COURSE	:EEE 4541
ASSIGNMENT	:01
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Radio network planning is essential in the deployment of wireless communication technology like LTE. Guidelines for effective LTE radio network planning are crucial as standardization development nears the conclusion. The process can be complicated by the fact that many different types of businesses and vendors lead the planning of the first stage, and they may not share their progress or discoveries with you. Consequently, this complicates efforts to design radio networks.

There are multiple steps involved in radio network planning:

1. **Initial Phase**: This phase consists of obtaining information for pre-planning and initiating the network dimensioning process, which includes generating a connection budget and determining coverage and capacity through simulations.
2. **Nominal and detailed planning:** In the nominal and detailed planning phase, a radio planning tool is selected and implemented. The propagation model is tuned, and link budget-based thresholds are established. On the basis of these thresholds, a full radio plan is developed and its capacity is evaluated using more detailed traffic projections. During this phase, configuration planning, site surveys, site pre-validation, and site validation are also performed.
3. **Defining KPI and parameter planning**: Using eNodeB system parameters and counters, performance KPIs are constructed and their target values are established based on vendor assurances. Planning and dimensioning tools are used to double-check the KPIs and goal values, and optimization is done both before and after launch.

Assignment:

Question no. 1:

Multiple providers in Bangladesh presently offer 5G service, including Grameenphone, Banglalink, Robi, and Teletalk. Each of these operators has access to a unique 5G service frequency, which can impact the accessibility and coverage of their 5G networks.

Grameenphone (GP) launched 5G network on trial basis in Dhaka and Chattogram on Tuesday (July 26). Besides, the company aims to trial 5G in the rest of the other divisional cities very soon. Grameenphone, for instance, has implemented 5G service in the 3.5 GHz band, which provides an optimal balance of coverage and capacity. Banglalink has also introduced 5G service in the 3.5 GHz band, in addition to the 26 GHz and 28 GHz millimeter wave (mmWave) bands, which can give very fast speeds but may have limited coverage due to the signal's high frequency. Tele talk's 5G service on the 3.5GHz spectrum has been operational.

I would prefer to remain with Grameenphone because it is one of the leading operators in Bangladesh, is deployed in the 3.5GHz band, and offers good speeds. 5G service in the 3.5 GHz band can offer high speeds and minimal latency, making it appropriate for a variety of applications, such as high-definition video streaming, virtual reality, and online gaming.It is essential to remember that the frequency bands utilized for 5G service can differ based on the operator and area.

Question no. 2:

For the deployment of telephone network, we chose Chittagong.

About Chittagong:

Population: 5.2 million

Area: 160.99 km^2

Terrain via Google Satellite view:

Chittagong city is a city of hills and a city by the seaside, considering its density of population and trees, it might be susceptible to higher interference and path loss.

Coverage:

According to the COST-Hata-Model, we get,

$$\mathbf{L=46.3+33.9\log f-13.82*\log h_B-f(h_R)+[44.9-6.55\log h_B]*\log d+ C}$$

$$\mathbf{f(h_R) =(1.1\log f- 0.7)h_R -(1.56\log f - 0.8)}$$

Where, C= 0 dB for medium cities and suburban areas, 3 dB for metropolitan areas

L = Median path loss. Unit: Decibel (dB)

f = Frequency of Transmission. Unit: Megahertz (MHz)

h_B = Base Station Antenna effective height. Unit: Meter (m)

d = Link distance. Unit: Kilometer (km)

h_R = Mobile Station Antenna effective height. Unit: Meter (m)

$a(h_R)$ = Mobile station Antenna height correction factor as described in the Hata Model for Urban Areas.

