HM 2

1. Outage Probability

a.

$$SNR = \frac{P_{out}}{N}$$

or

$$SNR_{dB} = P_{outdBm} - N_{dBm}$$

$\Rightarrow$

$$P_{outdBm} = SNR_{dB} + N_{dBm} = -90$$

b.

Path loss

$$L = \frac{P_t}{P_r}$$

and in dB, we get

$$L_{dB} = P_{tdBm} - P_{rdBm}$$

$$P_{rdBm} = P_{tdBm} - L_{dB}$$

$\Rightarrow$

$$K = P_{rdBm} - P_{tdBm} + \eta \cdot 10log\frac{d}{d_0} = -L_{dB} + \eta \cdot 10log\frac{d}{d_0} = -30$$

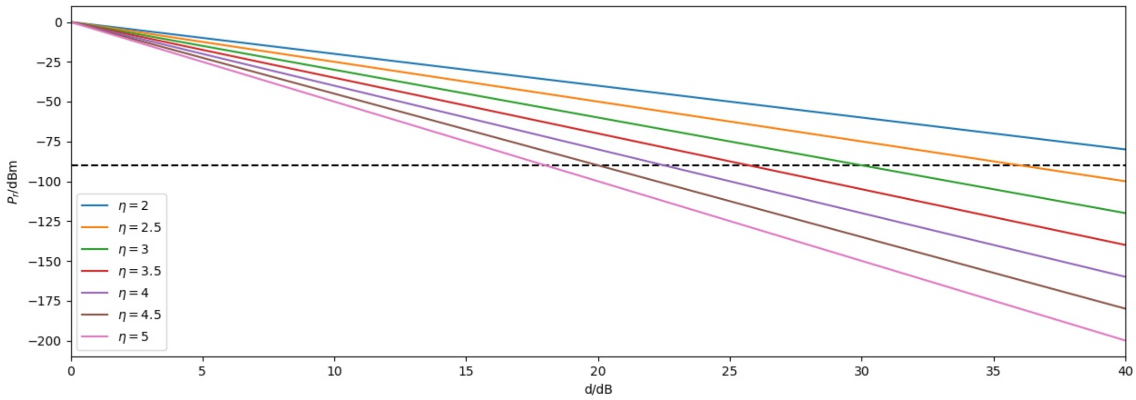
c. result

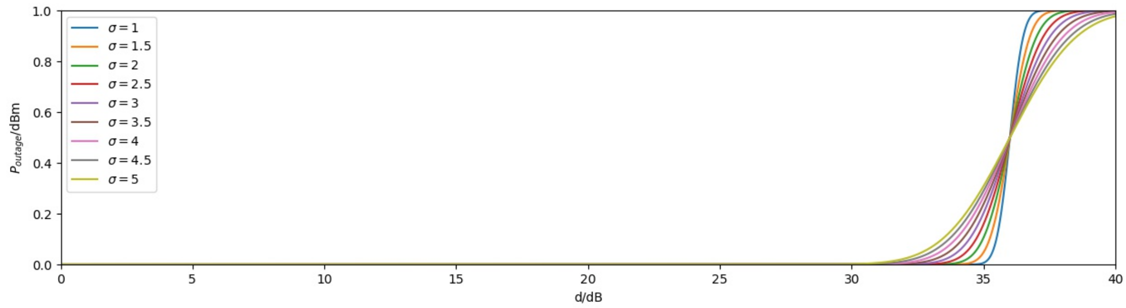
Draw the figure of $P_r - d$ as shown below.
And to calculate P_{outage}, we use the following equations:

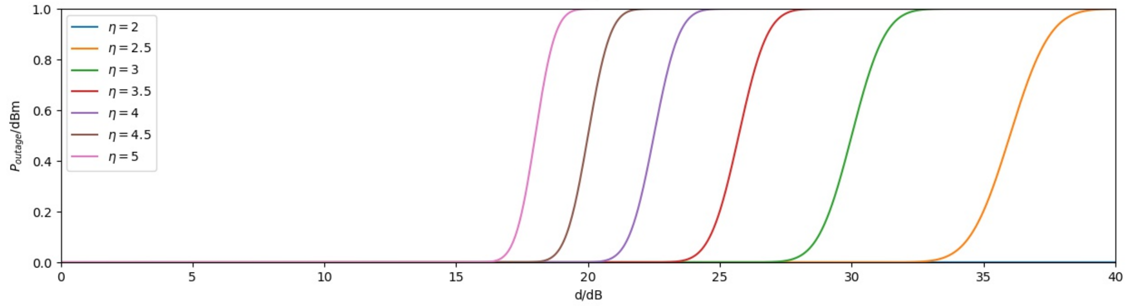
$$P_{outage} = 1 - Q(\frac{P_{out} - P_r}{\sigma})$$

where $Q(\cdot)$ is the Q function for standard normal distribution.

For η, as $P = P_t + K - \eta \cdot d$, increasing in η clearly result increasing for P, which results in longer distance when outage occured, as shown in the figure.

