City University of Hong Kong
Department of Electronic Engineering

EE3009 Data Communications and Networking

Solution to Tutorial 6

1. Maximum throughput for ALOHA is 0.184.
   Maximum throughput in frames/second = $\frac{56000}{1000} \times 0.18 \approx 10$

2. For slotted ALOHA, throughput is independent of *a*, therefore,
   maximum throughput = $10^7 \times 0.368 = 3.68 \times 10^6$ bps.

   For CSMA/CD,
   L=12500x8 =100000 bits
   $t_{prop} = \frac{2 \times 25}{2.5 \times 10^8} = 2 \times 10^{-7}$
   $a = \frac{t_{prop} R}{L} = \frac{2 \times 10^{-7} \times 10^7}{10^5} = 2 \times 10^{-5}$

   maximum utilization = $\frac{1}{1 + (2e+1)a} = 0.99987$

   maximum throughput is closed to the network bandwidth.

3. *d*=100 m from each station to the cabinet
   v = 2x10^8 m/sec
   b = 8 bits
   L = 1250 bytes = 10000 bits
   R = 25 Mbps
   $X = \frac{10000}{25 \times 10^6} = 4 \times 10^{-4}$ sec
   $\tau' = \frac{M 2d}{v} + \frac{8M}{R} = \frac{200M}{2 \times 10^8} + \frac{8M}{25 \times 10^6} = 1.32 \times 10^{-6} M$
   $a' = \frac{\tau'}{X} = \frac{1.32 \times 10^{-6} M}{4 \times 10^{-4}} = 3.3 \times 10^{-3} M$

   i) When all stations are allowed an unlimited number of frames/token, $\rho_{\max} = 1$ and $\rho = \lambda X$. Therefore,
   $\lambda_{\max} = \frac{1}{4 \times 10^{-4}} = 2500$ frames /sec.

ii) $\rho_{\max} = \dfrac{1}{1 + a'(1 + \dfrac{1}{M})}$

$$\lambda_{\max} = \frac{1}{1 + (3.3 \times 10^{-3} M (1 + \frac{1}{M})} \times \frac{1}{4 \times 10^{-4}} = \frac{2500}{1.0033 + 0.0033M}$$

iii) $\rho_{\max} = \dfrac{1}{1 + a'/M} = \dfrac{1}{1 + 3.33 \times 10^{-3} M / M} = 0.997$

$$\lambda_{\max} = 0.997 \times \frac{1}{4 \times 10^{-4}} = 2492 \text{ frames/sec}$$