In case of Grameenphone, f=3.5GHz=3500MHz

h_B = 35m

hR =1.5m

a(hR)=0.049

$f(h_R)$ =[1.1log(3500)- 0.7]*1.5 -(1.56log(3500) - 0.8)=0.068

d=3.254 km

L=46.3+33.9log3500-13.82*log35-.068+[44.9-6.55 log35]*log3.254+3dB=165.862dB

Area of the Hexagonal shape for one eNodeB site =$3\sqrt{3}d^2/2$= 27.51 sq km

No of eNodeBs for coverage=160.99/27.51≈6

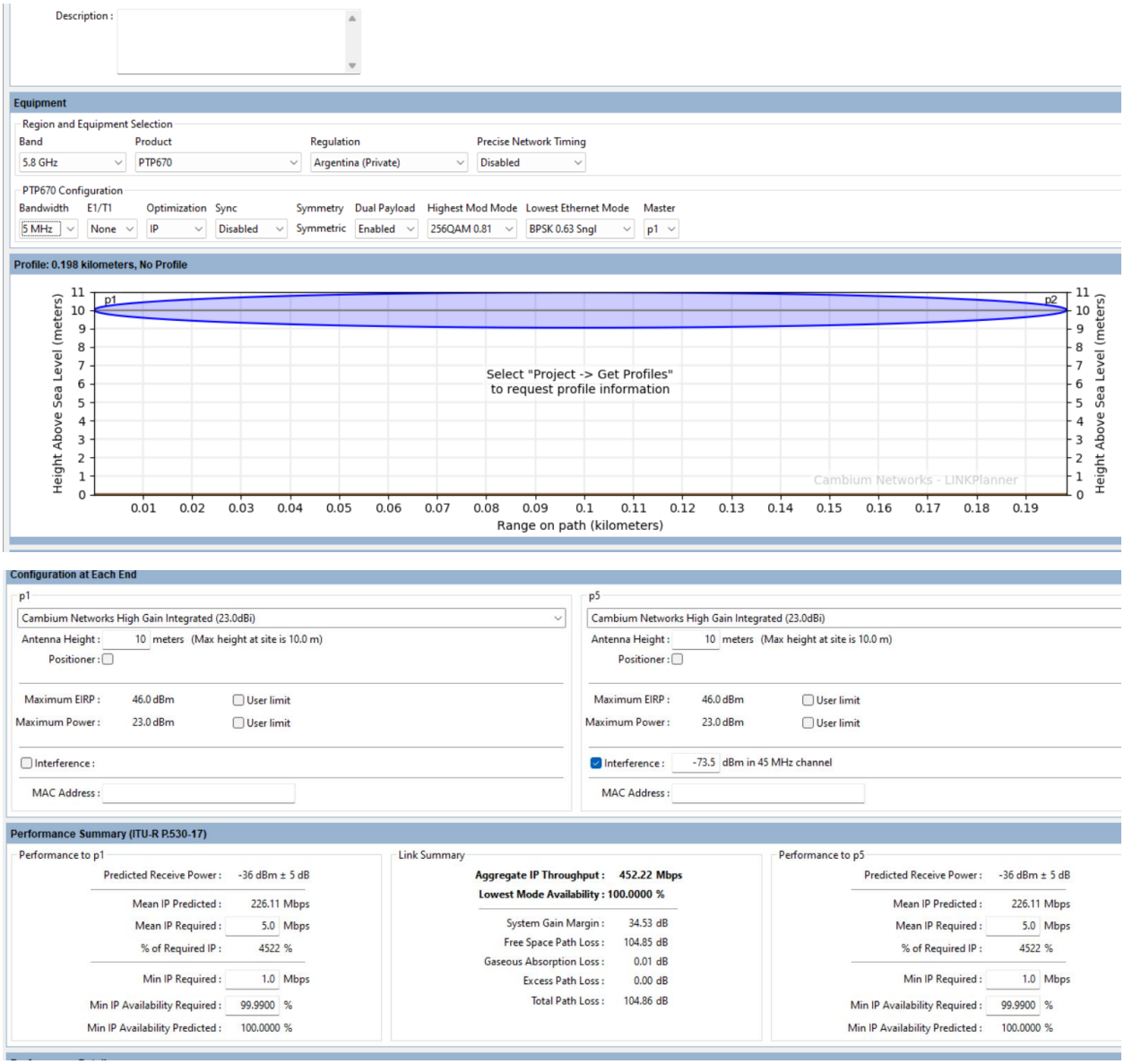
Capacity:

Carrying out the calculation via simulation in Link planner:

PTP Links in chittagong

Name	Range (km)	Product	Aggregate Throughput (Mbps)	Link Availability	Left Height (m)	Left Gain (dBi)	Right Height (m)	Right Gain (dBi)	Link Loss (dB)
p1 to p2	0.198	PTP670	48.287	100.0000	10	23.0	10	23.0	93.7
p6 to p5	0.410	PTP670	452.226	100.0000	10	23.0	10	23.0	100.0
p3 to p2	0.451	PTP670	48.287	100.0000	10	23.0	10	23.0	100.8
p3 to p4	0.552	PTP670	452.226	100.0000	10	23.0	10	23.0	102.5
p1 to p5	0.721	PTP670	452.225	100.0000	10	23.0	10	23.0	104.9
p5 to p4	1.199	PTP670	452.226	100.0000	10	23.0	10	23.0	109.3
p4 to p6	1.597	PTP670	452.226	100.0000	10	23.0	10	23.0	111.8

Average distance R=0.731143 km



Here we get an aggregate throughput of 452.22 Mbps within a 5MHz Bandwidth.

