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PERFORMANCE ANALYSIS OF AODV, DSR AND ZRP ROUTING PROTOCOLS IN MANET USING DIRECTIONAL ANTENNA

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Abstract: In this paper a comparative study is done for different routing protocols in mobile ad-hoc network by using directional antenna. The directional antenna is metamaterial rectangular patch antenna. Performance of MANET can be improved using metamaterial antenna, because of directivity and compact size of metamaterial antenna. Complexity of routing is day by day increasing between mobile users because of dynamic nature of mobile nodes and rapid change in mobile topologies in MANET. However, it is possible to reduce the network congestions by using the directional antenna. To find out which routing protocol gives better result for mobile ad-hoc networks, in the paper, the scenario of directional metamaterial antenna is simulated for comparing and analyzing of different routing protocols such as AODV, DSR and ZRP using QualNet simulator 6.1. The metrics used for performance evaluation of different routing protocols we used throughput, average unicast end to end delay, and average unicast jitter of routing protocols.

Keywords: *Ad-hoc Network, AODV, DSR, ZRP, Qualnet*

1. INTRODUCTION

MANET stands for "mobile ad-hoc networks". A MANET is a type of network which can change its location itself. A wireless ad-hoc network is a decentralized type of network. It means that it has no infrastructure. Wireless ad-hoc network does not depend on pre-existing infrastructure, such as routers in wired networks, that's why it is called "ad-hoc". MANET is a type of wireless ad-hoc network. Each device in MANET is movable independently in any of direction, and it can change its links to other devices frequently. Each must forward traffic unrelated to its own use, and therefore be a router. The first thing in building a MANET is every mobile user to continuously maintain the information needed to properly route the traffic. MANET consist of peer-to-peer, self-forming, self-handling network. Each protocol in mobile ad-hoc network are analyzed based on measures such as packet drop rate, the overhead introduced by the routing protocol, end to end delays, network throughput, ability to scale etc. Routing protocol plays a vital role in ad-hoc networking and can be categorized in to three ways, which are proactive ad-hoc routing protocol, reactive routing protocol and hybrid routing protocol. Reactive protocol are also called as on demand protocol, AODV and DSR are reactive protocol.

2. AD-HOC ROUTING PROTOCOLS

Routing protocols are categorized in to three wide category, reactive, proactive and hybrid. Reactive protocol is also called on demand routing protocol which tries to discover a path to a destination only when the network protocol receives a packet addressed to that destination. Ad-hoc on demand distance vector (AODV), dynamic source routing (DSR) and dynamic MANET on demand (DYMO) are reactive protocols. Categories of routing protocols according to their functionality are given below-

a. Reactive(On demand) Protocols(AODV and DSR)
b. Proactive(Table driven) Protocols(STAR)
c. Hybrid Protocols(ZRP)

A. Ad-hoc On Demand Distance Vector Protocol (AODV)

Ad-hoc network is the cooperative network and a collection of mobile nodes which are movable in routing zone without the required request of any existing infrastructure. The idea of forming an of wireless ad-hoc network of mobile nodes dates back to DARPA packet radio network (802.11b) now a days [1, 2]. There are different current papers on this topic have focused on algorithmic complexity of choosing the optimal set of ad-hoc routers [3, 4, 5], while other have proposed different routing solutions [6, 7, 8, 9, 10, 11] having leveraging features from the existing internet routing based algorithms.

When a node wishes to send a packet to same destination then it checks its routing table to determine if it has a current route to the destination, if yes then forwards the packet to next hop node and if no then it initiates a route discovery process and then finds a proper route to transfer the information packets. AODV utilizes routing table [13] to store routing information-

a. A routing table for unicast router
b. A routing table for multicast router

AODV discovers route as and when necessary and does not maintain routes from every node to every other mobile node. Routing is maintained just as long as necessary to maintain between mobile node, if any node is not in use then its routing can be avoided. Every node maintain its monotonically increasing number of sequence, increases every time the node notices in the neighborhood topology.

B. Dynamic Source Routing Protocol (DSR)

Dynamic source routing protocol is used for mesh type network for networking usage. [12]Dynamic source routing protocol works similarly as ad-hoc on demand distance vector (AODV) protocol, as on demand routing when source mobile node requests for transmitting. The remembering paths of routes are used to route the packet. To complete the source routing, the routed message packets are having the address of each device the packet will transverse. But this may results in overhead problem for long routing address. Dynamic source routing protocol substitutionally describes a flow id option that allow message packets to forward, for avoiding source routing.

Dynamic source routing (DSR) protocol is mainly based on source routing methodology whereas all routing information is dynamically updated at all the mobile nodes [13]. There are two functions in DSR, route discovery and route maintenance.

