Wireless Multimedia Systems Fall, 2008 (Topic 5, 2008)

1. **Today's topic:**

   Finishing 802.11/Bluetooth

   Cellular Concepts: Channel Assignments and Handoff"

Suggested Reading:

Required Reading:

- [Katzela96]Katzela, and M. Nahgshineh," Channel assignment schemes for cellular mobile telecommunication systems: a comprehensive survey," IEEE Personal Communications, June 1996
- [Pollinin96], G.P. Pollini, "Trends in handover design, "IEEE Communications Magazine, March 1996

a) Overviews:

(1) Demand Growth: (a) the Ubiquitous information access (b) increasing number of users (c) multimedia bandwidth demanding

(2) Challenges of Cellular Technologies:

(a) Efficient reuse of the scarce radio spectrum: Interference issues (e.g. co-channel interferences and proper channel assignments for different traffic demanding)

(b) Continuous QoS provisions: (handoff)

b) Channel Allocation Schemes (Channel Assignment Schemes)

(1) Channel Resources (FD (Frequency Division), TD (Time Division), CD (Code Division)

(2) Co-Channel: the same set of channels can be reused at a minimum distance (co-channel reuse distance) to maintain CIR (Carrier signal over co-channel interference)

(3) Fixed Channel Allocation (Fixed Channel Assignment)

Assign a number of channels to each cell according to some reuse pattern

(4) Dynamic Channel Allocations (Dynamic Channel Assignment)

All channels are placed in a pool and assigned to a new call to satisfy minimum CIR

(5) Flexible Channel Allocations

c) Handling Handoffs

Performance Metrics: Call blocking prob, Handoff blocking prob, Interruption, delay

Handoff initiations: relative signal strength, with threshold, with hysteresis, Prediction

SIR measurement by network controlled, mobile assisted, mobile-control handoff

Macrocell/Microcell Overlays: velocity estimation, multi-tier control, integrated system, teletraffic

d) More Schemes:

Reuse Partitioning: (RUP): each cell is divided into two or more concentric subcells

Overlapping Cells

Power Control

Frequency Reuse Strategy: Cluster Size (N)

Problem 1:
(A) If a total of 33 MHz of bandwidth is allocated total particular FDD cellular telephone system which uses two 25 kHz simplex channels to provide full duplex voice and control channels, compute the number of channels available per cell if a system uses (1) 3-cell reuse (2) 7-cell reuse. (3) 12-cell reuse. (B) If a signal to interference ratio of 15 dB is required for satisfactory forward channel performance of a cellular system, what is the frequency reuse factor (D/R) and cluster size (N) that should be used for maximum capacity if the path loss exponent is (a) n = 4, (b) n = 3 ? Assume that there are 6 co-channels cells in the first tier, and all of them are at the same distance from the mobile. Use suitable approximations. (Candidate Cluster sizes could be 3, 7, 12, 13).

Solution:

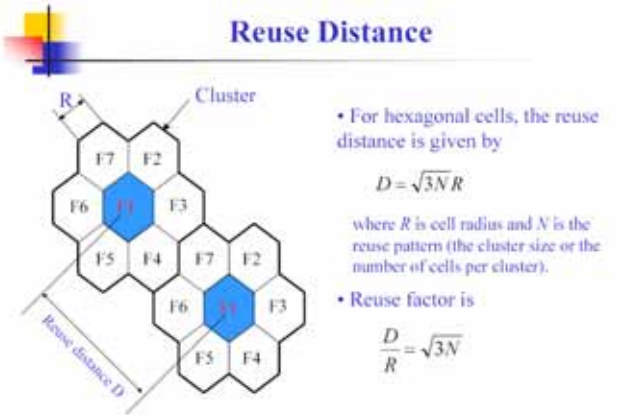
33 MHz / 2 * 25 kHz = 660

N= 4, 660/4 = 165

SIR (Signal to Interference Ratio, co-channel interference),

The cellular Concept/Frequency Reuse:

The same frequency will be reuse at the reuse distance D. (Co-Channel Interference)



N= 1, 3, 4, 7, 9, 12……

e.g.

