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Assignment : sectional

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Q2) An ESS ground terminal Located in Chicago at Latitude 41.5° N and longitude 87.6° W has access to two GSO satellite. one stationed at 70° W and the second at 135° W Longitude which satellite will provide the more reliable link higher elevation angle for the ground terminal? The ground terminal elevation above sea level is 0.5 km Assume 0° inclination angle for the satellites.

Solution :-

Given Data :-

Ground terminal Latitude and Longitude is

$L_E = 41.5° N = +41.5° N$

$l_E = 87.6° W = -87.6° W$

$H = 0.5$ km

Now we have two satellites. Let say set 1 and set 2

Longitude for set 1

$l_{s1} = 70° W = -70$

Latitude $L_{s1} = 0°$ As inclination angle $= 0°$

Longitude for set 2

$l_{s2} = 135° W = -135$

Now to check the reliability of link we find the elevation angles of the ground station to each satellite :

We know that

$$\theta = \cos^{-1}\left(\frac{re + base}{d}\sqrt{1-\cos^2(B)\cos^2(LE)}\right)$$

For finding the elevation angle we first find the range d,

so,

$$R = \sqrt{l^2+z^2}$$

$$l = \left(\frac{6378.13}{\sqrt{1-(0.08182)^2\sin^2(41.5)}} + 0.5\right)\cos(41.5)$$

$$l = \left(\frac{6378.13}{\sqrt{1-(6.69\times10^{-3})(0.4390)}} + 0.5\right)(0.745)$$

$$l = \left(\frac{6378.13}{\sqrt{0.99706}} + 0.5\right)(0.745)$$

$$l = \left(\frac{6378.13}{\sqrt{0.99706}}\right) + (0.5)(0.745)$$

$l = (6388.21)(0.7489)$

$l = 4784.13 km$

Now we have to find Z

$$Z = \left(\frac{r_e(1 - e_e^2)}{\sqrt{1 - e_e^2 \sin^2(L_E)}} + H \right) \sin(L_E)$$

$$Z = \left(\frac{6378.13(1 - 69 \times 10^{-3})}{0.9985} + 0.5 \right)(0.6626)$$

$$Z = \frac{6335.46}{0.9985} + 0.5 \times 0.6626$$

$Z = (6344.17 + 0.5)(0.6626)$

$Z = 4204.51 km$

Now $R = \sqrt{l^2 + Z^2}$

So

$R = \sqrt{4204.51 + 4784.13}$

$R = 6369.12 km$

$$\varphi_E = \tan^{-1}(z/l)$$

$$\varphi_E = \tan^{-1}\left(\frac{4204.51}{4784.13}\right)$$

$$\varphi_E = \tan^{-1}(0.8788)$$

$$\varphi_E = 41.31^\circ$$

Now, we have to find the differential longitude for both satellite let say

$$B_1 = l_E - L_{s1}$$
$$= -87.6 - (-70)$$
$$= -17.6$$

Similarly,

$$B_2 = l_E - L_{s2}$$
$$= -87.6 - (-135)$$
$$= -87.6 + 135$$
$$= 47.4$$

Now we find Ranges:-

$$d_1 = \sqrt{R^2 + r_s^2 - 2R, r_s \cos(\varphi_E) \cos(B_1)}$$

$$= \sqrt{(6369.12)^2 + (42164.17)^2 - 2(6369.12)(42164.17) \cos(41.31^\circ)\cos(17.6^\circ)}$$

$$= \sqrt{143827607}$$

$$d_1 = 37865.9\,km$$

Now

$$d_2 = \sqrt{R^2 + r_s^2 - 2R\cdot r_s \cos(\varphi E)\cos(B_2}$$

$$= \sqrt{(6369.12)^2 + (42164.17)^2 - 2(6369.12)(42164.17)\cos(41.31^\circ)\cos(47.4)}$$

$$d_2 = \sqrt{1542304029}$$

$$d_2 = 39310.35\,km$$

Now elevation angle are to find as:

$$\varphi_1 = \cos^{-1}\left[\frac{r_e + base}{d_1}\sqrt{1 - \cos^2(17.6)\cos^2(41.5)}\right]$$

$$\varphi_1 = \cos^{-1}\left[\frac{6378.14 + 35786}{37865.9}\sqrt{1 - (0.9085)(0.5609)}\right]$$

$\varphi_1 = \cos^{-1}(1.11353)\sqrt{(1-(0.5376)}$

$\varphi_1 = \cos^{-1}(1.11353)\sqrt{0.4627}$

$\varphi_1 = \cos^{-1}(1.1153)(0.67998)$

$\varphi_1 = \cos^{-1}(0.75718)$

$\varphi_1 = 40.78^\circ$

Now

$$\varphi_2 = \cos^{-1}\left[\frac{r_e + base}{d_2}\sqrt{1-\cos^2(B_2)\cos^2(l_E)}\right]$$

$$= \cos^{-1}\left[\frac{6378.14 + 85786}{39310.36}\sqrt{1-(0.4582)(0.6605)}\right]$$

$$= \cos^{-1}\left[\frac{42164.16}{39310.36}\sqrt{0.74299}\right]$$

$$= \cos^{-1}(1.0725)(0.8169)$$

$\varphi_2 = 22.39^\circ$

As

$\varphi_1 = 40.39^\circ$

$\varphi_2 = 22.39^\circ$

So, the satellite at 70° w. has more reliable link as comparse to 135°W.

