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Review Article

PERFORMANCE IMPROVEMENT OF THE BASE STATION ANTENNA BY USING MIMO IN MOBILE COMMUNICATION SYSTEM

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Abstract
This paper presents a design of base station antenna with high performance dual-polarized network sites and 4X4 MIMO Sector Antenna subscriber sites with sturdy constructions for micro-base-station applications. In this research the proposed one is design dual-polarized network sites are 5.25-5.85 GHZ, 2-FT (0.6M) height for point to point (PTP) link and point to multi point (PMP) link ePMP 4x4 MU-MIMO Sector Antenna for subscriber module at ePMP 3000, 5.8 GHz (5825 to 5875 MHz) Access Point RF frequency band for SU-MIMO 4X4 MIMO mode of transmission. Those frequencies used is the fifth generation (5G) mobile network planning and it improves the performance of the network in terms of coverage and capacity by using 4X4 MIMO antennas for indoor propagation model. Measured that the results shows the antenna has a 45MHz RF channel bandwidth with Antenna Gain is 28.58 dBi, port Free Space Path Loss is more than 117.53 dB and Performance 99.9995 % for 10.0 Mbps. This can be utilized for broadband base station in the cutting edge wireless correspondence framework. The Link Planner has been used to simulate network coverage and throughput performance of 4X4 MIMO antenna configurations of the deployed networks. The average simulated throughput per sector of 4X4 MIMO configuration was seen to be better than the 2X2 MIMO configuration.

Keywords: 4X4 MIMO, High Performance Dual-Polarized, Micro base Station, Fifth Generation, PTP, ePMP.

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INTRODUCTION

Cellular and mobile communication is developing rapidly and made an exceptional improvement, it is not only in voice communication, but also in a great improvement in data transmission. In the year of eighties (1980's) radio technologies of analog cellular system was launched. The growth is gradually increased in each generation. Now the fifth generation (5G), currently in development and planning, will be launched on the market in the year 2020. It may be expected that as large portions similarly as 50 billion gadgets will a chance to be joined with one another(International Telecommunications union radio communication standardization Sector (ITU-R) authoritatively named 5G IMT-2020 [3], ITU –R realized some important specifications for fifth generation mobile network. Specification are given in below table1.This consist existed network parameters also.ITU is a primary international body for telecommunications equipment and systems.

In the Mobile, communication to transmit the data for long distance without loss cellular concept was introduced. Hear area divided into small cell area, from cell to micro cell, and from micro to Pico cell area to increase the performance through it. Each cell area consist its own base station antenna and its separate frequency assignment. So the planned RF network for base station antenna has to remember some parameters like frequency band, channel allocation BCCH, TCCH, type of antenna etc.

In this research article, the first discussion was started with base station antennas. The radio transceiver Base station (BS) is answerable for moving data with the terminals through the mobile switching center (MSC). The receiving antenna, which goes about as one of the most significant part of the base station, is chiefly liable for the trading of the electrical signals of the correspondence hardware and the electromagnetic wave (EM) of the space radiation [4]. In fifth generation, [3] portable information movement will build dependent upon thousand times throughout the next decade, concerning illustration predicted on [2]. For a hazardous build for versatile administration and client demands, a developing amount from connected gadgets will place critical stress on the existing wireless communication system.

This will be possible in one way by increasing the antenna array. In 4G base station antennas are designs with help of 2x2 MIMO antennas. 5G this MIMO array antenna size is increase up to four transmitter antennas and four receiving antennas. That array antenna called 4x4 MIMO antennas.

Table 1: specifications of 5G

specifications of 5G	
Parameters	**Range**
Data capacity	20 Gbps
Frequency	3 to 300 GHz
Multiplexing	CDMA,BDMA
Peak Data Rate	10 Gbps
uploading speed	10Gbps
Downloading speed	20Gbps
Data Bandwidth	1Gbps and higher as per need
Spectral Efficiency	120 b/s/Hz
TTI (Transmission Time Interval)	Varying (100 µs (min.) to 4ms (max.))
Latency	<1 ms (radio)
Mobility	500 Kmph
Connection Density	1000000/Km2
Frequency Band	3 to 300 GHz
Technologies	Unified IP, seamless integration of broadband LAN/WAN/PAN/WLAN and advanced technologies based on OFDM modulation used in 5G
service	Dynamic information access, werable devices, HD streaming, any demand of users
Multiple Access	CDMA,BDMA
Core network	Flatter IP network, 5G network interfacing(5G-NI)
Handoff	Horizontal and vertical

Fourth generation frequency band range is 2 to 8 GHz, Peak Data Rate of 1 Gbps and data bandwidth of 2Mbps to 1Gbps. Fifth generation frequency band range is 3 to 300 GHz, Peak Data Rate 10 Gbps and data bandwidth 1Gbps and higher as per need. Spectrum efficiency 120 b/s/Hz, 100*network energy efficiency and more 1 ms over-the-air inactivity. [3] This expansion ability furthermore move forward vitality efficiency, cost, and additionally as spectrum utilization [3].

