Experiment 1: A spectrum of 30 MHz is allocated to a wireless FDD cellular system which uses two 25 kHz simplex channels to provide full duplex voice and control channels. Compute the number of channels available per cell if a system uses

a) Four cell reuse b) Seven cell reuse c) 12-cell reuse.

If 1 MHz of the allocated spectrum is dedicated to control channel determine the ~~x~~ equitable distribution of control channels and voice channels in each cell of each of the three systems.

Solution:

Given,

Total Bandwidth = 30 MHz

Channel Bandwidth = $25 \times 2 = 50$ kHz.

Total available channels = $\frac{30,000}{50} = 600$

a) For $N=4$, total number of channels available per cell = $\frac{600}{4}$

$= 150$

b) For $N=7$, total number of channels available per cell = $\frac{600}{7}$

$= 85$

c) For $N=12$, total number of channels available per cell = $\frac{600}{12}$

$= 50$

Allocated Spectrum = 1 MHz

$\therefore$ Control Channels = $\frac{1000}{50} = 20$

a) For $N=4$, control channels $= \frac{20}{4} = 5$

And voice channel $= 150 - 5 = 145$

b) For $N=7$, control channels $= \frac{20}{7} = 3$

voice channel $= 85 - 3 = 82$

c) for $N=12$, control channels $= \frac{20}{12} = 2$

voice channel $= 50 - 2 = 48$

b) ~~N=3~~ n=3

First let us consider a 7 cell reuse pattern

signal-to interference ratio,

$$S/I = \left(\frac{1}{6}\right)(4.583)^3$$

$$= 16.09$$

$$= 12.05 \text{ dB}$$

This is less than the minimum required S/I, so we need to use a larger N.

using equation, $N = i^2 + ij + j^2$

the next possible values of N is 12 here $i = j = 2$

$\therefore$ frequency reuse factor $Q = \sqrt{3 \times 12}$

$$= 6$$

$$S/I = \left(\frac{1}{6}\right)(6)^3$$

$$= 36$$

$$= 15.56 \text{ dB}$$

$\therefore N = 12$ can also used.

Experiment 2: For given path loss exponent a) $n=4$ and b) $n=3$ find the frequency reuse factor and the cluster size that should be used for maximum capacity. The signal to interference ratio of 15 dB is minimum required for satisfactory forward channel performance of a cellular system. There are six co channel cells in the first tier and all of them are at the same distance from the mobile. Use suitable approximation.

Sol^n:

a) $n=4$

First, let us consider a 7 cell reuse pattern

Frequency reuse factor, $Q = \sqrt{3N}$

$= \sqrt{3 \times 7}$

$= \sqrt{21}$

$= 4.583$

$i_0 = 6$

Signal to interference ratio $S/I = \dfrac{Q^n}{i_0}$

$= \dfrac{(4.583)^4}{6}$

~~78~~ $= 73.53$

$= 18.66\,dB$

As this is greater than the minimum required S/I,

N = 7 can be used

Experiment no: 02: How many users can be supported for 0.5% blocking probability for the following numbers of trunked channels in a blocked calls cleared system?

a) 1 b) 5 c) 10 d) 20 e) 100

Assume each user generates 0.1 Erlangs of traffic.

Soln:

Given, $GOS = 0.005$

$A_u = 0.1$

when $C = 1$, $A = 0.005$

a) For $C = 1$, $u = \frac{A}{A_u} = \frac{0.005}{0.1} = 0.05$ users $\cdot 1$ users

b) For $C = 5$, ~~u~~ $A = 1.13$

$\therefore$ Total number of users, $u = \frac{1.13}{0.1} = 11$ uses

c) For $C = 10$, $A = 3.96$

$\therefore$ Total number of users, $u = \frac{3.96}{0.10} = 40$ users

d) For $C = 20$, $A = 11.10$

$\therefore$ Total number of users, $u = \frac{11.10}{0.1} = 111$ users

e) For $C = 100$, $A = 80.9$

$\therefore U = \frac{A}{A_u} = \frac{80.9}{0.1}$

$= 809$ users

Number of users that support B = cells × u

$= 98 \times 468$

$= 45864$

Market penetration $= \frac{45864}{20,00000} \times 100$

$= 2.29\%$

c) for C, cells $= \cancel{100}\, 49$

$C = \cancel{49}\ 100$

$A = 87.97$

user, $u = \frac{A}{Au}$

$= \frac{87.97}{0.1}$

$= 880$

Nb of users that support C = cells × u

$= 49 \times 880$

$= 43120$

Market penetration $= \frac{43120}{20,00000} \times 100$

$= 2.156\%$

d) Total market penetration $= \frac{48462 + 45864 + 43120}{20,00000}$

$= \cancel{6.87\%}\ = 6.9\%$

Experiment 4

Given,

Population = 20,00000

GOS = 2%

Generated Traffic Intensity $A_u = \frac{3}{60} \times 2$

$= 0.1$ Erlangs

a) For A,

cells = 394

channel, c = 19

for c = 19 and GOS = 2%, A = 12.33

$user, u = \frac{A}{A_u} = \frac{12.33}{0.1} = 123$

∴ Number of users that support, A = cells × u

= 394 × 123

= 48462

∴ Market penetration = $\frac{48462}{20,00000} \times 100$

= 2.42%

b) For B,

cells = 98

channel, c = 57

A = 46.82

$user, u = \frac{A}{A_u} = \frac{46.82}{0.1}$

= 468

c) The direction is perpendicular. That means $\theta = 90°$.

