Serial #

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King Fahd University of Petroleum & Minerals
Electrical Engineering Department
EE418: Satellite Communications (101)
Quiz 3: Satellite Link Design
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Name: Key

1. A geostationary satellite carries a transponder with a 20 watt transmitter at 4 GHz. The transmitter is operated at an output power of 10 watts and drives an antenna with a gain of 30 dB. An earth station is at the center of the coverage zone of the satellite, at a range of 38,500 km.
Using decibels for all calculations, find:

a. The flux density at the earth station in dBW/m²

Answer: Flux density is given by $F = 20 \log [P_t G_t / (4 \pi R^2)]$ dBW/m²

Hence for R = 38,500 km, f = 4 GHz, $\lambda = 0.075$ m

$F = 10 \log P_t + G_t - 10 \log (4 \pi) - 20 \log (38{,}500 \times 10^3)$ dBW / m²

= 10.0 +30.0 - 11.0 - 151.7 = -122.7 dBW / m²

b. The power received by an antenna with a gain of 39 dB, in dBW.

Answer: Received power can be calculated from the effective area of the antenna aperture and the incident flux density, but since the antenna gain is given in dB, it is better to use path loss and the link budget.

Path loss $L_p = 20 \log (4 \pi R / \lambda) = 10 \log (4 \pi \times 38{,}500 \times 10^3 / 0.075) = 196.2$ dB

Downlink power budget gives

$P_r = P_t + G_t + G_r - L_p$ dBW = 10.0 + 30.0 + 39.0 – 196.2 = -117.2 dBW

Alternatively, the received power can be found from

$P_r = F \times A_{eff}$ where A_{eff} is the effective aperture area of the antenna.

Given $G = 4 \pi A_{eff} / \lambda^2 = 39$ dB, we can find A_{eff} from

$A_{eff} = G + 20 \log \lambda - 11.0$ dB = 39.0 – 22.5 –11.0 = 5.5 dB m²

P_r = -122.7 + 5.5 = - 117.2 dBW / m²

c. The EIRP of the transponder in dBW.

Answer: Transponder EIRP = $P_t + G_t$ = 10 + 30 = 40 dBW

You might also interpret the question as asking about the ERIP of the maximum power of the transponder then EIRP=20+30=43 dBW

2. A 12 GHz earth station receiving system has an antenna with a noise temperature of 50K, a LNA with a noise temperature of 100 K and a gain of 40 dB, and a mixer with a noise temperature of 1000 K. Find the system noise temperature.

Answer: System noise temperature is calculated from

$T_s = T_{antenna} + T_{LNA} + T_{mixer} / G_{LNA} + \ldots$

Hence for G_{LNA} = 40 dB = 10,000 as a ratio

T_s = 50 + 100 + 1000 / 10,000 = 150.1 K

Good Luck, **Dr. Ali Muqaibel**