(Q3) A VSAT receiver consists of a 0.66m diameter antenna, connected to a 4dB noise. noise receiver (LNR) by a a cable with a line loss of 1.5 dB. The LNR is connected directly to a down counter with 10 dB gain and 2800°k noise temperature .... receiver was measured as 65°k.

a) Calculate the system noise temperature and system noise-.........
b) The receiver operates at a frequency of 12.5 GHz. What is the G/T for the receiver assuming a 55% antenna efficiency?

Solution :- Given data :

Antenna diameter = d = 0.66m.
LNR has noise figure = NF = 4dB
Cable link loss = A = 1.5 dB
Down counter gain = 10 dB
" " temp = 2800°k
IF Amplifier has = 20dB

Scanned with CamScanner

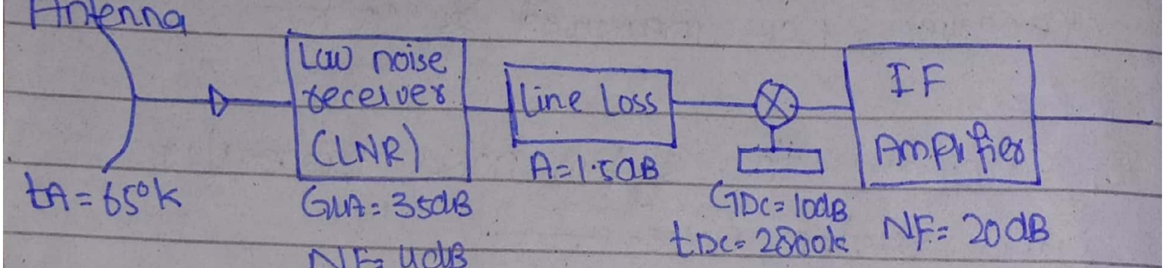
LNR has gain of = 35dB
Antenna temperature = 65°k.

a) Find

$T_s = ?$

$NF_s = ?$

On the base of the VSAT receiver information and parameter we draw the overall receivers system and respective value as below



Formula for the calculation of system noise temperature is

$$t_s = t_A + t_{LA} + \frac{290(l-1)}{g_{LA}} + \frac{t_{DC}}{l g_{LA}} + \frac{t_{IF}}{g_{DC}(1/l) g_{LA}} \quad \text{--- (1)}$$

Now we find the values of each given and noise temp.

Antenna = 65°k

LNR = $290(10^{NF/10} - 1)$

$= 290(10^{4/10} - 1)$

$= 290(1.51)$

$t_{LA} = 438k$

Parameters: $t_{DC} = 2800k$

IF amplifier $= 290(10^{NF/10} - 1)$

$= 290(10^{20/10} - 1)$

$= 290(99)$

$t_{IF} = 28710k$

IF amplifier $= 28710°k$

Line $= 290(l - 1)$

$= 290(10^{5.5/10} - 1)$

$= 290(0.41)$

$t_{RIN} = 119°k$

Now we calculate respective gain:

$g_{LA} = 10^{35/10} = 3162$

$g_{DC} = 10^{10/10} = 10$

$1/l = 1/10^{1.5/10} = \frac{1}{10^{0.15}} = 0.707$

Now putt all values in eq (1)

$$t_s = 65 + 438 + \frac{119}{3162} + \frac{2800}{(0.707)(3162)} + \frac{287.60}{10(0.707)(3162)}$$

$$t_s = 505.57k.$$

we have system noise figure formula is

$$NF_s = 10 \, Log \left(1 + \frac{t_s}{290}\right)$$

$$NF_s = 10 \, Log \left(1 + \frac{505.57}{290}\right)$$

$$NF_s = 10 \, Log (2.743)$$

$$NF_s = 4.382 dB$$

(B)

Find Figure of merit $= M = G/T = ?$

$f = 12.5 GHz$, $\eta_A = 0.55$, $d = 0.66m$.
we First solve for G in dB as

$$G_{dB} = 10 \, log \left(109.66 \times f^2 \times d^2 \times \eta_A\right)$$

$= 10 \log(109.66 \times (12.5)^2 \times (0.66)^2 \times (0.55))$

$= 10 \log(4105.05)$

$G_r = 36.13$ dB

Then

$T_s = ?$

$T_s = 10 \log(t_s)$

$= 10 \log(505.57)$

$= 27.03$ dB/k

$M = G/T = G_r - T_s$

$= 36.13 - 27.03$

$G/T = 9.1$ dB/k

Q4) The downlink transmission rate for a QPSK modulated SCPC satellite link is 60 Mbps. The Eb/No at the ground station receiver is 9.5 dB.

a) calculate the C/No for the link.

b) Assuming that the uplink noise contribution to the downlink is 7.5dB determine the resulting BER for the link.