$\cos 90° = 0$

Hence there is no doppler shift.

Experiment 5

frequency $f = 900$ MHz

$\lambda = \frac{3\times10^8}{900\times10^6} = 0.33$ m , Maximum dimension, $D = 1$ m

d_f, fraunhofer distance $= \frac{2D^2}{\lambda}$

$= \frac{2\times1}{0.33}$

$= 6.06$ m

Path loss $= -10 \log \left[\frac{\lambda^2}{(4\pi)^2 (d_f)^2}\right]$

$=$ ~~47.24~~ 47.26 dB

Experiment 6

a) Given,

$f_c = 900\ MHz$ or $900 \times 10^6\ Hz$

Velocity $v = \frac{70 \times 1000}{3600} = 19.44\ ms^{-1}$

wavelength, $\lambda = \frac{c}{f_c}$

$= \frac{3 \times 10^8}{900 \times 10^6} = 0.33\ m$

$\therefore f_d = \frac{v}{\lambda} = \frac{19.44}{0.33}$

$= 58.91\ Hz$

The vehicle is moving directly toward the transmitter.

The received frequency is $f_c + f_d$

$= 900 \times 10^6 + 58.91$

$= 900\ MHz$

b) The vehicle is moving away from the transmitter.

The received frequency is, $f_c - f_c$

~~= 900 - 58.91~~

~~= 841.09 MHz~~

$= 900 \times 10^6 - 58.91$

$= \cancel{900} = 899.99$

$= 900\ MHz$

c) Again,
given,

Indoor channel model = 500 ns.

$$\therefore \Delta J = \frac{500}{70} = 7.14\ ns.$$

The maximum RF bandwidth for the indoor channel model is $\frac{2}{\Delta J}$

$$= \frac{2}{7.14 \times 10^{-9}}$$

$$= 280112044.8\ Hz$$

$$= 280112044.8 \times 10^{-6}\ MHz$$

$$= 280.11\ MHz$$

SIRCIM — Simulation of Indoor Radio Channel Impulse Response

SMRCIM — Statistical Model for Recurrent Channel Impulse Response.

এটি signal processing এর field এ ব্যবহার করা হয় to enhance the performance

Noise reduce, data rate increase

$1ns$ — $10^{-9}s$
$1\mu s \rightarrow 10^{-6}s$
$1ms \rightarrow 10^{6}s$

$10^{6}\mu \rightarrow 1mm$

~~$\tau_N = 150\mu s$~~ ~~$\Delta\tau = \frac{\tau_N}{N} = \frac{150}{70} = 2.14\mu s$~~
~~$N = 70$~~

Experiment 7

a) Given,

Excess delay of statistical channel, $\tau_N = 150\mu s$

Multipath bin, $N = 70$

$$\therefore \Delta\tau = \frac{\tau_N}{N} = \frac{150}{70}$$

$$= 2.14\mu s$$

b) The maximum bandwidth that SMRCIM can present is

$$\cancel{\frac{\Delta\tau}{2}} \quad \frac{2}{\Delta\tau} = \frac{2}{2.14\mu s}$$

$$= 0.9346\,MHz$$

For microcellular channel, $\tau_N = 4\mu s$

$$\therefore \Delta\tau = \frac{\tau_N}{N} = \frac{4\times10^{-6}s}{70} = 0.0000000571s$$

$$= 0.0000000571\times10^{9}$$

$$= 57.1ns$$

The maximum bandwidth, $\frac{2}{\Delta\tau}$

$$= \frac{2}{(57.1\times10^{-9})s}$$

$$= 35026269.7\,Hz\times10^{-6}$$

$$= 35.03\,MHz$$

a) Total power in the carrier is, $\cancel{P_{AM}}$ $\frac{P_c}{P_{AM}} \times 100$

$$= \frac{312 \cdot 195}{400} \times 100$$

$$= 78 \cdot 05\%$$

b) The power in each sideband $= \frac{P_{AM} - P_c}{2}$

$$= \frac{400 - 312 \cdot 195}{2}$$

$$= 43 \cdot 9025$$

c) If the carrier and one of the sidebands are now suppressed the total power saving will be. $\left[1 - \frac{\text{Power in each sideband}}{400}\right] \times 100$

$$\left(1 - \frac{43 \cdot 9025}{400}\right) \times 100$$

$$= 89 \cdot 024\%$$

Zero mean sinusoidal value: The positive & negative values are equal in magnitude but opposite in sign, so they sum to zero.

