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Study and Performance Analysis of Homologous Routing Protocols in MANET: DSDV, AODV and ZRP

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ABSTRACT: In MANET's different routing protocols are used to establish the route and data transfer takes place from source to destination through those routes. The objective of this Paper is to investigate on the routing performance of the different types of protocols of MANET (AODV, DSDV & ZRP) by realizing different environments. The analysis is done theoretically and through simulations.

Keywords: AODV, DSDV, MANET'S, Reactive Protocols, ZRP.

I. INTRODUCTION

The aim of the communication system is to exchange the data between the source and destination, but MANET's are different from traditional wireless networks, as the former don't have a fixed topology, no base-station support, and no fixed routers. The nodes within the network are free to move anywhere anytime that means the topology of the MANET is ever changing [1]. All the nodes of MANET are capable to receive and to transmit the messages. If the source and destination nodes are directly within the range of each other they can communicate directly (single-hop) otherwise the nodes between the source and destination node can forward the data (multi-hop)[2]. In case of multi hoping, each intermediate node acts as router. These type of networks are desirable in many fields like emergency services (search and rescue operations, disaster recovery, policing and firefighting), commercial and civilian environment (business, sports stadiums), education (universities and campus setting, virtual classrooms), entertainment (multi user games, outdoor internet access) and sensor networks (home applications) etc [3]. But whatever may be the required application efficient and reliable routing is the main requirement.

The various features of MANET are Self-organization, Fully De-centralization, Highly Dynamic nature, Low cost, Broadcast nature of the medium and Frequent network Partitions. The biggest challenge of MANET is the design and implementation of routing protocol that may be able to transfer maximum data packets with minimum overheads. The other challenges faced are security issues, Quality of Service and power consumption of the devices. The available routing protocols are categorized as Reactive routing protocols, Proactive routing protocols and Hybrid routing protocols.

The rest of the paper is organized as follows: Section II give the details of various categories of MANET routing protocols Section III presents overview of the all protocols i.e. AODV, DSDV and ZRP. Section IV provides the simulation environment and performance metrics are described in Section V and then the results are presented in Section VI. Finally Section VII concludes the paper.

II. ROUTING PROTOCOLS

A. Reactive Routing Protocols

These are the protocols in which route is traced only and only when they are required. When any of the nodes has data to send then and only then routes are discovered by route discovery process [12].

That route remains valid only for the duration of communication. In reactive routing protocols, to discover the route they broadcast a Route Request (RREQ) packet in the network and that request packet is multi time replicated in the network until it find the destination. It will lead to broadcast storm problem [4] and particularly in dense networks it increase the MAC collision rate and reduce the packet delivery ratio [11, 13]. The reactive protocols include: AODV, DSR etc.

B. Proactive routing protocols

In these routing protocols, the paths to the destination are computed automatically and independently at the start up and maintained by using a periodic route update process [15]. The tables contain the information about nodes to maintain the latest view of network. As the nodes move away from one another then the network topology changes which propagate update messages throughout the network in order to maintain consistent and up-to-date routing information about the whole network. These routing protocols differ in the method by which the topology change information is distributed across the network and the number of necessary routing-related tables [16].

C. Hybrid routing protocols

Proactive or reactive protocols alone work well within limited region of network setting but the combinations of proactive and reactive protocols, called as hybrid routing protocol, can work very well for any particular network. It may work as for any nearby routes (for example, maximum two hops) are kept up-to-date proactively, while far-away routes are set up reactively. Both proactive and reactive routing protocols prove to be inefficient under these circumstances. Hybrid routing protocol combines the advantages of the proactive and reactive approaches. Hybrid protocols include: ZRP, ZHLS routing protocols [9] [10].

