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COMPARITIVE ANALYSIS OF ROUTING PROTOCOLS IN MOBILE ADHOC NETWORKS

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Abstract

Mobile Adhoc Network (MANET) is a collection of wireless mobile nodes that dynamically form a network temporarily without any support of central administration. Moreover, every node in MANET moves arbitrarily making the multi-hop network topology to change randomly at unpredictable times. There are several familiar routing protocols like DSDV, AODV, ZRP, etc… which have been proposed for providing communication among all the nodes in the network. This paper presents a performance comparison of proactive, reactive and hybrid protocols DSDV, AODV and ZRP based on metrics such as packet delivery ratio, number of Collisions and average end-to-end delay by using the GloMoSim simulator.

Keywords: *MANET, DSDV, AODV, ZRP, Collision, Packet Delivery Ratio, Average End-to-End delay*

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1. INTRODUCTION

A mobile adhoc network is a collection of wireless mobile nodes that dynamically establishes the network in the absence of fixed infrastructure (Krishna Gorantala, 2006). One of the distinctive features of MANET is each node must be able to act as a router to find out the optimal path to forward a packet. As nodes may be mobile, entering and leaving the network, the topology of the network will change continuously. MANETs provide an emerging technology for civilian and military applications. Since the medium of the communication is wireless, only limited bandwidth is available. Another important constraint is energy due to the mobility of the nodes in nature. One of the important research areas in MANET is establishing and maintaining the adhoc network through the use of routing protocols. Though there are so many routing protocols available, this paper considers DSDV, AODV and ZRP for performance comparisons due to its familiarity among all other protocols. These protocols are analyzed based on the important metrics such as throughput, packet delivery ratio and average end-to-end delay and is presented with the simulation results obtained by GloMoSim simulator.

Section 2 presents the related works with a focus on the evaluation of the routing protocols. Section 3 briefly discusses the MANET routing protocols classification and the functionality of the three familiar routing protocols DSDV, AODV and ZRP. The simulation results and performance comparison of the three above said routing protocols are discussed in Section 4. Finally, Section 5 concludes with the comparisons of the overall performance of the three protocols DSDV, AODV and ZRP based on the packet delivery ratio, number of Collisions and average end-to-end delay metrics.

2. RELATED WORK

Lu Han (2004) described in paper "Wireless Ad-Hoc Networks" that Mobile Ad-hoc Networks (MANET) are a fundamentally flawed architecture. The most important thing for the networks is security. It is even important for Wireless Ad hoc Networks because its applications are in military. The MANET cannot appropriately solve the problem of the security. Routing is also a big problem. All the routing protocols for Wireless Ad hoc Networks are need patches. No suitable and stable routing protocols until now. Energy consumption problem still cannot be solved even much of efforts have been done to it. All these prove that the Wireless Ad hoc Networks is a flawed architecture.

Humayun Bakht (2011) mentioned in paper "Routing Protocols for Mobile Ad-hoc Network" that The Mobile ad-hoc network (MANET) is deployed in applications such as disaster recovery and distributed collaborative computing. Existing protocols for ad-hoc network can generally be categorized into pro-active and re-active protocols types. It is a well known fact that most of these protocols have certain weaknesses. Some of the main problem includes Limitation: limited area to a particular scenario i.e. does not perform well in all environments; Lack of analytical studies: not sufficient work has been done to evaluate their performance with respect

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to other techniques of similar types. In this paper the author analyzing some of the known and famous routing schemes like as DSDV, AODV, and ZRP.

Mrs. Razan Al-Ani (2011) defined in paper “Evaluation For Variant Manet Routing Protocols” first describes the characteristics of Mobile Ad hoc Networks (MANETs), and their Routing protocol. The simulation study of this paper for MANET network under five routing protocols AODV,DSR,OLSR,TORA, GRP, where deployed using FTP traffic analyzing. It’s checked out the behavior of these protocols with respect to three performance matrices Delay, Network, Load and Throughput. This experiment is shown behavior of MANET Routing protocols for different number of mobile nodes.

