Assignment - I

en data:

$\frac{S}{I}$ = 15dB (minimum required)

Path loss exponent (a) $n=4$, (b) $n=3$

no. of. co-channels $i_0 = 6$

soln :-

Frequency reuse factor $Q = \frac{D}{R} = \sqrt{3N}$

(a) considering 7 cell reuse pattern, $n=4$, $N=7$

$N=7$

$Q = \sqrt{3\times7} = \sqrt{21} = 4.5826 \simeq 4.58$

$\frac{S}{I} = \frac{(D/R)^n}{i_0} = \frac{(4.5826)^4}{6} = \frac{440.01}{6} = 73.33$

$\frac{S}{I} = 18.65$ dB

As the S/I is greater than the minimum requirement, N=7 can be used.

(b) $n=3$, $N=7$ (7 cell reuse pattern)

$\frac{S}{I} = \frac{(D/R)^n}{i_0} = \frac{(4.58)^3}{6} = \frac{96.07}{6} = 16.01$

$\frac{S}{I} = 12.04$dB

As the S/I is less than the minimum requirement, have to use N>7.

By checking $i=2, j=2$ next possible value of $N = i^2+j^2+ij = 12$;

N=12 (12 cell reuse pattern)

For N=12

$Q = \frac{D}{R} = \sqrt{3N} = \sqrt{36} = 6$

$$\frac{S}{I} = \frac{(D/R)^n}{i_0} = \frac{(6)^3}{6} = 36$$

$$\frac{S}{I} = 15.56 \text{ dB}$$

AS S/I is greater than the minimum requirement,

N = 12 can be used.

2)

System	A	B	C
No. of cells	394	98	49
Channels / cell	19	57	100

Blocking probability = 5% = 0.05

Request rate $\lambda = 2$ hour

holding time $H = 3$ mins $= (3/60)$ hours

System A

no. of. channels / cell $(C) = 19$

traffic intensity per user $= A_u = \lambda H = 2 \times (3/60)$

$A_u = 0.1$ Erlangs

For GOS = 0.05, C=19. From Erlang B chart / table

total traffic $A = 14.32 \simeq 14$ Erlangs

∴ The number of users can be supported per cell is

$U = A/A_u = 14/0.1 = 140$ users.

∴ For total 394 cells, total no. of. subscribers that can be supported by system A is $140 \times 394 = 55{,}160$

System B

No. of. channels / cell (C) = 57

Traffic intensity per user = $A_u = \lambda H = 2 \times 3/60$

$A_u = 0.1$ Erlangs.

For GOS 0.05, C = 57. From Erlang B chart/table

total traffic A = 51.55 ≈ 51 Erlangs.

∴ no. of. users that can be supported per cell $U = A/A_u = 51/0.1$

$= 510$

∴ As there are 98 cells, the total no. of. subscribers that can be supported by system B is, $510 \times 98 = 49,980$

System C

no. of. channels / cell (C) = 100

traffic intensity per user = $A_u = \lambda H = 2 \times (3/60)$

$A_u = 0.1$ Erlangs

For GOS = 0.05, C = 100, from Erlang B chart/table,

total traffic A = 95.24 ≈ 95

∴ the no. of. users that can be supported per cell

$U_f = A/A_u = 95/0.1 = 950$

∴ As there are 49 cells, the total no. of. subscribers that can be supported by system C is, $950 \times 49 = 46,550$

3) Given data:

Total city coverage = 1300 sq.miles

cell radius $R = 4$ miles

allocated spectrum = 40 MHz = 40,000 KHz

each channel bandwidth = 60 KHz

Frequency reuse factor = 7

Erlang B sys → GOS = 2% = 0.02

traffic per user = 0.03 Erlangs

soln

(a) no. of. cells in the service area.

cell radius $R = 4$ miles

Cell coverage area $= 2.598 \times R^2 = 2.598 \times 4^2$

$= 41.57$ sq.miles

total no. of. cells (Nc) $= \dfrac{\text{total city coverage}}{\text{one cell coverage}}$

$N_c = \dfrac{1300}{41.57} = 31.27 \simeq 31$

$N_c = 31$ cells

(b) no. of. channels per cell (C)

$C = \dfrac{\text{allocated spectrum}}{\text{channel BW} \times \text{freq reuse factor}}$

$C = \dfrac{40000}{60 \times 7} = 95.24 \simeq 95$ channels/cell

(c) traffic intensity of each cell

For GOS = 0.02, C=95. From Erlang B chart/table,

traffic intensity, A = 83.13 ≃ 83

A = 83 Erlangs/cell

d) maximum traffic carried

= no. of. cells x traffic intensity per cell

= 31 x 83 = 2573 Erlangs.

e) the total no. of. users that can be served for 2% GOS

traffic per user = 0.03 Erlangs

total no. of. users = $\frac{\text{Total traffic}}{\text{traffic per user}}$

total no. of. users = $\frac{2573}{0.03}$ = 85766 users

f) No. of. channels = $\frac{40\ MHz}{60\ KHz}$ = 666

the no. of. mobiles per channel = $\frac{\text{no. of. users}}{\text{no of. channels}}$ = $\frac{85766}{666}$

= 128.78

no. of. mobiles per channel ≃ 128

(g) the theoritical maximum number of users that could be served at one time by the system

= C x Nt

= 95 x 31 = 2945 users.

which is 3.4% of the occupied customer base.

4) Given data:

Total BW = 24 MHz

Channel BW = 30 KHz → 2 simplex channels

= 60 KHz

traffic intensity per user = 0.1 Erlangs

Erlang B is used.

Soln:

(a) no. of. channels in each cell for 4 cell reuse system

$$\text{no. of. channels} = \frac{24\text{ MHz}}{2 \times 30\text{ KHz}} = 400 \text{ channels}$$

$$\text{no. of. channels/cell} = \frac{400 \text{ channels}}{4 \text{ cells}} = 100 \text{ Channels/cell}$$

(b) 90% capacity for perfect scheduling

Total traffic = 90% of 100 Erlangs = 90 Erlangs

$A = UA_u$

no. of. users $(U) = A/A_u = 90/0.1 = 900$ users

Maximum no. of. users supported per cell = 900

(c) blocking probability of system in (b) when maximum users available in user pool

C = 100, A = 90 Erlangs from Erlang B chart/table,

GOS = 3% = 0.03

(d) If each cell now uses 120° sectoring instead of omnidirectional for each base station. What is the new total no. of. users that can be supported per cell for same blocking probability in (c) ?

total 100 channels/cell.

→ now by 120° sectoring → 33.3 channels/cell

GOS = 3%.

From Erlang B chart/table.

traffic intensity A = 25 Erlangs/sector

no. of. users/sector = A/A_u = 250/sector

no. of. users/cell = 250 × 3 = 750 users

U = 750 users.

(e) If each cell covers 5 sq.km, then how many subscribers could be supported in an urban market that is 50km×50km for the case of omnidirectional base station antenna.

totalarea = 50 × 50 = 2500 sq.km

cellarea = 5 sq.km

no. of. cells = $\frac{2500}{5}$ = 500 cells.

no. of. users = 500 cell × 900 users/cell

U = 4,50,000 users

(f) same scenario as (e) with 120° sectored antenna.

500 cells ; 750 users/cell

no. of. users U = 500 × 750 = 3,75,000 users.