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# SEMI BEAM SECTOR ANTENNA FOR MANET HET PROBLEM

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**ABSTRACT**

The Mobile Adhoc Network is the most widely self-organizing and simply established network for instant communication; nevertheless, addressing the Hidden and Exposed node terminals limits the preference for quick communication via MANET. Incorporating the directional antenna within the MAC layer functionality can help with the hidden and exposed nodes problem. Initially, Omni antennas were employed in MANET for transmission; however they did not handle extended range, power optimization, or interference. This research article discusses the incorporation of a semi-beam sector directional antenna technology into the physical layer to address hidden and exposed node difficulties in the MAC layer. This proposed antenna is divided into four sectors based on the location of the neighbor node. The respective sector transmitter or receiver will transmit or receive the packet. This antenna also determines the receiver direction based on the location of the next hope received and focuses the packet floating. This technique supports the Hidden and Exposed node problem in MANET while also improving routing efficiency and power optimization. This study was simulated using Network Simulation, and the results showed a 20% to 30% improvement in total MANET Network performance and metric value, as well as an overall antenna gain of 10 dBi in the Semi Beam sector antenna.

**Keywords:** *MANET, Semi Beam Antenna, Physical Layer, Hidden Terminal, Exposed Terminal*

## 1. INTRODUCTION

Smart antennas [1] have recently surpassed these antennas in terms of number of nodes connected and gain power. Some types of antennas support interference [2], long transmission range [3], and transmission capacity [4]. Many studies on Medium Access Control protocol-based antennas have provided solutions to the restrictions of Omni directional antennas. Mahmud et al. [5] developed a GPS-based MAC-designed directional antenna to address the concealed and exposed terminal problem. Wang et al. [6] developed the CMDMAC protocol to handle the MANET Hidden and Exposed node problem with a corporative directional antenna, whereas Kulcu et al. [1] presented a smart antenna that uses the IETF 6TiSCH protocol for MAC layer scheduling to overcome the hidden and exposed node issue.

Vigneshwaran, P., et al. [7] created the sector-based direction antenna by partitioning geographical location into sectors and suggested it. K. Periyakaruppan [8] proposes the COASC technique to overcome the MAC layer problem with scheduling in the physical layer network capacity using MIMO links. To reduce convergence time, a set of research studies has evolved in node location-based directed with the support of neighbor node discovery [ND] [9]. Sorribes et al. [10] developed a collision detection algorithm that takes into account the placement of neighbor nodes.

Wei et al. [11] used the Gossip technique to identify the ND in VANET by placing sensors on the road vehicle. The ISAC technique developed in [12] [13] uses spectrum and hardware devices to reduce the overhead in convergence time. Radar sensing is used to obtain prior knowledge about the ND, as discussed by D. Ji et al. [14] and Wei et al. [15]. D. Cason et al. introduced gossip strategies for knowing ND in [16] to shorten convergence time. A group of researchers developed Machine Learning (ML)-based ND algorithms. Liu et al. [17] combined a filter prediction algorithm with reinforcement machine learning, the Q-learning model proposed by Y. Wang et al. [18] and B. E. Khamlichi et al. [19] [20], and the policy-based scheduling model proposed by B. El Khamlichi et al. [20] and Y. Zhao et al. [21].

Among the several smart antenna proposals discussed in this chapter, the MAC layer routing protocol, ND prediction for convergence time, and ML algorithms do not help to provide solutions for the MAC layer and Physical layer, which are not permanently solved; however, the existence of the Hidden and Exposed node problem and power management in the MAC and Physical layers remains a major issue in MANET.

This article discusses smart antennas with ND and semi-beam sectors that define how to float packets to the next node in order to discover hidden and exposed nodes in the network. This could result in greater performance in the MANET Physical and MAC layers. The organization of this article begins with a literature scan in section 2, followed by a proposed technique in chapter 3, research methods and results discussion on chapters 4 and 5, and finally a conclusion and feature work in chapter 6.

## 2. LITERATURE REVIEW

Kulcu et al. [1] developed steerable directional antennas for greater range transmission and lower interference as compared to Omni directional antennas for IoT networks. The IETF 6TiSCH protocol was proposed for an industry IoT network, and the simulation results produced outperforms in high density circumstances. However, because this work is for Industry IoT, it cannot be done in real time with the best algorithms, such as machine learning, to comprehend the original performance.