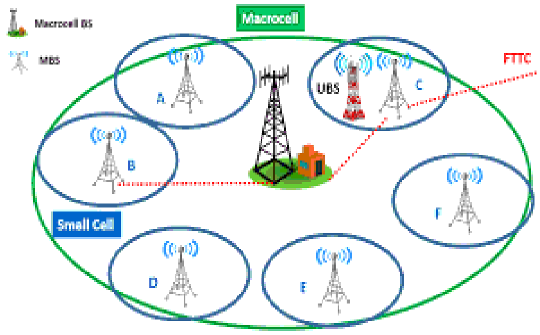


Fig. 1: Fifty-generation system Architecture

The area covered by macro base station could not meet the requirements of subscribers [5], and in addition, there are dead spots due to resistance, fading and shielding of EM waves or intense traffic resulting from unequal coverage, so the depth of coverage has become a key factor in the performance of mobile networks. Micro base stations are widely used in densely populated areas (cities). The stacked patch antenna is very suitable for micro base station applications due to its merits such as low profile, lightweight, easy manufacturing and installing.

Fifth generation modern base station antennas design with broadband and Dual polarizations are preferred over antenna applications because they can reduce the installation cost, improve system capacity and signal quality to a large extent. Modern base station the design of the antenna has many requirements, such as broadband, high isolation from port to port, radiation pattern of the table, high gain and so on.

It could a chance to be seen that the present cell division system works principally in the frequency bands between 2 to 8 GHz [3], and the aggregate amount about authorized range utilized today will be over 1 GHz. Such as The greater part frequency bands underneath 3GHz would occupy and the efficiency of the air interface spectrum has approached its capacity limit [5], attention in the acquisition of new spectrum for 5G networks has shifted to frequency bands above 3 to 300 GHz Among the promising 5G technologies, the proposed has much higher data rate and much higher system capacity can be achieved using mm Wave communication, MIMO antennas that can take advantage of a large amount of available bandwidth, are widely considered in the 5G mobile networks. In existed network (4G) planned by using 2X2 MIMO antenna. Here, signals are propagated by using spatial multiplexing method.

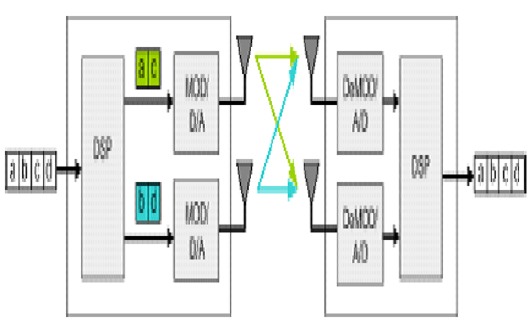


Fig. 2: Spatial multiplexing for a 2X2 MIMO system

Advantages of 4X4 MIMO over 2X2 MIMO antenna

2X2 MIMO devices with dual radios and antennas can communicate through two transmission and reception flows. A 4X4 MIMO device with four antennas and radios is capable of transmitting and receiving through four flows. The base station transmits 4 different signals (or sequences) through 4 transmit antennas to a user equipment (UE).

PROBLEM STATEMENT

Earlier generation base station antennas design using 2X2 MIMO antennas. It has been found that the dual polarized array is performs improved for 2x2MIMO communication strategy than planar array of vertically polarized essentials. Vertically polarized flat array gives less performance compared to 4x4 MIMO. Fifth generation mobile network base station design by using 4x4 MIMO antennas for subscriber site and dual polarized antennas network sites. It improves the performance in terms of coverage capacity and quality. Increasing MIMO array size means through data transmission speed and quality also increases. Dual polarized flat array antenna use for adaptive beam shaping, and a couple of 4 double polarized base position antennas to agree on the efficiency of these design for MIMO base stations.

RESEARCH OBJECTIVES

The essential approach of this thesis is to plan the 5G structure of the RF network in the prediction planning tools and observe its performance in terms of capacity, coverage and quality of service. It provides reliable, secure, cost-effective connectivity system.

PRAPOSED ANTENNA SYSTEM

In this research the designed one, the base station antennas to achieve high performance. Base station antennas with different structures are proposed in recent literatures. Here, the author plan to design BS antenna with 4x4 MIMO dual polarized antennas. These antennas improve the transmission (base station) and receiver (mobile terminals) performance. Base station consists of two types of antennas, one is network sites and second one is subscriber site antenna. Network sites provide the channel point-to-point (PTP) and subscriber site use to transfer data from point to multipoint (PMP).Sector Antenna subscriber sites Sector Antenna with sturdy constructions for micro-base-station applications which frequency band is 45MHz .Here the using one is adaptive beam forming and TDD technique.

LITERATURE REVIEW

MIMO is an antenna technology for wireless communications during which multiple antennas are utilized in each the transmitter and receiver. The antennas at every finish of the communications circuit mix to attenuate errors and optimize data speed. In a MIMO framework presents spatial degrees of opportunity that can expand limit and abatement bit blunder rates and advance information speed .It has been demonstrated that the limit of a MIMO framework developed directly with the base number of receiving antennas on the transmission and gathering sides. In this article, the writer depicted a few highlights of a successful MIMO base station receiving antenna. The performance assess the four mainstream existing base station radio antenna plans, a double enraptured 2ft array for PTP and a couple of two double captivated for PMP interface base station receiving antennas to decide whether they will function work as MIMO base station antennas[8].

