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

CMPE 206-01 Computer Network Design Spring 2020

HW#2 Solutions

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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)

SNR=30dB=10$\log_{10}$S/N ->S/N=1000

According to shannon's theorem the noise Max data rate=B$\log_2$(1+S/N) =4000* $\log_2$(1+1000)=39868.90bps

2.2

300THZ, Accoring to the formula f=$c \cdot x / y^2$, f is bandwidth, C is light speed, x is the amount of spectrum, y is the carrier wavelength. C=3*10^8 m/sec, and 1 meter=1*10^6 microns . so f=3*10^14HZ, and for the question situation bandwidth is 0.1*10^{-6}*3*10^{14}=30MHz

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.

According to the formula PL= $PL_0+10*r*\log_{10}^{d/d0}$

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 $\text{Log}_{10}^{d/d0}=1$, so we have $d=10d_0$.

6.

Throughtput Capacity C=W $\log_2(1+SINR)$ bits/sec

SINR=SNR(according to the question)=P/ N_0 W.

P is the Received signal power, N_0 is noise power, W is bandwidth.

$PL(d)=PL(d_0)+\alpha*10\log^{d/d0}$

Accroding to the situation: $PL_{0=}$25dB, α =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

$PL(A-B)=25+25*\log^{30}=57.5dB$

$PL(B-C)=25+25*\log^{20}=61.9dB$

Besides also $PL=10\log_{10}^{ps/pr}$

So for (A-B)= $10\log_{10}^{10^{\wedge}-3/pr}=10\log_{10}^{10^{\wedge}-3}-10\log_{10}^{pr}=57.5dB=-30dB-10\log_{10}^{pr}=57.5dB$,
->$pr(A-B)=10^{-8.75}$dB

Same for B to C ->$Pr(B-C)=10^{-9.19}$ dB

$C(ab)=1*10^7*\log_2(1+22228)=14.4*10^7$

$C(bc)= 1*10^7*\log_2(1+8070)=13*10^7$

In order to get the maximum throughtput, we should let the A-B and B-C get the same amount of data, so assume time x for AB and(1-x) for BC,then 14.4x=13(1-x) ->x=0.47.

So total throughput =0.47*14.4*10^7=6.83*10^7 bits/sec.

7.1

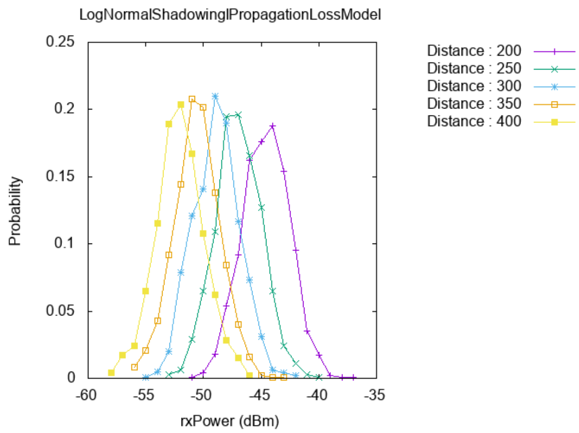

Figure1:Exponent2.5 N(0,4)

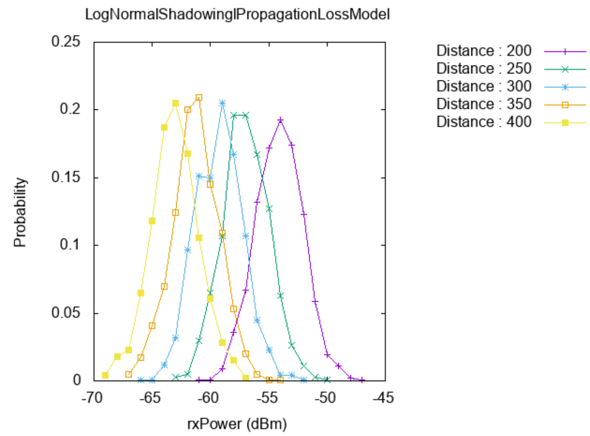

Figure2:Exponent3.0 N(0,4)

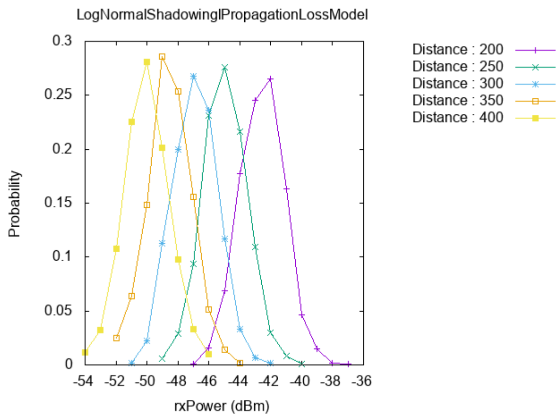

Figure3:Exponent2.5 N(0,2)

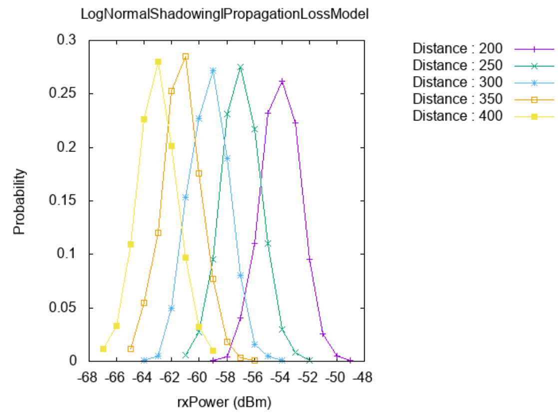

Figure4:Exponent3 N(0,2)

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 $P_{(\text{dBW})} = P_{(\text{dBm})} - 30$, 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

8.Disgussed problem 4 and 6 with my teammate friend XiaoMan Zhang.(Originally I was trying to use Logdistance Normal shadowing path loss Model, however, I found XiaoMan's theory is better and seems to be correct, the main different part is $PL=10\log_{10}{}^{ps/pr}$ which she used to count Pr, and my original part use PL=PS-PR, but I didn't count the random variable, then I changed to this way)