Liang et al. [3] found neighbor node detection in FANET to solve multiple channel accessing problems. They present two algorithms, BR-DA and BR-DA-FANET, as well as two protocols, ND-LP and ACI-LP, for beam tracking and channel enabling. All of this comes together to produce the FA-MMAC-DA protocol for ND discovery and interruption avoidance. When compared to the previous ND protocol, the simulation of our protocol results in less delay. However, this method fails to detect the rapid finding of ND and transmission delay.

To mitigate the energy losses in the Omni antenna, P. Vigneshwaran and S. Suthaharan [7] developed Dynamic sector routing with directional antenna. This research improves signal strength, collision rate, efficiency, and signal power, although the results provide a slight difference in antenna gain of just 12.5 dBi when compared to the present model antenna gain of 13dBi.

K. Periyakaruppan et al [8] proposes the advanced antenna model for forest application using MANET. Research made the different environment set up to understanding the antenna capacity based on the transmission range, loss and data. Finally, reached a new PL path antenna with optimum cost was used for achieving the results in the forest area. This research could not able to solve the mobility nodes movement and not covers the energy related issues.

Yang et al. [9] introduced the BD-SBA technique to solve the reception node beam receiving mode and interference problem in a wireless sensor network. This study included two more signals, Scanning Request and Scanning Response. The simulation of the research effort was unable to compare the ND algorithm in order to improve performance.

Z. Wei et al. [11] proposed gossip-based neighbor node discovery in VANET by deploying numerous sensors on the roadside and receiving information via GSIM-ND multi packet reception. Simulation results were compared to other existing CRA and SBA algorithms. The convergence time is reduced by 40 to 90% when the number of modulation modes k is set to 1.When the number of modulation modes is changed, the outcome fails to improve convergence time. This approach works well when the derivation of a neighbor node can be completed within the time constraints.

In this study, Ji et al [14] used radar communication technology to forecast neighbor nodes in a wireless Adhoc network. It uses the radar's full location information to determine the direction of the neighbor. This study restricts the upper and lower bounds for the mathematical derivation to anticipate the ND while also conserving energy.

Z. Wei et al. [15] conducted research on wireless networking for ND detection using radar and machine type communication. When compared to the old technique, simulation results demonstrate that this method uses previous knowledge from the radar to predict the ND, which increases the speed of ND prediction; however, in wireless network nodes, prior information will not be practical to predict the neighbor node.

Khamlichi et al [20] suggested a reinforcement-based ND algorithm for Adhoc networks to overcome the discovery latency problem and the long tail problem with the help of narrow beam. To reduce route discovery latency, this study employs a stochastic multi-player game and a Q-learning-based method. The research results, as compared to other ND, produced the substantially faster but has a higher computational complexity.

The authors, B. El Khamlichi et al [21] proposed the ND method for tackling the ND problem in wireless Adhoc Networks using the learning automation discovery process model. This model learns the node and changes the surroundings to obtain a high rate of ND detection. This job is faster only in low density networks, but much slower in high density networks.

Bowen Zhen et al [22] overcome the synchronization problem on unsynchronized nodes via a digital phased antenna array. A directional antenna based on a corporative antenna array was presented, with the packet's direction narrowed to produce higher antenna gain. As 5 nodes were simulated, the synchronization time was reduced by 50% as compared to the Omni antenna. This antenna's disadvantage was that it was well suited in ALOHA, and the method required estimating the geometric position, relationship, and probability distribution. After adjusting the beams to 10 and the interference value to 2 with five nodes, the simulation result of synchronization was lowered by 60%.

Mahendrakumar et al. [23] suggest a smart antenna in an adaptive antenna array to replace the Omni antenna with a unidirectional antenna to increase MANET performance and tackle the hidden and exposed node problem, as well as the beam problem. The proposed work's simulation findings achieve performance variation when compared to the AMAC-MLSR. However, the antenna array and beam sector value of dynamic nature topology are difficult to maintain.

Among the several proposal of smart antenna discussed in this chapter, with the MAC layer routing protocol, ND prediction for convergence time and ML algorithms are not assist to provide solution for MAC layer and Physical layer which are not solved permanent, still the existence of Hidden and Exposed node problem and power management, in MAC and Physical layers predominant issue in MANET. This article addresses the smart antenna with the support of ND and beam defining to float the packet to the next node in the network. Through this could achieve the better performance in MANET Physical and MAC layer.