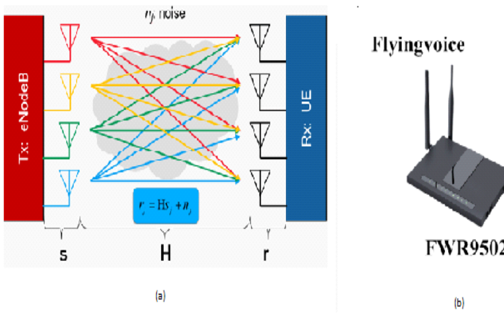


Fig 3: (a) spatial multiplexing for a 4X4 MIMO system, (b) 4X4 MIMO antennas

High Performance dual Polarized Antenna

High performance Dual polarized antenna: A single polarized antenna is one that reacts just to a polarization direction, either even or vertical. However, a double polarized antenna can react to on a level plane and vertically radio waves at the same time. Depending on the polarization mode, the antenna of the base station can be isolated into single and twofold polarization types [4]. For the customary single enraptured polarized antenna, if it is necessary to increase the number of antennas we should extend its establishment stage for the thought of the isolation prerequisite of the port, which will put a weight on the interest in framework.

For the dual polarized antenna, the polarity bearing symmetry of ± 45 ° will guarantee the detachment between the antenna units. Under this condition, there is no compelling reason to fabricate extra stages.

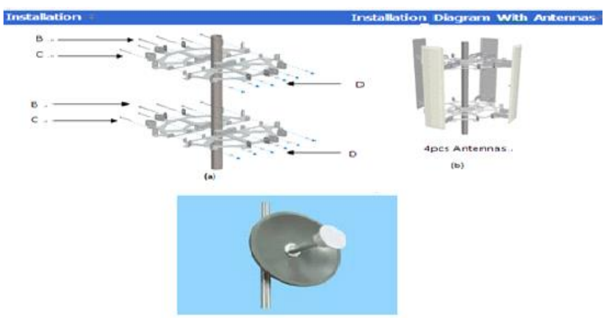


Fig. 4: (a) Base station installation, (b) 4pcs antennas and (c) Dual polarized 5G MIMO antenna

The dual polarized array is new efficient as a MIMO base station antenna. [8] So, the designed base station of MIMO antenna with help of dual polarized antenna. Because Subscribers are currently demanding higher information rates to help applications such as internet access, video and games. Current cellular advances such as global switching for mobile communications "GSM based on general package radio service GPRS, enhanced data GSM EDGE and code division multiple access CDMA based on CDMA2000 1x and CDMA2000 1xEV evolution, comprising of CDMA2000 1xEV-DO data only and 1xEV-DV" data voice can meet in part the request for high information rate. Information rates of up to 100 Mbps can be conceived using MIMO innovation, currently one piece of cellular principles such as "IEEE 802.16 Wi-MAX [2], fast packet to reach (HSPA) download 7 [3], and the third generation partnership project (3GPP) long term evolution LTE" [4]. This antenna is low profile, gain and reliability is high, Radiation performance also good and provide for good network [5].

RF PLANNING METHODOLOGY

The structure of radio system arranging is follows some steps to design radio frequency network

Inputs and outputs, the major inputs to link planner are:

Name of the cell site, place, maximum antenna height and place definition, and subscriber/network

Necessary performance target for every network or link input by the user

Particulars of any obstruction or reflection that may concern the performance of a link (Obtain from maps, survey data & Google earth TM).

Details of the equipment and license constraint selected by the user.

It shows predict and necessary throughput performance and accessibility at each end of the link.

Report of the terrain next to the path of each link obtains using a Cambium tool. The major o/p from link planner is a performance summary that shows how well the "link is predicted to perform in response to the selected combine of i/p".

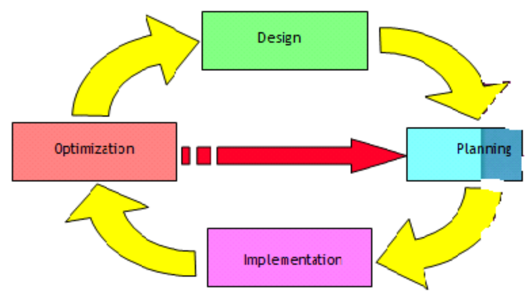


Fig. 5: Flow chart of RF Network Planning

RF PLANNING TOOL

Cambium Networks is an autonomous organization giving RF arranging programming answers for the wireless industry. This is completely independent from equipment suppliers and telecom operators. Cambium Networks provides the LINK Planner software, company providing customized RF planning solutions to the telecommunications industry and was involved in the early stages of the GSM technology.

