

CELL COVERAGE IN WIMAX

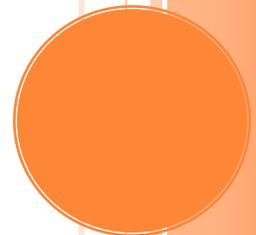
Assignment 2

To calculate the dependency between SNR and distance, plotting the throughput and coverage area, and calculating maximum demand of users in various modulation schemes.

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Cell Coverage in Wimax

Assignment 2

I declare that all material in this assignment is my own work except where there is clear acknowledgement and appropriate reference to the work of others.

TASK1: To show the dependency between SNR and distance

Procedure:

The pathloss calculation is created as a function pathloss.m

The link budget calculation to calculate Receiver SNR is in a function LB.m. This function calls pathloss.m

The dependency is worked out in the main program Task1.m This function uses both SNR.m and pathloss.m. All the values to calculate the pathloss and SNR are passed from Task1 as parameters to the functions.

```

W = 20 * 1e+6;
F = 12;
N = -174;
PT = 40;
heightTrans = 20;
heightRecv = 3;
terrain = 'C';
Freq = 2.5 * 1e+9;

```

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pathloss: based on distance
PL = 20 * log10(4 * pi * dist/l);
or
PL = A+(10*v*log10(dist/d0))+PLf+PLh;

SNR = PT - PL - 10log10W - F - N

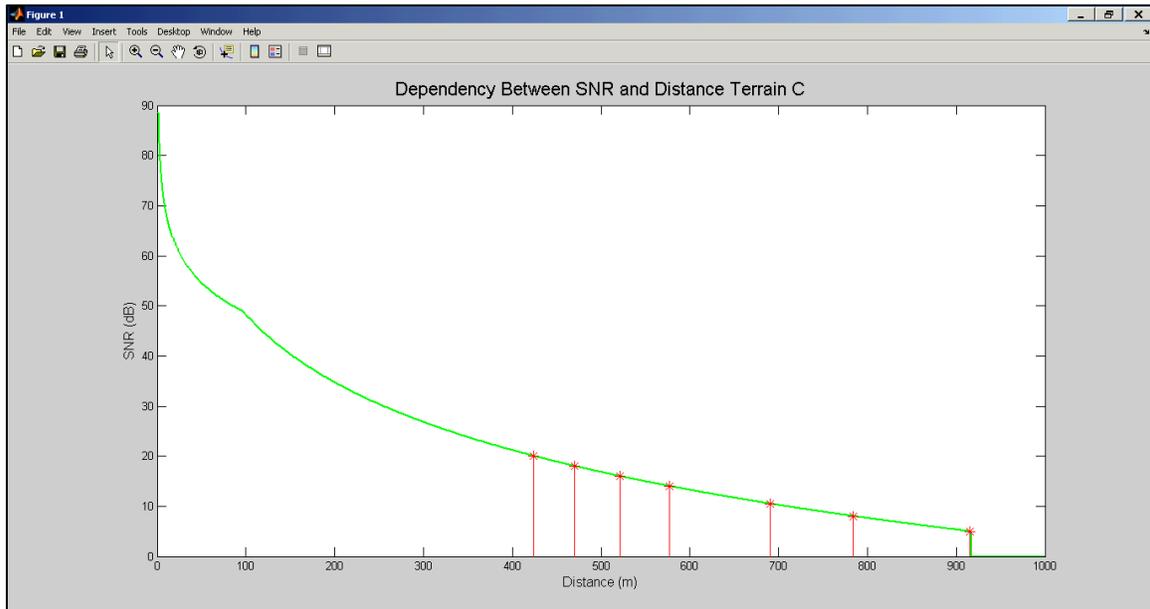
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In the main program, the graph between distance and pathloss is plotted. Then using this program, I calculated the distance where the receiver SNR is 5, 8, 10.5, 14, 16, 18, and 20 dB corresponding to WiMAX modulation schemes. I marked those points on the distance versus SNR plot. The distance is calculated for Terrain C, Terrain B and Terrain A. The distance for Terrain C is more than terrain A.