## 3. PROPOSED METHOD

The objective of this chapter to propose the system model to overcome the Physical layer and MAC layer issues are like antenna usage which support Hidden and exposed node problem.

### 3.1 Semi Beam Antenna Design

This proposed work uses the semi beam sector antenna because of its advantages, Antenna has transmitter and receiver .By making the smart alteration on the directional antenna transmission and receiving signal could support for MAC layers issues of hidden and exposed node problem.

Antenna direction is divided in to four sector as shown in the Figure 3.1, each beam having individual transmitter and a receiver as shown in the Figure 3.2, the operation of the beam either transmit or receive the packets which is based the next hop neighbor location the respective transmitter forward the packet same for the receiving packet. For selection of the beam for the purpose of the transmit or receive is defined in the algorithm 3.1

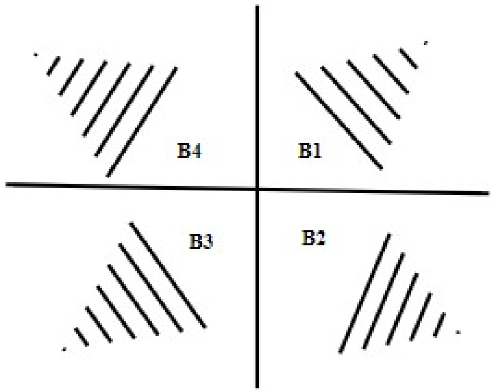


*Figure 3.1 Antenna Model*

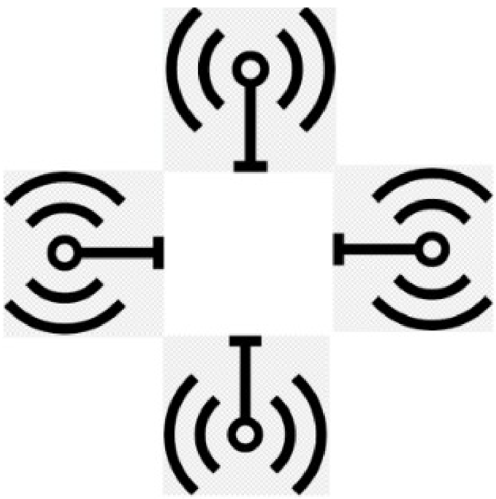

*Figure 3.2 Node Antenna Setting*

**Algorithm 3.1**
**MANET SET N = {N1, N2, N3, ...Nn}**
**Where n is the maximum number of nodes in MANET**
**The algorithm design stages as follows**
**Step 1**: Finding the neighbor node of each node
Suppose the node $N_i$ has received the neighbor node of $N_{i1}$, $N_{i2}$ ...Nin then go to stage 2
**Step 2:** Select the antenna semi beam sector for each node transmission and receiving using the Eq (1) and Eq (2).
Let S (t) power signal sent from an antenna Transmission signal weight for each semi beam sector antenna sector wRi.
Where 1≤ i ≤ 4 T received signal of the i th antenna

$$xi(t) = s(t) \sum_{j=1}^{N} wTj\, hji \quad \text{Eq (1)}$$

$$Received\ signal\ output\ of\ r(t) = \sum_{i=1}^{N} WriXi(t) \quad \text{Eq (2)}$$

**Step 3** Start Transmit and receiving packet based on the transmission with the respective antenna sector.

For an illustration of the Algorithm working, assuming the MANET node has two nodes A, B as shown in the Figure 3.3. Every node send request for live location, upon receiving the location and predict the neighbor node list .Finally applies the semi beam sector selection for transmit and receive the packets.

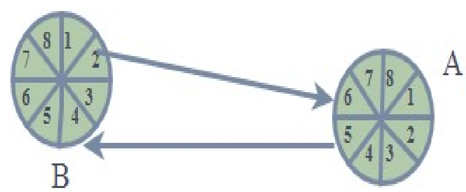


*Figure 3.3 Node Antenna Semi Beam Sector Selections*

## 4. RESEARCH METHOD

Initially the proposed work is established, the physical layers uses the CSMS/CA techniques over the hidden and exposed node prediction ME-MAC protocol relays [23] to predict the Hidden and Exposed nodes tables, RTS , CTS , Data Packets supports for making the connection establishment. Later Semi beam sector Antenna determines based on the available location which beams to be act for transmitting and receiving of the packet, finally the packet will be send from the sender node to reach the receiving node. Antenna set Zero gain value in other direction so that the other nodes interference will be avoids this support for overcome collision among the nodes.