Throughput Analysis:

UE in the close region (within a 100 m radius of eNodeB) average throughput is:1.1 Mbps

UE positioned in an intermediate region (within a 175 m radius of eNodeB) target average throughput is: 0.9 Mbps

UE in far region (within 250 m radius of eNodeB) target average throughput is :0.7 Mbps

Target Capacity Calculation:

The total population of Chittagong is 5,200,000. Taking 20% of the total population =1,04,000.

Assuming overbooking factor =50

Users to be supported simultaneously=104000/50 = 2080

no.3: Assume Tk. 20,00,000 installation cost for an additional eNodeB.

Question no.4:

the number of eNodeBs:6

Locations:

p1
Location:
22.34224N 091.82903E

Name:
p2
Location:
22.34267N 091.82716E

p3
Location:
22.34196N 091.82285E

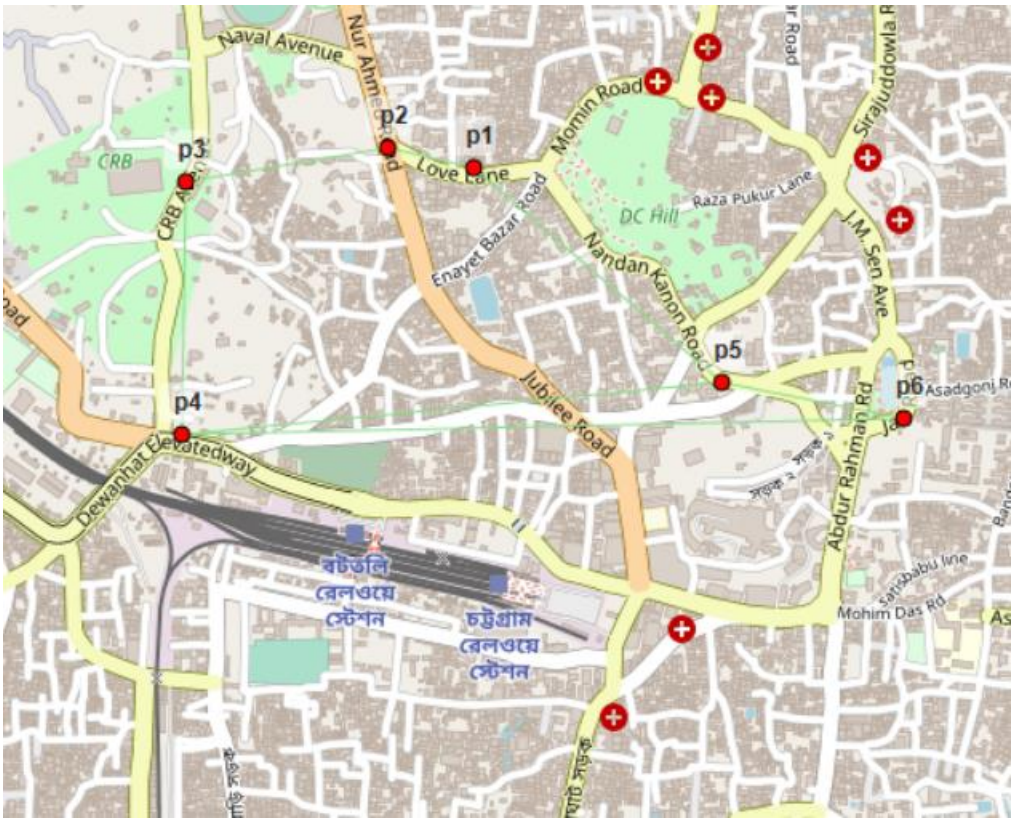
p4
Location:
22.33698N 091.82274E

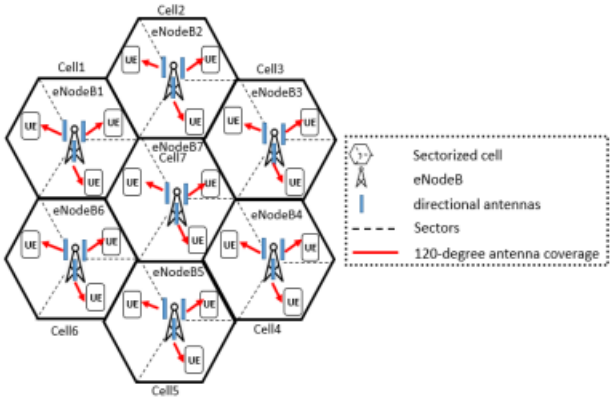
p5
Location:
22.33799N 091.83433E

p6

Location:

22.33729N 091.83824E





The sectorized cells have been intended to increase the capacity of the cellular system. The term sectorization refers to the division of cells into distinct sectors. Each sector is covered by a single sector antenna. The significance of cell sectorization is mostly attributable to the enhancement of transmission capabilities and capacity gain; hence, mobile communication industries employ

it extensively to raise the data rate. Compared to omnidirectional antennas, tri sector cells have three times the capacity of omnidirectional antennas, while the antenna with the highest capacity is composed of six sector cells. They employ adaptive array, active antennas and are optimized to cover the greatest distance and provide the most coverage. So, in *total number of cells=6*6=36*