RESULTS:

The plot between distance and SNR is as follows:

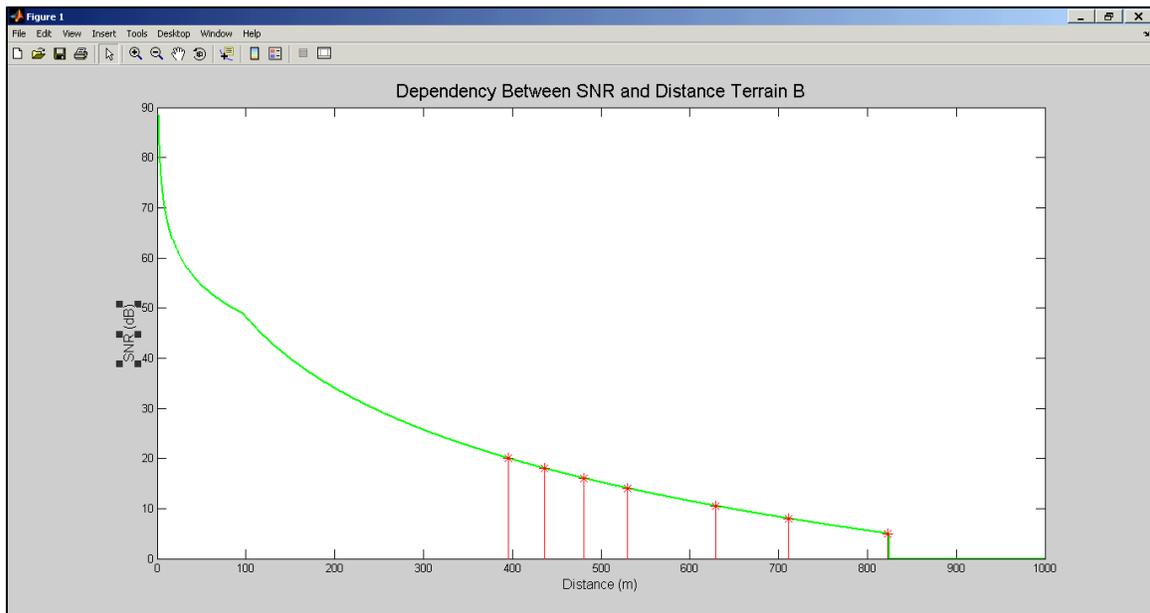
Graph for Terrain C



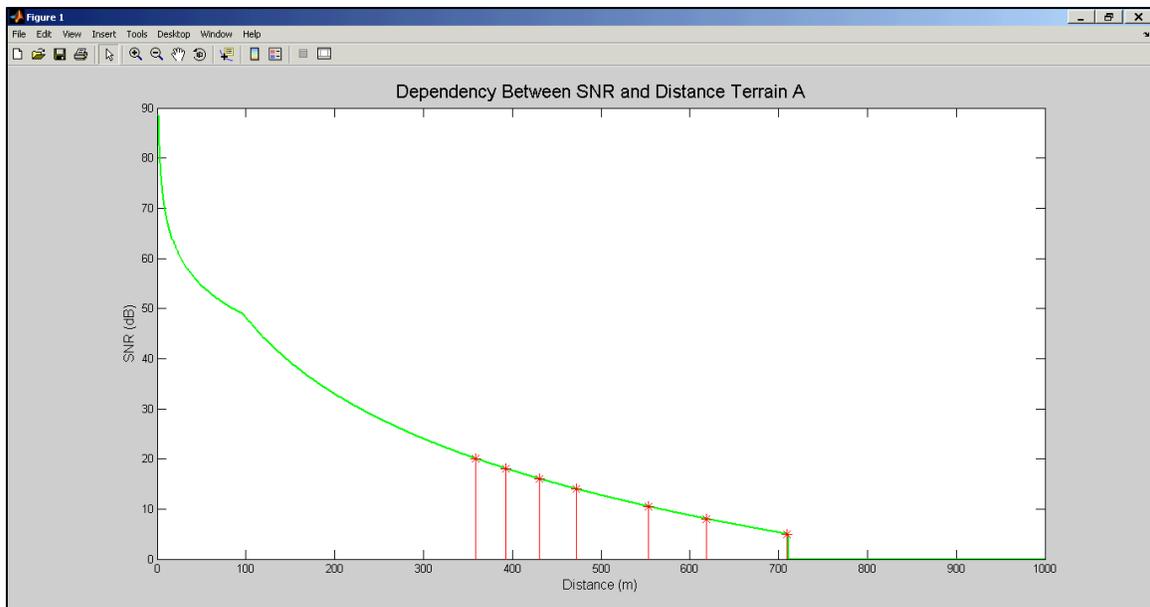
The distance for the following SNR values where the modulation scheme changes:

Modulation scheme	QPSK $\frac{1}{2}$	QPSK $\frac{3}{4}$	16-QAM $\frac{1}{2}$	16-QAM $\frac{3}{4}$	64-QAM $\frac{1}{2}$	64-QAM $\frac{2}{3}$	64-QAM $\frac{3}{4}$
SNR in dB	5	8	10.5	14	16	18	20
Distance in Metres Terrain C	915	784	690	577	521	470	424
Distance in Metres Terrain B	823	711	629	530	481	436	396
Distance in Metres Terrain A	709	619	553	472	431	393	359

Graph for Terrain B:



Graph for Terrain A



TASK2: To plot the throughput versus coverage area in 3D for each modulation scheme

Procedure:

The pathloss calculation function, pathloss.m and the link budget calculation function, LB.m, to calculate Receiver SNR created in Task1 are used in this task as well. In addition, a function R.m to calculate throughput is created. The main function Task2.m calls all the three functions to calculate the pathloss, SNR, and throughput and plots the graph of the throughput.

To plot the graph as a circle, a circle.m function was created. The main function calls circle function with distance as the radius and datarate as the Z – axis elevation.

To calculate the datarate - throughput, sampling frequency, length of NFFT, bandwidth, coding rate, bits per modulation and sampling factors are used.

BW = 20 MHz

n = 57/50 based on the bandwidth used

NFFT = 256

G = 1/4

Nused= 192

These values are provided in R.m function

Recv_SNR =[5,8,10.5,14,16,18,20];

CR=[1/2,3/4,1/2,3/4,1/2,2/3,3/4];

BM = [2,2,4,4,6,6,6];

W = 20 * 1e+6;

F = 12;

N = -174;

PT = 40;

heightTrans = 20;

heightRecv = 3;

terrain = 'C';

Freq = 2.5* 1e+9;

All other values, such as Frequency, Bandwidth, Receiver height etc., are provided in the Task2.m function and are the same as Task 1 values.

FS= (floor(n*BW/8000))*8000;

f = FS/NFFT;

TB= 1/f;