LINK Planner 4.9 version is used to design the antenna in this software. [1] The Cambium Networks arrangement of "point-to-point wireless Ethernet" (PTP) port sand point-to-multi point wireless broadband (PMP) broadband arrangements are intended to Opera in conditions "Non line sight(NLoS) and line of sight (LoS) connect". The arranging and estimation permitted introducing a connection of known quality. LINK Planner uses route profile data to predict data rates and reliability has an extension of each hug, by and adjusts the height of the antenna and the RF power. When the link is installed, is able to verify the loss of the average route to confirm these predictions. It performs the computations from the ITU suggestions ITU-R P.526-10 and ITU-R P.530-12 to anticipate NLoS and LoS ways for anyplace on the planet. Path profile information can be obtained in various distinctive ways depending upon global location. This tool gives a technique to getting way profile information. Trees and structures (blocks) can change this profile, and frequently the way should be over viewed to build up the right estimation.

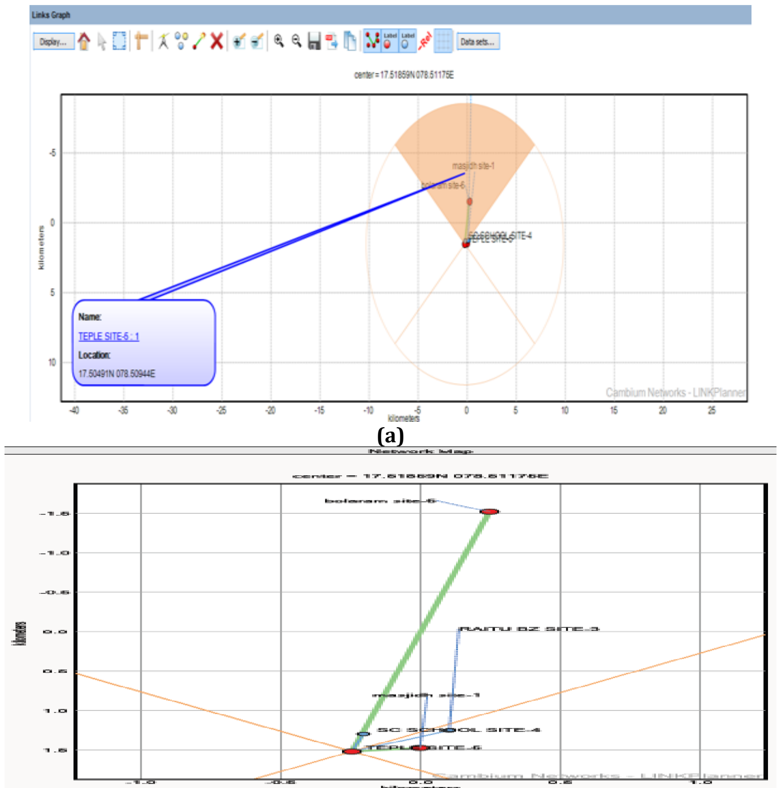
ANTENNA DESIGN

In this exploration, different base station antennas are designed. Here examine different base station antennas, like Network Site, Subscriber Site, Access Point, Subscriber Module, Link, and Path.

- Design network: a lot of information about the sites and links in a wireless network.
- Network Site area: the area of a point-to-point (PTP) outdoor unit and its reception apparatus or a PMP hub Site.
- Subscriber Site area: the area of a point to multipoint (PMP) Subscriber Module outdoor unit and receiving wire or antenna.
- Hub Site: an area, which contains at least one or more Access Point outdoor units and antenna.
- Access Point: an outdoor unit and antenna, which associates with multiple user Modules.
- Subscriber Module: an outdoor unit and antenna at a client or remote premises.
- Link: a wireless connection between two PTP sites or between an Access Point and a solitary user Module.
- Path: an elective remote connection between two PTP units at various sites, when each site has different units

Network sites design by 5.25-5.85 GHZ, 2-FT (0.6M), high performance dual-pol Parabolic and Subscriber Site design ePMP 4x4 MU-MIMO Sector Antenna (for ePMP3000AP). Hear we planned five sites indifferent areas, in this three sites are network sites, one is hub site and two sites subscriber Site. Radio planning stage with LINK Planner taking Hyderabad digital map as input shown in fig6 &7. Site locations shown map with below table2.

SIMULATION RESULTS AND DISCUSSION



(a)

(b)

