Problem Set 2 of Mobile Computing

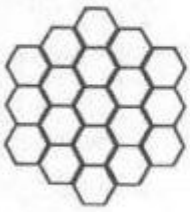
Due Date: Nov. 10, 2005

1. A new wireless service provider decided to employ a cluster of 19 cells as the basic module for frequency reuse.
   （1） Can you identify such a cluster structure?
   （2） Repeat (1) for reuse factor of 28.
   （3） Can you get an alternative cluster structure for part (1)?
   （4） What is the reuse distance for the system of part (3) in terms of cell radius *R*?
   （5） Can you find the worst case co-channel interference in such a system as exact as possible? (Assume the path loss slope is set to 4.)

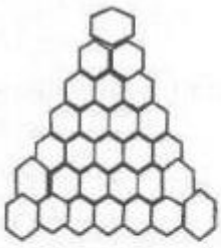
Ans:

[Solution]

(a) 19-cell cluster $i = 3, j = 2 \Longrightarrow N = 4 + 9 + 6 = 19$



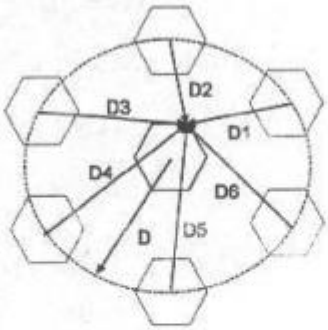
(b) 28-cell cluster, $i = 4, j = 2 \Longrightarrow N = 16 + 4 + 8 = 28$



(c) An alternative cluster will turn out to be the same, but seen from a different angle, i.e., with the shift parameters (i, j) interchanged. It will have the same reuse distance as the 19-cell cluster pattern shown above.

(d) Reuse distance $D = \sqrt{3N}R = \sqrt{57}R = 7.55R$

(e) Let the reuse distance D and the radius of the cell R.

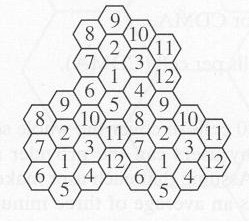


When $D_1 = D_2 = D - R$, $D_3 = D_6 = D$, $D_4 = D_5 = D + R$,

$$\frac{C}{I} = \frac{1}{(2(q-1)^{-\gamma} + 2(q)^{-\gamma} + 2(q+1)^{-\gamma})},$$

where $q = \frac{D}{R} = \sqrt{57} = 7.55$ (for $N = 19$).

2. For the following cell pattern,



（1） Find the reuse distance if the radius of each cell is 2 km.

（2） 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 available and each simplex channel of 25 kHz?

Ans:

(a) $D = \sqrt{3N}R \Rightarrow D = 2 * (3 * 12)^{0.5}$
The reuse distance $= 12$ kms

(b) One duplex channel $= 2$ (BW of one simplex channel) $= 2 * 25 = 50$ kHz
Number of channels $= (\frac{30*10^3}{50}) - 10 * 12 = 600 - 120 = 480$ channels
Number of channels per cell $= \frac{480}{12} = 40$ /cell
Total number of calls per cell $= 8 * 40 = 320$ calls/cell

3. Given a bandwidth of 25 MHz and a frequency reuse factor of 1 and RF channel size

of 1.25 MHz and 38 calls per RF channel, find

（1） The number of RF channels for CDMA.

（2） The number of permissible calls per cell (CDMA).

Ans:

(a) The number of RF channels $= \frac{25}{1.25} = 20$ channels

(b) The number of permissible calls per cell $= 20 * 38 = 760$ calls per cell.

4. What is the difference between collision detection and collision avoidance?

Ans:

Walsh codes are used in the order of power of 2. A large number may not be used as it will be difficult to maintain the orthogonality among the wave forms and make sure that they are all aligned in time. Also, the power level of the walsh codes needs to be at the required level to measure the code domain power (ratio of power in each of the forward link walsh codes to the total CDMA channel power transmitted) to more accurately monitor the performance.

5. What are the purposes of using RTS/CTS?

Ans:

RTS/CTS is used for:

(a) Solving the hidden terminal problems;

(b) Reducing the collision period.

6. Find the Walsh functions for 16-bit codes.

We know that

$$\mathbf{H}_0 = [0]$$

$$\mathbf{H}_n = \begin{bmatrix} \mathbf{H}_{n-1} & \mathbf{H}_{n-1} \\ \mathbf{H}_{n-1} & \overline{\mathbf{H}_{n-1}} \end{bmatrix}$$

$$\text{If } \mathbf{H}_n = \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix}, \overline{\mathbf{H}_n} = \begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix}$$

$$\mathbf{H}_1 = \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix}$$

$$\mathbf{H}_2 = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 \\ 0 & 1 & 1 & 0 \end{bmatrix}$$

$$\mathbf{H}_3 = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 & 0 & 0 & 1 & 1 \\ 0 & 1 & 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 \\ 0 & 1 & 0 & 1 & 1 & 0 & 1 & 0 \\ 0 & 0 & 1 & 1 & 1 & 1 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 0 & 0 & 1 \end{bmatrix}$$

and so on for $\mathbf{H}_4$.

7. Why does power control become one of the main issues for the efficient operation of CDMA?

Ans:

The power control is critical for efficient operation of CDMA. Because, the sender's transmission power level determines the signal quality at the receiver. There is a need to conserve the limited battery power of the MS for quality signal and also hand off will be smooth with high quality signal. Also, since interference is converted to noise, a strong interference implies a strong noise and degrades the channel for all other users. Therefore, CDMA must use very tight power control for efficient operation.