DSR routing protocol is mainly designed to overcome from the bandwidth problem because of consuming by the control packets in wireless ad-hoc networks by extracting the periodic update messages required in the table driven approach. The main point in DSR routing protocol is that it does not require periodic hello packet (beacon) transmissions. The mobile nodes uses these hello packet to inform the nearby nodes of their presence. Route request packet is send by mobile node and route reply packet sends back to the source for the acknowledgement.

C. Zone Routing Protocol (ZRP)

Zone routing protocol (ZRP) comes under the hybrid routing protocols (ZRP) are having the best properties of both proactive and reactive protocol. In proactive routing protocol greater bandwidth to maintain routing information, whereas reactive routing protocols involves large route request time.

The amount of routing information which are not in use is minimized. In ZRP routing protocol each mobile node is having routing information only for those mobile nodes which are in the routing zone, that's why this protocol is called zone routing protocol. The amount of update traffic required to maintain routing zone, never depends on the number of network nodes of both table driven and on demand routing protocol.

3. METAMATERIAL ANTENNA

Metamaterial are assemblies of various elements such as plastics and metamaterial are fabricated to get properties that have not yet been found in original natural materials. Metamaterial are a class of electrically small antennas and increased performance. Using metamaterial, the size of conventional antenna can be reduced. Metamaterial added on conventional antenna with added spacing of greater relative permittivity, in given antenna the spacing is given by FR-4 lossy element and above this lossy material the layer of PEC material is added. The metamaterial antenna used here having hexagonal structure of PEC above fr-4 lossy spacing. The metamaterial antenna which is used in this paper for performance analysis is given below
Frequency of metamaterial antenna = 1.382 GHz
Gain of metamaterial antenna = 4.2 dB

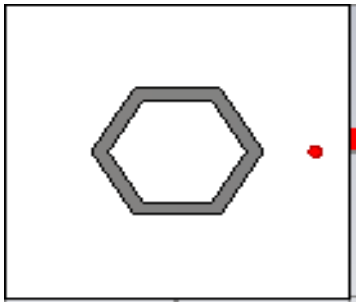

Fig-1: Front View of Metamaterial Antenna

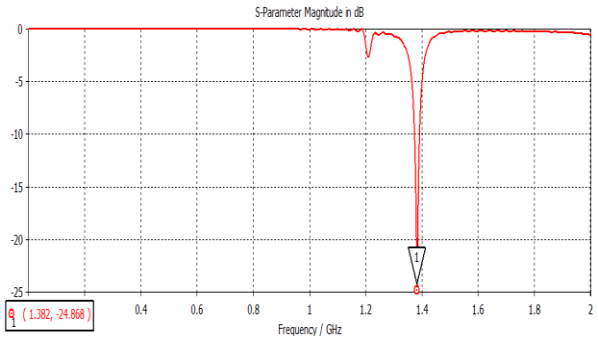

Fig-2: Return loss of metamaterial Patch Antenna

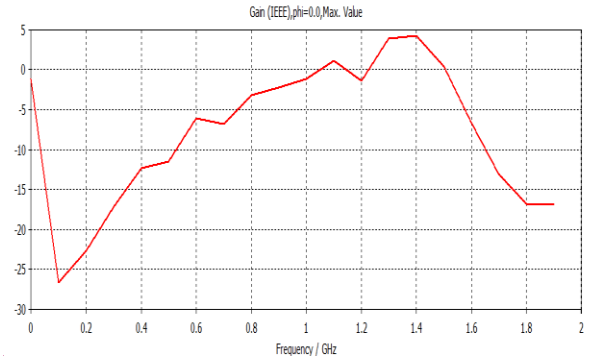

Fig-3: Gain of Metamaterial Patch Antenna

4. SIMULATION ENVIRONMENT

Performance analysis of the routing protocols can be done by evaluating and comparing of effectiveness of performance metrics in mobile ad-hoc network. We performed the simulations of different routing protocols such as AODV, DSR and ZRP on QualNet simulator 6.01. Each simulation is done under none mobility of mobile nodes. The channel used here is of wireless type with 40 mobile nodes.

5. SIMULATION PARAMETERS

Simulation of the proposed performance analysis using different routing protocol was done in QualNet 6.1 simulator using steerable antenna. The proposed scenario is simulated with 40 mobile nodes and CBR. Performance metrics are compared of three antennas with varying simulation time from 30 sec to 150 sec. Start time and end time are set to 1 sec and 150 second respectively.

