4.(a) (3 pts) For N = 7 (cluster size is 7) with P(Blocking) = 0.01 and average call length of two minutes, find the traffic capacity loss due to trunking of 42 channels/cell (294 voice channels in total) when going from omni directional antennas to 60° sectored antennas. Assume that blocked calls are cleared and average call rate per user is 1 call per hour. Also assume that the user population is uniformly distributed.

(b) (3 pts) Is there any increase in total number of users/cluster, due to using the same frequency in other cells in the cluster after sectoring? What are the total number of users/cluster before and after using sectored antennas?

(a) omni-to-60° sector, # of Ch/sector = 42/6 = 7ch

for GOS = 1% & C = 7 ⇒ A_{sec} = 2.5 Erlang

μ = 1 call/hr, $H = \frac{2}{60} = \frac{1}{30}$ hr ⇒ $A_u = \frac{1}{30}$ Erl

for each sector $U_{sec} = \frac{A_{sec}}{A_u}$ = 75 users

" " sectored cell $U = 6U_{sec}$ = 450 users

cell with omni antenna: C = 42 ⇒ A_o = 30.77

$U_o = \frac{A_o}{A_u}$ = 923 user/cell

Trunking loss = $1 - \frac{450}{923}$ = 0.51 = 51%

(b) When sectored, every cell interferes only one cell in the first tier: ~~cell~~

∴ S/I improves by 6 or 7.8 dB

since $\frac{S}{I} \approx \frac{(\sqrt{3N})^n}{i_o}$ where n is path loss exp

N is cluster size

i_o is # of int. cells

Then $N = \frac{\left[i_o\left(\frac{S}{I}\right)\right]^{2/n}}{3}$ ⇒ for omni: $N_o = (6)^{2/n}\left(\frac{S}{N}\right)^{2/n}$

for sector: $N_s = (1)^{2/n}\left(\frac{S}{N}\right)^{2/n}$

∴ $N_s = \frac{N_o}{(6)^{2/n}}$ eg. for n = 4 ⇒ $N_s = N_o/2.45$ ⇒ $N_s = 3$

" n = 3 ⇒ $N_s = N_o/3.3$ ⇒ $N_s = 3$

since $N_o = 7$ as given

∴ We can use the same freq once in every three cells

∴ # Ch/cell = 294/3 = 98 channels

Ch/sector = 32.7 = 32 ⇒ user/sec = $22.05/A_u$ = 661

Users/cell = 1983

It was = 923

∴ 265% increase in user capacity

Ans: (a)

(b)