The link budget

Example: TV signal, Modulation: QPSK, Bandwidth B = 2.048MHz, B_{dB}= 63.1dBHz

Boltzmann constant $k = 1.38 \times 10^{-23}$ W/Hz/K, k_{dB} = -228.6 dBW/Hz/K

$L_0=(4\pi d/\lambda)^2$

$S/N= EIRP/L_0 \times G/T \times 1/kB \times 1/L_a \rightarrow S/N_{dB} = EIRP - L_0 + G/T - k - B - L_a$

Transmit (Tx) figures:

EIRP = 50 dBW

Tx frequency = 29.7 GHz

Pointing loss = 1 dB

Atmospheric loss = 0.9 dB

Terminal to satellite distance = 38 039.81 km

G/T satellite = 13 dB/K

$L_0=10\log_{10}(4\pi d/\lambda)^2 = 213.5$ dB

L_a= 1 dB + 0.9 dB

$S/N_{dB}= EIRP - L_0 + G/T - k - B - L_a$

$= 50 - 213.5 + 13 + 228.6 - 63.1 - 1.9$

$= 13.1$ dB

Receiver (Rx) figures:

EIRP = 29.8 dBW

Rx frequency: 18.5 GHz

Pointing loss: 0.3 dB

Atmospheric loss: 0.6 dB

Coupling loss: 0.5 dB

Satellite to receiver distance: 38 460.53 km

G/T receiver = 35.12 dB/K

$L_0=10\log_{10} (4\pi d/\lambda)^2 = 209.5$ dB

L_a= 0.3 dB + 0.6 dB + 0.5 dB

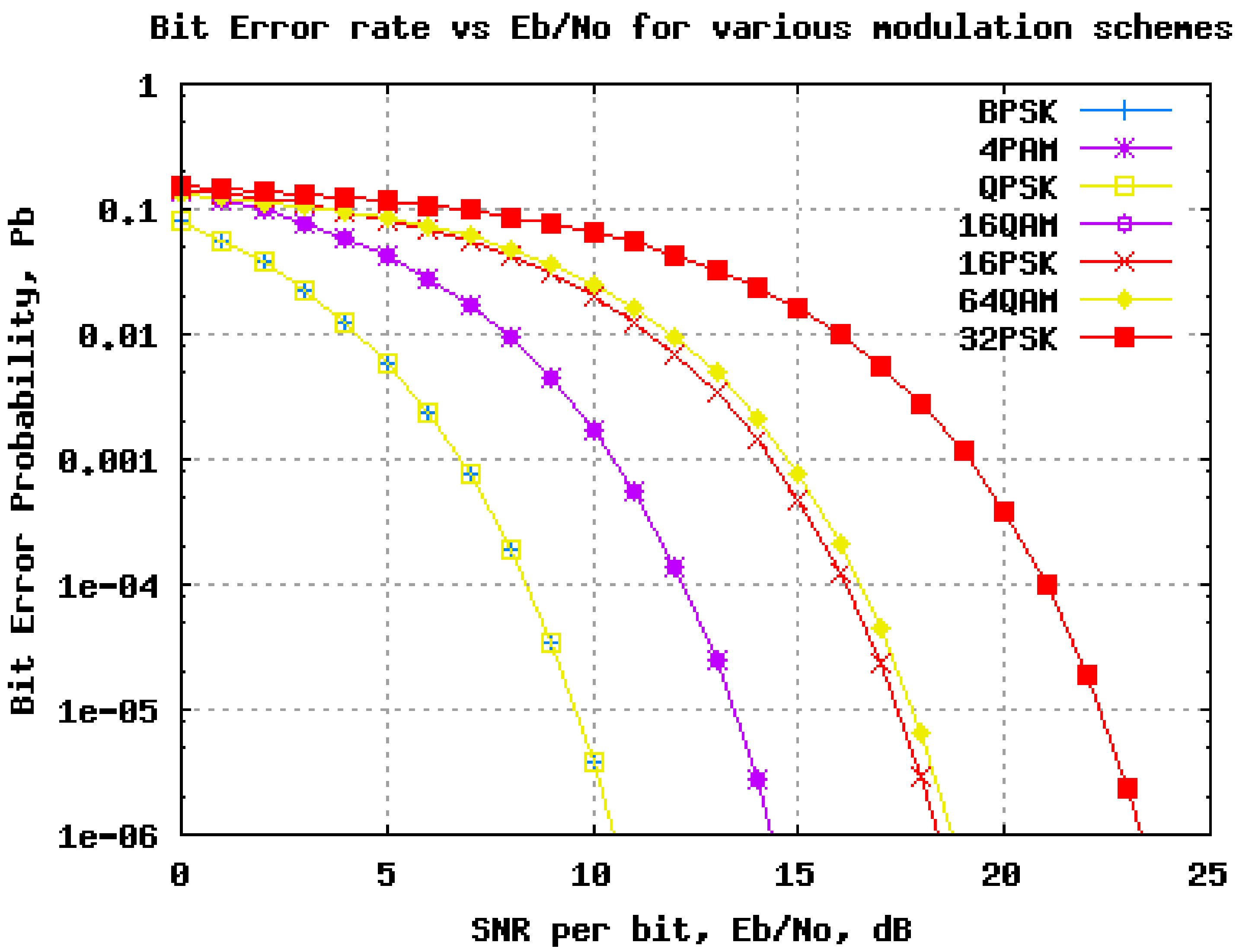
$S/N_{dB}=29.8 - 209.5 +35.12 +228.6 - 63.1 - 1.4$

$= 19.5$ dB

$S/N = ((S/N\ up)^{-1} + (S/N\ down)^{-1})^{-1}$ NB! Linear calculation, convert to dB: S/N = 12.2 dB

$S/N = E_s/N_0 = E_b \times m /N_0 = E_b \times 2/N_0 \rightarrow E_b/N_{0dB} = S/N_{dB}$ –3dB = 12.2 – 3 = 9.2 dB

We want a BER < 10^{-6} $\rightarrow E_b/N_{0dB}$ = 10.5 dB → Margin = 9.2 – 10.5 = -1.3 dB → ☹



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http://i.cmpnet.com/dspdesignline/2008/07/image045.gif

Channel coding to solve the link budget challenge

TV signal, Modulation: QPSK, Bandwidth 2.048MHz

Boltzmann constant k_{dB} = -228.6 dBW/Hz/K

$L_0=(\lambda/4\pi d)^2$

$S/N = EIRP/L_0 \times G/T \times 1/kB \times 1/L_a \rightarrow S/N_{dB} = EIRP - L_0 + G/T - k - B - L_a$

$S/N = ((S/N\ up)^{-1} + (S/N\ down)^{-1})^{-1} \rightarrow S/N = 12.2$ dB

$S/N = E_s/N_0 = E_b \times m / N_0 = E_b \times 2/N_0 \rightarrow E_b/N_{0dB} = S/N_{dB} - 3dB = 12.2 - 3 = 9.2$ dB

We want a BER < $10^{-6} \rightarrow E_b/N_{0dB} = 10.5$ dB $\rightarrow$ Margin = 9.2 – 10.5 = -1.3 dB

So if we select a code with 3 dB coding gainin E_b/N_0 at BER < 10^{-6}

$\rightarrow$ Margin = -1.3 dB + 3dB = 1.7 dB

And we have a positive margin.

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