Fig. 6: a, b RF Network Planning Offline Map

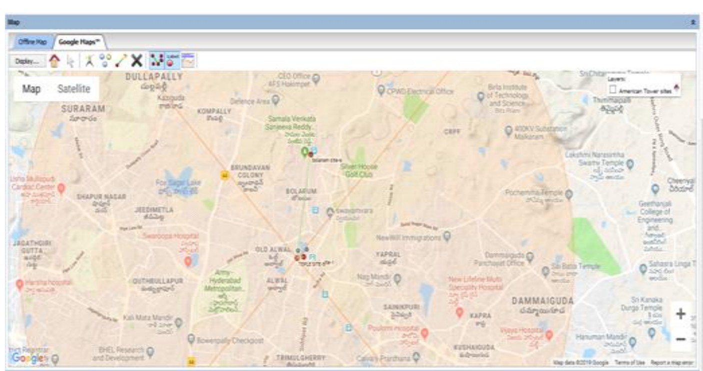


Fig. 7: RF Network Planning Google Maps

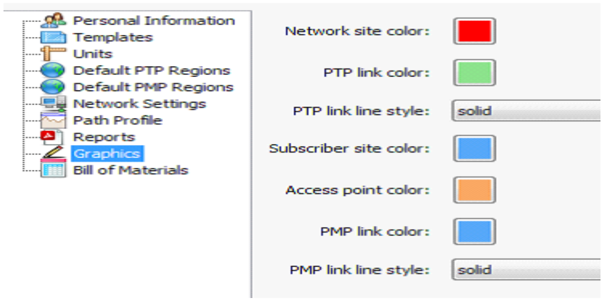


Fig. 8: Link colors

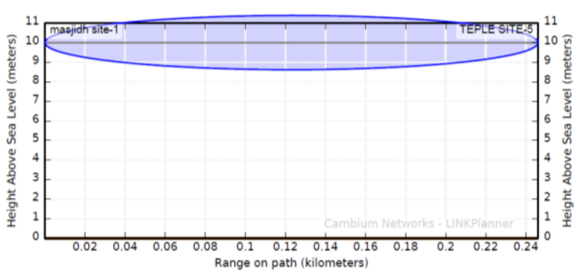
List of the designed sites and its Latitude and Longitude given in below table 2.

Table 2: Location of the sites in Map

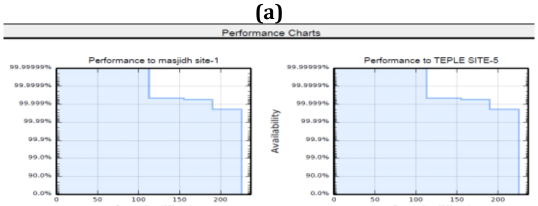
NETWORK SITES					
Name	Latitude	Longitude	Maximum Height (m)	PTP Links	PMP Hub
bolaram site-6	17.53227 N	078.51406 E	10	1	No
masjidh site-1	17.50531 N	078.51172 E	10	1	No
TEPLE SITE-5	17.50491 N	078.50944 E	10	2	Yes
SUBSCRIBER SITE					
Name	Latitude	Longitude	Maximum Height (m)	PMP Links	
RAITU BZ SITE-3	17.50729 N	078.51270 E	10	0	
SC SCHOOL SITE-4	17.50690 N	078.50983 E	10	1	

Table 3: point to pint network sites coverage

PTP LINKS										
Name	Range (km)	Product	Aggregate Throughput (Mbps)	Link Availability	Left Height (m)	Left Gain (dBi)	Right Height (m)	Right Gain (dBi)	Link Loss (dB)	type of antenna
masjidh site-1 to TEPLE SITE-5	0.246	PTP670	451.1	100	10	28.6	10	28.6	95.6	2ft Dual-Polar
TEPLE SITE-5 to bolaram site-6	3.068	PTP670	180	99.9999	10	28.6	10	28.6	117.6	2ft Dual-Polar



(a)



(b)

Fig. 9: (a) Path profile of the site 1 to 5, (b) Capacity performance charts of the site1 &5

In this research, three network sites are imported. After that, three sites are connected to each other by using point-to-point (PTP) link. Those site names are site 1, site 5 & site 6. Those sites latitude and longitude given in above table2. Here PTP link given between site5 to site1and site5 to site6.in below. After importing the antenna predicted result given in below Table5. In Above Fig9 shown the performance of the sites. Here gave only two sites results, it gives 99.9995% coverage for network sites. In Table4 shown RF network site5&6 modulation performance results.

In these three sites one site taken as Hub site from here we gave connection to subscriber site to increase the performance and capacity to full fill client requirement.

Table 4: RF network site 5 & 6 Modulation Performance Results

Mode	Max Aggregate User IP Throughput (Mbps)	Max User IP Throughput in Either Direction (Mbps)	TEPLE SITE-5			bolaram site-6		
			Fade Margin (dB)	IP Throughput Availability (%) *	Receive time in Mode (%)	Fade Margin (dB)	IP Throughput Availability (%) *	Receive time in Mode (%)
256QAM 0.81 Dual	449.19	224.60	-12.03	0.0000	0.0000	-12.03	0.0000	0.0000
64QAM 0.92 Dual	378.46	189.23	-8.29	0.0006	0.0005	-8.29	0.0006	0.0005
64QAM 0.75 Dual	309.27	154.64	-4.17	0.0227	0.0221	-4.17	0.0227	0.0221
16QAM 0.87 Dual	240.60	120.30	-1.04	14.1056	14.0829	-1.04	14.1056	14.0829
16QAM 0.63 Dual	172.96	86.48	2.58	97.1347	83.0291	2.58	97.1347	83.0291
256QAM 0.81 Sngl	224.59	112.30	-8.37	0.0000	0.0000	-8.37	0.0000	0.0000
64QAM 0.92 Sngl	189.22	94.61	-5.00	0.0000	0.0000	-5.00	0.0000	0.0000
64QAM 0.75 Sngl	154.63	77.32	-1.04	0.0000	0.0000	-1.04	0.0000	0.0000
16QAM 0.87 Sngl	120.30	60.15	2.02	0.0004	0.0004	2.02	0.0004	0.0004
16QAM 0.63 Sngl	86.48	43.24	6.53	99.9877	2.8525	6.53	99.9877	2.8525
QPSK 0.87 Sngl	60.14	30.07	8.86	99.9978	0.0101	8.86	99.9978	0.0101
QPSK 0.63 Sngl	43.23	21.62	12.88	99.9998	0.0020	12.88	99.9998	0.0020
BPSK 0.63 Sngl	21.61	10.81	15.99	99.9999	0.0002	15.99	99.9999	0.0002