III. OVERVIEW OF THE AODV, ZRP, DSDV PROTOCOLS

A. Ad Hoc on demand distance vector (AODV) routing protocol

AODV [7] is designed specifically to address the routing problems in ad hoc wireless networks and provides communication between mobile nodes with minimal control overhead and minimal route acquisition latency. It makes the route when it is needed and does not require nodes to maintain the routes to various destinations that are not being used in communication. As long as the endpoints of a communication connection have valid routes to each other AODV does not play any role. It is loop free protocol. It provides quick convergence when the network topology changes. The algorithm used by AODV to establish a uni-cast route is as follows:

Route Discovery: When a source node wishes a route to a destination for which it does not already have a route, it broadcasts a route request (RREQ) packet across the network. Nodes receiving this packet update their information for the source node and set up backwards pointers to the source node in the route tables. In addition to the source node's IP address, current sequence number, and broadcast ID, the RREQ also contains the most recent sequence number for the destination of which the source node is aware. The receiving node checks if it has a route to the desired node. If a route exists and the sequence number for this is higher than the supplied number a new route is found. The node generate the route reply (RREP), otherwise, it rebroadcasts the RREQ. Nodes keep track of the RREQ's source IP address and broadcast ID. If they receive a RREQ which they have already processed, they discard the RREQ and do not forward it. For active route i;e if data packets periodically exchanged between source and the destination along that path the route remain continued and maintained. Once the source stops sending data packets, the links will time out and finally be deleted from the intermediate node routing tables.

Route maintenance:

Once the route between the source and the destination nodes is established it is maintained for the source node as long as it remains active. If the source node moves during an active session, it can simply reinitiate a route discovery process and establish a new route to the destination and continue communication. However, if either the destination or an intermediate node moves a RERR packet is sent to the source affected nodes to notify it that the destination is unreachable for that moment, and on receiving the RERR, if the source node still wants to establish the route, it can reinitiate route discovery.

B. Destination Sequenced Distance Vector Routing Protocol (DSDV)

This is one of the first protocols proposed for ad hoc wireless networks. It is an enhanced version of the distributed Bellman-Ford algorithm where each node maintains a table that contains the shortest distance and the first node on the shortest path to every other node in the network. It corporate table updates with increasing sequence number tags to prevent loops, to counter the count-to-infinity problem, and for faster convergence.

Routing Table Management: The routing table in each node consists of a list of all available nodes, their metric, the next hop to destination and a sequence number generated by the destination node. The routing table is used to transmit packets through the ad hoc network. In order to keep the routing table consistent with the dynamically changing topology of an ad hoc network the nodes have to update the routing table periodically or when there is a signi?cant change in the network. Therefore mobile nodes advertise their routing information by broadcasting a routing table update packet. The metric of an update packet starts with metric one for one-hop neighbors and is incremented by each forwarding node and additionally the original node tags the update packet with a sequence number.

The receiving nodes update their routing tables if the sequence number of the update is greater than the current one or it is equal and the metric is smaller than the current metric. Delaying the advertisement of routes until best routes have been found may minimize fluctuations of the routing table. On the other hand the spreading of the routing information has to be frequent and quick enough to guarantee the consistency of the routing tables in a dynamic network. There exist two types of update packets. One is the full dump which contains the entire routing table and must be periodically exchanged. The other is an incremental update which only consists of the information changed since the last full dump.

Responding to Topology Changes: DSDV responds to broken links by invalidating all routes that contain this link. The routes are immediately assigned an in?nite metric and an incremented sequence number. Broken links can be detected by link and physical layer components or if a node receives no broadcast packets from its next neighbors for a while. Then the detecting node broadcasts immediately an update packet and informs the other nodes with it. If the link to a node is up again, the routes will be re-established when the node broadcasts its routing table.

C. Zone routing Protocol (ZRP):

The Zone Routing Protocol (ZRP) [5] combines the advantages of both reactive and pro-active protocols into a hybrid scheme, taking advantage of pro-active discovery within a node's local neighborhood, and using a reactive protocol for communication between these neighborhoods. In a MANET, it can safely be assumed that the most communication takes place between nodes close to each other. The ZRP is not so much a distinct protocol as it provides a framework for other protocols. The separation of a nodes local neighborhood from the global topology of the entire network allows for applying different approaches - and thus taking advantage of each technique's features for a given situation. These local neighborhoods are called zones; each node may be within multiple overlapping zones, and each zone may be of a different size. The ``size'' of a zone is not determined by geographical measurement, but is given by a radius of length, where is the number of hops to the perimeter of the zone. By dividing the network into overlapping, variable-size zones, the Zone Routing Protocol consists of several components, which only together provide the full routing benefit to ZRP. Each component works independently of the other and they may use different technologies in order to maximize efficiency in their particular area.