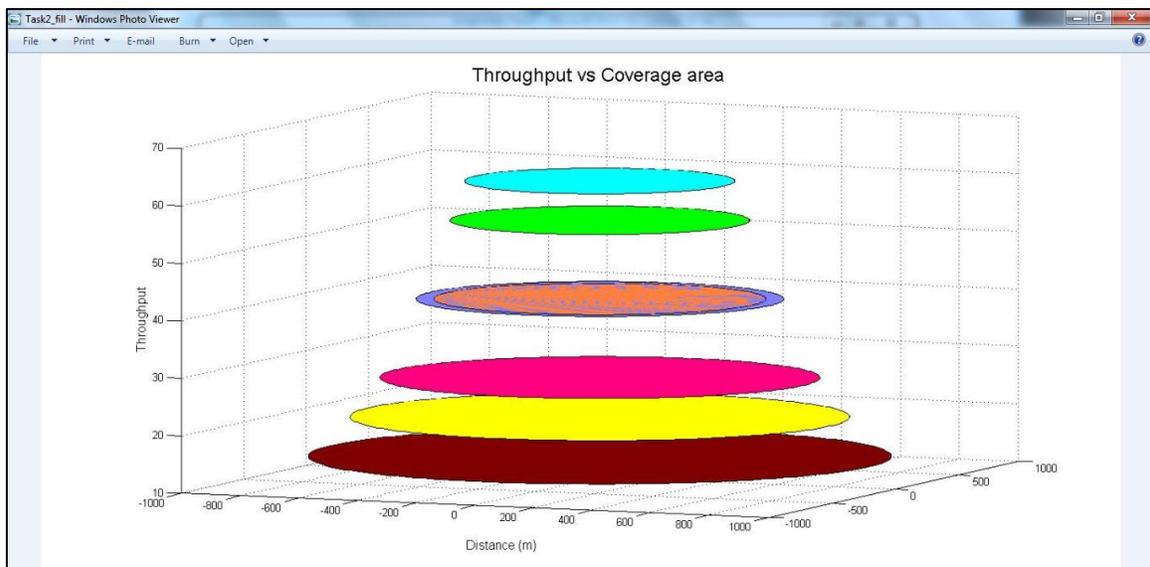
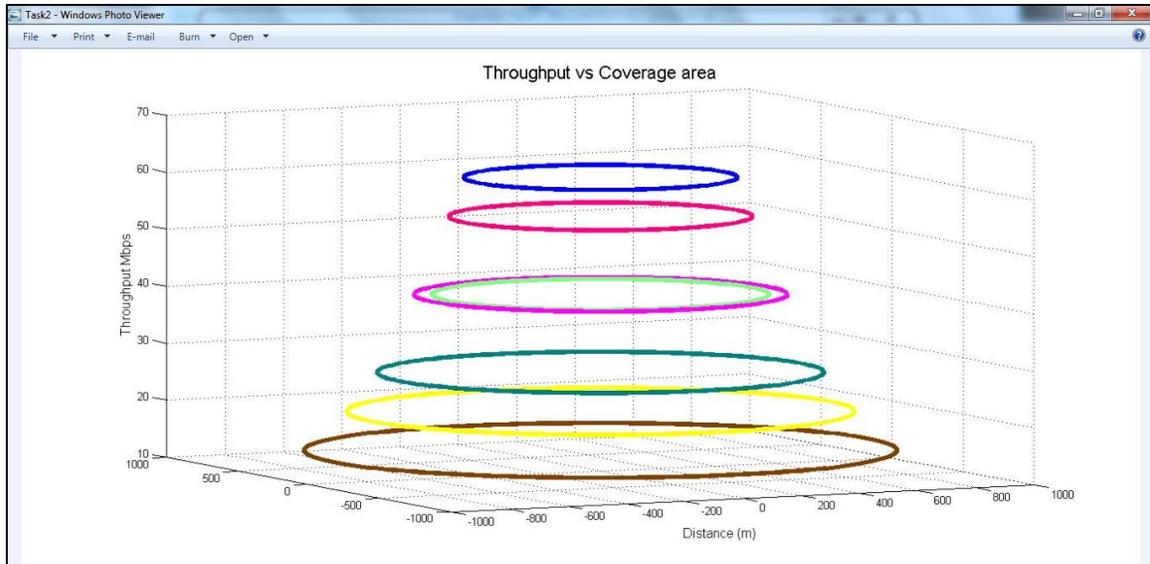
TS = (G+1)*TB;

TP = (Nused*bm*cr)/TS;

The throughput is plotted versus distance for each modulation scheme and I plotted two graphs with fill and without fill.

RESULTS:

The plot between throughput and coverage area is as follows:



The throughput in Mbps for each modulation scheme:

Modulation scheme	QPSK $\frac{1}{2}$	QPSK $\frac{3}{4}$	16-QAM $\frac{1}{2}$	16-QAM $\frac{3}{4}$	64-QAM $\frac{1}{2}$	64-QAM $\frac{2}{3}$	64-QAM $\frac{3}{4}$
SNR in dB	5	8	10.5	14	16	18	20
Throughput in Mbps	13.68	20.51	27.35	41.03	41.03	54.70	61.53

TASK3: To identify the modulation scheme and to calculate cell support for a specified throughput for two users.

Procedure:

The pathloss calculation function, pathloss.m and the link budget calculation function, LB.m, to calculate Receiver SNR created in Task1 and function R.m to calculate throughput are used in this task as well. In addition, a function chkmod.m was created to compare the modulation scheme.