Table 5: RF network site 5 & 6 performance results

Regulatory Conditions	
Country	India
Antenna Type &Description	5.25-5.85 GHZ, 2-FT (0.6M), HIGH PERFORMANCE DUAL-POL
Polarization	Dual
Propagation	ITU-R P.530-12
Operating Frequency Band	5.25 - 5.85 GHz
Max EIRP	32.6 dBm
Output Power	5.0 dBm
Antenna Beam width	6.1°
Antenna Gain	28.58 dBi
Cable Loss	1.0 dB
Predicted Link Loss	117.56 dB ± 5.00 dB
Free Space Path Loss	117.53 dB
Connectorized Antenna Type	Directional, 2ft parabolic
Channel Bandwidth	45 MHz
Max Receive Modulation Mode	256QAM 0.81 Dual
Lowest Data Modulation Mode	BPSK 0.63 Sngl
TDD Synchronization	Enable
Link Mode Optimization	IP Traffic
Predicted Receive Power	-54 dBm ± 5 dB
Predicted Link Loss	117.56 dB ± 5.00 dB
Mean IP Throughput Predicted	90.02 Mbps
Mean IP Throughput Required	5.00 Mbps
Minimum IP Throughput Required	10.00 Mbps
Minimum IP Throughput Availability Predicted	99.9999%
Interference Expected	-73.47 dBm/ 45 MHz
Link Length	3.068 km
System Gain Margin	3.068 km System Gain 133.55 dB
System Gain	133.55 dB

Subscriber sites are design by using 4X4 MIMO antenna, which provides the subscriber requirements. Subscriber antenna model is ePMP 4x4 MU-MIMO Sector Antenna (for ePMP3000AP). Here only two subscriber antennas MIMO connected to Hub site. Site3 and site4 are subscriber antennas. Those sites latitude and longitude given in above table2. This Subscriber sites connected to Hub site by using point to multipoint (PMP) link connectors.

Table 6: (a) Hub site, (b) subscriber site Access points and PMP Links

(a)

Hub site							
Name	Latitude	Longitude	Maximum Height (m)	Number of Access Points	Number of Subscriber Modules	Connected Subscribers	Unconnected Subscribers
TEPLE SITE-5	17.50491N	078.50944E	10	4	2	2	0

(b)

PMP Links and AcesspointS						
M Name	Product	Band	SM Latitude	SM Longitude	SM Antenna	SM Height (m)
SC SCHOOL SITE-4	ePMP Force 300-16	5.8 GHz	17.50690N	078.50983E	90° ePMP 4x4 MU-MIMO Sector Antenna, 15° ePMP Force 300-16	10
RAITU BZ SITE-3	ePMP Force 300-16	5.8 GHz	17.50729N	078.51270E	90° ePMP 4x4 MU-MIMO Sector Antenna, 15° ePMP Force 300-16	10

After connecting Subscriber, sites to Hub site checked the uplink and downlink propagation result. It gives Total Predicted DL throughput 182.55 Mbps (100%), Total Predicted UL throughput 163.51 Mbps(100%) and Total Predicted mean throughput is 346Mbps for 256QAM 0.83 Dual modulation.

Table 7: RF network of Hub site 5 and subscriber site 4 performance results

PMP LINKS site result	
Country	India
Antenna Type &Description	ePMP 4x4 MU-MIMO Sector Antenna (for ePMP3000AP)
Antenna Azimuth	0.00° from True North 0.64° from Magnetic North
RF Frequency Band	5.8 GHz (5825 to 5875 MHz)
RF Channel Bandwidth	40 MHz
MIMO Mode of transmission	4x2 Single User
Total Predicted DL Throughput	182.55 Mbps
Total Predicted UL Throughput	163.51 Mbps
Total Predicted Throughput	346.06 Mbps
DL/UL Ratio	50/50
Antenna Gain	15.1 dBi
Link Range	3.068 km
Antenna Beam width	90°
Cable Loss	0.8 dB
Driver Mode	TDD
Channel Bandwidth	40 MHz
DL/UL Ratio	50/50
Synchronization Source	GPS
Max EIRP	36 dBm
POWER	18 dBm
Downlink Max Rate	MCS9 (256QAM 0.83 Dual)
Frame period	5ms

