	Homework #1	Due: in class

1. Consider a cellular system that uses a 7-cell reuse cluster with hexagonal" cells.

a) Show graphically the worst case co-channel interference for the reverse channel.

b) Assuming the simple power-law path loss model, calculate the worst case Signal-to-Interference ratio in terms of propagation exponent n. Figure 2.9 will be useful for this problem.

c) Calculate the values of S/I for $n=2,3,4$.

2. Consider the one dimensional array of base stations in Figures 2.3 and 2.4, and only one tier of co-channel interference as was considered for eq. 2.3 and 2.5. Further consider the user moving to the right from point p in Figures 2.3 and 2.4.

a) For $n=3$ and $M=2$, how far would the user move before the downlink failed, if the downlink fails at S/I of 10 dB

b) Assume that the user is back at p and that the cochannel users are in the close user positions of Figure 2.4. Now assume that the closest cochannel interferer (the one to the right of p) moves left towards base station II. Under these conditions, how far to the left does the closest cochannel user move before the $\frac{S}{I}$ of the user at p decreases to 10dB.

3. Derive the number of channel sets (C_s) and the reuse interval (M) formulas for the 2-dimensional hexagonal grid base stations:

$$C_s = k^2 + l^2 + kl$$

$$M = \sqrt{k^2 + l^2 + kl}$$

4. Suppose that we decided to use more realistic model than Erlang C, in which we have still N channels but queue size is not infinite but a finite value M. An arrival which occurs when queue is full is blocked, leaves the system and does not return. Besides, each customer in the queue, after waiting for some random time interval, cancels his call, leaves the system and does not return. Waiting times are assumed to be iid and distributed according to negative exponential distribution with parameter ω. Find the blocking and wait probabilities for this model.

5. Exercises in trunking (queueing) theory:

a) What is the maximum system capacity (total and per channel) in Erlangs when providing 2% blocking probability with 4 channels, with 20 channels, with 40 channels. Use enclosed Erlang B chart as necessary.

b) How many users can be supported with 40 channels at 2% blocking? Assume $\frac{1}{\mu} = 105\,s$, $\lambda = 1$ call/hour

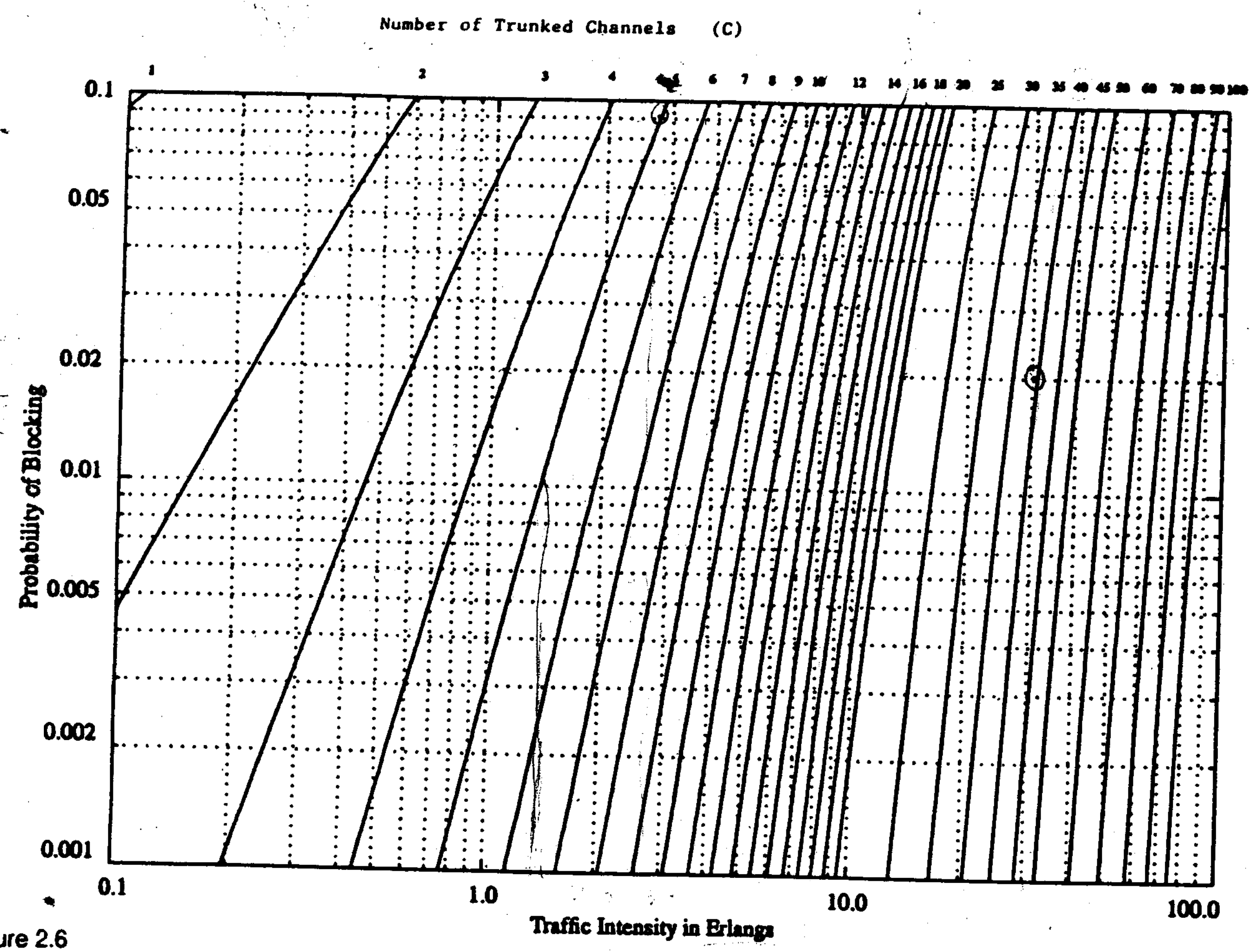

Figure 2.6
The Erlang B chart showing the probability of blocking as functions of the number of channels and traffic intensity in Erlangs.

Source : Rappaport

6. 5 years ago, there was a single company offering wireless communications service to a certain city. There were 15 channels per base station throughout the coverage area. Due to a recent court case result against undesirable monopolies, we now have 3 companies to provide personal communications service in the same area and not changing the density of channels per area, with the argument that it is the same total 15 channels. However, you note that the customers of one company will not be able to access the channels of the others. Therefore, the channel access group has been reduced by a factor of 1/3.

Assume that the offered traffic is also divided equally among the three companies, and that each company can now provide 15/3 = 5 channels per base station. Also, assume access to only one base station and that you want to use the same base station placement as would have been used for the 15 channel per base station system.

Summary : base station placement is the same, and the same number of channels are available in each base station. The difference is that customers are only allowed access to 5 channels per base station (depending on which company they are subscribing to).

Assume a specified blocking probability of 0.01 for the cases before and after the split.

a) What is the Erlang B blocking probability of a 1/3 capacity (5 channels) base station when offered 1/3 of the 8.11 Erlangs of traffic?

b) What is the Erlang B blocking probability if the traffic offered to the 5 channels is reduced to 1.36 Erlangs?

c) What is the ratio of the traffic offered capacity in Erlangs when used undivided (15 channels/base station) to the traffic offered in Erlangs when divided among 3 equal sets of users (5 channels/base station). Assume base station density is the same in both cases and that the required blocking probability is the same at 0.01.

d) What could you do to decrease the blocking probability of the 1/3 size system (5 channels/base station?)