

102 Wireless Midterm

1. (a) How do CSMA (2%), CSMA/CD (2%), CSMA/CA (2%) and CSMA/CA with RTS/CTS (6%) work? Suppose the propagation delay is α , SIFS is α , DIFS is 4α , and RTS and CTS are 6α , respectively, for CSMA/CA with RTS/CTS. (b) What is the earliest time for the receiver to send the CTS message? (過程 2% , 答案 1%) (c) If the data packet is 100α long, what is the shortest time for the receiver to send the ACK signal? (過程 2% , 答案 1%) (18%)
2. Compare Nonpersistent CSMA Protocol (4%), 1-persistent CSMA Protocol (4%) and p-persistent CSMA Protocol (6%). (14%)
3. A TDMA system uses 320 kbps data rate to support 8 users per frame. (12% total)
 - (a) What is the raw data rate provided for each user? (2%)
 - (b) What is the guard time in TDMA? (2%)
 - (c) If guard time and synchronization occupy 10 kbps, determine the traffic efficiency? (4%)
4. Consider a CDMA system in which users A and B have codes (1, -1, 1, -1, 1, -1, 1, -1) and (-1, -1, 1, 1, -1, -1, 1, 1) respectively. Show the output bit value at the receiver of A if A transmits a data bit 1 and B transmits a data 0. Assume the received power from both A and B is the same. (要列出 A output, B output, Received, Receiver codeword, Multiplication 等, 分別為計算過程中表格的一列) (每列 2% , Received data bit 2% , 共 12%)
5. (a) List the following cells in ascending order of the cell range: Global, Picocell, Macrocell, Microcell. (8%) (b) List three kinds of wave propagation. (6%) (c) List two kinds of channels between the MS and the BS according to the channel type (4%) (d) according to the channel direction (名稱 2% , 方向 1%) (6%) (e) What is the difference between fast fading and slow fading? (4%) (28% total)
6. For the following cell pattern,

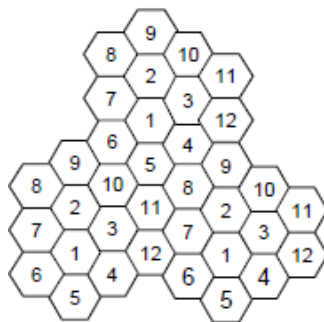


Figure for problem 5.9

- (a) Find the reuse distance if radius of each cell is 2 kms. (N 3% , 公式3% , 結果2% , 共8%)
- (b) If each channel is multiplexed among 8 users, how many calls can be simultaneously processed by each cell if only 10 channels per cell are reserved for control, assuming a total bandwidth of 30 MHz is available and each simplex channel consists of 25 kHz ? (One duplex channel, Number of channels, Number of channels per cell, Total number of calls per cell: 2% , 共8%) (16% total)

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1. (a) How do CSMA (2%), CSMA/CD (2%), CSMA/CA (2%) and CSMA/CA with RTS/CTS (6%) work? Suppose the propagation delay is α , SIFS is α , DIFS is 4α , and RTS and CTS are 6α , respectively, for CSMA/CA with RTS/CTS. (b) What is the earliest time for the receiver to send the CTS message? (過程2%, 答案1%) (c) If the data packet is 100α long, what is the shortest time for the receiver to send the ACK signal? (過程2%, 答案1%) (18%)

Ans:

(a)

CSMA (Carrier Sense Multiple Access) (2%)

- Start transmission only if no transmission is ongoing

CSMA/CD (CSMA with Collision Detection) (2%)

- Stop ongoing transmission if a collision is detected

CSMA/CA (CSMA with Collision Avoidance) (2%)

- Wait a random time and try again when carrier is quiet. If still quiet, then transmit

CSMA/CA with RTS/CTS

- Transmitter sends an RTS (request to send) after medium has been idle for time interval more than DIFS (2%)
- Receiver responds with CTS (clear to send) after medium has been idle for SIFS (2%)
- Then Data is exchanged (2%)

- (b) If a terminal has a packet ready to transmit, it will sense the medium first. If the medium is idle for DIFS, it will transmit RTS, then wait for the CTS from the receiver. Therefore, the earliest time for the receiver to send CTS message is:

$$4\alpha + 6\alpha + \alpha + \alpha = 12\alpha . \text{ (過程2\%, 答案1\%)}$$

- (c) When the sender receives the CTS from the receiver, it waits for SIFS, and then sends its data packet.

Therefore, the shortest time for the receiver to send the ACK signal is:

$$4\alpha + 6\alpha + \alpha + \alpha + 6\alpha + \alpha + \alpha + 100\alpha + \alpha + \alpha = 122\alpha . \text{ (過程2\%, 答案1\%)}$$

Note that we should include the propagation delay also.