M.Sreerama Murty and M.Venkat Das (2011) mentioned in this paper “Evaluation of Manet Routing Protocols Using Various Mobility Models” that an ad hoc network is often defined as an “infrastructure less” network, meaning a network without the usual routing infrastructure like fixed routers and routing backbones. In this paper it is implemented that the Random Waypoint Model is the best model which outperforms both Random Walk Model and Random Direction Model in both scenarios. The results indicate that Random Waypoint produces the highest throughput but the throughput of the Random Walk Model and Random Direction drastically falls over a period of time.

3. MOBILE ADHOC NETWORK ROUTING PROTOCOLS

3.1 Classification of Routing Protocols

There are many ways to classify the MANET routing protocols as shown in fig 1 depending on how the protocols handle the packet to deliver from source to destination. But Routing protocols are broadly classified into three types such as Proactive, Reactive and Hybrid protocols (Abolhasan, Wysocki and Dutkiewicz, 2004).

a) Proactive Protocols

These types of protocols are called table driven protocols in which, the route to all the nodes is maintained in routing table. Packets are transferred over the predefined route specified in the routing table. In this scheme, the packet forwarding is done faster but the routing overhead is greater because all the routes have to be defined before transferring the packets. Proactive protocols have lower latency because all the routes are maintained at all the times. Some protocols for example are DSDV, WRP etc.

b) Reactive Protocols

These types of protocols are also called as On Demand Routing Protocols where the routes are not predefined for routing. A Source node calls for the route discovery phase to determine a new route whenever a transmission is needed. This route discovery mechanism is based on flooding algorithm which employs on the technique that a node just broadcasts the packet to all of its neighbors and intermediate nodes just forward that packet to their neighbors. This is a repetitive technique until it reaches the destination. Reactive techniques have smaller routing overheads but higher latency. Some protocols for example are DSR, AODV etc.

c) Hybrid Protocols

Hybrid protocols are the combinations of reactive and proactive protocols and takes advantages of these two protocols and as a result, routes are found quickly in the routing zone. Some protocol for example is ZRP.

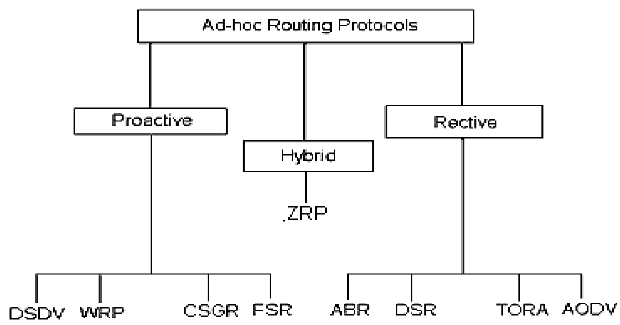

Fig-1: MANET Routing Protocols

3.2 Overview of Routing Protocols

In this section, a brief overview of the routing operations performed by the familiar protocols DSDV, AODV and DSR are discussed.

3.2.1. Destination-Sequenced Distance-Vector (DSDV) protocol

DSDV is a distance vector routing protocols. It is based on the famous distributed bellman-ford routing algorithm. DSDV is a proactive routing protocol (Sachin Kumar Gupta and R.K. Saket, 2011). It works on hop-by-hop basis meaning that every node maintains a routing table that contains next-hop entry and the number of hops needed for all reachable destinations. DSDV assumes bidirectional links and thus not have unidirectional link support. DSDV uses a concept of sequence

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numbers to provide loop freedom. The sequence number is originated by the destination node. To maintain routing information consistent within a network DSDV requires nodes to broadcast periodical route advertisement contains the routing table entries of the advertising node. This entry contains routing table entries of the advertising node. These entries contain the address of destination, next hop and hop count to that destination and the last known sequence number originated by that destination. When a node receives an advertisement it updates its routing table on the basis. Routes with greater sequence numbers are always preferred. If the sequence numbers are equal, a route with lower hop count is chosen. Note that the receiving nodes increase the hop counts in the advertisement since the destination needs one hops more to be reached. The receiving node will then subsequently pass this new information forward within its own route advertisement. The advantages are latency for route discovery is low and loop-free path is guaranteed. The disadvantage is the huge volume of control messages.

