

Performance Analysis Of Effect Of Directional Antennas On Energy In Routing Protocol

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ABSTRACT

In this paper we have presented an analytical model for power-aware, multi-hop wireless network nodes equipped with antennas such as omni directional, steerable and switched beam antennas. Complexity is day by day increasing of routing between the nodes because of highly dynamic nature of the mobile ad hoc network results due to frequent change in network topology. However, it may be possible to improve the network Congestion by using directional antennas. To find out which directional antenna gives better performance for mobile ad hoc networks, In this paper, we compare and analyze different directional antennas for various routing protocols such as DSR, OLSR, ZRP which comprise a good mix of reactive, proactive and hybrid protocols. To determined the average jitter, average end to end delay and throughput for application layer and power consumption between nodes in physical layer by using omni- directional, steerable and switched beam antennas. We are using Random waypoint mobility with rectangular frame in this simulation which is done with the QualNet 5.01 simulator.

Keywords - Ad hoc network, AODV, DSR, Directional antenna, QualNet, ZRP

I. INTRODUCTION

Established wireless communication systems employ directional antennas which waste channel resource by radiating radio frequency energy in all directions. Directional antennas provide large coverage area and lower power consumption, because of these advantages; directional antennas have been adopted in Mobile ad hoc networks, cellular network system 2G and 3G. Complexities day by day increasing of routing between the nodes because of highly dynamic nature and bandwidth of the mobile ad hoc network results in regular change in network topology. If the networks have a large number of nodes, the transmission of routing information will consume most of the bandwidth. Nodes in mobile ad-hoc network sharing same random access wireless channel and each node function not only as a host

but also as a router that maintains routes to and forwards data for the other nodes in the networks that may not be within wireless transmission range. Routing in the mobile ad hoc networks faces challenges due to mobility of the nodes a large number of nodes, and communication between nodes resource constrained like energy and bandwidth [1][9]. This requires the ad hoc network to have high capability of self-organization and maintenance which is fulfilled by utilizing intellectual routing protocol and efficient resource management in a distributed manner. The routing protocol may generally be categorized three types such as: Reactive, Proactive and hybrid routing protocol. Reactive type of routing creates routes only when desired by the source node for example AODV, DSR and DYMO [2]. Table driven routing protocols attempt to maintain up to date routing information from each node to every other node in the network for example OLSR, LANMAR[3]. Hybrid routing is a combination of proactive and reactive for example ZRP [4]. Both reactive and proactive routing protocols have their advantages and disadvantages in conditions of routing power consumption and table size. In this paper we have compared and analysis the reactive proactive and hybrid routing protocols like: DSR, OLSR and ZRP on the basis of average jitter, average end to end delay, throughput and power consumption in receive transmit and ideal mode using omni-directional, steerable and switched mode directional antennas. Which may be possible to improve the network node congestion?

The rest of the paper is organized in following structure: Section II presents the related work. Section III presents a description of omni directional, steerable, and switched beam antenna and routing protocols. Section IV presents simulation setup and analysis of the results and section V contains conclusion of the paper.

II. RELATED WORKS

In this paper authors have evaluated to find out which directional antennas are more beneficial between these omni-directional, steerable and switched beam to ad hoc network and are essential to evaluate the effects of directional antennas on the

performance of various routing protocols DSR, OLSR and ZRP. In this paper we evaluated the performance of DSR, OLSR and ZRP using different directional antenna and all parameters selected by simulator [7]. In the ad hoc wireless networks, battery power is a very critical resource in sensor networks. One such aspect nodes are operated normally power is provided by batteries. Therefore energy conserving has become a very important goal, for energy conservation different algorithms have been proposed to realize power efficiency during the routing process. Directional antennas have been used to reduce transmission power as well as to decrease obstruction in the networks. Author design an energy model for the use of different directional antenna based scenario in QualNet to find out energy consumption on each node when data is transmit or receive.