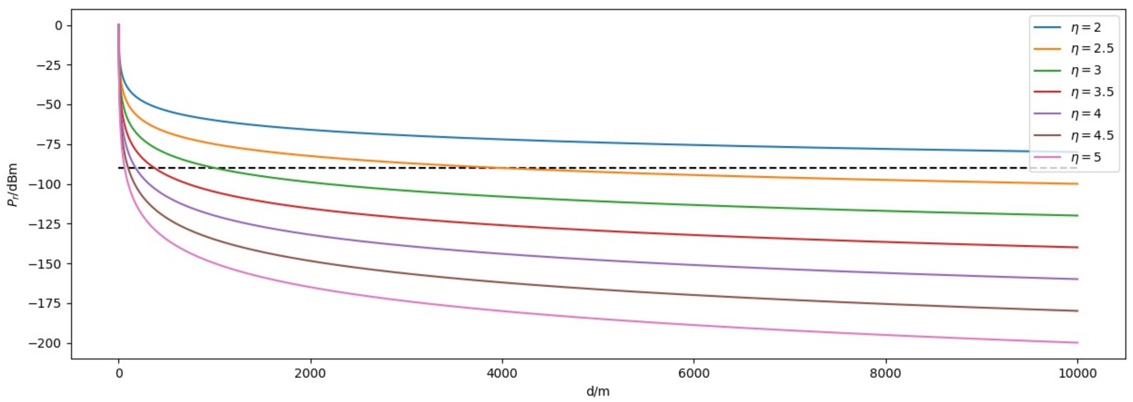


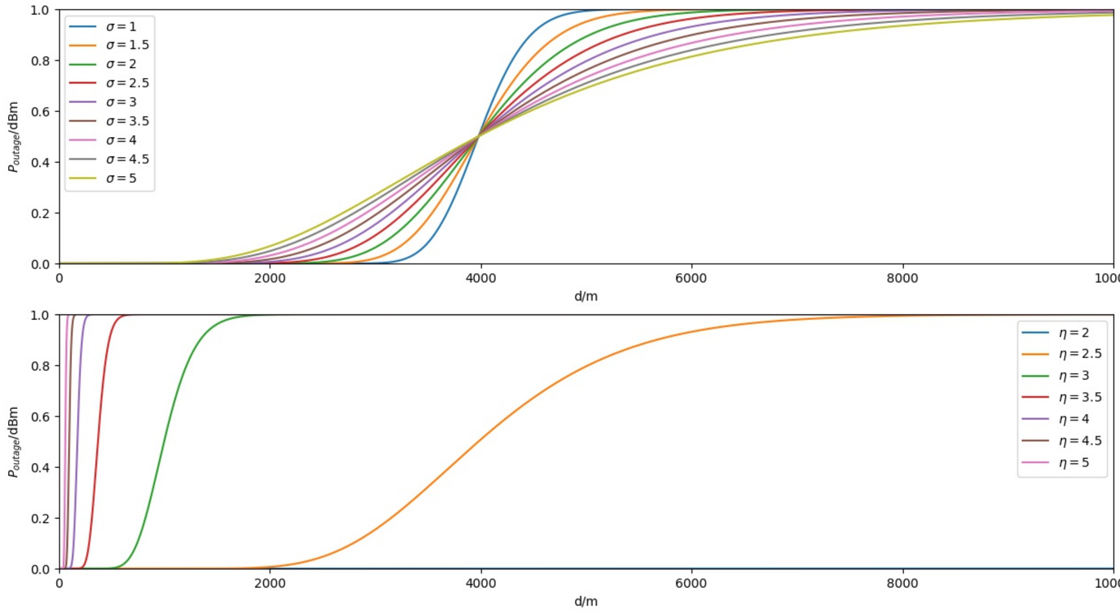




On ther other hand, change in σ will not result in the same thing. It does not influence $P - d$ curve. It appears in $1 - Q(\frac{P_{out} - P}{\sigma})$. As we notice, before $P = -90$, $P_{outage} - P < 0$. At this time, higher the σ is, lower the $Q(\frac{P_{out} - P}{\sigma})$ is, and higher the P_{outage} is. And after $P < -90$, higher in σ results in lower the P_{outage}

The following figures are ploted for d in meters.





2.