3.2.2. Ad Hoc On-demand Distance Vector Routing (AODV) protocol

Ad hoc On-Demand Destination Vector, (AODV) is a distance vector routing protocol that is reactive (Nilesh P.Bobade, Nitiket N.Malah, 2010). The reactive property of the routing protocol implies that it only requests a route when it needs one and does not require that the mobile nodes maintain routes to destinations that are not communicating. AODV guarantees loop-free routes by using sequence number that indicate how new, or fresh, a route is. AODV require s each node to maintain a routing table containing one route entry for each destination that the node is communicating with. Each route entry keeps track of certain fields. Some of these fields are: Destination IP Address: The IP address of the destination for which a route is supplied. Destination sequence number: The destination sequence number associated to the route. Next Hop: Either the destination itself or an intermediate node designated to forward packets to the destination. Hop Count: The number of hops from the originator IP Address to the Destination IP Address Lifetime: The time in milliseconds for which nodes receiving the RREP consider the route to be valid Routing flags: the state of the route; up (valid), down (not valid) or in repair

The Advantage of AODV is Routes are established on demand and destination sequence numbers are used to find the latest route to the destination. Least delay is there for connection setup. Disadvantages are AODV doesn't allow handling unidirectional links. Multiple Route Reply packets can lead to heavy control overhead. Periodic beaconing leads to unnecessary bandwidth consumption.

3.2.3 Zone Routing Protocol (ZRP)

Zone Routing Protocol (ZRP) was first introduced by Haas and Pearlman. It is a hybrid protocol. To perform operations it divides the total network area into different zones (Nicklas Beijar, 2001). Zone size or radius does not depend on the distance; it depends on the number of hops. It is applicable in a wide variety of mobile ad-hoc networks with diverse mobility across a large span. It uses separate strategy to find out new routes for nodes which are lying within or outside the zone. There are four elements available in ZRP: MAC level function, IARP, IERP and BRP. IARP, proactive protocol is used to discover route within zone and in this case, links are considered as unidirectional. But in order to communicate with the nodes which locate in different zones, nodes use IERP, on-demand routing protocol. ZRP also follows different strategies, such as routing zone topology and proactive maintenance, for improving the efficiency and quality to discover a globally reactive route using query/reply mechanism. The ZRP has versatile properties and applications. Zone radius is an important parameter of ZRP. A large routing zone is more suitable for slowly moving nodes and high demand of route scenarios. In fixed topology, network zone would be infinitely large. In fixed internet, pure proactive routing protocols are best suited. Smaller routing zone is suitable for minimum nodes and where demand of route is low. ZRP works as a normal flooding protocol.

4. SIMULATION RESULTS AND PERFORMANCE COMPARISON

4.1. Simulation Model

Simulation is a fundamental tool in the development of MANET protocols, because the difficulty to deploy and debug them in real networks. GloMoSim stands for Global Mobile information systems Simulation library is designed as a set of library modules, each of which simulates a communication protocol in the protocol stack (Tan Hwee Xian, 2004). GloMoSim simulator is chose here because it is a scalable simulator that was designed especially to large wireless networks. It supports thousands of nodes, using parallel and distributed environment.

A simulation study was carried out to evaluate the performance of MANET routing protocols such as DSDV, AODV and ZRP based on the metrics collision, packet delivery ratio and average end-to-end delay with the following parameters given in this table 1.

