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

Reshma Begum Shaik1, Dr. G. Sasikala2

1Research Scholar, School of Electrical and Communication Engineering, Vel Tech Rangarajan Dr. Sakunthala R&D Institute of Science and Technology, Chennai, India. skreshmabegum456@gmail.com
2Associate Professor, School of Electrical and Communication Engineering, Vel Tech Rangarajan Dr. Sakunthala R&D Institute of Science and Technology, Chennai India. sasikalaevelest369@gmail.com

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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 subscribers sites with sturdy constructions for micro-base-station applications. In this research, the proposed one is design dual-polarized network sites for 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 MIMO Sector Antenna for subscriber modules 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 100 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.

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 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 | Range |
|---------------------|-------|
| Data Capacity       | 20 Gbps |
| Frequency           | 3 to 300 GHz |
| Multiplexing        | CDMA, BDMA |
| Peak Data Rate      | 10 Gbps |
| Data Bandwidth      | 1 Gbps and higher as per need |
| Spectral Efficiency | 120 bps/Hz |
| TTI (Transmission Time Interval) | Varying (100 µs (min) to 4ms (max)) |
| Latency             | ≤100 ms |
| Mobility            | 500 Km/h |
| Connection Density  | 10000000 Km² |
| Frequency Band      | 3 to 300 GHz |
| Technologies        | Unified R9, seamless integration of broadband LAN/WAN/PAN/WLAN and advanced technologies based on OFDM modulation used in 5G |
| Multiple Access     | CDMA, BDMA |
| Core network        | TDD/LTE 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
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.

Advantages of 4X4 MIMO over 2X2 MIMO antenna
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”.

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 in different 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

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

Fig. 7: RF Network Planning Google Maps
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 table 2. Here PTP link given between sites 5 to site 1 and site 5 to site 6. After importing the antenna predicted result given in below Table 5. In Above Fig 9 shown the performance of the sites. Here gave only two sites results, it gives 99.9995% coverage for network sites. In Table 4 shown RF network site 5 & 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.
Subscriber sites are designed using 4x4 MIMO antennas, which provide the subscriber requirements. Subscriber antenna models include ePMP 4x4 MU-MIMO Sector Antennas (for ePMP3000AP). Here, only two subscriber antennas MIMO are connected to Hub site. Site 3 and site 4 are subscriber antennas. Those sites' latitude and longitude are given in Table 2. 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 Access Points | 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 |
| RAIITU 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

| Country | PMP LINKS site result |
|---------|-----------------------|
| India   | ePMP 4x4 MIU-MIMO Sector Antenna (for ePMP3000GAP) |
|         | Antenna Gain: 21.9 dBi |
|         | Driver Mode: TOD |
|         | Channel Bandwidth: 40 MHz |
|         | Downlink Gain: 19 dBi |
|         | Downlink Max Rate: 18 Mbps |
|         | Frame period: 5ms |

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 planned in software tool 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, check the coverage and capacity performance in the form of optimization.

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

Performance of Hub site to Subscriber Site

![Fig. 10: Path profile between hub site5 and subscriber site4](image1)

![Fig. 11: Simulation performance UL/DL results](image2)
In this research, a designed 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

| Country       | RF Channel Bandwidth (MHz) | MIMO Mode of Transmission | Predicted total output coverage | Link Range (km) | Cable Loss (dB) | Channel Bandwidth (MHz) | Max EIRP (dBm) | Predicted Receive Power (dBm) | Antenna Gain (dBi) | Transmitter Output Power (dBm) |
|---------------|---------------------------|---------------------------|---------------------------------|-----------------|----------------|------------------------|----------------|-------------------------------|-------------------|-----------------------------|
| India         | 25 MHz                    | 2x2 MIMO                  | 99.99%                          | 2.24            | 0.8            | 5                      | 26.5           | -36                           | 28.58             | 22                          |

Result Analysis: In this research, 4x4 MIMO antenna is gives predicted the total output coverage is 99.99%, 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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