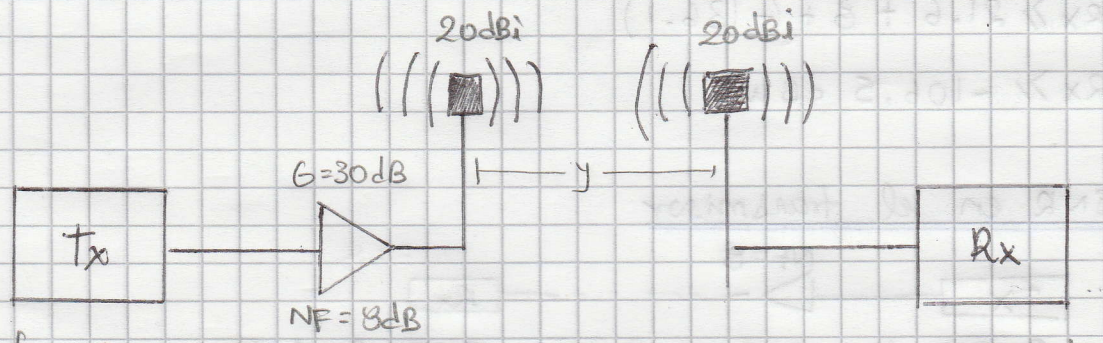
1. Se transmiten 100 canales de video digital MPEG 4.0 HD, para lo que se requiere un BER en el receptor de 10^{-9}.



Transmisor

$$Pn = KTB = 1.38\times10^{-23}\times298\times6\times10^{9} = 2.47\times10^{-11}$$

$$Pn_{dB} = -106.1\ dBW$$

$$SNR = X$$

Amplificador (G = 30dB, NF = 8dB)

NF = 8dB

* Las antenas y las pérdidas por espacio libre son elementos pasivos, por lo tanto, no influyen en el SNR.

Receptor: NF = 8dB, BER = 10^{-9}, Tasa de bits MPEG4.0 HD ⇒ B = 6Mbps

$$SNR = 4Q^2 \rightarrow BER = 10^{-9} \rightarrow Q = 6$$

$$SNR = 4(6)^2 = 144 \rightarrow \text{lineal}$$

$$SNR_{dB} = 21.6\ dB$$

$$Pn = KTB = 1.38\times10^{-23}\times298\times6\times10^{6} = 2.47\times10^{-14}\ W$$

$$Pn_{dB} = -136.1\ dBW$$

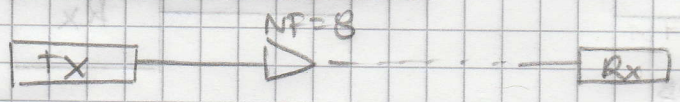
Sensibilidad en el Receptor:

$$P_{RX} \geq SNR_{dB} + NF + Pn_{dB}$$

$$P_{RX} \geq 21.6 + 8 + (-136.1)$$

$$P_{RX} \geq -106.5 \text{ dBW}$$

SNR en el transmisor



$$8 = X - 21.6$$

$$X = 29.6 \rightarrow \text{SNR transmisor}$$

Presupuesto de potencia:

$$P_t X + 30 + 20 - PEL + 20 = -106.5$$

$$30 + 70 - PEL = -106.5$$

$$PEL = 100 + 106.5 = 206.5 \text{ dB}$$

Distancia máxima

$$PEL = 206.5 = 82.44 + 20\log(Y) + 20\log(6 \times 10^3)$$

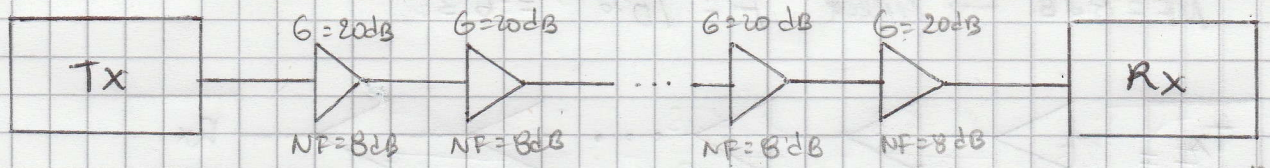
$$206.5 = 108 + 20\log(Y)$$

$$\log(Y) = \frac{98.5}{20}$$

$$Y = 10^{98.5/20}$$

$$Y = 84139.5 \text{ Km}$$

2 Enlace Submarino.



$P_{Tx} = 2dBm$

$P_{Tx} = -28\ dBW$

7855.78 Km

$BER = 10^{-12}$

$NF = 12\ dB$

Tasa de bits $= 10\ Gbps$

Receptor:

$BER = 10^{-12} \Rightarrow Q = 7$

$SNR_{dB} = 10\log(4 \times 7^2) = 23.dB$

$P_n = 1.38 \times 10^{-23} \times 298 \times 10 \times 10^{9} = 4.1 \times 10^{-11}$

$P_{n_{dB}} = -103.9\ dBW$

Sensibilidad:

$P_{rx} \geq SNR_{dB} + NF + P_{n_{dB}}$

$P_{rx} \geq 23 + 12 + (-103.9)$

$P_{rx} \geq -68.9\ dB$

Presupuesto de Potencia

y # Amplificadores, Atenuación de fibra 0.3 dB/km

$-28 + 20y - 0.3(7855.78) = -68.9$

$20y = -68.9 + 28 + (0.3)(7855.78)$

$20y = -40.9 + 2356.734$

$20y = 2315.834$

$y = 115.8 \approx 116$ Amplificadores

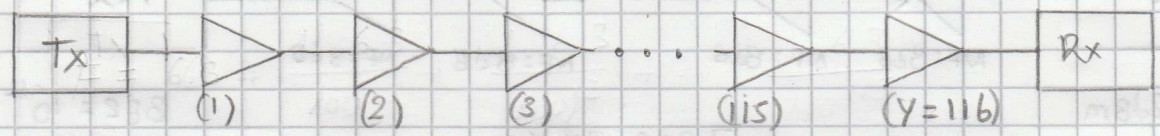
Longitud máxima entre amplificadores

$$\ell_{max} = \frac{7855.78}{117} = 67.14\ km$$

Amplificadores:

$G = 20dB \rightarrow$ lineal $\quad G = 10^{\frac{20}{10}} = 100$

$NF = 8dB \rightarrow$ lineal $\quad F = 10^{\frac{8}{10}} = 6.3$



Factor de Ruido.

$$F = 6.3 + \frac{6.3-1}{100} + \frac{6.3-1}{100^2} + \cdots + \frac{6.3-1}{100^{Y-1}}$$

$$F = 6.3 + \frac{5.3}{100}\left(1 + \frac{1}{100} + \frac{1}{100^2} + \cdots + \frac{1}{100^{Y-2}}\right)$$

$$F = 6.3 + \frac{5.3}{100}\left(1.\left[\frac{\left(\frac{1}{100}\right)^{Y-1} - 1}{\left(\frac{1}{100} - 1\right)}\right]\right)$$

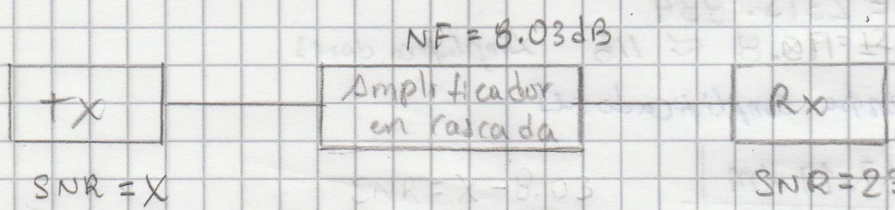
$$F = 6.3 + \frac{5.3}{100}\left(\frac{\left(1 - 100^{Y-1}\right)100}{100^{Y-1}(-99)}\right), \quad Y = 5.116$$

$$F = 6.3 + 5.3\,\frac{\left(100^{Y-1} - 1\right)}{(99)\,100^{Y-1}}$$

$$F = 6.3 + 5.3\,\frac{\left(100^{115} - 1\right)}{(99)\,100^{115}} = 6.3 + 5.3\,\frac{\left(100^{115} - 1\right)}{99} \times 100^{-115}$$

$$F = 6.3 + 5.3\left(\frac{1 - 100^{-115}}{99}\right) = 6.35$$

$NF = 8.03\ dB$



$$X - 23 = 8.03$$

$$X = 31.03\ dB$$