Based on the Figure 3.3 , node A wants to send packet B nodes, RTS signal from A nodes send to other nodes B that A need to communicate with B, and the semi beam sector directional antenna set for transmitting of the packet from A to B is sector 5 and receiving antenna beam sector is 6 , other beam sector gain are become null so that to avoid the interference .After all the packets transmitted CTS received from other nodes as well from B which make other node can communicate with B. RTS,CTS and Packet frame is modified.

The proposed Physical and MAC layer based Semi beam sector antenna design was simulated with the support of Omni directional

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antenna set up with Semi beam sector directional antenna. The several metric are taken for comparing with the Omni directional antenna [22] with the proposed antenna Efficiency, Simulation parameters [23] are defined as in the Table 4.1. The total numbers of nodes are ranging from 50 to 100 for making the comparison between the proposed works with existing Omni directional antenna. Starting the simulation with 50 numbers of nodes and slowly increasing the nodes count by 5 in every time duration of 20 ms and computed the evolution metric.

Efficiency of Omni directional antenna and Semi Beam sector design antenna received power, which depict that the semi beam sector antenna signal strength is double time better than Omni directional antenna From this Comparison the Gain of Omni directional antenna is 8 dBi where the Beam sector Antenna 10 dBi. Comparison summary of Efficiency metric value compared between the Omni directional antenna and beam sector antenna depicted in the Figure 4.1.

## 5. RESULTS AND DISCUSSION

In this part the performance analysis of proposed beam sector based antenna was compared with Omni Directional antenna [24] with the support of Network simulator NS3 version. Existing On demand protocol AODV was chosen for route finding. Collaborative Physical and MAC layers works alone made modification with the support of Semi Beam sector antenna. The performance factors are taken for comparisons are Energy Consumption, Throughput, Delay, and Signal to Noise Ratio.

### 5.1 Energy consumption

The motivation of this research work focus on antenna design to attain maximum energy during the packet delivery with respect to the synchronization packet and data packet. This is computed as in Joules with varying the time from 50 ms to 1000 ms.

$$Energy\ Consumption = \frac{Ratio\ of\ Energy\ Spent}{Overall\ Network\ Energy}$$

The result proved that semi beam sector antenna consumed 10 % of energy compared with Omni directional antenna which is depicted in the Figure 5.1.

### 5.2 Throughput

Throughput is defined at successful packet send from the sender to the receiver which is measure in bps. With efficient utilization of wireless bandwidth and minimum interference makes the throughput is 20 % excellent compared with the Omni directional antenna method which is depicted in the Figure 5.2.

### 5.3 Signal to Noise Ratio

Signal to noise ratio is the ratio of between signal power average and interferences on noise sources. It is expressed in decibel value db. Usage of semi beam sector based antenna in transmission the possibility of collision and interference is less which support for improving the signal power and reduce the interferences. As a resultant the SNR produces betterment in 50% comparing with Omni directional antenna which is shown in the Figure 5.3.

### 5.4 Delay

Delay is occur when the more time taken for transmitting of packet from sender to the receiver. Semi Beam sector based antenna the transmission beam and receiving beam is determined and hidden and exposed nodes collision avoided which aids in improvement of reducing the delay. Delay variation proposed and compared model is tolerable accepting delay also shown in the Figure 5.4

## 6. CONCLUSION

This article elaborates the Semi Beam based directional antenna for making the transmission between the nodes in MANET. The simulation results are shown that better improvement from the performance factors of Physical layer. Comparing with the proposed work with existing Omni direction antenna the semi beam based antenna performance proved in 20 % to 30% and Efficiency metric value in better improvement in 20 % to 25% .From this Comparison the Gain of Omni directional antenna is 8 dBi where the Beam sector Antenna 10 dBi . This metric value comparison taken only the efficiency parameter which can be enhance in to other factors like speed, collision rate and power. In future this antenna can be implemented with any kind of MANET protocol to find the better environment.

