Example 2

A satellite based mobile phone communications system operates at 1.6 GHz. Calculate the transmit power required from a handset of the system and comment on the result.

System parameters are:

Satellite antenna diameter	1 m
Satellite antenna efficiency	80%
Satellite receiver antenna noise figure	500 K
Signal bandwidth	150 kHz
Satellite receiver noise figure	3 dB
Boltzman's constant k	1.38×10^{-23} J/K
Operating margin	15 dB
Uplink C/N	10 dB
Handset antenna gain	0 dBi
Path length	800 km

Solution

$$\left(\frac{C}{N}\right)_U = E_e - L_U - M + G_s - N_U$$

- E_e = earth station eirp = P_e x G_e
- L_U = uplink path loss
- M = operating margin
- G_s = satellite antenna gain
- N_U = uplink thermal noise = k T_s B_{RF}
- = -228.6 + 10log T_e + 10log B_{RF} dB
- B_{RF} = bandwidth
- T_s = satellite transponder noise temperature (antenna + receiver)

$E_e = P_e + 0$ dB

$L_u = 92.5 + 20\log_{10}800 + 20\log_{10}1.6 = 92.5 + 58.06 + 4.08 = 154.64$ dB

Satellite antenna gain = $4\pi A\eta/\lambda^2 = 4\pi.\ \pi.0.5.0.5.0.8/0.1875^2 = 225 = 23.52$ dBi

Receiver noise = kTB = N_u

Temp T = antenna noise temp + (F-1)290 = 500 + 290 = 790 K

N_u = kTB = $1.38 \times 10^{-23} \times 790 \times 150000 = 1.63 \times 10^{-15}$ W = -147.9 dBW

Hence uplink equation gives $10 = P_e - 154.64 - 15 + 23.52 + 147.9 = P_e + 1.78$

P_e = 8.22 dBw = 6.6 W

Large power from handset so battery will deteriorate rapidly.