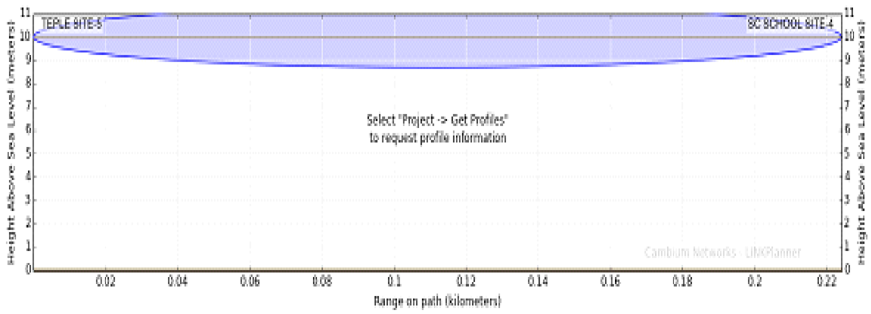
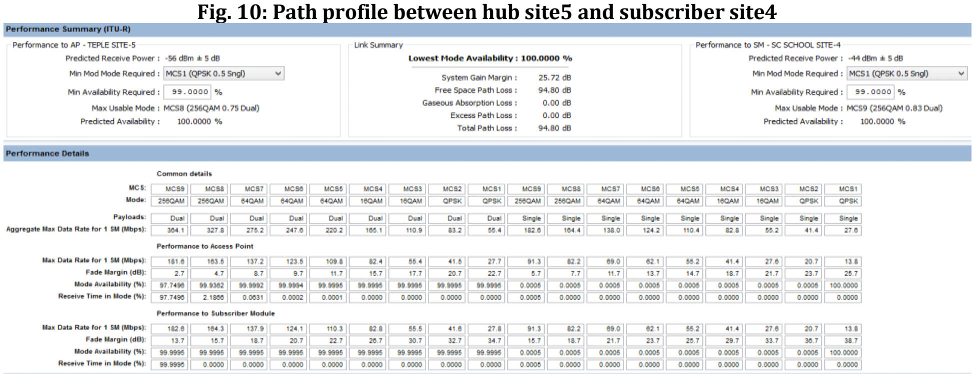


Fig. 10: Path profile between hub site5 and subscriber site4



Performance Summary (ITU-R)

Performance to AP - TEPLE SITE-5
Predicted Receive Power : -56 dBm ± 5 dB
Min Mod Mode Required : MCS1 (QPSK 0.5 Sngl)
Min Availability Required : 99.0000 %
Max Usable Mode : MCS8 (256QAM 0.75 Dual)
Predicted Availability : 100.0000 %

Link Summary
Lowest Mode Availability : 100.0000 %
System Gain Margin : 25.72 dB
Free Space Path Loss : 94.80 dB
Gaseous Absorption Loss : 0.00 dB
Excess Path Loss : 0.00 dB
Total Path Loss : 94.80 dB

Performance to SM - SC SCHOOL SITE-4
Predicted Receive Power : -44 dBm ± 5 dB
Min Mod Mode Required : MCS1 (QPSK 0.5 Sngl)
Min Availability Required : 99.0000 %
Max Usable Mode : MCS9 (256QAM 0.83 Dual)
Predicted Availability : 100.0000 %

Performance Details

Common details									
MCS:	MCS9	MCS8	MCS7	MCS6	MCS5	MCS4	MCS3	MCS2	MCS1
Mode:	256QAM	256QAM	64QAM	64QAM	64QAM	16QAM	16QAM	QPSK	QPSK
Payloads:	Dual	Dual	Dual	Dual	Dual	Dual	Dual	Dual	Dual
Aggregate Max Data Rate for 1 SM (Mbps):	364.1	327.8	275.2	247.6	220.2	165.1	110.9	83.2	55.4
Performance to Access Point									
Max Data Rate for 1 SM (Mbps):	181.6	163.5	137.2	123.5	109.8	82.4	55.4	41.5	27.7
Fade Margin (dB):	2.7	4.7	8.7	9.7	11.7	15.7	17.7	20.7	22.7
Mode Availability (%):	97.7496	99.9362	99.9992	99.9994	99.9995	99.9995	99.9995	99.9995	99.9995
Receive Time in Mode (%):	97.7496	2.1866	0.0631	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000
Performance to Subscriber Module									
Max Data Rate for 1 SM (Mbps):	182.6	164.3	137.9	124.1	110.3	82.8	55.5	41.6	27.8
Fade Margin (dB):	13.7	15.7	18.7	20.7	22.7	26.7	30.7	32.7	34.7
Mode Availability (%):	99.9995	99.9995	99.9995	99.9995	99.9995	99.9995	99.9995	99.9995	99.9995
Receive Time in Mode (%):	99.9995	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Common details									
MCS:	MCS9	MCS8	MCS7	MCS6	MCS5	MCS4	MCS3	MCS2	MCS1
Mode:	256QAM	256QAM	64QAM	64QAM	64QAM	16QAM	16QAM	QPSK	QPSK
Payloads:	Single	Single	Single	Single	Single	Single	Single	Single	Single
Aggregate Max Data Rate for 1 SM (Mbps):	182.6	164.4	138.0	124.2	110.4	82.8	55.2	41.4	27.6
Performance to Access Point									
Max Data Rate for 1 SM (Mbps):	91.3	82.2	69.0	62.1	55.2	41.4	27.6	20.7	13.8
Fade Margin (dB):	5.7	7.7	11.7	13.7	14.7	18.7	21.7	23.7	25.7
Mode Availability (%):	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	100.0000
Receive Time in Mode (%):	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Performance to Subscriber Module									
Max Data Rate for 1 SM (Mbps):	91.3	82.2	69.0	62.1	55.2	41.4	27.6	20.7	13.8
Fade Margin (dB):	15.7	18.7	21.7	23.7	25.7	29.7	33.7	36.7	38.7
Mode Availability (%):	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	100.0000
Receive Time in Mode (%):	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Fig. 11: Simulation performance UL/DL results