Experiment Parameter	Experiment Value
Simulation Time	15M
Terrain Dimension	[2000-2000]m
No. of mobile nodes	20 to 80
Node Placement	Uniform, Random waypoint motion
Mobility Speed	0-25m/s
No. of Connection	5-70
Routing Protocol	AODV,ZRP,DSDV

Table-1: General Experimental setup Parameters

Packet Delivery Ratio (PDR): It was the ratio of the number of packets actually delivered without duplicates to the destinations versus the number of data packets supposed to be received. This number represents the effectiveness and throughput of a protocol in delivering data to the intended receivers within the network. Number of successfully delivered legitimate packets as a ratio of number of generated legitimate packets.

PDR= Total Number of packets Sent / Total Number of packets Received

PDR with No. of Nodes			
No of nodes	**AODV**	**DSDV**	**ZRP**
20	0.6	0.52	0.53
40	0.73	0.61	0.68
60	0.5	0.40	0.47
80	0.47	0.31	0.35

Table-2(a): Effect of PDR with varying number of nodes

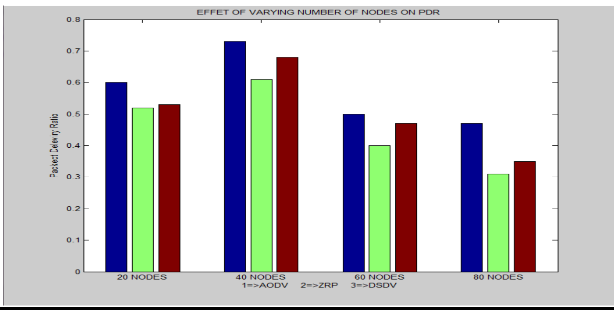

Fig-2(a): Effect on PDR with varying number of nodes.

PDR with Area of manet			
Area of Manet	**AODV**	**DSDV**	**ZRP**
250000	0.93	0.87	0.80
500000	0.88	0.82	0.75
1000000	0.85	0.79	0.71
1500000	0.81	0.73	0.68

Table-2(b): Effect of PDR with varying area of manet

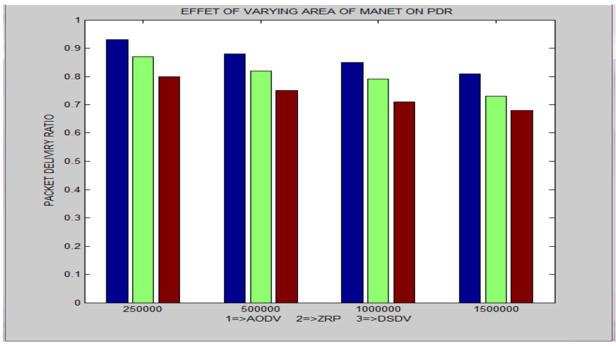

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Fig-2(b): Effect on PDR with varying Area of Manet

PDR with Varying Mobility			
Mobility Speed	**AODV**	**DSDV**	**ZRP**
5	0.97	0.92	0.86
10	0.86	0.89	0.82
15	0.79	0.85	0.76
20	0.75	0.78	0.71

Table-2(c): Effect of PDR with varying speed of mobility

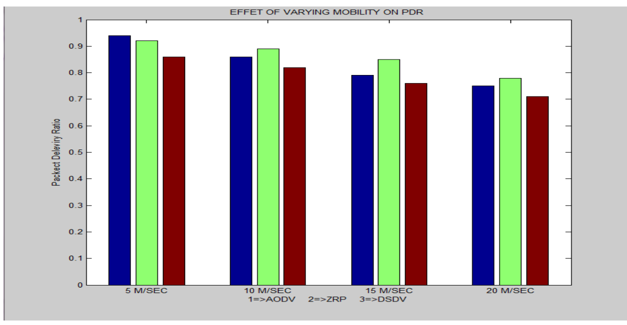

Fig-2(b): Effect on PDR with varying different Mobility

Number of Collisions: In a network, when two or more nodes attempt to transmit a packet across the network at the same time, a packet collision occurs. When a packet collision occurs, the packets are either discarded or sent back to their originating stations and then retransmitted in a timed sequence to avoid further collision. Packet collisions can result in the loss of packet integrity or can impede the performance of a network. This metric was used to measure such collisions in the network.