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*Table 4.1 Network Simulator Parameter Setup*

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| S.No | Parameter | Value set |
|---|---|---|
| 1 | PHY | DSSS |
| 2 | CWmin | 32 bit |
| 3 | CWmax | 1024 bit |
| 4 | Channel Data Rate | 11Mbps |
| 5 | Basic Data Rate | 1Mbps |
| 6 | SIFS | 15 µs |
| 7 | DIFS | 45 µs |
| 8 | Slot time | 15 µs |
| 9 | Propagation delay | 1 µs |
| 10 | Packet Payload | 10000bits |
| 11 | MAC Header | 200 bits |
| 12 | PHY Header | 150bits |
| 13 | ACK | 250 bits |
| 14 | RTS | 250 bits |
| 15 | CTS | 250 bits |
| 16 | Hidden signal | 250 bits |
| 17 | Exposed Signal | 250 bits |

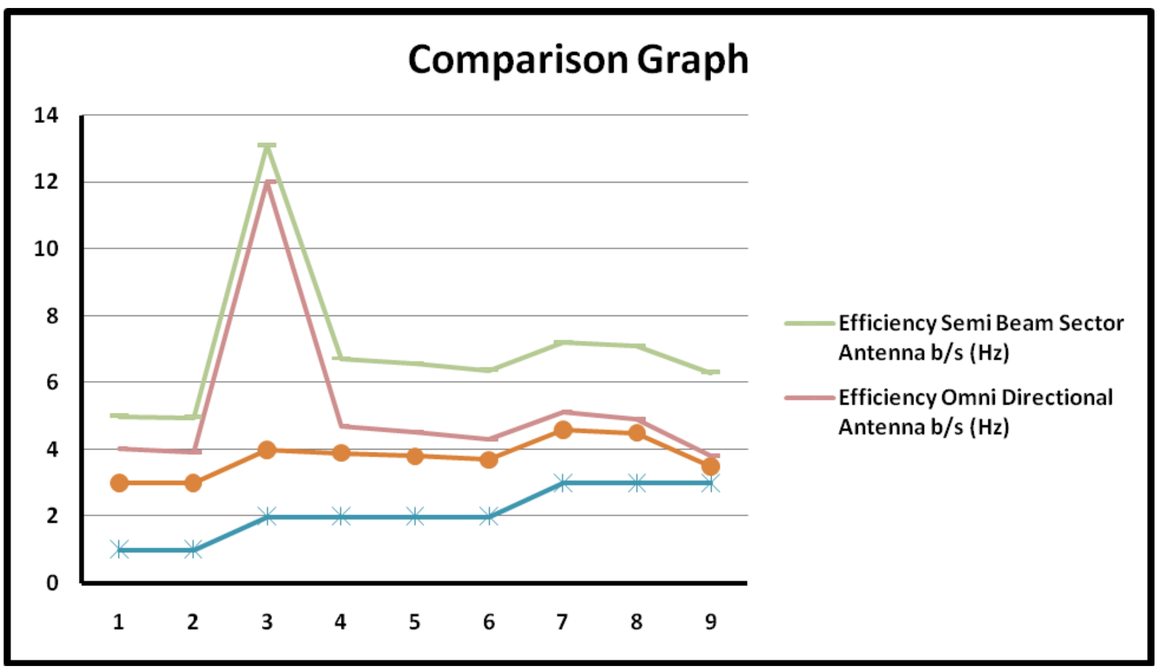


*Figure 4.1 Efficiency Metric Value*

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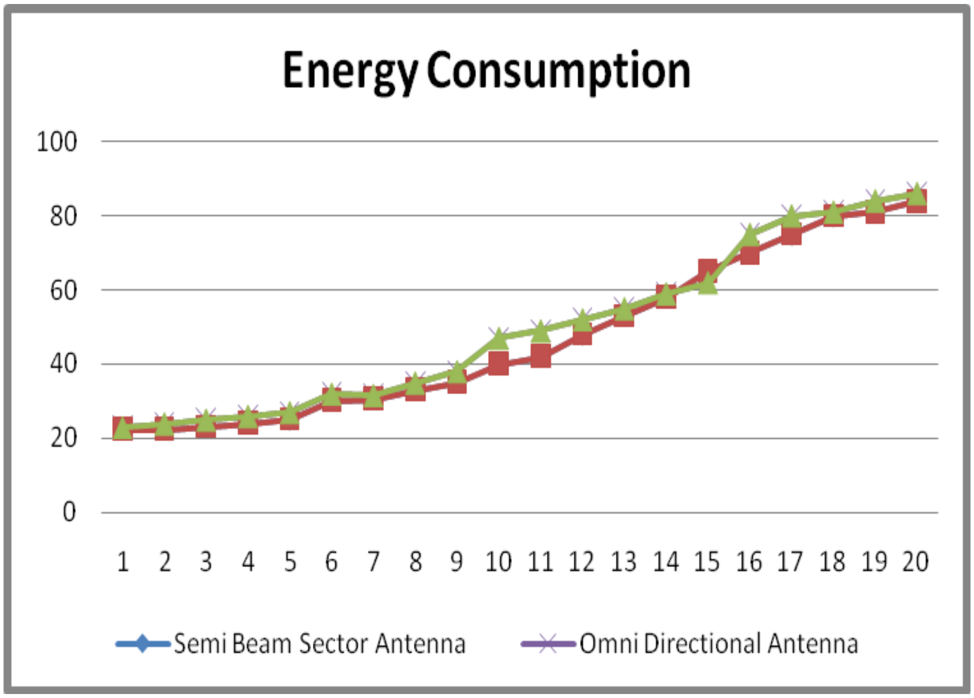


