25$ pkt/sec

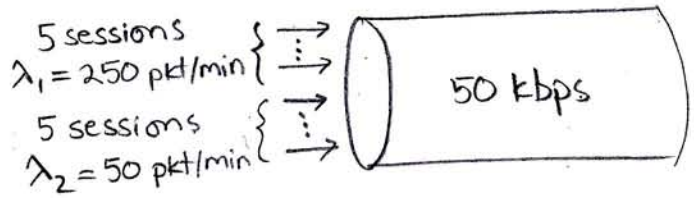
$$\rho = \frac{\lambda}{\mu} = \frac{1}{2}$$

$$N = \frac{\rho}{1-\rho} = 1 \quad , \quad N_Q = \frac{\rho^2}{1-\rho} = \frac{1}{2}$$

$$T = \frac{N}{\lambda} = \frac{1}{25} = 0.04 \text{ sec}$$

$$\boxed{N=1, \; N_Q = 0.5, \; T = 0.04 \text{ sec}}$$

(b)



① 10 TDM ch. , 5 kbps each , $\mu = 5$ pkt/sec $= 300$ pkt/min

each session of "type 1" ($\lambda_1 = 250$ pkt/min)

$$\rho_1 = \frac{\lambda_1}{\mu} = \frac{250}{300} = \frac{5}{6}$$

$$N_1 = \frac{\rho_1}{1-\rho_1} = 5 \quad , \quad NQ_1 = \frac{\rho_1^2}{1-\rho_1} = \frac{25}{6} = 4\tfrac{1}{6}$$

$$T_1 = \frac{N_1}{\lambda_1} = \frac{5}{250/60} = \frac{300}{250} = 1.2 \text{ sec}$$

each session of "type 2" ($\lambda_2 = 50$ pkt/min)

$$\rho_2 = \frac{\lambda_2}{\mu} = \frac{50}{300} = \frac{1}{6}$$

$$N_2 = \frac{\rho_2}{1-\rho_2} = 0.2 \quad , \quad NQ_2 = \frac{\rho_2^2}{1-\rho_2} = \frac{1}{30}$$

$$T_2 = \frac{N_2}{\lambda_2} = \frac{0.2}{50/60} = \frac{12}{50} = 0.24 \text{ sec}$$

"type 1" session : $N_1 = 5$, $NQ_1 = 4\frac{1}{6}$, $T_1 = 1.2$ sec
"type 2" session : $N_2 = 0.2$, $NQ_2 = \frac{1}{30}$, $T_2 = 0.24$ sec

② Statistical multiplexing , $\mu = 50$ pkt/sec $= 3000$ pkt/min

arrival rate $\lambda = 5 \times 250 + 5 \times 50 = 1500$ pkt/min
(aggregate)

$$\rho = \frac{\lambda}{\mu} = \frac{1}{2} \qquad \text{(same as part (a))}$$

$$\boxed{N = 1 \ , \ NQ = \tfrac{1}{2} \ , \ T = 0.04 \text{ sec}}$$