計算機網路 HW2

許博翔

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Problem 1.

- A circuit-switched network is more appropriate for this application.
  Reason:
  - A circuit-switched network provides a dedicated path for the transmission, which gaurantees the steady bandwidth.
  - The bandwidth usage is not inefficient since the application will continue running for a relatively long period of time when it starts.
  - A circuit-switched network provides low latency since the path is predetermined.
  - A packet-switched network may have packet-overflow problem.
- No congestion control is needed.
  Reason: Even if all of the applications transmit at the same time, since the bandwidth of each link is greater than the sum of all of the applications' data rate, no congestion will happens. Therefore, no congestion control is needed.

Problem 2.

- $d_{prop} = \dfrac{m}{s}$.
- $d_{trans} = \dfrac{L}{R}$.
- The end-to-end delay $= d_{prop} + d_{trans} = \dfrac{m}{s} + \dfrac{L}{R}$.
- The last bit of the packet is at host A.

- The first bit of the packet is $\dfrac{md_{trans}}{d_{prop}} = d_{trans}s$ meters away from host A.
- The first bit of the packet is at host B.
- $\dfrac{m}{s} = d_{prop} = d_{trans} = \dfrac{L}{R} \Rightarrow m = \dfrac{sL}{R} = \dfrac{2.5 \times 10^8 \times 120}{56 \times 10^3} = \dfrac{300}{56} \times 10^5 \approx 5.357 \times 10^5$ meters.

Problem 3.

- $\dfrac{3 \text{ Mbs}}{150 \text{ kbs}} = 20.$
- $10\% = 0.1.$
- There are $\dbinom{120}{n}$ ways to choose n users, and the probability for those n users to transmit and other $120 - n$ users not to transmit is $0.1^n 0.9^{120-n}$.
  Therefore, the probability is $\dbinom{120}{n} 0.1^n 0.9^{120-n}$.
- Let $Z \sim \mathcal{N}(0, 1)$.
  From central limit theorem, $\lim\limits_{n \to \infty} \mathbb{P}\left(\dfrac{\sqrt{n}(\bar{X}_n - \mu)}{\sigma} \le \dfrac{z}{\sigma}\right) = \Phi\left(\dfrac{z}{\sigma}\right)$.
  Let $X_i \sim \text{Ber}(0.1)$.
  $\Rightarrow \mu = 0.1, \sigma = \sqrt{0.1 \times 0.9} = 0.3.$
  $\mathbb{P}\left(\sum\limits_{i=1}^{120} X_i \le 20\right) = \mathbb{P}\left(\bar{X}_{120} \le \dfrac{1}{6}\right) = \mathbb{P}\left(\bar{X}_{120} - 0.1 \le \dfrac{1}{15}\right)$
  $= \mathbb{P}\left(\sqrt{120}\dfrac{\bar{X}_{120} - 0.1}{0.3} \le \dfrac{\sqrt{120}}{15 \times 0.3}\right) \sim \mathbb{P}\left(Z \le \dfrac{4\sqrt{30}}{9}\right) \sim \mathbb{P}(Z \le 2.434) = 1 - \mathbb{P}(Z \le -2.434) \sim 1 - 0.0075.$
  $\therefore$ the probability there are 21 or more users transmitting simultaneously $\sim$ 0.0075.

Problem 4.

- $\dfrac{IL}{R(1-I)} + d_{trans} = \dfrac{IL}{R(1-I)} + \dfrac{L}{R} = \dfrac{L}{R(1-I)}.$
- $\dfrac{L}{R(1-I)} = \dfrac{1}{1-I} \cdot \dfrac{L}{R} = \dfrac{\frac{L}{R}}{1 - a(\frac{L}{R})}.$

Problem 5.

- $R \times d_{prop} = 2 \times \dfrac{2 \times 10^4 \times 10^3}{2.5 \times 10^8} = 1.6 \times 10^{-1}$ Mb.

- 1.6×10^{-1} Mb.
- Bandwidth-delay product is the product of link transmission rate and the time it used to send bits from host A to host B. Therefore, it is the number of bit in the link.
- The width of a bit $= \dfrac{2 \times 10^7}{1.6 \times 10^{-1} \times 10^6} = 1.25 \times 10^2$ meters. The length of a football field is at most 120 meters, which is less then the width of a bit.
- $\dfrac{m}{R \times \frac{m}{s}} = \dfrac{s}{R}$.