Collision with No. of Nodes			
No of nodes	**AODV**	**DSDV**	**ZRP**
20	0.12	0.12	0.15
40	0.18	0.25	0.22
60	0.23	0.29	0.28
80	0.32	0.35	0.38

Table-3(a): Effect of Collisions with Varying number of transmitted nodes

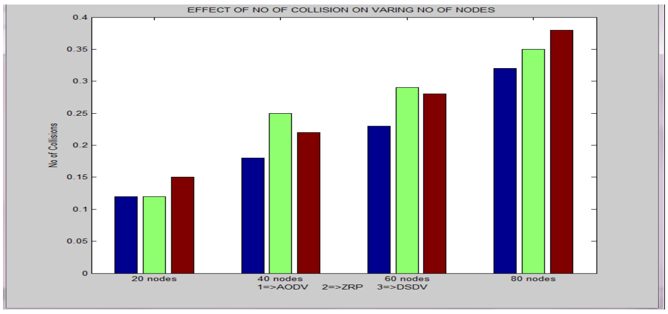

Fig-3(a): Effect on Collisions with varying number of nodes

Collision with Area of manet			
Area of Manet	**AODV**	**DSDV**	**ZRP**
250000	0.21	0.32	0.28
500000	0.15	0.14	0.16
1000000	0.07	0.06	0.08
1500000	0.03	0.02	0.04

Table-3(b): Effect of Collisions with varying area of manet

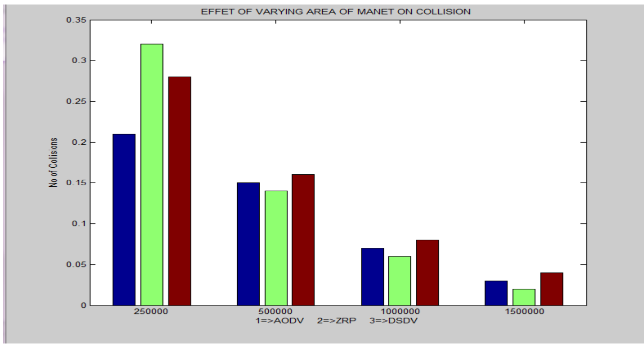

Fig-3(b): Effect on Collisions with varying Area of Manet

Collision with Varying Mobility			
Mobility Speed	**AODV**	**DSDV**	**ZRP**
5	0.15	0.24	0.21
10	0.19	0.28	0.23
15	0.23	0.31	0.25
20	0.28	0.35	0.27

Table-3(c): Effect of Collisions with varying speed of mobility

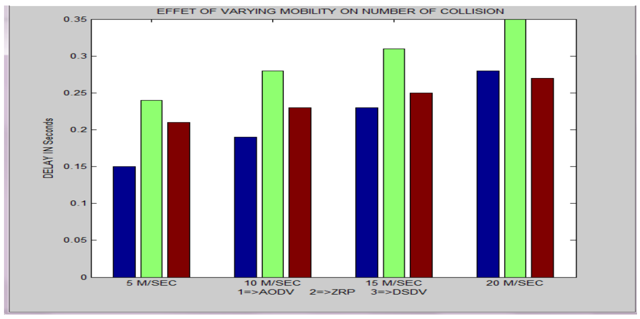

Fig-3(c): Effect on Collisions with varying different Mobility speed

Delay: The packet end-to-end delay was the time from the generation of a packet by the source up to the destination reception, so this was the time that a packet takes to go across the network. This time was expressed in seconds (sec)

Delay with No. of Nodes			
No of nodes	**AODV**	**DSDV**	**ZRP**
20	0.0026	0.0025	0.0031
40	0.0034	0.0032	0.0039