In the main function Task3.m, the SNR is calculated based on the distance of the users from the antenna. Then, this SNR is compared with the Receiver SNR for each modulation scheme to find the modulation scheme of each user. As the antenna height is 50m as opposed to the antenna height of 20m in Task 1, this Task is run on Terrain A. For any distance less than 509m in Terrain B or 569m in Terrain C, the SNR is over 20dB for the antenna height of 50m and BW of 10MHz and W of 20MHz at 2.5Ghz frequency.

Then the throughput for each of those modulation schemes is calculated to check if the demand of each user can be met.

BW = 20 MHz

n = 57/50 based on the bandwidth used

NFFT = 256

G = 1/4

Nused= 192

These values are provided in R.m function

W = 20 * 1e+6;

F = 12;

N = -174;

PT = 40;

heightTrans = 50;

heightRecv1 = 2;

heightRecv2 = 3;

terrain = 'A';

Freq = 2.5* 1e+9;

maxdist1 = 470;

maxdist2 = 450;

CR=[1/2,3/4,1/2,3/4,1/2,2/3,3/4];

BM = [2,2,4,4,6,6,6];

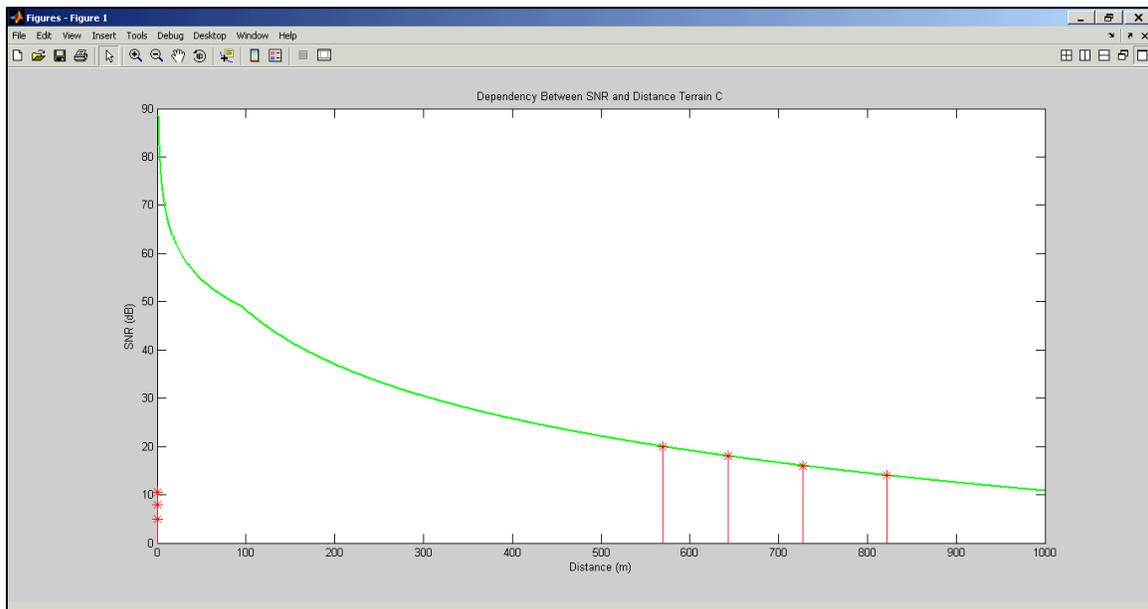
Modulation = ['A', 'A', 'B', 'B', 'C',

```
SNR(1) =
LB(maxdist1,W,F,N,PT,heightTrans,heightRecv1,terrain,Freq);
if (SNR(1)- Recv_SNR(j) < 0)
% calculate datarate using CR array for that SNR.
SNR1= SNR(1)
ModulationScheme= chkmod(Modulation(j))
CodingRate = CR(j)
Maxdatarate = (R(BM(j),CR(j)))/1e+6
break;
end
```