This paper can be concluded from the following four aspects:

- Author presents the summary of directional antennas (omni-directional, steerable and switched beam) technology starting from very essential elements and gives a general overview of operating principle [15].
- We present the current ad hoc MAC protocols (IEEE 802.11 family protocols) and three categories of ad hoc routing protocols (reactive, proactive and hybrid routing protocols) in detail. We present one popular routing protocols for each category and ignored others. The three routing protocols are dynamic source routing (DSR), Optimized Link State Routing (OLSR) and Zone Routing Protocol (ZRP) [14].
- We perform the result in the application and physical layer when utilizing directional antennas and reviews several proposed average jitter, average end to end delay, total packet receive, and throughput for a comparison of these proposals from technical point of views.
- We investigate the improvement in ad hoc routing and network performance with directional antennas in power consumption mode routing protocols compared with omni-directional antenna, steerable and switched beam antenna for static and mobility scenarios through case study which is done with the QualNet simulator[15].
- The Random way point mobility model metric and node pause time in this paper covers the classes of routing protocols like proactive, reactive and hybrid, which provides valuable direction for the performance of all routing protocols under various network conditions.

III. OVERVIEW OF ANTENNAS

There are two main types of directional antenna: mechanically switched and phased array. Even as both have the desired directional attributes. In our simulation we are taking number of directional antennas as follows.

A. Omni-directional Antenna

An omni-directional antenna [9] scheme may provide more connecting links than a directional antenna scheme if nodes in a network are located within each other's transmission range. However, closely located nodes are very likely to face co-channel interference during simultaneous transmission. The number of collisions and packet drops increases and hence the network performance degrades. A directional antenna scheme may provide fewer links in a network. Fewer links may seem to cause poor routing performance, but we believe that using directional antenna schemes can outperform omni-directional antenna schemes. Our simulation results support this [11][15]. Omni-directional antennas radiate energy in all directions for a given transmission power. The range using omni-directional antennas is lower than when using directional antennas. Ad-hoc routing algorithms with omni-directional antennas and fixed transmission power have an upper bound to the number of intermediate hops between a pair of source and destination. Directional antennas may resolve this problem using the same amount of transmission energy. They can focus beams at narrow angles. This can decrease channel interference of other nodes falling beyond the transmission angle, increase the transmission range and contribute to bridging voids in a network. Gain of a directional antenna over its omni-directional counterpart depends on how narrow the primary beam (lobe) is. Interference by secondary lobes can reduce the effective transmission range of the primary lobe [11].

B. Steerable Antenna

Steerable Antenna is directional antennas and has the ability to direct the beam in a particular direction. In Steerable antenna whose major lobe can be readily shifted in direction. The beam cannot be focused to the specific angle of the receiver [9][15]. Steerable antenna has a capability to do above mentioned task. Even steerable antennas are complete setup up of a number of antenna elements. Steerable antenna system have a logic combines the antenna elements in such a way that the beam is directed towards any given angle. These antennas are also capable to minimize the obstruction from the unwanted nodes. By mixing the antenna elements in such a way that main lobe, side lobes and tail lobe is not intended towards the interferer, then antenna reduces the interference.

C. Switched beam Antenna

In switched beam antennas [15], space is divided into a fixed number of equally divided sectors. Each antenna element transmits a beam such that covers one sector. The switched beam antenna is the simplest smart directional antenna. The antenna that explores a number of fixed beams

in prearranged directions at the antenna site. Switched beam antenna base station selects the beam that supports the maximum Signal to Interference and Noise Ratio (SINR) [13]. As the mobile terminal moves, base station would switch among several beams that provide the best performance according to changing propagation conditions. Switched beam antenna could attain an array gain of K due to K beams and a range gain. The switched beam antenna construct a group of overlapped fixed directional beams together result in omni-directional coverage. The opinion of switching function is to select among separate antenna elements in receiving mode or predefined range beams in transmission mode. The main disadvantage of the switched beam antenna is the permanent nature of the beams. These beams cannot be focused to the specific angle of the receiver. Switched Beam Antennas are simpler and cheaper than steerable antennas.

IV. MANET ROUTING PROTOCOLS

Routing means to select a path. Routing in MANET means to select a right and suitable path from source to destination. Routing protocols [5] in MANETs are classified into three different categories according to their functionality.