Experiment 9

Given sinusoidal signal,

$$m(t) = 8\cos(2\pi\, 4\times10^3 t + 10)$$

here, $A_m = 8V$

$f = 4\times10^3$ or $4\ kHz$

$K_0 = 10$ $\qquad G_f = 10\ kHz/V$

a) The peak frequency deviation, $\Delta f = A_m G_f$
$= 8\times10$
$= 80\ kHz$

b) The modulating index, $\beta_f = \frac{\Delta f}{f_m} = \frac{80}{4} = 20$

c) The phase modulating index, $\beta_p = K_0 A_m = 10\times8 = 80$ radians

Experiment 8

we know, $P_{AM} = P_c(1 + k^2/2)$

here, $P_{AM} = 400\ kw$

$k = 0.75$

$$P_c = \frac{P_{AM}}{1 + k^2/2}$$

$$= \frac{400}{1 + \frac{(0.75)^2}{2}}$$

$= 312.195\ kw$

2G & 3G তে use হয়।

CDMA তে same frequency band use করে by assiging a unique code to each user's data.

যেমন: একটি crowded room এ অনেকজন person একে অপরের সাথে কথা বলে। আমরা শুধু তাকেই focus করব যে আমাদের ভাষাতে কথা বলে।।

TDMA voice call এর জন্য efficient, FDMA early mobile system এর জন্য ও CDMA capacity & security increase করে।

Frame: Structure unit of data. Frame এ header, ~~tailer~~ trailer থাকে।

Ethernet – 512 bits contain করে

GSM – 1250 " " "

Experiment 10

a) Time duration of a bit $= \frac{1}{\text{Data trammitted rate}}$

$= \frac{1}{270.833} = 3.692\,\mu s$

b) Time duration of a slot, $T_d = 156.25 \times 3.692 \times 10^{-6}$

$= 0.000577\,s \times 1000$

$= 0.577\,ms$

c) Time duration of a frame $= 8 \times T_d$

$= 8 \times 0.577 = 4.615\,ms$

d) A user has to wait 4.615 ms.

Given,

Each time slot contains 156.25 bits

data trammitted 270.833 kbps

Each frame consist 8 time slots.

Brust

- এটি একটি specific structure of data. GSM TDMA system use করে।

TDMA system এ frequency channel ~~অনেকগুলো~~ time slot এ ভাগ করা থাকে। brust হচ্ছে unit of transmission within each time slot.

GSM frequency channel কে ~~অনেকগুলো~~ time slot এ ভাগ করে, Brust এ ~~অনেকগুলো~~ bit এর mix থাকে [data bit, training bit, guard bit, start, stop bit].

TDMA, FDMA, CDMA → efficiently manage করে and limited resources share করে among multiple users.

বেশি use হয় TDMA তে single freq channel কে multiple time slot এ ভাগ করা হয়। This method ensures that multiple users can share the same frequency without interfering with each other. [যেমন: প্রত্যেক student কে class এ কিছু limited time দেয়া হল কিছু বলার জন্য বাকিরা ততক্ষণ wait করে থাকে, turn এর জন্য]

FDMA

Analog mobile system & satellite এ used হয়

Single freq channel কে অনেকগুলো ছোট frequency band এ ভাগ করা হয়। যেমন: radio station গুলো বিভিন্ন frequency broadcast করে, কিন্তু কাউকে interfere করে না।

Experiment 11

Given, there are 3 start bits, 3 stop bits, 26 training bits, 8.25 guard bits and 2 brusts of 58 bits.

∴ A time slot has $= 3+3+26+8.25+(2\times58) = 156.25$ bits

a) Number of overhead bits per frame, $B_{oh} = 8\times6 + 8\times26 + 8\times8.25$

$= 322$ bits

b) Total number of bits/frame $= 8 * 156.25 = 1250$ bits/frame

c) Frame rate $= \frac{270.833\times1000}{1250} = 216.67$ frame/sec   transmitted rate $= 270.833$ kbps

d) Time duration of a slot $= \frac{156.25}{270.833\times1000} = 576.92\ \mu s$

e) Efficiency, $\eta = \left(1 - \frac{322}{1250}\right)\times100 = 72.24\ \%$

VIVA

#GSM - Global System for Mobile communication → এটি 2G network এর protocol describe করে। It was developed by European Telecommunication standard Institute.

Start bit: → Indicate করে beginning of a new data frame/brust.

Stop bit: ending

Training bit: Receiver কে help করে incoming signal কে adjust & synchronize করতে। They allow receiver to accurately detect & demodulate the data.

Guard bit:
↳ They used to prevent overlap or interference between consecutive brusts.

c) Again,
given,

Indoor channel model = 500 ns.

$\therefore \Delta\tau = \frac{500}{70} = 7.14\ ns.$

The maximum RF bandwidth for the indoor channel model is $\frac{2}{\Delta\tau}$

$= \frac{2}{7.14 \times 10^{-9}}$

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[illegible] signal processing [illegible] field [illegible] to enhance the performance

NO

1ns — 10^{-9}s
1μs → 10^{-6}s
1ms → 10^{6}s

10bm → 1 mm

$\tau_N = 150\mu s$ $\Delta\tau = \frac{\tau_N}{N} = \frac{150}{70} = 2.14\mu s$

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