Id:012484781
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GithubLink: https://github.com/spring2020-cmpe206-01/HaoRan-012494781

1.1

since 1 watt=1000milliwatt so 1.25*10^-4 W=0.125 milliwatt =10 $\log_{10}{}^{0.125}$=-9.03dBm
2.5*10^-4W=0.25 milliwatt=10$\log_{10}{}^{0.25}$=-6.02dBm
5*10^-4W=0.5milliwatt=10$\log_{10}{}^{0.5}$=-3.01dBm
1*10^-3W=1milliwatt=10$\log_{10}{}^{1}$=0dBm
2*10^-3W=2milliwatt=10$\log_{10}{}^{2}$=3.01dBm
4*10^-3W=4milliwatt=10$\log_{10}{}^{4}$=6.02dBm
8*10^-3W=8milliwatt=10$\log_{10}{}^{8}$=9.03dBm

Except 1 milliwatt, the power that represented by dBm or watt/milliwatt are Corresponding proportionality.

1.2

-100dBm=10^{-10} milliwatt

1000 W=10^{6} milliwatt, therefore the signal power of microwave has 10^{16} times than the signal power of RF radio.

2.1

According to the Nyquist's theorem the Noiseless Max data rate =2B$\log_2{}^{v}$=2*4000*$\log_2{}^{2}$=8000 bps(assuming sending binary bit)

According to shannon's theorem the noise Max data rate=4000$\log_2{}^{(1+30)}$=4000*4.954196=19516~=20000 bps

2.2

300THZ, Accoring to the formula □□=□· □□ / □², f is bandwidth, C is light speed, □□ is the amount of spectrum, □ is the carrier wavelength. C=3*10^8 m/sec, and 1 meter=1*10^6 microns . os the answer =3*10^14=300THZ.

3.1

	Sf1	Sf2	Sf3	Sf4	Sf5	Sf6	Sf7	Sf8
A data	1							
A code	1	1	1	1	-1	-1	-1	-1
A transmit	1	1	1	1	-1	-1	-1	-1
B data	-1							
B code	1	1	1	1	1	1	1	1
B transmit	-1	-1	-1	-1	-1	-1	-1	-1
D data	-1							
D code	1	-1	-1	1	1	-1	-1	1
D transmit	-1	1	1	-1	-1	1	1	-1
Total trans	-1	1	1	-1	-3	-1	-1	-3

So the chip sequence received by base station is -111-1-3-1-1-3

3.2

	Sf1	Sf2	Sf3	Sf4	Sf5	Sf6	Sf7	Sf8
Total transmitted	0	0	-2	2	4	0	2	2
Station A	0	0	-2	-2	-4	0	-2	-2
Decode	-1							
Station B	0	0	-2	2	4	0	2	2
Decode	1							
Station C	0	0	-2	-2	-4	0	-2	2
Decode	-1							
Station D	0	0	2	2	4	0	-2	2
Decode	1							

So A :-1, B:1, C:-1, D:1

4.

(1)let's assum one bit was flipped, so 0000011 -> 0001

(2)1010111->0010

(3)1110011->1100

(4)1110000->1110

(5)1111100->1110

5.

When $d=2d_0$ $PL(d)=40+10*2.4*\log_{10}{}^{2}=40+10*2.4*0.3010=47.22dB$

when $d=4d_0$ $PL(d)=40+10*2.4*\log_{10}{}^{4}=40+10*2.4*0.6020=54.44dB$

5.2

We can easily get that 40+10*2.4=64, so we will let $\mathrm{Log}_{10}{}^{d/d0}=1$, so we have $d=10d_0$.

6.

According to the Wikipedia Log-distance path loss:
$PL=P_{TxdBm}-P_{RxdBm}=PL_0+10*r*\log_{10}{}^{d/d0}+x$
$P_{TxdBm}=10\log_{10}{}^{Ptx/1mW}$ is the transmitted power in dBm
Ptx is the transmitted power in watt
$P_{RxdBm}=10\log_{10}{}^{Prx/1mW}$ is the received power in dBm
Prx is the received power in watt.
PL_0 is the path loss at the reference distance d_0
R is a constant as exponent.
X is a Gassuian Variable, which assumes 0 for the situation

Accroding to the situation: $PL_0=25dB$,r =2.5,(A to B)d/d0=30,(B to C)d/d0=20, Ptx=1mW=10^-3W,$N_0=8*10^{-21}$ W/Hz , W=10MHz

For A to B

$10\log_{10}^{10^{\wedge}-3}$- P_{RxdB}=20dB+10*2.5$\log_{10}^{30}$ -> -30-P_{RxdB}=20+25*1.477-> P_{RxdB}=-86.925dB,

so the $N_0W=10^{-14}W$=-130dB, so SINR=SNR=(86/130)=0.66, then throughput from A to B=**W $\log_2$ (1+SINR) =7.3*10^6bits/second**

