3.1

Q1) 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.

Soln Here,

System A

Probability of blocking = 2% = 0.02 (GOS)

No. of channels per cell, C = 19

Call request rate ($\lambda$) = 2 calls / hr

$$= \frac{2 \text{ calls}}{60 \times 60 \text{ sec}}$$

Holding time (H) = 3 mins

$$= 3 \times 60 \text{ sec}$$

Now,

Traffic intensity per user,

$$A_u = \lambda H$$

$$= \frac{2}{60 \times 60} \times 3 \times 60$$

$$\therefore A_u = 0.1 \text{ Erlangs}$$

for GOS = 0.02 & C = 19,
from Erlang B chart, we get

Total Traffic intensity (A) = 12 Erlangs

Again,
No. of users per cell (U) = $\frac{A}{A_u}$

$= \frac{12}{0.1}$

$\therefore U = 120$

Again,
No. of cells in system A = 394 (Given)
So,
The total no. of subscribers that can be supported by system A.
= No. of users per cell x No. of cells in system A

= 120 x 394
= 47280

Similarly, do for system 'B' & 'C'

Now,
Total no. of subscribers supported by A, B & C,
$= 47280 + 44100 + 43120$
$= 134,500$

Total population = 2million
$= 2,000,000$

Market penetration by system A,
$= \frac{47280}{2,000,000} \times 100\%$
$= 2.36\%$

Market penetration by system B,
$= \frac{44,100}{2,000,000} \times 100\%$
$= 2.205\%$

Market penetration by system C,
$= \frac{43120}{2,000,000} \times 100\%$
$= 2.156\%$

Market penetration by all three system (A, B & C),
$= \frac{134,500}{2,000,000} \times 100\%$
$= 6.725\%$

2) A city with a coverage area of 500 sq. km is covered with a 12 cell system each with a radius of 1.387 km. If the total spectrum allocated is 28.5 MHz with a full duplex channel bandwidth of 25 KHz. Assume a GOS of 0.02 for an Erlang B system is specified and the offered traffic per user is 0.03 Erlangs, Compute

a) the no. of cells in the service area

⇒ Here,

Total city coverage area = 500 sq. km
Cell radius (R) = 1.387 km
} ⇒ Given

Now,

Area of a cell (hexagon) $= \frac{3\sqrt{3}}{2} R^2$

$= 2.5981 R^2$

$= 2.5981 \times (1.387)^2$

$= 5$ sq. km

Hence,

The total no. of cells in the service area

$= \frac{\text{Total city coverage area}}{\text{Area of a cell (hexagon)}}$

$= \frac{500}{5}$

$= 100$ cells

b) the no. of channels per cell

⇒ Here,

Allocated spectrum = 28.5 MHz
= 28500 KHz
channel bandwidth = 25 KHz
Frequency reuse factor = 12

} Given

Now,

No. of channels per cell = $\frac{\text{Allocated spectrum}}{\text{channel B/w} \times \text{Freq. reuse factor}}$

$= \frac{28500}{25 \times 12}$

$= 95$ channels/cell

c) Traffic intensity of each cell

⇒ Here,

No. of channels per cell (C) = 95
GOS = 0.02

} Given

From Erlang-B chart, we have,

Traffic intensity per cell,

A = 84 Erlangs/cell

d) the maximum carried traffic

⇒ We know,

Maximum carried traffic = Total No. of cells (from a) × traffic intensity per cell (from c)

= 100 × 84

= ~~Erlang~~

= 8400 Erlangs

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

⇒ Here,

Traffic per user = 0.03 Erlangs → Given

Now,

Total no. of users = Total traffic (from d) / traffic per user → Given

= 8400 / 0.03

= 2,80,000

f) the no. of mobiles per unique channel (where it is understood that channels are reused).

⇒ Here,

No. of mobiles per channel = No. of users (from e) / No. of channels in cluster

Also,

No. of channels in cluster = No. of channels per cell (from b) × freq. reuse factor

= 9.5 × 12

= 1140

Now,
No. of mobiles per channel = $\frac{2,80,000}{1140}$

= 245 mobiles/channel

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

⇒ Here,
The theoretical maximum number of served mobiles is the number of available channels in the system (all channel occupied),

~~= No of channels each~~

= No. of channels per cell × total no. of cell in service area
(from b) (from a)

= 95 × 100
= 9500 users

Customer ~~Market~~ penetration,

= theor. max. no. of users that could be served at one time / total no. of user (from e)

= $\frac{9500}{2,80,000}$ × 100%
= 3.4%