IV. SIMULATION ENVIRONMENT

To verify the results through the simulation using Network Simulator-2, the simulation parameters are as per table 1. The traffic sources are CBR (continuous bit rate). The source-destination pairs are spread randomly over the network. The number of source-destination pairs and the packet sending rate in each pair is varied to change the offered load in the network. Traffic sources are CBR (continuous bit-rate). Each node starts its journey from a random location to a random destination according to the speed parameter specified in the scenarios. Once the destination is reached, another random destination is targeted after specified pause. Simulations are run for 100 simulated seconds for 50 nodes. For fairness, identical mobility and traffic scenarios are used across protocols.

Table 1: Simulation Parameters.

Simulation Parameter	Values
Simulator	Network Simulator-2
Transmission Range	250 m
Bandwidth	2 Mbits/s
Simulation Time	100s
Number of Nodes	50
Scenario Type	2000 x 2000 m^2
Trafic Type	Constant Bit rate
Packet Size	64 Bytes
Flows	25
Rate	4 packets/s

V. PERFORMANCE ANALYSIS

A. Packet Delivery Ratio

It is the ratio of number of data packet successfully received by the CBR (constant bit rate) destination to the number of data packet generated by the CBR source. It measures the loss rate by transport protocols. Mathematically, it can be expressed as:

$$PDR = \frac{\Sigma(\text{ all the packets received by destination})}{\Sigma(\text{all the packets sent by source})}$$

B. End to End Delay

End-to-End Delay is average time a packet takes for delivery to its destination after it was transmitted. It tells how a protocol adapts or arranges for an immediate delivery of packets to its desired destination. Average delay is all possible delays caused by Route Discovery Latency, Queuing at the interface queue, and Retransmission delays at the MAC, Propagation delay and Transfer time.

C. Average Throughput

Throughput is defined as the total number of packets delivered over the total simulation time. Mathematically, it can be defined by below equation as:

$$\text{Throughput} = \frac{N}{1000}$$

Where N is the number of bits received successfully by all destinations. And average of the total throughput is called as average throughput.

D. Normalized routing overhead

It is the ratio of total packet size of control packets (including the RREQ, RREP, RERR and Hello) to the total packet size of data packets delivered to the destination.

VII. RESULTS AND DISCUSSIONS

A. Scenario 1: Varying the mobility of Nodes

In this scenario, the speed of nodes is varied from 10 m/sec to 50 m/sec. As the speed of node is varied its neighborhood of the nodes changes regularly. So this scenario provides a good testing challenge for the routing protocols. Figure 1 shows that as the mobility of nodes increases, so the packet delivery ratio decreases a little. The efficiency of DSDV is better than other two protocols and ZRP is least efficient. Figure 2 show that ZRP generate the highest routing overhead. DSDV has lowest routing overhead among all. Figure 3 show that there is a little rise in average end to end delay in AODV and ZRP as compared with DSDV protocol.

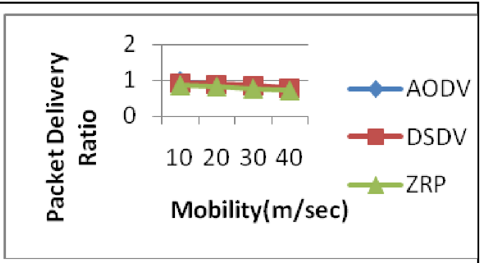

Fig. 1. Packet Delivery Ratio in Scenario 1

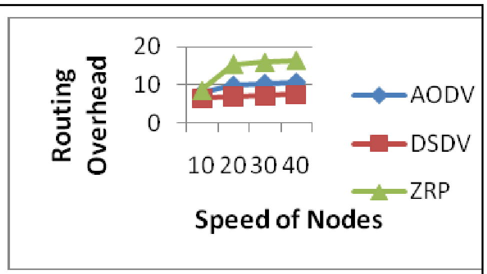

Fig. 2. Routing Overhead in Scenario 1

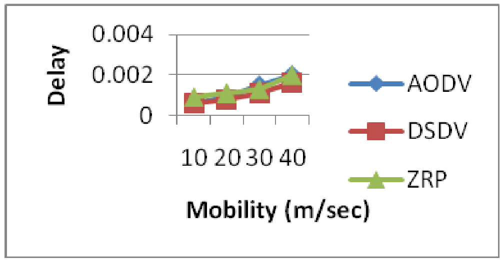

Fig. 3. Average end to end delay in Scenario 1

A. Scenario 2: Varying the Network Size

In this scenario, the area of the network is varied. The analysis is done using all parameters, Packet delivery ratio, and Routing overhead and End-to-End delay.