B to C
-86.9dB- P_{RxdB}=20dB+10*2.5$\log_{10}^{20}$-> P_{RxdB}=-138.5dB

Same for B to C, SINR=SNR=(138/130) almost =1, then throughput from B to C=**W $\log_2$ (1+SINR) =10Mbits/second.**

And In order to get the maximum of the throughput, Assume that we have 10 seconds and AB's efficiency is 7.3 and BC's efficiency is 10, then we have function:

7.3* X=10(10-x), x=5.78 seconds for A to B work and 4.22 seconds for B to C work, if we have only 1 second then the Maxmium throughput is 0.578*7.3*10^6+0.422*10^6=8.44*10^6bits/second.

7.1

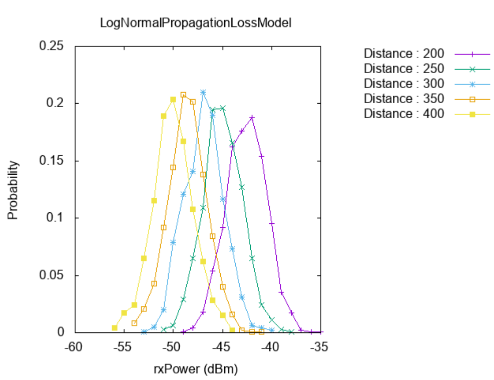


Figure1:Exponent2.5 N(0,4)

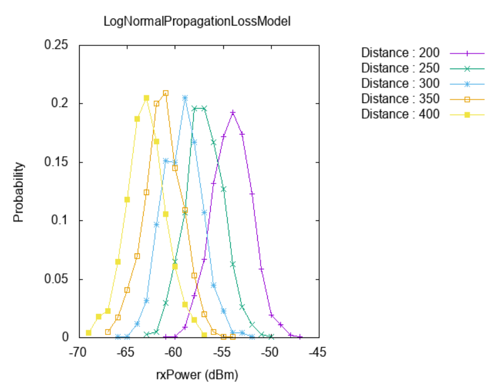
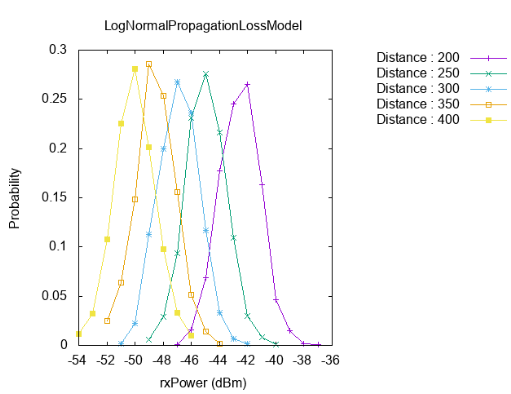


Figure2:Exponent3.0 N(0,4)



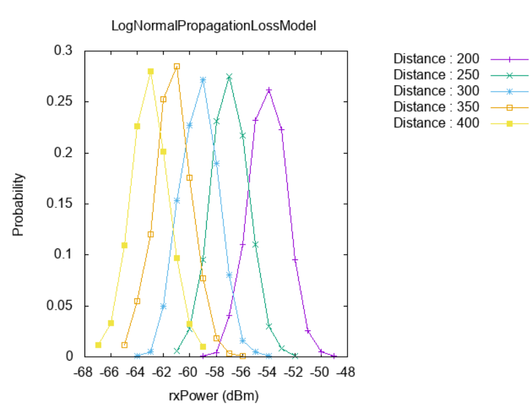


Figure3:Exponent2.5 N(0,2) Figure4:Exponent3 N(0,2)

7.2

Compared with Figure 1 and Figure 2, It seems that when exponent increased the received power also increased.

7.3

According to the reference that $P_{(dBW)} = P_{(dBm)} - 30$, so -95dB=-95+30=-65dbm.
Then for scenario 1 all of them lose the signal.
For scenario 2, it losing signal at disthance 200 and distance 250.
For scenario 3, all of them lose the signal.
For scenario 4,it losing signal at 300 distance, 250 distance and 200 distance

Reference:1. https://www.geeksforgeeks.org/maximum-data-rate-channel-capacity-for-noiseless-and-noisy-channels/
2. https://dsp.stackexchange.com/questions/2775/relating-bandwidth-and-wavelength-of-a-carriera (problem 3, solution and concept)
3.Lecture ppt.
4. https://en.wikipedia.org/wiki/Log-distance_path_loss_model (Problem 6, the formula)
5. https://www.youtube.com/watch?v=4bCqRaxxGCg (problem 5&7 youtube video about pathloss)
6. https://www.rapidtables.com/electric/dBm.html#dB_to_dBm

7. Appendix