Solution:

Given data:

$R_b = 60$ Mbps

$Eb/No = 9.5 dB$

a) Find

$C/No = ?$

We know that

$eb/no = 1/Rb \, (C/No)$ — ①

convert it from db::

$Eb/No = 10 \log (eb/no)$

$9.5 = 10 \log (eb/no)$

$eb/no = 10^{0.95}$

$eb/no = 8.912$

put in eq (1)

$8.912 = 1/60\text{Mbps} \, (C/No)$

$C/No = 8.912 \times 60 \times 10^6 \text{bps}$

$C/No = 534.72 \times 10^6$

$C/No = 10 \log (534.72 \times 10^6)$

$C/No = 87.28 2 BHZ$

(b) As $Eb/No = 9.5 dB$ and we have uplink noise contribution to downlink is 1.5dB.

Now,

$Eb/No = 9.5 dB - 1.5 dB = 8 dB$

$eb/no = 10^{0.8}$

$eb/no = 6.309$

Now we know that

$$BER \cong \frac{e^{-(eb/no)}}{\sqrt{4\pi(eb/no)}}$$

$$\cong \frac{e^{-(6.309)}}{\sqrt{4\pi(6.309)}}$$

$$\cong \frac{1.819 \times 10^{-3}}{\sqrt{79.28}}$$

$$= \frac{1.819 \times 10^{-3}}{8.904}$$

$BER = 2.0429 \times 10^{-4}$

Q5) An automobile is moving toward a stationary police radar at 65 statue miles per hour .... - -

the receivered each signal and the Doppler shift?

Solution:-

moving automobile has $V_R = 65$ Mbps

radar transmit freq $f_T = 24.150$ GHz

$fd = ?$
$f_0 = ?$

First we convert VR = from smph to m/s as

$\because 1\,smph = 0.44704\,m/s$

use Ex1-3

$$f_d \cong 2 f_T \, V_R / c$$

$$= \frac{(2)(24.150 \times 10^9)(29.0576)}{3 \times 10^8}$$

$$f_d = 4678.27\ Hz$$

Also we know that

$$f_d = f_R - f_T$$
$$f_R = f_d + f_T$$
$$= 24.150 + 0.00000467827$$

$$f_R = 24.150004\ GHz$$

Q6) Many tactical radars have antenna beamwidth of about 3°. Determine that how for a part ......

range of 24.5nmi in order to be resolved?

Solution:

Antenna beamwidth = 3°
range from order $R = 24.5 nmi = 45,374 km$
How far part should be the targets in the cross-range to be resolved = ?

$$\Delta x = R\,\theta_3\,(\pi/180^\circ)$$
$$= 45374 \times 3 \times \pi/180^\circ$$
$$\Delta x = 2400\ m$$

if we relate antenna beamwidth with the wavelength of EMW and Antenna length Then =

$$\theta_3 = \frac{\lambda}{D_{elf}}\ \text{(radians)}$$

$$\theta_3 = \frac{\lambda}{D_{elf}}\left(\frac{180}{\lambda}\right)\text{(degrees)}$$

'λ' is signal's wavelength. 'D_{elf}' is the effective length (meters) of antenna. The D_{elf} size is about 0.7 times to its actual size. so we can use antenna dimensions and the cross range resolution becomes

$$\Delta x \cong \frac{R\lambda}{Delf} \text{ (meter)}.$$

Q1) Which type of satellite orbit provides the best performance for a communication network for each of the following.

a) minimum free space path loss.

b) Best coverage of high latitude location.

c) Full global coverage for a mobile communication network.

d) minimum latency for voice and data networks.

e) Ground terminals with little or no antenna tracking required.

Answer:-

a) The LEO orbits have minimum free space path losses, because these orbits are nearer to the earth and thus losses are minimum.

b) LEO orbit satellite also provides a good coverage to high latitude area.

c) Satellite in GSO orbit give full global coverage for a mobile communication network. Because GSO sees about one-third of the earth's surface and they are 120° apart each other as to cover the whole earth wee need only 3 GSO satellites.

d) LEO satellite provides minimum latency as they are nearer.

e) At GSO orbit the satellites complete its revolution equal to the earth rotation i.e 23 hours and 56 min for one satellite revolution is required which act as a stationary so for them ground terminal with latitude no antenna tracking required.