Free Space Propagation Model

Line of Sight (***far field***)

$$P_R = \frac{P_T G_T G_R \lambda^2}{(4\pi)^2 d^2 L}$$ -> **received power density**

$$\left(\frac{P_t(d)}{P_r}\right)_{dB} = -10\log\left(\frac{G_T G_R \lambda^2}{(4\pi)^2 d^2 L}\right)$$ -> ***path loss***

Where:
P_R : receiver power
G_R : receiver antenna gain
P_T : transmitter power
G_T transmitter antenna gain
$\lambda = c/f_0$: carrier wave length
c: speed of light ($3x10^8$ m/s)
f_0 : carrier frequency
d: distance between receiver and transmitter
L: loss exponent (transmitter or receiver) [4]

Path Loss: the difference between transmitted and received power

Free Space Path Loss in dB:

$$FSPL = 20\log_{10}(d) + \log_{10}(f) - 145.55$$

d: distance in km
f: carrier frequency in Megahertz