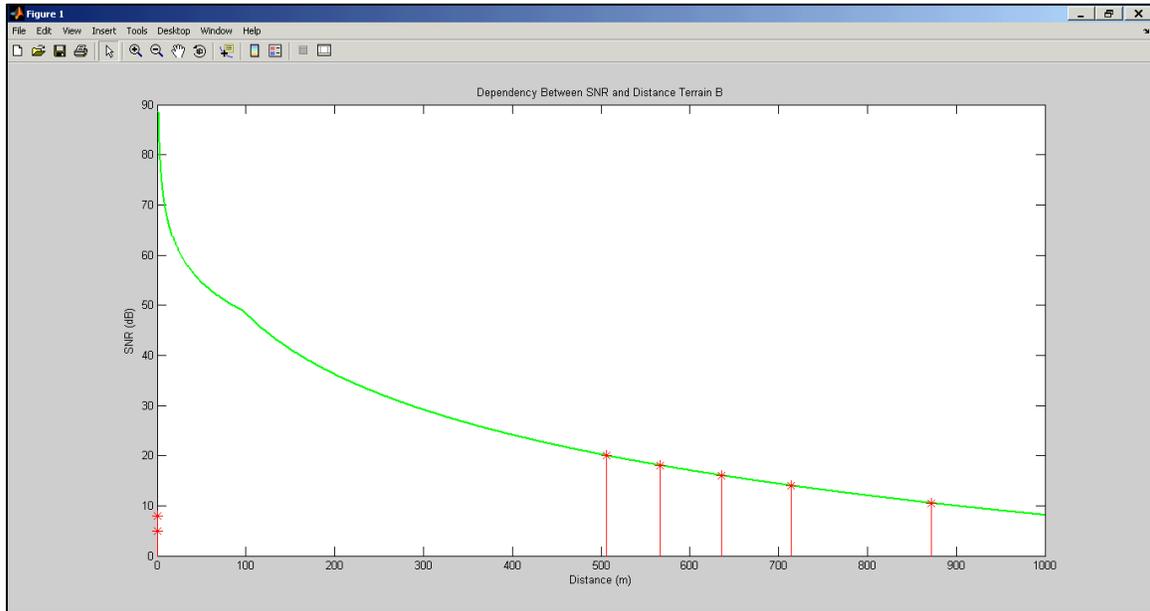
```
'C', 'C'];
datarate = zeros(1,7);
Recv_SNR =[5,8,10.5,14,16,18,20];
dist = zeros(1,7);
SNR = zeros(1,maxdist);
% for part b
demand1= 20;
demand2 = 25;
All other values, such as Frequency, Bandwidth, Receiver height etc., are provided in the
Task3.m function.
```

RESULTS:

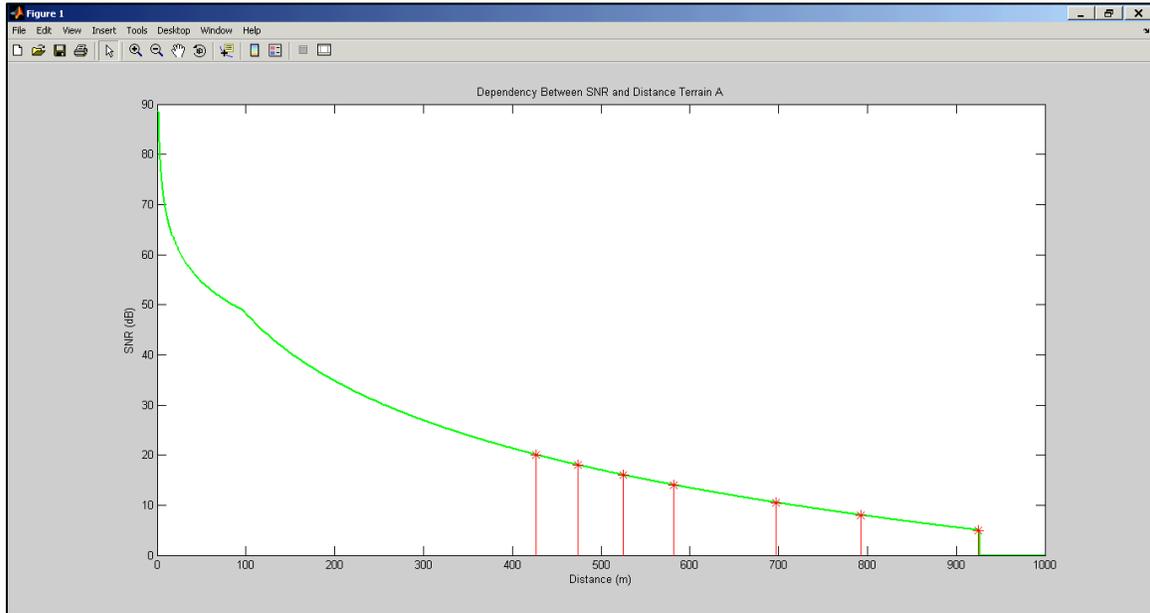
Modulation scheme change in Terrain C at 50m Antenna Height:



Modulation scheme change in Terrain B at 50m Antenna Height:



Modulation scheme change in Terrain A at 50m Antenna Height:



Modulation scheme	QPSK $\frac{1}{2}$	QPSK $\frac{3}{4}$	16-QAM $\frac{1}{2}$	16-QAM $\frac{3}{4}$	64-QAM $\frac{1}{2}$	64-QAM $\frac{2}{3}$	64-QAM $\frac{3}{4}$
SNR in dB	5	8	10.5	14	16	18	20
Distance in Metres Terrain C	0	0	0	822	727	643	569

Distance in Metres Terrain B	0	0	872	714	636	567	506
Distance in Metres Terrain A	925	793	697	582	525	474	427

Modulation scheme	QPSK $\frac{1}{2}$	QPSK $\frac{3}{4}$	16-QAM $\frac{1}{2}$	16-QAM $\frac{3}{4}$	64-QAM $\frac{1}{2}$	64-QAM $\frac{2}{3}$	64-QAM $\frac{3}{4}$
SNR in dB	5	8	10.5	14	16	18	20
Throughput in Mbps	13.68	20.51	27.35	41.03	41.03	54.70	61.53

Output of Task3:

ANS = MODULATION SCHEME OF USER 1:
SNR1 = 17.2033
MODULATIONSCHEME = 64-QAM
CODINGRATE = 0.6667
MAXDATARATE = 54.7008

ANS = MODULATION SCHEME OF USER 2:
SNR2 = 19.0231
MODULATIONSCHEME = 64-QAM
CODINGRATE = 0.7500
MAXDATARATE = 61.5384

Analysis:

User 1 is at a distance of 470m and User2 at a distance of 420m from the antenna. The antenna height is 50m. From the table on distance versus Receiver SNR, we can see that the Task 3 could only be worked out on Terrain A. Terrain B and Terrain C can only support a distance of 506m and 569meters. Else the SNR is over 20dB.

For the given specification on terrain A, the SNR of User 1 is 17.2dB and User 2 is 19.02dB. Though they both come under 64-QAM modulation they have different coding rate. User 1 is in $\frac{2}{3}$ rate and User 2 in $\frac{3}{4}$ rate.

The max throughput for 64 QAM – $\frac{2}{3}$ coding rate is 54.7Mbps and for 64-QAM – $\frac{3}{4}$ coding rate is 61.5Mbps. So the demand of 20Mbps by User1 and 25Mbps by User2 can be met by the cell. The max demand for 64QAM $\frac{3}{4}$ coding rate is 61.5Mbps. A user can demand up to 61.5Mbps. But if both User1 and User2 are in the same modulation scheme then User2 can demand a maximum of: $(61.5 - 20) = 41.5$ Mbps

To Run:

- At the command prompt of Matlab, enter Task1 or Task2 or Task3.

- All other functions are called from these. All required values are already entered at the Task level functions or at R.m
- Task3 output is printed on the screen. Task1 and 2 are plots.
- Structure:
 - Task1>> pathloss.m, LB.m, Task1.m
 - Task2 >> pathloss.m, LB.m, R.m, Task2.m
 - Task3 >> pathloss.m, LB.m, R.m, chmod.m, Task3.m

Attachments:

- *All .m functions for Task1, Task2 and Task3.*
- *All plots and results.*