Question no.6:

From link planner, Bandwidth=5MHz

6 sectors in a cell have bandwidth of 5MHz, so each cell has=5MHz/6=0.8333MHz

Assume, N=6

Frequency Reuse factor =1/N=1/6

3500 MHz/200 kHz = 17500 channels available

In a cluster 6×6 = 36 sectors.
Each sector has 486 or 487 channels.
Assuming 487 channels ,487×8 = 3896 time slots are available.
2 slots are used for control signaling.
3894 voice users can be supported simultaneously.
If both parties, of the voice call, remain in the same cell, 1947 calls can be set
up

Question no.7:

Considering the antenna height to be 30m and target height from ground for UE=1.5m

Antenna beam=60 degrees

Vertical beam=4 degrees.

Result:

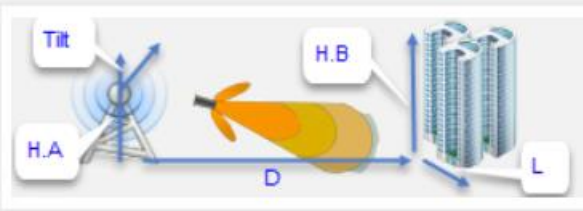
Azimuth=61.80 degrees

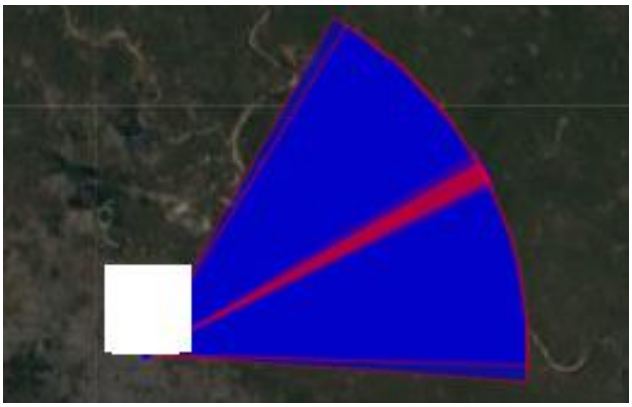
Antenna tilt=10.92

Distance site target=148m

Horizontal coverage=171m

Vertical coverage=7m





Link Budget:

Uplink Budget		
Tx-UE		
A. Max. Tx Power (dBm)	30	
B. Tx antenna gain (dBi)	0	
C. Body loss (dB)	1	
D. EIRP (dBm)=A+B-C	29	
E. Body Loss(dB)	4	
F.Vehicle Loss(dB)	5	
G. Fade Margin (dB)	6	
X. Effective tx power (dBm)	15	
eNodeB		
H. eNodeB noise figure	4	
I. Thermal noise (dBm)	-122.1	T=290 K; B=25kHz
J. Receiver Noise floor	-118.1	H+I
K. SINR (dB)	10	assumption
L. Receiver sensitivity (dBm)	-100.1	J+K
M. Intereference margin (dB)	2	
N. Cable Length	220ft	
O. Cable loss per 100ft (dB/100-ft)	0.6	
P. Cable loss (dB)	2	
Q. Body and Vehicle Loss	3 dB	
R. Receiver Antenna Gain	9 dBd	
S. Receiver Diversity Gain	5 dB	
Maximum path loss	-78.1	X-L-M-P+R+S-Q