Figure 4 show that the packet delivery ration of AODV is better than other two protocols as the area of network increases. Figure 5 show that the routing overhead of ZRP is a little more than other two protocols. Figure 6 show that there is a little rise in average end to end delay of all protocols as the area of network increases.

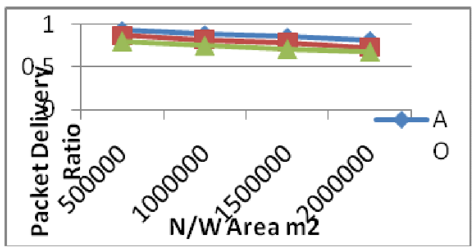

Fig. 4. Packet Delivery Ration in Scenario 2

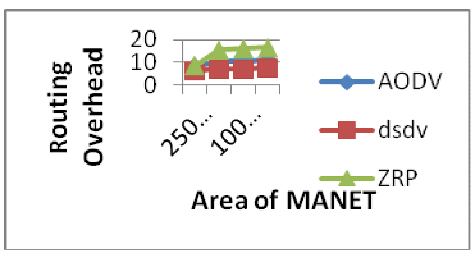

Fig. 5. Routing Overhead in Scenario 2

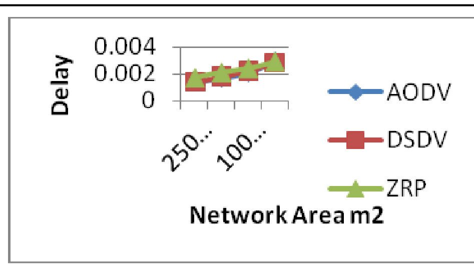

Fig. 6. Average End to End delay in Scenario 2

B. Scenario 3: Varying the No. of Source Nodes

In this scenario, the number of the source nodes is varied from 1 to 8. The analysis is done using all parameters, Packet delivery ratio, and Routing overhead and End-to-End delay. Figure 7 shows that the packet delivery ratio of AODV is better than other two protocols as the area of network increases.

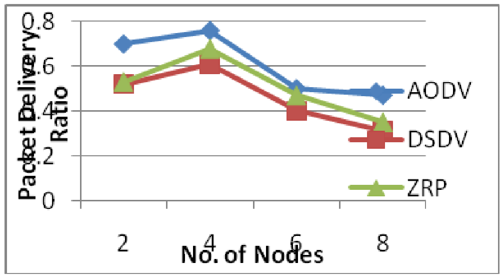

Fig. 7. Packet Delivery Ration in Scenario 3

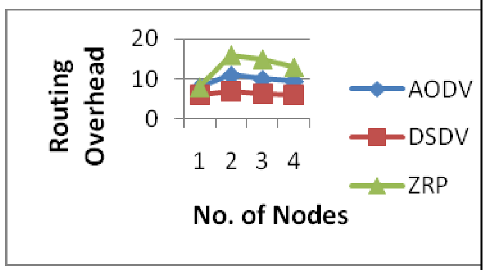

Fig. 8. Routing Overhead in Scenario 3

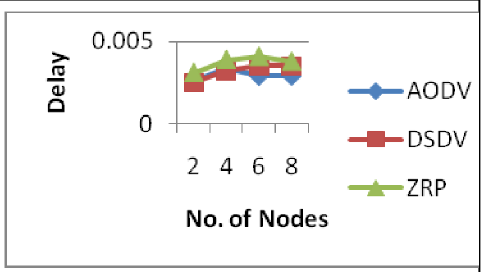

Fig. 9. Average end to end delay in Scenario 3

Figure 8 Shows that the routing overhead of ZRP is a little more than other two protocols. Figure 9 show that there is a little rise in average end to end delay of all protocols as the area of network increases.

VIII. CONCLUSION

In this paper the performance of AODV, DSDV & ZRP is compared on the basis of packet delivery ratio, normalized routing overheads, delay using Network Simulator. From the simulation results it is clear that almost all protocols perform relatively well. Nevertheless, ZRP already at this point fails to deliver a greater percentage of the originated data packets - it only reaches a delivery ratio of 66%. The average performance of AODV is better than other two protocols in different scenarios.

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