P_{TX} dB dBm $X\left(\frac{1}{100}\right)^{\frac{x}{100}}$

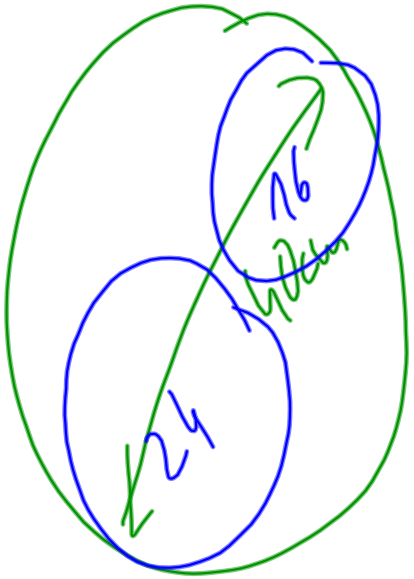
$1\,W$ 0dB (Watt) 30 dBm (Watt) 20dB $x-20$ dB

$L_{Path} = 100dB$

$G_{Tx}, G_{R} = 0dB$ ——— $-70\,dBm$

$P_{RX} = -100dB$

dB_A air pressure



reduce capacity by ? dB

$\pi \cdot (40)^2 \text{ km}^2 = 1600 \cdot \pi \text{ km}^2$

$\pi \cdot (24^2 + 16^2) \text{ km}^2 = 576 + 256 =$

832

$\frac{832}{1600} \approx 0.5$ → 3 dB

P.

