For the sensor network example from the lecture 7 notes, what would the range be if the fade margin was zero? In that case, how would the range increase if we used a better RFIC that had a sensitivity of -99 dBm (reduced by 1 dB)?

Solution:

\[-98 \text{ (dBm)} = S/N + P_N \text{ (dBm)} = P_t \text{ (dBm)} + \sum \text{ dB Gains} - \sum \text{ dB Losses} \quad (1)\]

1. $P_t \text{ (dBm)} = 0$ dBm.
2. Gains: Two antennas at 3 dBi (the units are effectively dB), so the total gains are 6 dB.
3. Losses: There is the 40 dB loss to 1 m, then an additional $10(3.0)\log_{10} d \text{ dB}$.

So

\[-98 \text{ (dBm)} = 0 \text{ (dBm)} + 6 \text{ (dB)} - 40 \text{ (dB)} - 30 \log_{10}(d/1\text{m}) \quad (2)\]

Solving for $d$, we have .

$$d = (1\text{m})10^{64/30} = 136\text{m}. \quad (3)$$

For part two of this question, now the -98 is reduced to -99 dBm. Effectively, the LHS of (2) becomes one lower. This increases the 64 on the RHS of (3) to 65, and so $d = (1\text{m})10^{65/30} = 147\text{m}$. 