2. Compare Nonpersistent CSMA Protocol (4%), 1-persistent CSMA Protocol (4%) and p-persistent CSMA Protocol (6%). (14%)

Ans:

Nonpersistent CSMA Protocol

Step 1: If the medium is idle, transmit immediately (same as $p=1$) (2%)

Step 2: If the medium is busy, wait a random amount of time and repeat Step 1 (2%)

- Random backoff reduces probability of collisions
- Waste idle time if the backoff time is too long

1-persistent CSMA Protocol:

Step 1: If the medium is idle, transmit immediately (2%)

Step 2: If the medium is busy, continue to listen until medium becomes idle, and then transmit immediately (2%)

- There will always be a collision if two nodes want to retransmit

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p-persistent CSMA Protocol:

Step 1: If the medium is idle, transmit with probability p (2%), and delay for worst case propagation delay by one packet with probability $(1-p)$ (2%)

Step 2: If the medium is busy, continue to listen until medium becomes idle, then go to Step 1 (2%)

Step 3: If transmission is delayed by one time slot, continue with Step 1

■ A good tradeoff between nonpersistent and 1-persistent CSMA

3. A TDMA system uses 320 kbps data rate to support 8 users per frame. (12% total)

(a) What is the raw data rate provided for each user? (2%)

(b) What is the guard time in TDMA? (2%)

(c) If guard time and synchronization occupy 10 kbps, determine the traffic efficiency? (4%)

Ans:

(a) Since 8 users are supported per frame the raw data rate is $\frac{320}{8} = 40$ kbps (2%)

(b) "guard time" is used in TDMA to reduce interference between adjacent time slots in TDMA. (2%)

(c) If 10 kbps is for guard and synchronization information the traffic efficiency is given by

$$\frac{40-10}{40} \times 100 = 75\% \quad (4\%)$$

4. Consider a CDMA system in which users A and B have codes (1, -1, 1, -1, 1, -1, 1, -1) and (-1, -1, 1, 1, -1, -1, 1, 1) respectively. Show the output bit value at the receiver of A if A transmits a data bit 1 and B transmits a data 0. Assume the received power from both A and B is the same. (要列出 A output, B output, Received, Receiver codeword, Multiplication 等, 分別為計算過程中表格的一列) (每列 2%, Received data bit 2%, 共 12%)

Ans:

(每列 2%, Received data bit 2%, 共 12%)

A output (data = 1)	1	-1	1	-1	1	-1	1	-1	
B output (data = 0)	1	1	-1	-1	1	1	-1	-1	
Received	2	0	0	-2	2	0	0	-2	
Receiver codeword	1	-1	1	-1	1	-1	1	-1	
Multiplication	2	0	0	2	2	0	0	2	=8

Received data bit is 1! (2%)

5. (a) List the following cells in ascending order of the cell range: Global, Picocell, Macrocell, Microcell. (8%) (b) List three kinds of wave propagation. (6%) (c) List two kinds of channels between the MS and the BS according to the channel type (4%) (d) according to the channel direction(名稱 2%, 方向 1%) (6%) (e) What is the difference between fast fading and slow fading? (4%) (28% total)

Ans: (a) Picocell < Microcell < Macrocell < Global. (2% * 4 = 8%)

(b) Ground, Sky and Space waves (2% * 3 = 6%)

(c) Control Channel, Traffic Channel (2% * 2 = 4%)

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(d) Reverse channels (Uplink) (2%): from MS to BS; (1%)

Forward channels (Downlink): from BS to MS

(e) Slow fading is caused by movement over distances large enough to produce gross variations in overall path length between base station and mobile station. (2%)

Rapid fluctuations caused by local multipath are known as fast fading. It is short-term fading. (2%)

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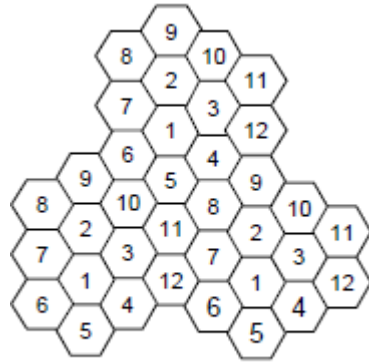


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(b) If each channel is multiplexed among 8 users, how many calls can be simultaneously processed by each cell if only 10 channels per cell are reserved for control, assuming a total bandwidth of 30 MHz is available and each simplex channel consists of 25 kHz ? (One duplex channel, Number of channels, Number of channels per cell, Total number of calls per cell: 2%, 共8%) (16% total)

Ans:

(a) $N=12$ (3%)

$$D = \sqrt{3NR} \Rightarrow D = 2 * (3*12)^{0.5} \quad (\text{公式3\%})$$

The reuse distance = 12 kms (結果2%)

(b) One duplex channel = 2 (BW of one simplex channel) = $2 * 25 = 50$ kHz (2%)

$$\text{Number of channels} = \left(\frac{30 * 10^3}{50} \right) - 10 * 12 = 600 - 120 = 480 \text{ channels (2\%)}$$

$$\text{Number of channels per cell} = \frac{480}{12} = 40 / \text{cell (2\%)}$$

$$\text{Total number of calls per cell} = 8 * 40 = 320 \text{ calls/cell (2\%)}$$