The simulation parameters are listed in table given below

Table-1 simulation parameters

PARAMETERS	VALUE
Antenna type	Metamaterial Antenna
Traffic Type	CBR
Item to Send	100
Item Size	512 bytes
Start Time	1 sec
End Time	150 sec
Number of Nodes	40
Channel Type	Wireless Channel
Data Rate	2Mbps
Protocol Used	AODV, DSR, ZRP
Antenna Frequency	1.382Ghz
Antenna Gain	4.2db
Terrain Size	1500× 1500
Simulation Time	Varying From 30 sec to 150 sec

6. PERFORMANCE METRICS

Performance metrics used in the simulation for performance analysis of ad-hoc routing protocols are given below

a. Average Jitter

Jitter shows the unsteady movement or unsteadiness behavior of data transfer in mobile ad-hoc network. Jitter shows the irregular movement of transmitted packets. Low jitter or low unsteadiness is required for better performance of the MANET.

b. Average End-to-End Delay

Average end-to-end delay represents the average time taken by the information packets to reach from source node to the destination mobile node. The end-to-end delay should

be as small as possible for better performance of mobile ad-hoc network. With less amount of end-to-end delay the mobile network performs better as compared to having large value of end-to-end delay.

c. Throughput (bits/sec)

Throughput shows the average rate of message delivery over wireless communication channel. Throughput is measured from the received message information and total transmitted information packets or we can say throughput as amount of data packets received successfully at the destination mobile node in wireless ad-hoc network. Number of connection or complexity of network affects the throughput. For better wireless network through should be as high as possible.

7. SIMULATION RESULTS

Performance of the AODV, DSR and ZRP routing protocols using directional antenna are decided from comparison of performance metrics like average jitter, average end-to-end delay, throughput and average packet received ratio. Ad-hoc routing protocol having maximum the throughput and lower the average end to end delay and jitter will perform better in networking then other routing protocols. The performance metrics are compared one by one using different routing protocols. By using given parameters, the simulation of performance metrics has been done in QualNET simulator 6.1 and given below in tabular and graph form.

Table-2 Average Jitter

Routing Protocol	Simulation Time (sec)				
	30	60	90	120	150
AODV	0.0049	0.0025	0.0018	0.0016	0.0016
DSR	0.0052	0.0027	0.0019	0.0017	0.0017
ZRP	0.0037	0.0020	0.0015	0.0014	0.0014
Omnidirectional	0.021	0.015	0.012	0.010	0.010

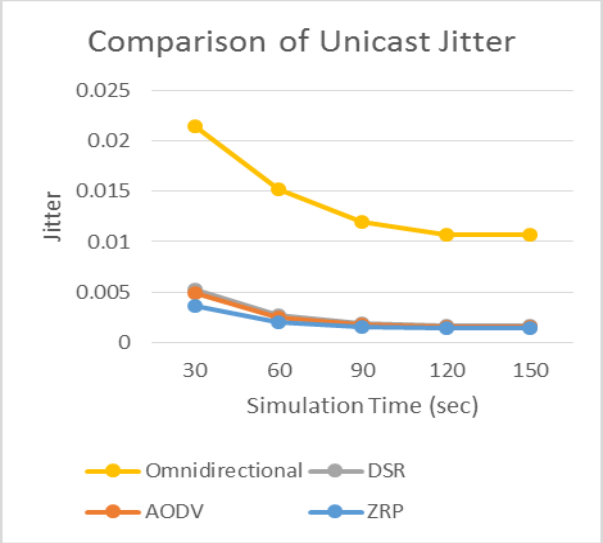

Fig-4: comparison of jitter

So, while we use AODV routing protocol, unicast jitter is found moderate, so this protocol does not give the better performance. DSR routing protocol has maximum jitter value among all these three routing protocol for given metamaterial directional rectangular patch antenna. ZRP routing protocol has minimum value of average unicast jitter, which is suitable condition of ad-hoc network to perform better. Jitter using omnidirectional antenna is maximum that's why directional antenna is preferred.

Table-3 Average End-to-End Delay

Routing Protocol	Simulation Time (sec)				
	30	60	90	120	150
AODV	0.0115	0.0092	0.0085	0.0083	0.0083
DSR	0.0117	0.0093	0.0085	0.0083	0.0083
ZRP	0.0113	0.0092	0.0085	0.0083	0.0083
Omnidirectional	0.035	0.027	0.024	0.022	0.022