1. Reactive (On-demand) protocols (DSR)
2. Proactive (Table driven) protocols (OLSR)
3. Hybrid protocols (ZRP)

A. Dynamic Source Routing (DSR) Protocol

Dynamic Source Routing (DSR) [10] is a reactive protocol and as well known as on demand i.e. it doesn't use interrupted advertisements. It computes the routes when required and then maintains them. Dynamic Source routing is a routing method in which the sender of a packet determines the complete string of nodes through which the packet has to pass. There are two major stages in working of DSR: Route Discovery and Route Maintenance. A host initiating a route discovery broadcasts a route request packet which may be received by those hosts within wireless transmission range of it. The route request packet identifies the host, referred to as the target of the route discovery, for which the route is requested. If the route discovery is successful the initiating host receives a route reply packet listing a sequence of network hops through which it may reach the target. While a host is using any source route, it monitors the continued correct operation of that route. This monitoring of the correct operation of a route in use is called route maintenance. When route maintenance detects a problem with a route in use, route discovery may be used again to discover a new, correct route to the destination. DSR [10] uses no periodic routing advertisement messages, thereby reducing network bandwidth overhead, particularly during periods when little or no significant host

movement is taking place. DSR has a unique advantage by virtue of source routing.

B. Optimized Link State Routing (OLSR)

Optimized Link State Routing (OLSR) is a proactive MANET routing protocol. OLSR reduces the number of retransmissions by providing best possible routes in terms of number of hops. For this purpose, the protocol uses Multipoint Relays to efficiently flood its control messages by declaring the links of neighbors. Only the Mid Point Relays of a node retransmit its broadcast messages, hence no extra control interchange is generated in response to link failures [12]. OLSR is particularly suitable for huge and dense networks. The path from source to destination consists of a sequence of hops through the Mid Point Relays. In OLSR, a HELLO message is broadcasted to all of its neighbors containing information about its neighbors and their link status and received by the nodes which are one hop away but they are not passed on to further nodes. OLSR is designed to work in a completely different manner and does not need to transmission of control messages. Control messages contain a string number which is incremented for each message. Thus the receiver of a control message can easily identify which information is needed and up-to-date - even if the received messages are not in order.

C. Zone Routing Protocol (ZRP)

ZRP [12][14] is a hybrid routing protocols which combines the best properties of both proactive and reactive and takes improvement of proactive routing uses excess bandwidth to maintain routing information, while reactive routing involves long route request delays. Therefore, ZRP reduces the proactive scope to a zone centered on each node. In a limited zone, the amount of routing information never used is minimized. In ZRP each node is assumed to maintain routing information only for those nodes that are within its routing zone. Because the updates are only propagated locally, the amount of update traffic required to maintain a routing zone does not depend on the total number of network nodes of both ON-demand and table driven routing protocol .

V. SIMULATION SETUP

A. QuaiNet 5.01:

The simulator used in this paper is QualNet 5.0.1, [16] which is developed by Scalable Network Technologies. The simulation is running based on discrete event scheduler. So as to means the simulation is not performed in a constant time flow, but at specific points of time when events occur. QualNet is a predictive high-fidelity modeling tool for wired and wireless networks of tens of thousands of nodes. It employ of computational resources of

mobility models in large-scale networks with heavy traffic load for reasonable simulation times.

B. QualNet implemented models:

QualNet is implemented using a TCP/IP network model which is similar to layered architecture as shown in Fig. 2. The application layer takes place of traffic generation and application level routing. Numerous traffic generator models and application level routing protocols have been implemented in QualNet. Different Traffic generators supported include HTTP, MCBR, CBR, FTP, VoIP, TELNET, VBR etc. FTP (File Transfer Protocol) is often used to simulate transferring files between server and client, CBR (Constant Bit Rate) is often used to simulate fixed-rate uncompressed multimedia traffic. The (VoIP) Voice over Internet Protocol is used to simulate the routing of voice conversations over the internet or through any other IP based network. In PHY layer, QualNet supports three propagation models pathloss, free space, two ray and irregular terrain. It offers two fading models: Ricean and Rayleigh model. QualNet provides three antenna models: omni-directional, switched-beam and steerable antenna [16].

C. Simulation Methodology

In this paper simulation is performed by increasing the no. of node 10 to 100 linearly with in the simulation area 1500x1500. The nodes are deployed randomly in the specified area and node follows the random way point mobility model. These source nodes transmit 1000 byte data packets per second at a constant bit rate (CBR) across the established route for the entire simulation time 30 second.

