8.

a. users = link rate / transmission rate = 3Mb / 150kb = 20

b. 0.1

c. $\binom{120}{n} \cdot 0.1^n \cdot 0.9^{120-n}$

d. $1 - \sum_{k=0}^{20} \binom{120}{k} \cdot 0.1^k \cdot 0.9^{120-k}$

The transmission probability of users obeys the rule of Bernoulli-Distribution. Let X_i be $i.i.d$ random variables that $P(X_i = 1) = p$ denotes that the probability of user X_i is transmitting. Therefore we have

$$lim_{n\to\infty} P(\frac{n_A - np}{\sqrt{np(1-p)}} \leq x) = \Phi(x)$$

according to De Moivre–Laplace theorem.

$$\begin{aligned} P(users\ \geq 21) &= 1 - P(\sum_{k=0}^{120} X_k \leq 20) \\ &= 1 - P(\frac{\sum_{k=0}^{120} X_k - np}{\sqrt{np(1-p)}} \leq \frac{20 - np}{\sqrt{np(1-p)}}) \\ &\approx 1 - \Phi(2.43) \\ &\approx 0.007 \end{aligned}$$

10.

Total delay = $2d_{proc} + \sum(\frac{d_i}{s_i} + \frac{L}{R_i}) = 48.25ms$

11.

Total delay = $\frac{L}{R} + \sum \frac{d_i}{s_i}$