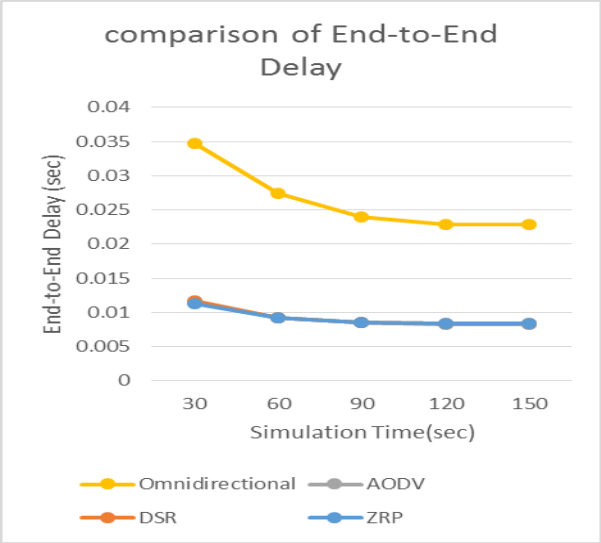

Fig-5: comparisom of average end-to-end delay

So, ZRP routing protocol shows minimum end-to-end delay. It means time taken in transfer of information packets using AODV routing protocol is maximum whereas while we are using DSR routing protocol, end-to-end delay is almost same as end to end delay in AODV routing protocol. Above graph and table shows that ZRP routing protocol takes minimum time to transfer the information packets from source node to the destination node. AODV and DSR takes almost same time to transfer the data from source node to destination node. Delay comes maximum while omnidirectional antenna is used.

Table-4 Throughput

Routing protocol	Simulation Time (sec)				
	30	60	90	120	150
AODV	4115.5	4105.6	4102.4	4142.9	4142.9
DSR	4116.2	4105.9	4102.6	4143	4143
ZRP	4108.9	4102.4	4100.2	4140.9	4140.9
Omnidirectional	4008	3983	3975	4028	4028

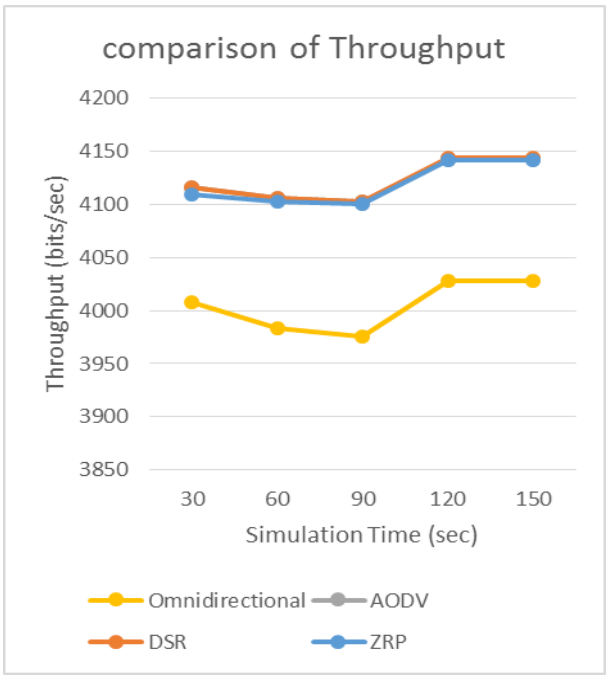

Fig-6: comparison of throughput

So, while we use DSR routing protocol, the average throughput found to be maximum compared to the other routing protocols. ZRP routing protocol having smaller throughput in compared to DSR routing protocol. Throughput using omnidirectional antenna is minimum so directional antenna is used to increase throughput.

7. Conclusion

The use of directional antenna in mobile ad-hoc network can improve the performance of wireless networks. Small interference and higher data rates can be received due to narrow directional beams using these directional antennas. In this paper we have simulated and analyzed the

directional antenna on AODV, DSR and ZRP routing protocols in mobile ad-hoc networks. These routing protocol performs throughput, unicast jitter, end-to-end delay and average packet received ratio in application layer and simulation results of all protocols are shown above. The DSR protocol exhibits higher rate of successfully routing data packets and larger number of packets/bytes delivered to their receiving end. ZRP incurs the lowest end-to-end delay per data packet and the average jitter among the three routing protocols, ZRP having the minimum value. So DSR routing protocol performed better in comparison to AODV and ZRP routing protocol when minimum end-to-end delay is required but highest throughput and almost same jitter value and by using DSR routing protocol.

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BIOGRAPHIES

Abhishek Dixit obtained his B.Tech in Electronics and Communication Engineering from Uttar Pradesh Technical University Lucknow, India, in 2012. Currently he is pursuing his M.Tech in Microwave Engineering from Madhav Institute of Technology and Science, Gwalior (M.P.), India. His current area of interest is to improve the performance of ad-hoc networking by using Directional Antennas.

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