dB

25 W dBm (+30 .. dB)

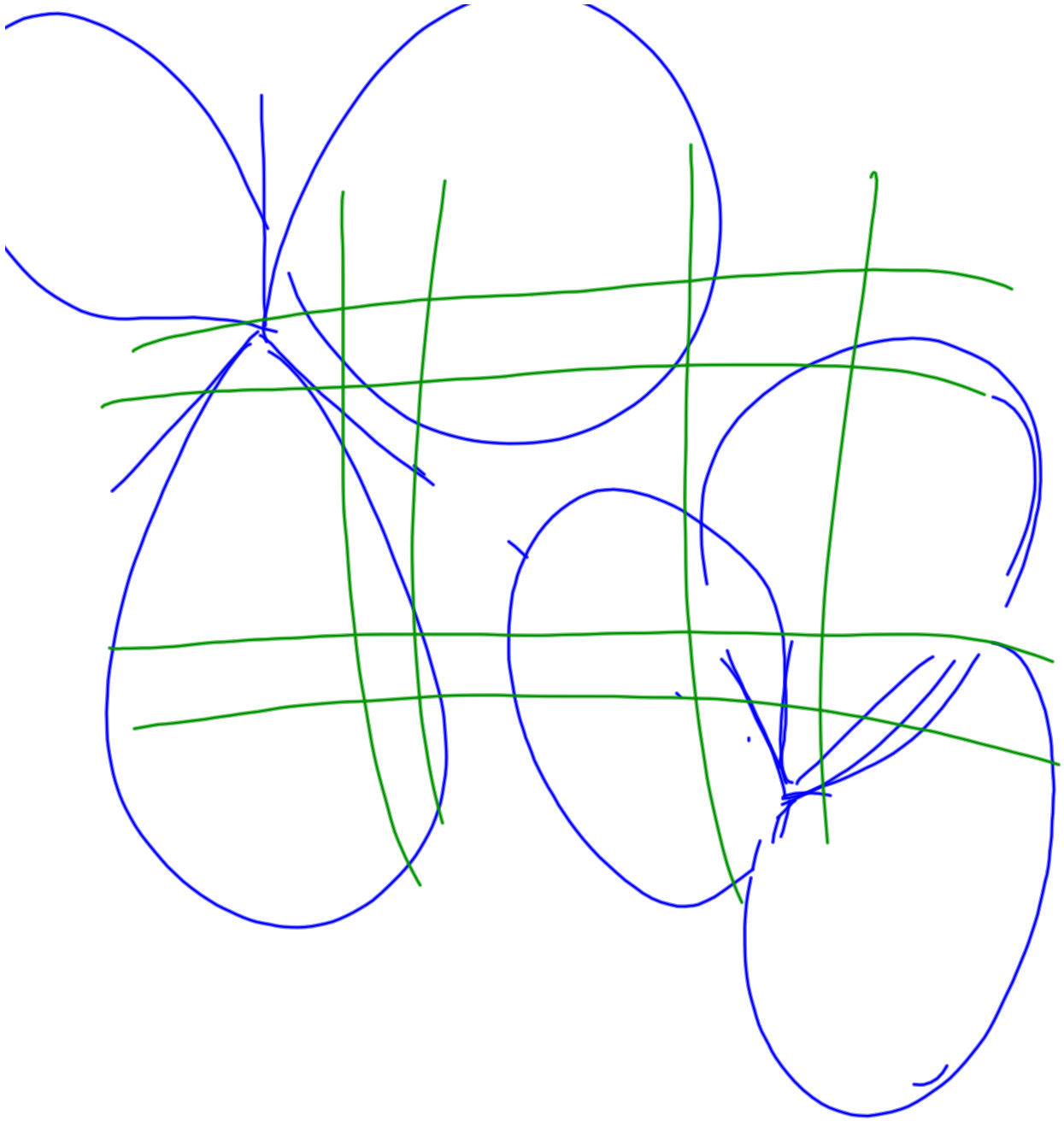
$G_A + G_R + P_{Tx} - L = P_{Rx}$

$\log(25)$

10 $\log(25 \cdot 1000) \overset{10}{=} \log(25) +$

$\log(1000) =$

$= 10(\log(25) + 3)$



Handover

$\log(a \cdot b) = \log + \log b$ ✓

$25 \cdot 1000$

1.4

$14 + 30 = 44$

$$P_{R_x} = P_{T_x} + G_{T_x} + G_{R_x} - L_{PdL}$$

~~25~~ ~~14~~ ~~4~~

→ Convert to dB_m

$30 + 10 \log(25) + 14\,dB + 2\,dB$

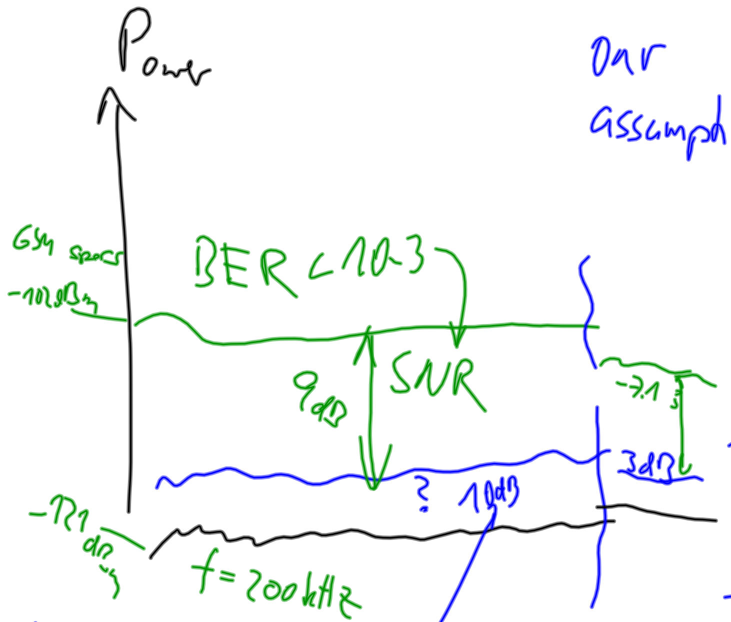
dB_m

25

$44\,dB_m$

$GSM_{specs} = -102\,dBm$

Our assumptions



noise figure receiver

Thermal noise

$1J = 1W \cdot s$

$k = 1.38 \cdot 10^{-23} \frac{kg\, m^2 s}{s^3\, K}$

$T = 293\ K$

$B = 200\ kHz$ (GSM)

$200 \cdot 1000 \frac{1}{s}$

$1.38\ E{-23} \cdot 293\ 2E5$

$121 - 102 - 9 \approx 10\,dB$

hwh = Energi

$k\ T\ B$

$[J = Ws]$

$E = m \cdot g \cdot h = \frac{1}{2} m v^2$

$k\ T\ B$

$kg \frac{m}{s^2} m \quad kg \frac{m^2}{s^2} \quad \frac{Ws}{K} \cdot K \cdot \frac{1}{s} \left[\frac{J}{s}\right] = \left[\frac{kg\, m^2}{s^3}\right] = [W]$

$+30 \frac{dBm}{dB}$

2

$$SNR = \frac{E_b}{N_0} - 10 \log \frac{B_W}{\text{datarate}} \sim 20 \qquad \frac{200\,\text{kHz}}{12.2\,\text{kHz}}$$

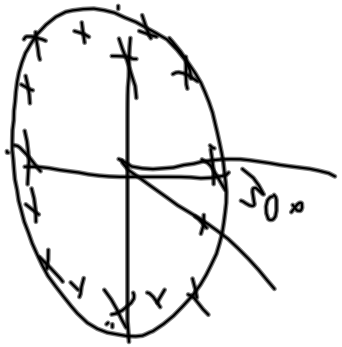
Energie/bit
Noise floor

data 100 kbit/s

Speech

5 dB − 12 ~ −7 dB ??

Signal coding Phase +1 / −1 BPSK



according to Wikipedia BPSK has $\frac{E_B}{N_0} = 10$ for $BER = 10^{-3}$

data 100 kbit/s ≈ 7 dB

BPSK $\frac{E_B}{N_0} = 7\,\text{dB} \leadsto SNR = 4\,\text{dB}$

UMTS sensitivity ~1 hour

Literature: specs
Receiver sens = -117 dBm

Kerran Berge
→ presentation

GSM 900→1800
Appendix
+2 - UMTS sys
- comparison

Literature comparison of typical values
Hata, Okumura, WI ~1h