- **n=4**
- **2. worst case is at D0 = R (when MH is at the fringe of its cell)**
- **3. only the six "first-tier" co-channel cells are considered**
- **4. D1 = D2 = D3 = D4= D5 = D6 = D**

system	(C/I)min	D/R	N
AMPS	18 dB	4.6	7
GSM	11 dB	3.0	4

Customer Request and Service Offer:

Trunking and Grade of Service:

Example: a radio channel is occupied for thirty minutes during an hour carries 0.5 Erlangs of traffic.

Capacity of an Erlang B System

$$\textbf{Pr[blocking]}=\frac{\frac{A^C}{C!}}{\sum_{k=0}^{c}\frac{A^k}{k!}}=\textbf{GOS (Grade of Service)}$$

Number of Channels C	**Capacity (Erlangs) for GOS = 0.01**	**= 0.005**	**= 0.002**	**= 0.001**
2	0.153	0.105	0.065	0.046
4	0.869	0.701	0.535	0.439
5	1.36	1.13	0.900	0.762
10	4.46	3.96	3.43	3.09
20	12.0	11.1	10.1	9.41
24	15.3	14.2	13.0	12.2
40	29.0	27.3	25.7	24.5
70	56.1	53.7	51.0	49.2
100	84.1	80.9	77.4	75.2

Problem 2

How many users can be supported for 0.5% blocking probability for the following number of trunked channels in a blocked calls cleared system? (A) 2, (b) 5, (c) 10, (d) 20, (e) 100. Assume each user generate 0.1 Erlangs of traffic.

Solve:

Given C = 5, GOS = 0.005, A = 1.13

$U = A/A_u = 1.13/0.1 = 11$ users

(a) C = 2, $A_u = 0.1$, GOS = 0.005

A = 0.105 -> $U = A/A_u = 0.105/0.1 = 1$ user

(b) C = 5, $A_u = 0.1$, GOS = 0.005

A = 1.13 -> $U = A/A_u = 1.13/0.1 = 11$ users

(c) C = 10, $A_u = 0.1$, GOS = 0.005

A = 3.96 -> $U = A/A_u = 3.96/0.1 = 39$ users

(d) C = 20, A_u = 0.1, GOS = 0.005

A = 11.10-> U = A/A_u = 11.10/0.1 = 110 users

(e) C = 100, A_u = 0.1, GOS = 0.005

A = 80.9-> U = A/A_u = 80.9/0.1 = 809 users

Market Penetration

Problem 3

An urban area has a population of two million residents. Three competing trunked mobile networks (systems A, B, and C) provide cellular service in this area. System A has 394 cells with 19 channels each, system B has 98 cells with 57 channels each, and system C has 49 cells, each with 100 channels. Find the number of users that can be supported at 2% blocking if each user averages two calls per hour at an average call duration of three minutes. Assuming that all three trunked systems are operated at maximum capacity, compute the percentage market penetration of each cellular provider.

(GOS= 0.02, C = 19, A = 12, GOS=0.02, C=57, A = 45, GOS= 0.02, C= 100, A = 88.

Solve:

System A:

C = 19

GOS = 0.02

A = 12

A_u = 2 * (3/60) = 0.1

U = = A/A_u = 12/0.1 = 120

Total user = 120 * 394 = 47280

The percentage market penetration = 47280 / 2,000,000 = 2.36 %

System **B**:

C = 57

GOS = 0.02

A = 45

A_u = 2 * (3/60) = 0.1

U = = A/A_u = 45/0.1 = 450

Total user = 450 * 98 = 44100

The percentage market penetration = 44100 / 2,000,000 = 2.205 %

System **B**:

C = 100

GOS = 0.02

A = 88

A_u = 2 * (3/60) = 0.1

U = = A/A_u = 88/0.1 = 880

Total user = 880 * 49 = 43120

The percentage market penetration = 43120 / 2,000,000 = 2.156 %