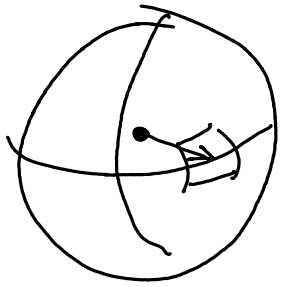
Statistical Models of Average Path Loss

Exercise 1: What is the free-space path loss, in dB, at 10 m for $f = 1500$ MHz? What is the value of $PL(1\text{ km})$?

from Friis equation

(using $G_T = G_R = 1$)

$$P_L = \frac{P_R}{P_T} = \left(\frac{\lambda}{4\pi d}\right)^2$$



$$\lambda = \frac{c}{f} = \frac{3\times10^8}{1.5\times10^9} = 0.2\text{m}$$

$d = 10$ m

$$P_L = \left(\frac{0.2}{4\pi\cdot 10}\right)^2 = 2.5\times10^{-6}$$

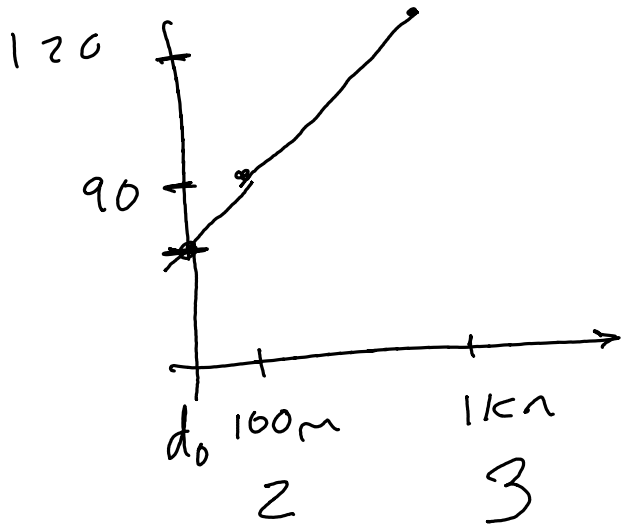
$$P_L\,(\text{dB}) = -56\text{ dB}$$

$10\times\log\left(\frac{0.2}{4\times\pi\times10}\right)^2 =$

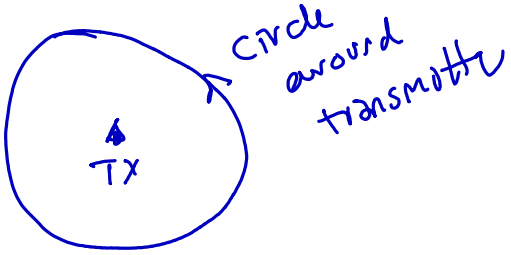
-55.96359737

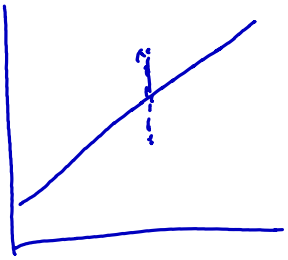
Exercise 2: If the path loss is 90 dB at 100 m and 120 dB at $d = 1$ km, what are n and $PL(d_0 = 1\text{ m})$?

$$PL(d)_{\text{dB}} = PL(d_0) + 10n\log\left(\frac{d}{d_0}\right)$$



Exercise 3: What path would you have to travel if you wanted to measure the average path loss at a given distance from a particular transmitter?





Exercise 4: Compute the median path loss predicted by the Okumura-Hata model at $f = 900$MHz, base station and mobile antenna heights of 30m and 1m respectively, and a distance of 2km.

$$L_b = 69.55 + 26.16 \cdot \log \frac{f}{\text{MHz}} - 13.82 \cdot \log \frac{h_{Base}}{\text{m}} - a(h_{Mobile}) + (44.9 - 6.55 \cdot \log \frac{h_{Base}}{\text{m}}) \cdot \log \frac{d}{\text{km}}$$

where:

$$a(h_{Mobile}) = (1.1 \cdot \log \frac{f}{\text{MHz}} - 0.7) \frac{h_{Mobile}}{\text{m}} - (1.56 \cdot \log \frac{f}{\text{MHz}} - 0.8)$$

The model is restricted to:

f:	150 ... 1000 MHz
h_{Base}:	30 ...200 m
h_{Mobile}:	1 ...10 m
d:	1 ...20 km

1) "log" means "$\log_{10}$"

$\log 900 = 2.95 \approx 3$

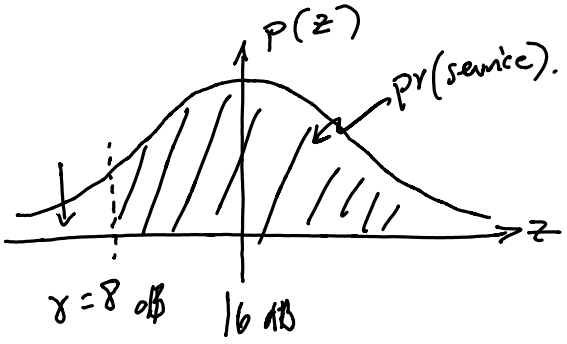
$\log 30 = 1.47 \approx 1.5$

$\log 2 = 0.3$

$a = 2.4 - 3.7 \sim -1$ dB

$L_b \approx 139$ dB ??

Exercise 5: A cellular system is designed so that users on the cell edge have an average SNR of 16 dB. The system requires that users have a minimum SNR of 8dB to place a call. The standard deviation of the log-normal fading is 8dB. What fraction of users at the cell edge will be able to place calls?



z is SNR $\quad \sigma = 8$ dB

find the area.