Downlink Budget		
Data rate (kbps)	2 Mbps	
Tx		
A. Max. Tx Power (dBm)	41	
B. Tx antenna gain (dBi)	10	
C. Body loss (dB)	1	
D. EIRP (dBm)=A+B-C	50	
E.Vehicle Loss(dB)	3	
F. Fade Margin (dB)	4	
X. Effective tx power (dBm)	45	
Rx-UE		
G. UE noise figure	3	
H. Thermal noise (dBm)	-110.5	
I. Receiver Noise floor	7	E+F
J. Cable loss per 100ft (dB/100-ft)	0.6	
K. Cable loss (dB) for 220ft	1.6	
L. SINR (dB)	15	assumption
M. Receiver sensitivity (dBm)	22	I+L
N. Intereference margin (dB)	3	
O. RX Antenna gain (dBi)	0	
Maximum path loss	-11.6	X-M+O-K-N

Question no.8:

Co-channel reuse ration, $D/R=(3N)^{1/2}= (3*6)^{1/2}4.2426$

CINR=1/6*4.2426=.707

=18.87dB

We know, S/I = $(20)^{-n}$

From here, we find interference is 452.22 MBps.

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p5 to p4	1.199	PTP670	452.226	100.0000	10	23.0	10	23.0	109.3
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Average throughput: 336.81 Mbps

Question no.9:

There are various potential health risks associated with exposure to radiation:

1. *Acute radiation syndrome (ARS):* This is a severe sickness that can arise when an individual is exposed to a high dose of radiation in a short period of time. Symptoms may include nausea, vomiting, diarrhea, skin burns, and a reduction in the number of white blood cells.
2. *Cancer:* Exposure to high levels of ionizing radiation can raise the risk of acquiring cancer, including leukemia and breast, lung, stomach, and thyroid cancers.
3. Ionizing radiation can cause DNA damage, which can result in the transmission of *genetic mutations* to future generations.
4. *Effects on reproduction*: Radiation exposure can decrease a person's fertility and raise the likelihood of birth abnormalities in their progeny.
5. High quantities of radiation can cause cataracts by *damaging the lens of the eye.*

6. *Damage to the skin:* Prolonged exposure to radiation can cause skin burns and color changes.

no.10: 10. Assume Tk. 1,00,00,000 installation cost for the core network and backhaul of all eNodeBs.

Question no.11:

Depreciation in a year=20 million Tk

PP&E for the current period =.15 million Tk

PP&E for the prior period = 10 million Tk

Capital expenditures = PP&E (current period) - PP&E (prior period) + depreciation (current period)

Capital expenditures = ((15 - 10) + 20) million=25 million Tk

Capital expenditures = 20million + 5 million

Capital expenditures = $25 million

There total expenditure of the company is 25 million

Operating expense= Sales Commission + Advertising Expense + Salaries + Depreciation + Rent + Utilities

Sales Commission=1.2 million

Advertising expense=2 million

Salaries=1 million

Depreciation=.75 million

Rent=.5 million

Utilities=.3 million

Operating expense=5.75 million

Question no.12:

Present call rates for GP:

Voice Call (GP-Any local number)	Current tariff	New tariff
Nishchinto	26 poisha/10 second	26.5 poisha/10 second
djuice	26.5 poisha/10 second	27 poisha/10 second
Bondhu	27.5 poisha/10 second	28 poisha/10 second
GP public phone	0.49 poisha/min (12PM-4PM); 0.99 poisha/min (4PM-12PM)	20 poisha/10 second
Super FnF	7.5 poisha/10 second	9 poisha/10 second
FnF	12 poisha/10 second	12.5 poisha/10 second

Let us assume, Average cost/person for 1 year=2300Tk,

Profit=5%

If 5G subscription is provided in Chittagong, there will be an increase in GP users, so revenue will increase. If 70000 users increase in a year, then revenue is= 70000*2300=161 million Tk

Profit in a year=8 million Tk

Break-Even Point (units) = Fixed Costs ÷ (Sales price per unit – Variable costs per unit) =161/(1.51-0.22)million=125 million Tk.

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