*Figure5.1 Energy Consumption*

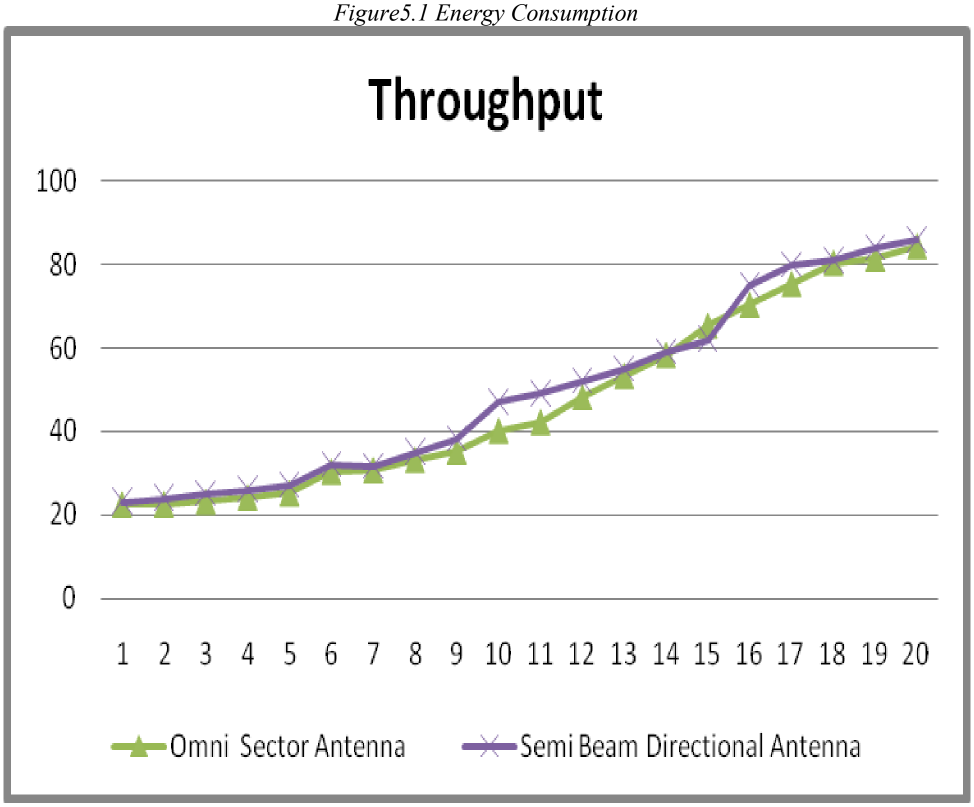


*Figure 5.2 Throughput*

