CARLETON UNIVERSITY

Department of Systems and Computer Engineering

SYSC 4700 Telecommunications Engineering Winter 2007

Assignment 3

Posting date: Thursday, March 22, 2007
Due date: 3:30 pm, Friday, March 30, 2007 (in box outside ME 4438)

Question 1 [20 marks] Cellular Networks I

- A metropolitan area is to be given cellular telephony service. Throughout this area there is approximately uniform service demand. Assume that radio spectrum is allocated to a cellular operator in two blocks of 6 MHz (one block for uplink and the other for downlink).

- Assume that one digital voice call link consumes 20 KHz of bandwidth each way (that is, 20 KHz for uplink and 20 KHz for downlink).

- To limit the co-channel interference, a cluster size of 4 is used (i.e., 4 cells per clusters).

- Due to the high number of subscribers, a total of 400 cells are deployed in this metropolitan area.

Determine the total capacity of this network (i.e., the number of simultaneous voice calls that it can handle).

Solution:

Total bandwidth: W = 6 MHz
Bandwidth per channel: B_c = 20 KHz

Total number of channels = $\frac{W}{B_c} = \frac{6\times10^6}{20\times10^3} = 300$ channels

→ Number of channels per cluster = 300 channels/cluster

Number of clusters = $\frac{400}{4} = 100$ clusters

→ Network capacity = 300 channels/cluster x 100 clusters = 30,000 channels (i.e., users)

Question 2 [20 marks] Cellular Networks II

An urban area is to be given cellular telephony service with FDMA technology. Throughout this area there is approximately uniform service demand. Assume that frequency is allocated in two block of 1.35 MHz with sufficient separation, one block for uplink and the other for downlink; this constitutes an FDD/FDMA operation. Assume that each one-way voice link consumes 15 KHz of bandwidth.

(a) The cellular network is supposed to give service to 1,800 simultaneous users (network capacity = 1800). If the cluster size is 7, how many Base Stations are needed?

Total number of channels = $\frac{W}{B_c} = \frac{1.35 \times 10^6}{15 \times 10^3} = 90$ channels

→ Number of channels per cluster = 90 channels/cluster

Number of clusters = $\frac{1800}{90} = 20$ clusters

Number of cells = 20 x 7 = 140 cells → Number of Base Stations = 140 Base Stations

(b) If the cluster size is reduced to 4, while the total number of Base Stations is kept at the level found in part (a), what will be the new network capacity?

Number of clusters = $\frac{140}{4} = 35$ clusters

Network capacity = 35 clusters x 90 channels = 3150 channels (i.e., users)

(c) What determines the cluster size? What are the main advantage and the main disadvantage of an FDMA network with a cluster size 1?

For a fixed number of Base Stations, as the cluster size (N) decreases, the cell capacity increases, and therefore the network capacity increases as well. On the other hand, as N decreases, the co-channel interference increases; this results in decreasing quality-of-service (QoS). In the network design, one should obtain the right operating value for N taking into account the conflicting goals of capacity and QoS.

N =1 → Advantage: High capacity
Disadvantage: Low QoS