D. Snapshot

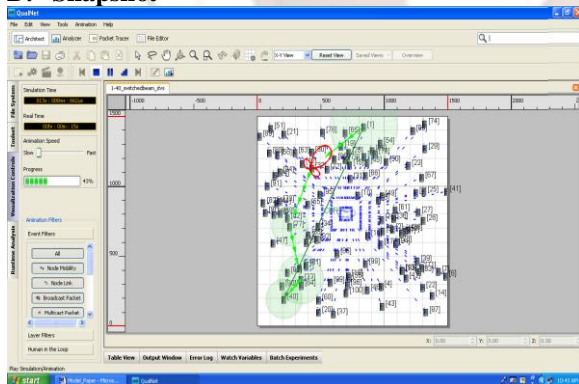


Fig. 1 snapshot of simulation scenario representing route discovery mechanism of 100 nodes for dsr routing.

Fig. 2 QualNet Implemented protocols

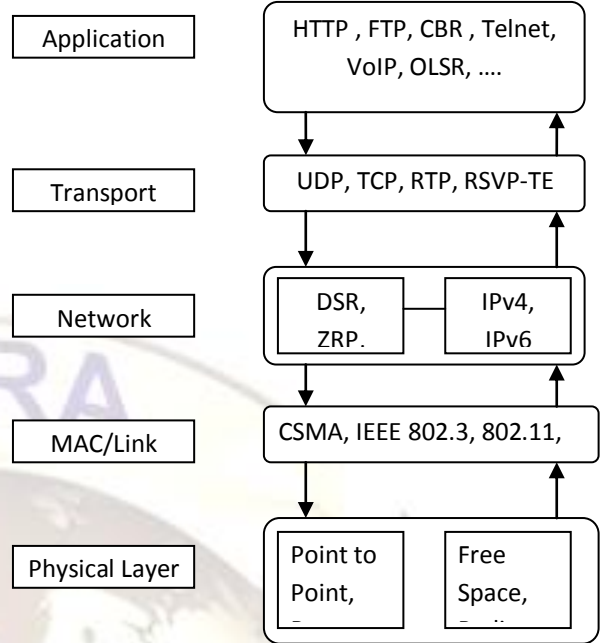


Table 1 Parameters we consider for Simulation Setup

Parameter	Value
Simulator	QUALNET 5.01
Routing Protocols	OLSR, DSR, ZRP
Mac Type	IEEE 802.11
Number of Nodes	100
Transmission range	600m
Simulation Time	30s
Simulation Area	1500 X 1500
Mobility Model	Random Waypoint Mobility
Energy Model	Mica-Motes
Traffic Type	Constant-Bit Rate
Node Placement Model	Random
Battery Model	Linear Model
Full Battery Capacity	1000 (mA,h)
Battery Charge Monitoring Interval	30 Sec.
Antenna Models	Omni direction Steerable Switched Mode
Total packet sent	24
Packet Size	12288 Bytes
Throughput	4274
Channel Frequency	2.4 GHz

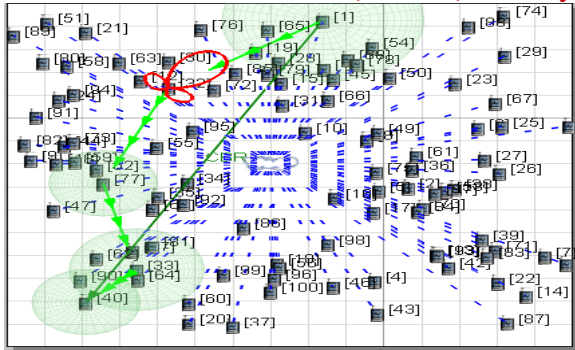


Fig. 3 snapshot of simulation scenario representing cbr between nodes 1 to node 40

VI. RESULTS AND DISCUSSION

A. Impact on Average Jitter

Average Jitter: It is the alteration in arrival time of the packets and caused due obstruction, topology changes. It is measured in second.