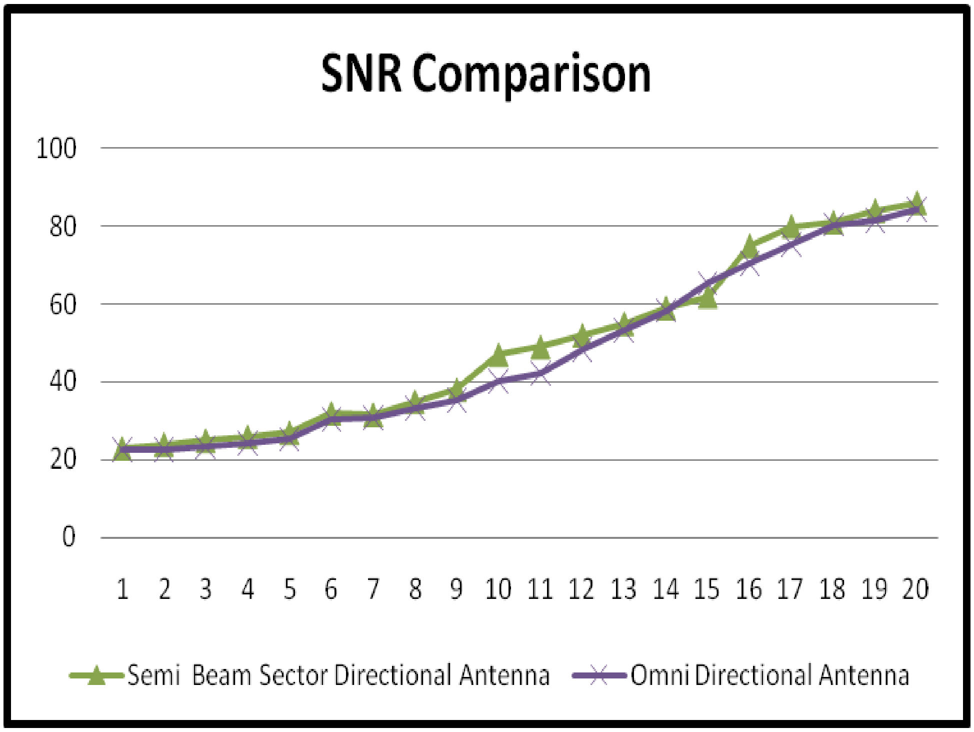


*Figure 5.3 Signal To Noise Ratio*

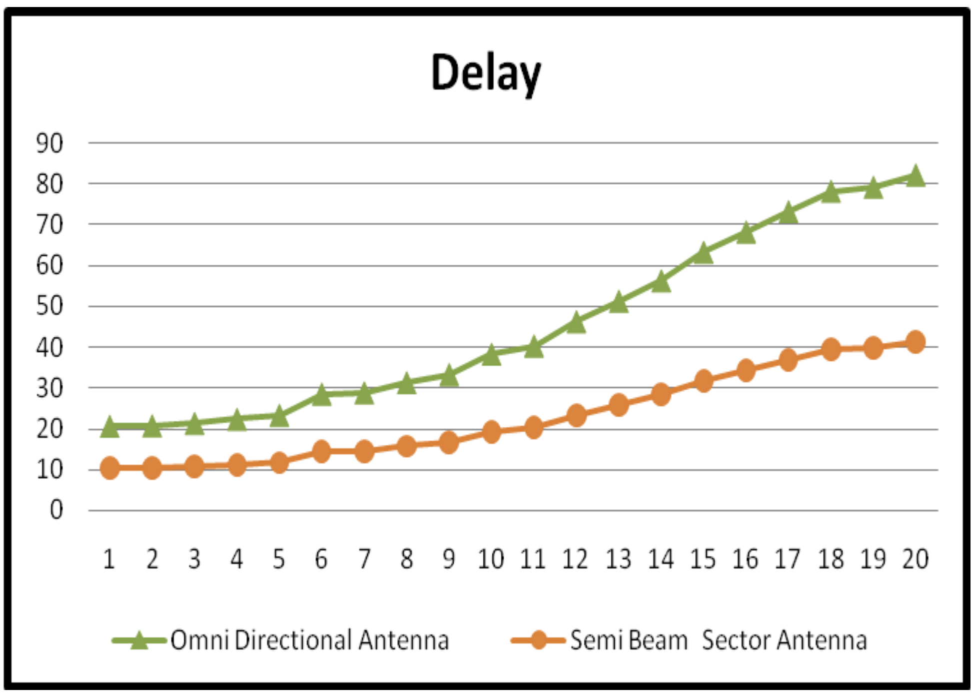


*Figure 5.4 Delay*