60	0.0029	0.0035	0.0041
80	0.0029	0.0035	0.0038

Table-4(a): Effect of Delay with varying number of nodes

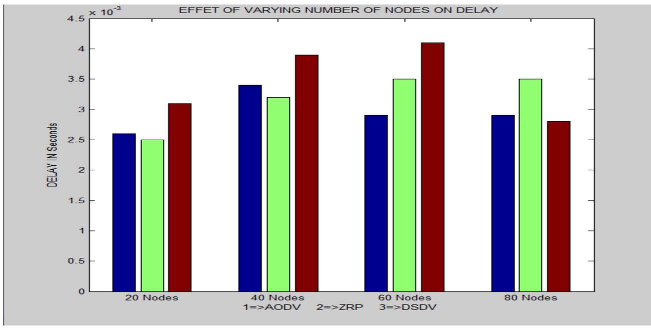

Fig-4(a): Effect of Delay with varying number of nodes

Delay with Area of manet			
Area of Manet	**AODV**	**DSDV**	**ZRP**
250000	0.0014	0.0014	0.0017
500000	0.0017	0.0018	0.0021
1000000	0.0021	0.0022	0.0024
1500000	0.0029	0.0028	0.0029

Table-4(b): Effect of Delay with varying area of manet

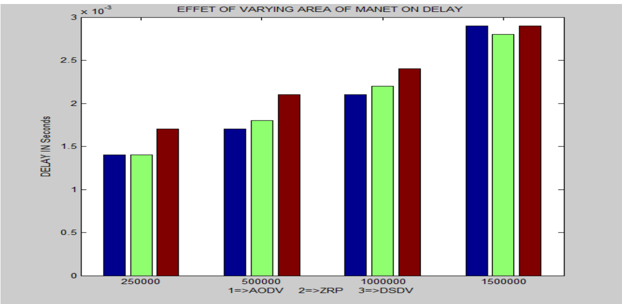

Fig-4(b): Effect of Delay with varying area of manet

Delay with Varying Mobility			
Mobility Speed	**AODV**	**DSDV**	**ZRP**
5	.0006	.0006	.0009
10	.0009	.0008	.0011
15	.0015	.0011	.0013
20	.0020	.0016	.0020

Table-4(c): Effect of Delay with varying speed of mobility

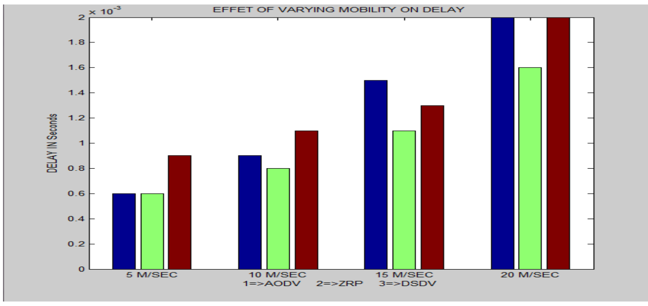

Fig-4(c): Effect on Delay with Varying Mobility

5. CONCLUSION

In this paper AODV, ZRP and DSDV routing protocol has been studied for evaluating their performance. Performance evaluation metrics for these protocols were PDR, collisions and delay. The impact of mobility and scalability on the collision, PDR & delay were studied there. The comparison study between above three protocols shown that AODV

protocols has been average number collisions were least as compare to other two DSDV & ZRP in case of mobility. As the node mobility increased, link breakage occurs more frequently, this leaded to the more route repair and maintenance. So the Time was also increased. The comparison between three protocols according to Mobility Speed has shown that Packet delivery Ratio of AODV much better as compare to other two protocols DSDV and ZRP. For study the impact of scalability, the parameters were varying number of transmitted nodes & area of manet. As the number of attackers increased, it caused more number of collisions. Average Collision on packet delivered in AODV protocol has been least values. As the number of transmitted nodes was increased Packet Delivery Ratio of DSDV & ZRP having almost same values. As the area of MANET gets increased, average number of collision on data packet delivered by AODV have been least values. This comparative study shown that AODV protocol has minimum number of collision in area of manet. In area of manet as the area increase PDR was decreased. All these comparative studies between three protocols i.e. AODV, ZRP & DSDV shown that AODV protocol was best in all above studied comparison.

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