Performance of access point (AP) site to subscriber modules(SM) site simulated performance results are shown in above fig11. it gives received time mode of the signal is 99.9995%, fade margin is 13.7dB, mode availability 99.9995%, maximum data rate is 182.6Mbps and average maximum data rate is 364.1 Mbps. for 4x4 MIMO. MIMO transmission mode is 4X2 single user.

This RF network is designed and planed in software toll like Link Planner. After planning this predicted output, result gives to hardware engineers to mount base station sites on the specified location. That output is in the form of estimated bill of material (BOM). After installing the site again, cheek the coverage and capacity performance in the form of optimization.

Table 8: BSRF Network Bill of Materials for Results for PTP, PMP and HUB

PTP NETWORK BOM		
Part Number	**Description**	**Quantity**
01010419001	Coaxial Cable Grounding Kits for 1/4" and 3/8" Cable	16
C000065L007	LPU and Grounding Kit (1 kit per ODU)	4
C050067H014	PTP 670 Connectorized END with AC+DC Enhanced Supply (ROW - EU Line Cord)	4
EW-E4PT6XX-WW	PTP 650/670 Extended Warranty, 4 additional years (per END)	4
RDH4503	5.25-5.85 GHZ, 2-FT (0.6M), WITH FINE ADJUSTMENTS	4
WB3176	328 ft (100 m) Reel Outdoor Copper Clad CAT5E (Recommended for PTP)	1
PMP NETWORK BOM		
Part Number	Description	Quantity
C000000L033	Gigabit Surge Suppressor (56V)	4
C050910A401	ePMP 3000 5 GHz Access Point Radio (ROW) (India cord)	4
C050910D301	ePMP 4x4 MU-MIMO Sector Antenna (for ePMP3000AP)	4
PMP SUBSCRIBER MODULES BOM		
Part Number	Description	Quantity
C000000L065	Gigabit Surge Suppressor (30V)	2
C050910C411	ePMP 5 GHz Force 300-16 Radio (ROW) (India cord)	2
EW-E1EPF300-WW	ePMP Force 300 Extended Warranty, 1 Additional Year	2
BILL OF MATERIALS FOR HUB		
Part Number	Description	Quantity
C000000L033	Gigabit Surge Suppressor (56V)	4
C050910A401	ePMP 3000 5 GHz Access Point Radio (ROW) (India cord)	4
C050910D301	ePMP 4x4 MU-MIMO Sector Antenna (for ePMP3000AP)	4

In this research after designed of RF network for base station antenna by using 4x4 MIMO antenna for single user transmission, the result performance compared with 2x2 MIMO antenna performance output result.

Table 9: RF network performance results for 2x2 and 4x4SU-MIMO antenna

	4x4 SU-MIMO site result	2x2 MIMO site result
Country	India	India
Antenna Type & Description	4x4 MIMO	2×2 MIMO
RF Frequency Band 5.8 GHz (5825 to 5875 MHz)	5.8 GHz (5825 to 5875 MHz)	1710MHz-1785 MHz,1805 MHz-1880 MHz
RF Channel Bandwidth	40 MHz	5 MHz
MIMO Mode of transmission	4x2 Single User	2×2 MIMO
predicted the total output coverage	99.9995%	96.2%
Link Range	0.224 km	5.26km
Cable Loss	0.8 dB	2dB
Channel Bandwidth	40 MHz	5 MHz
Max EIRP	36 dBm	22 dBm
Predicted Receive Power	-54 dBm ± 5 dB	43dBm
Propagation	ITU-R	Cost-hata
Antenna Gain	28.58 dBi	18dBi
Transmitter Output Power	22 dBm	18.0 dBm

Result Analysis: In this research, 4X4 MIMO antenna is gives predicted the total output coverage is 99.9995%, from the above figure, area of total computation area. The path profile represents the average signal strength throughout the area. From the simulation, it can be determined that 99.9995%, Hyderabad areas can be covered by 5G service.

CONCLUSION

The main goals of this research is 5G radio network planning. With the presents of 5G features, the basic model for radio propagation planning is to improve the performance of network in terms of coverage, capacity and quality. The project assists in the advancement of different instruments utilized in RNP. Like 4x4 MIMO subscriber antennas, dual polar network antennas, and 4x4 MIMO mode of transmission is SU-MIMO, interface LINKPLANNER was used which offers unique capabilities of using both predictions and live network data throughout the network planning and optimization process. In future work we can plane 5G cellular RF network with 4X4 MU-MIMO transmission mode.

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