無線通訊網路

期中考正確解答

1. Please explain the below five terms in details. [20%]
   a) FDMA and TDMA (請務必 繪圖 加上文字 作答)
   b) Backoff mechanism in CSMA/CA
   c) Multi-path effect
   d) Cell sectoring
   e) Slow Fading

2. Consider a cruise with 10 passengers and two public phone sets (no waiting seats available). On the average, each passenger will use the public phone to make 3 calls per hour with each call of 4-minute duration.
   a) Please draw the Markov Chain for the system. [8%]
   b) Please calculate the probability of two phones being occupied while another person wishes to make a call. (Namely, please calculate the blocking probability.) [8%]
   c) Please compute the efficiency (i.e. utilization) of the phone system in the cruise. [5%]

3. Please calculate the maximum transmission rate for a transmission system if the delay spread is 5 ns (nano-seconds). [5%]

4. Consider an antenna transmitting at 800 MHZ. The receiver is traveling at a speed of 40 km/h toward the antenna.
   a) Calculate its Doppler shift. [6%]
   b) Assume the receiver is in free space and the antenna gain is 1. What is the path loss (in dB) if the receiver reaches a distance of 1 km away from the antenna? [6%]

5. Consider a mobile communication system in which a total bandwidth of 30 MHz is available and each channel consists of 25kHz. The city is covered by 10 clusters of cells. Each cell is deployed so that the radius of a cell is 2 km and the frequency-reuse distance is 12 km. Each channel is multiplexed (shared) among 8 users in a cell. How many users can be simultaneously processed by the system if total channels are equally allocated to all cells in a cluster? (Recall the purpose of frequency reuse.) [10%]

6. Define the **first-meter path loss** as the received signal strength (in dB) when the receiver stands one meter away from the transmitter. Now, if we have found the first-meter path loss to be 20 dB. Please calculate the free-space path loss for a receiver if the distance between the transmitter and receiver is [15%]
   a) 10 meters, b) 800 meters, and c) 3 KM.

7. Please draw the structure of a cluster of 12 cells in the context of frequency reuse. Also calculate the reuse distance in terms of the radius R of a cell. [6 %]

8. Please give the pseudo code of p-persistent CSMA/CD protocol. [5%]

9. Please explain what is the hidden-terminal problem and give a solution to it. [6%]

1.

(a) FDMA：對頻率切割，user能在任何時間使用特定頻率。
TDMA：對時間切割，user在分配到的時間能用任意頻率。

(b) If medium is idle, 在contention window內取random number作為back off counter，並開始倒數，counter歸0後就傳，若這期間有人傳，停止倒數直到傳完，等待DIFS後繼續倒數

(c) 訊號傳到receiver的過程中會有散射、繞射、反射的發生，會由不同路徑傳到receiver，多個訊號先後到達會造成confusion。

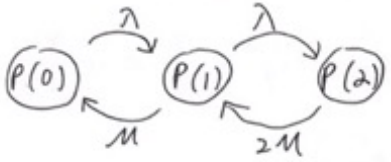
(d) 將一個cell 分成多個sector，每個sector使用不同頻率能降低cochannel interference

(e) 當訊號通過不同的環境，例如建築物、空地等，會使得接收者在與訊號源距離相等的地方，卻收到不同的頻率。

2. $\lambda = 30$ cells/hour

$\mu = 60/4 = 15$ cells/hour

(a)



※

(b) by (a), $\begin{cases} \lambda P(0) = \mu P(1) \\ \lambda P(0) + 2\mu P(2) = \mu P(0) + \lambda P(1) \\ \lambda P(1) = 2\mu P(2) \end{cases}$,

, and $P(0) + P(1) + P(2) = 1$

$\Rightarrow \gamma = \frac{\lambda}{\mu} = 2 \Rightarrow P(1) = \gamma P(0)$, $\Rightarrow P(0) + \gamma P(0) + \gamma P(0) = 1$

$P(2) = \gamma P(0)$

$\Rightarrow P(0) = \frac{1}{5}$

Blocking probability $= P(2) = 2P(0) = \frac{2}{5}$ ※

(c) $\frac{30\left(1 - \frac{2}{5}\right)}{30} = \frac{3}{5}$ ※

3. $\tau_d > \frac{1}{2} T \Rightarrow$ communication failed

$T = \frac{1}{R} \Rightarrow \tau_d > \frac{1}{2} \cdot \frac{1}{R} \Rightarrow R > \frac{1}{2\tau_d}$

$\therefore$ max transmission rate $= \frac{1}{2\tau_d} = \frac{1}{2 \times 5 \times 10^{-9}} = 10^8$ #

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4. 800MHz, 40 km/hr

(a) $\lambda = \frac{c}{f_c} = \frac{3 \times 10^8}{8 \times 10^8} = \frac{3}{8}$, $V = 40\ km/hr = \frac{40000}{3600} = \frac{100}{9}\ m/s$

$\therefore$ doppler shift $= f_d = \frac{V}{\lambda} \cos 180^\circ = -\frac{100}{9} \times \frac{8}{3} = -\frac{800}{27}$ #

(b) $P_{loss} = 32.45 + 20 \log 800 + 20 \log 1$

$= 32.45 + 20 (2 + 3 \log 2) + 0 = 90.51\ (dB)$ #

5. Bandwidth = 30 MHz , each channel 25 kHz

10 cluster, $R = 2$ reuse distance = 12

channel is multiplex (8 users)

$12 = \sqrt{3N} \cdot 2 \Rightarrow N = 12$ ∴ a cluster has 12 cells

# of total channels $= \frac{30 \times 10^6}{25 \times 10^3} = 1200$

# of channel per cells $= \frac{1200}{12} = 100$

total users $= 10 \times 12 \times 100 \times 8 = 96000$ ※

6. $X + 20 \log 1 = 20 \Rightarrow X = 20$

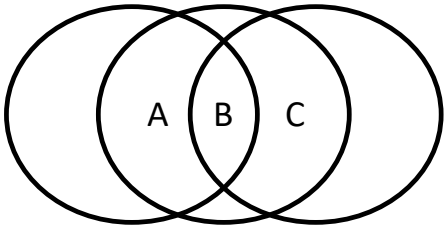
(a) $P_{loss} = 20 + 20 \log 10 = 40\,(dB)$ ※

(b) $P_{loss} = 20 + 20 \log 800 = 60 + 60 \log 2\,(dB)$ ※

(c) $P_{loss} = 20 + 20 \log 3000 = 80 + 20 \log 3\,(dB)$ ※

8.

1. 如果idle，有p的機率可以傳，而有 1 － p 的機率要等一個delay time。
2. 如果busy，就要等到idle再回到step 1
3. 如果等完delay time，就再回到step 1
4. 如果在傳的時候發生collision，則停止傳
5. 等一個random time，再重複以上step。



9.

Problem：

如圖(A,B) (B,C) 互相看得到，但A,C 不知道對方存在，A,C 互為hidden-terminal，若A,C在carrier sense後同時向B 傳資料，在B會有collision，造成hidden-terminal problem

Solution：

RTS/CTS，sender在傳資料前先發RTS，receiver若同意(沒其他人在傳資料)則回傳CTS，其她terminal也會收到CTS，知道誰能傳資料，如此就能避免hidden-terminal problem的collision的發生。