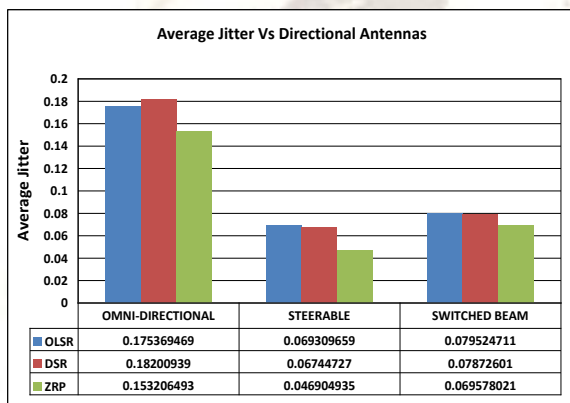


Fig. 4 average jitter for different routing protocols vs using directional antennas

Fig. 4 shows the impact of directional antennas on the Average Jitter taking routing protocol as parameter. Following assumption can be made:

- The DSR presents highest values of Average Jitter for omni and switched beam antennas.
- The OLSR shows highest value of Average Jitter for steerable antenna.
- The ZRP presents least value of the average jitter for all three directional antennas.

B. Impact on Average End to End Delay

End-to-End Delay: Delays due to buffering during the interface queues, route discovery process, and transfer the channel. It measured in second.

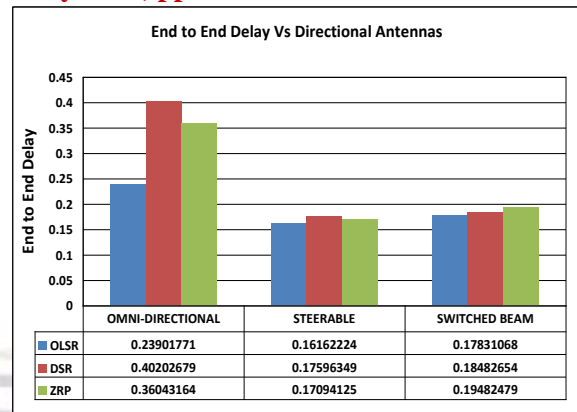


Fig. 5 end to end delay for different routing protocols vs using directional antennas

Fig. 5 shows the impact of directional antennas on the End to End Delay taking routing protocol as parameter. Following assumption can be made:

- The DSR presents highest values of End to End Delay for omni and steerable antennas.
- The OLSR presents least value of End to End Delay for all three directional antennas.

C. Impact on Throughput

Throughput: Average rate of successful data packets received at destination is called throughput. It is genuine output and precise in bps (bit/s)

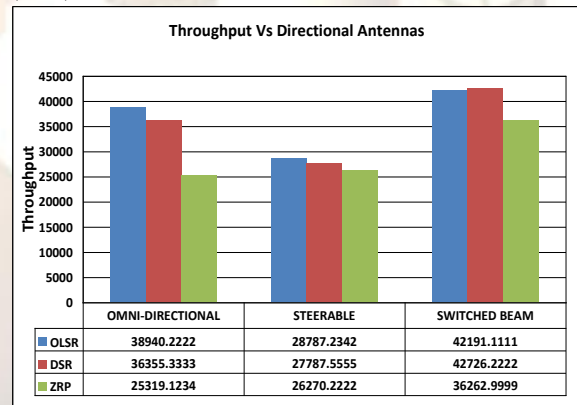


Fig. 6 throughput for different routing protocols vs using directional antennas

Fig. 6 shows the impact of directional antennas on the Throughput taking routing protocol as parameter. Following statement can be made:

- The DSR presents highest values of Throughput for switched beam antenna.
- The OLSR shows highest value of Throughput for omni-directional antenna.
- The ZRP presents least value of the average jitter for all three directional antennas.

D. Impact on Energy consumed in Transmit Mode:

The mobility, scalability, efficiency, lifetime, effective sampling frequency and response

time of nodes, all these parameters of the MANET depend upon the power. In case of power failure the network goes down break therefore energy is required for maintaining the individual health of the nodes in the network, during receiving the packets and transmitting the data as well.

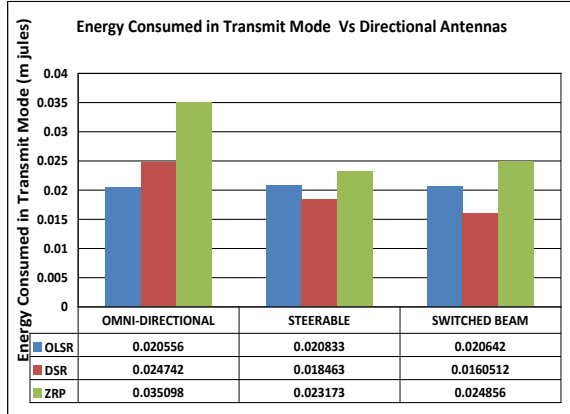


Fig. 7 energy consumed in transmit mode for different routing protocols using directional antennas

Fig. 7 shows the impact of directional antennas on the Energy Consumed in Transmit Mode taking routing protocol as parameter. Following interference can be made:

- The ZRP presents highest energy consumed in all directional antennas.
- The DSR consumes moderate energy for all three directional antennas.
- The OLSR consumes least energy in omni directional antenna.