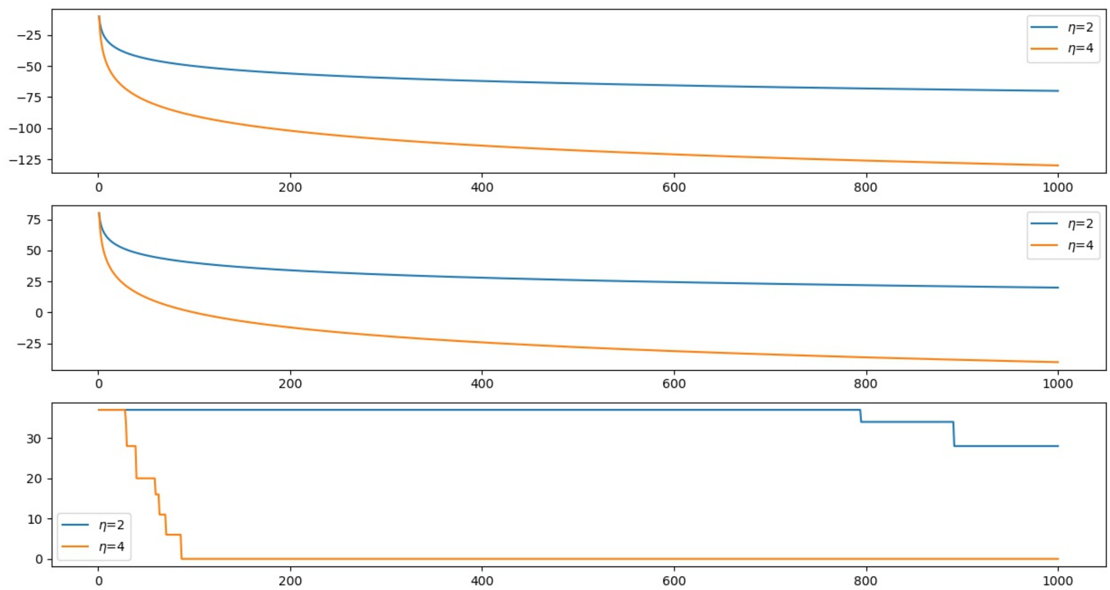
As usual, determine parameters for $P_r - d$.

$$P_r = P_t + K - n10log(\frac{d}{d0}) = P_t + K$$

$$K = P_R|_{d=1} - P_t = -33$$

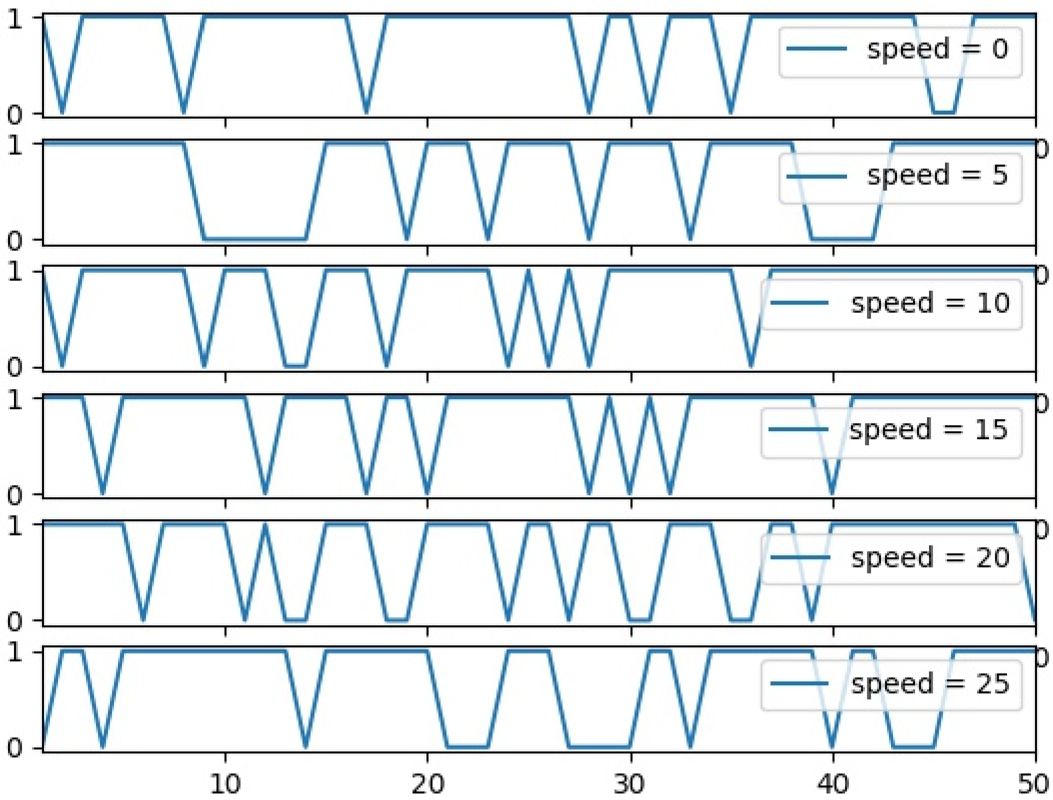
$$SNR_{dB} = P_{rdBm} - N_{dBm}$$

We first calculate P_r for each distence d and get SNR. Then compare with fig 8(a) to get goodput. Distence d in the figure set is in meters. The y-axis for each figure is P_r, SNR, goodput rate, repectively.



3.

First generate power_ray in dB for different mobile speeds [0, 5, 10, 15, 20, 25], and discretize them using 3.25dBm as threshold. The following figure plots state changes from [0, 50] for different speed.



The list below indicates probability distribution for different speeds.

speed	P00	P01	P10	P11
0	0.3027	0.6973	0.1767	0.8233
5	0.3150	0.6850	0.1823	0.8177
10	0.3560	0.6440	0.2148	0.7852
15	0.3529	0.6471	0.1747	0.8253
20	0.3317	0.6683	0.1756	0.8244
25	0.3428	0.6572	0.1947	0.8053