Chapter #5

Problems:-

(1) We have to find the transmitted power P_t, As we know for VSAT network,

$$\left(\frac{C}{n_o}\right) = \left[\frac{\eta_t \eta_r A_t A_r}{l_o k}\right] \frac{P_t}{\lambda^2 r^2 t_s} \quad (1)$$

Given values:

$\eta_t = 0.65$, $\eta_r = 0.55$, $r = 35900\,km$, $d_t = 3.2m$

$d_r = 1.2m$, $K = 1.39 \times 10^{-23}\, J/K$, $\frac{C}{N_o} = 55\,dBHz$, $t_s = 400K$

$f = 12.25\,GHz$, $L_o = 1.2\,dB$

Firstly we calculate:

$$A_t = \frac{\pi d_t^2}{4} = \frac{\pi (3.2)^2}{4} = \frac{(3.14)(3.2)^2}{4}$$

$$A_t = 8.038\,m^2$$

$$A_r = \frac{\pi d_r^2}{4} = \frac{\pi (1.2)^2}{4} = \frac{(3.14)(1.2)^2}{4}$$

$$A_r = 1.1304\,m^2$$

Also,

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{12.25 \times 10^9}$$

$$\lambda = 0.024\,m$$

$L_o = 1.2\,dB$

$l_o = 10^{1.2/10}$

$l_o = 1.318$

$\frac{C}{N_o} = 55\,dB\,Hz$

$\frac{C}{n_o} = 10^{5.5}$

$\frac{C}{n_o} = 316227.76$

From eq ①, P_t can be written as:

$$P_t = \left(\frac{c}{n_o}\right) \frac{\lambda^2 R^2 t_s l_o k}{\eta_t \eta_r A_t A_r}$$

(400)

$$= \frac{316227.76 \times (0.024)^2 (35900)^2 (1318)(1.39 \times 10^{-23})}{(0.65)(0.55)(1.1304)(8.038)}$$

$$= \frac{3.71 \times 10^{-12}}{3.248}$$

$$P_t = 1.142 \times 10^{-12}\ W$$

$$P_t = 5.295 \times 10^{-10}\ W$$

② :-

$$f = 20.15\,GHz$$

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{20.15}$$

$$\lambda = 0.0148\,m$$

Now put values in eq ①:

$$P_t = \left(\frac{c}{n_o}\right) \frac{\lambda^2 R^2 t_s l_o k}{\eta_t \eta_r A_t A_r}$$

(400)

$$P_t = \frac{(316227.76) \times (0.0148)^2 (35900)^2 (1318)(1.39 \times 10^{-23})}{(0.65)(0.55)(1.1304)(8.038)}$$

$$P_t = \frac{1.60 \times 10^{-12}}{3.248}$$

$$P_t = 4.926 \times 10^{-13}\ W$$

$$P_t = 2.0141 \times 10^{-10}\ W$$

$⑤$:- $\frac{C}{N_o} = 58\,dBHz$, $L_{FSu} = 207.5\,dB$, $t_s = 380\,k$

$G = 22\,dBi$ and $L_u = 1.2\,dB$, $EIRP_u = ?$

Now we know that:

$$\left(\frac{C}{N_o}\right) = EIRP_u + \left(\frac{G}{T}\right)_u - L_{FSu} - L_u + 228.6 \quad \text{—— ①}$$

here, $t_s = 380k$ convert to dB.

$$T = 10 \log (t_s)$$
$$T = 10 \log (380k)$$
$$T = 25.79\,dB$$

Put all given values in eq ①.

$$58\,dBHz = EIRP_u + \left(\frac{22\,dBi}{25.79\,dB}\right) - 207.5\,dB - 1.2\,dB + 228.6\,dB.$$

$$EIRP_u = 58\,dBHz - 0.85 + 207.5\,dB + 1.2\,dB - 228.6\,dB$$

$$EIRP_u = 266.7 - 228.6 - 0.85$$

$$EIRP_u = 37.25$$

Now $eirp_u = 10^{3.725}$ $\quad \because EIRP = 10 \log(eirp)$

$$\{ eirp_u = 5308.84 \}$$

⑦ :- Find annual outage, hr/yr for link availability.
ⓐ 99.97 % ⓑ 95 % ⓒ 100 %.

As we know that for FSS the link availibility is specified by 8769 hours. basis.
and for BSS often specify an worst month (730 hour) basis.

(a) link availability = 99.97%

Outage = 100% − 99.97%

= 0.03%

So the outage time on annual basis will be.

0.03% × 8769 hours.

$= \frac{0.03}{100} \times 8769$

= 2.63 hrs.

(b) if link availability = 95%

Outage: 100% − 95% = 5%.

So the annual outage time is:

5% × 8769

$= \frac{5}{100} \times 8769$

= 438.45 hrs

(c) link availability = 100%

Outage = 0%.

So the annual outage time is also 0 hrs.

Now if the annual outage is to be kept max. of 60min/month. what will be the link average annual availability.

Availability = 100% − outage

So for 60 min. outage will be.

Outage % × 8769 = outage time.

$\text{Outage }\% = \frac{60\text{min}}{8769 \times 60} = 1.14 \times 10^{-4}$

= 0.0114%

So average link availability is

= 100% − 0.0114%

= 99.9886%.

(8) :-

First consider link with 99.93% annual availability. (3)

Outage of this link:

$100\% - 99.93\% = 0.07\%$

The other link, which is specified by worst month basis (730-hrs).

So the outage percentage can be determined if outage time is:

$(\text{Outage } \%) \times 730 \text{ hrs} = 8 \text{ hrs}$

$\text{Outage } \% = 0.01095 \times \frac{100}{100}$

$\text{outage} = 1.09\%$

Now we can see that this above link has greater outage percentage, so $\frac{C}{N_0}$ ratio for a link sized to 99.93% annually will be greater