E. Impact on Energy consumed in Transmit Mode:

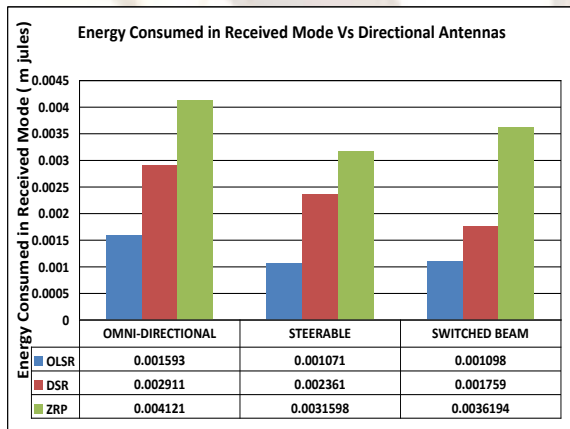


Fig. 8 energy consumed in received mode for different routing protocols using directional antennas

Fig. 8 shows the impact of directional antennas on the Energy Consumed in Received Mode taking routing protocol as parameter. Following interference can be made:

- The ZRP presents highest energy

consumed in received mode in all directional antennas.

- The DSR consumes moderate energy for all three directional antennas.
- The OLSR consumes least energy in switched beam directional antenna.

F. Impact on Energy consumed in Ideal Mode:

Fig. 9 shows the impact of directional antennas on the Energy Consumed in Ideal Mode taking routing protocol as parameter. Following interference can be made:

- The ZRP presents highest energy consumed in Ideal mode in all directional antennas.
- The DSR consumes moderate energy for all three directional antennas.
- The OLSR consumes least energy in all directional antennas.

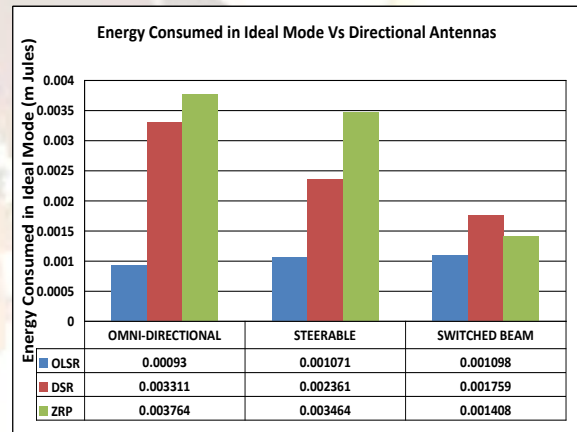


Fig. 9 Energy Consumed in Ideal Mode for different routing protocols using Directional Antennas

VII. CONCLUSION

The use of directional antennas inside Mobile Ad-hoc network can extensively improve the performance of wireless networks. Less interference and higher data rates can be achieved due to narrow directional beams using these antennas. In this paper, we have simulated and analyzed the impact of directional antennas on reactive proactive and hybrid routing protocols (OLSR, DSR and ZRP) in mobile ad-hoc networks using omni, steerable and switched beam directional antennas. These routing protocols performed throughput, delay, jitter in application layer and energy consumption in physical layer of TCP/IP and simulation results of all protocols are shown above. All these parameters of the MANET depend upon the power. In case of power failure the network goes down break therefore energy is required for maintaining the individual health of the nodes in the network, during receiving the packets and transmitting the data. Our analysis shows that by using directional antennas, ad hoc networks may achieve better performance. However, scenarios

exist in which omni-directional antennas may be suitable. With the fast development of directional antenna technology, the size of a directional antenna becomes smaller and the cost of it reduces also. The nature of radiating radio energy only towards a certain direction makes directional antennas save more power, increase transmission range and reduce neighborhood interference compared with omni-directional antennas.

However for further research is desirable to establish the best combination of physical, MAC and routing protocols in order to be able to get the most benefit out of directional antennas.

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