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PERFORMANCE EVALUATION OF AODV AND ZRP ROUTING PROTOCOLS IN MOBILE AD-HOC NETWORKS

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ABSTRACT

An Ad-hoc network is a network in which the locations of the switches, hubs, or routers can be mobile, the number of routers available at an instant can increase or decrease, and the available routing paths can change. An ad-hoc network does not have any centralized server or arbitrator. A mobile ad-hoc network (MANET) is a self-organizing, dynamic network comprising of mobile nodes, where each and every participating node voluntarily transmit the packets destined to some remote node using wireless transmissions. In MANET, each and every mobile node is assumed to be moving with more or less relative speed in arbitrary (random) direction.

Because of that, there is no long term guaranteed path from any one node to other node. In this paper we have compared the protocols AODV (Ad-hoc On-demand Distance Vector Routing) and ZRP (Zonal Routing Protocol) using Packet Delivery Ratio (PDR), End-to-end Delay (E2ED) and Routing Load (RL). The results have shown, the performance of AODV and ZRP routing protocols using PDR, E2ED and RL with graphs.

KEYWORDS: AODV, MANETS, NS-2 and ZRP

I. INTRODUCTION

Wireless networking is a technology that enables two or more computers to communicate using standard network protocols, but without network cabling. The mobile devices or wireless sensors as well as the access-points have switches or routers. The routers available to the mobile devices or wireless sensors can thus change at any time depending on the presence and location of other wireless devices in their vicinity.

Each mobile device or sensor connects to an access-point, base station, or gateway with a switch, hub or router. A switch is used as the connectivity between the two or more paths to route a message or packet, so that the part can be used as instant. Mobile Ad-hoc Networks (MANETs) [1] [2] are wireless networks that continually re-organize themselves in response to their environment without the benefit of a pre-existing infrastructure.

Several routing protocols in MANETs are classified into three different categories according to their functionality and performance: Proactive (table-driven) routing protocols, Reactive (on-demand) routing protocols and Hybrid routing protocols [3].

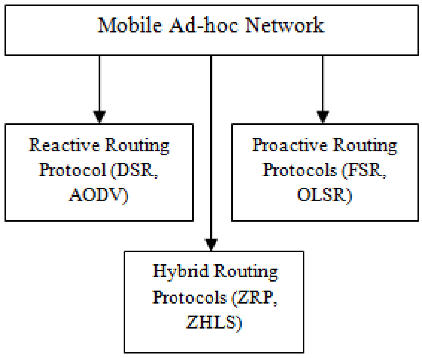

Figure 1: Classification of Routing Protocols

Proactive Routing Protocols

In these protocols, each and every node maintains its own routing information. These tables are to be updated due to frequent change in topology of the network. These protocols are used where the route requests are frequent. STAR (Source Tree Adaptive Routing), FSR (Fisheye State Routing), GSR (Global State Routing), DSDV (Destination Sequenced Distance Vector Routing), CGSR (Cluster-head Gateway Routing), OLSR (Optimized Link State Routing) and WRP (Wireless Routing Protocol) are the examples.

Reactive Routing Protocols

Whenever a route is required, they involve in discovering the routes to other nodes. A route discovery process is invoked when it has no route table entry. DSR (Dynamic Source Routing), AODV (Ad-hoc On-Demand Distance Vector Routing), LAR (Location Aided Routing), TORA (Temporally Ordered Routing Algorithm), CBRP (Cluster Based Routing Protocol) and ARA (Ant-colony based Routing Algorithm) are the examples.

Hybrid Routing Protocols

Hybrid routing protocols are the protocols which combine merits of both the reactive and proactive approaches. Such hybrid protocols offer means to switch dynamically between proactive and reactive parts of the protocol. For instance, proactive protocols could be used between networks and reactive protocols inside the networks. ZRP (Zonal Routing Protocol), DST (Dynamic Source Tracing), DDR (Distributed Dynamic Routing), ZHLS (Zone-based Hierarchical Link State) are the examples.

The rest of the paper is organized as follows: Section-II gives a brief description and overview of the MANET routing protocols AODV and ZRP. Section-IV tells about the Simulation setup and environment which gives the detailed description of our proposed work. Finally the Conclusion is presented.

II. BRIEF DESCRIPTION AND OVERVIEW OF AODV AND ZRP ROUTING PROTOCOLS IN MANET

Ad-hoc On-Demand Distance Vector Routing Protocol (AODV) enables, “dynamic, self-starting, multi-hop routing between mobile nodes which wish to establish and maintain an ad-hoc network” [4]. AODV allows for the construction of routes to specific destinations and it is not needed to keep these routes when they are not in active communication. AODV avoids the “count to infinity” problem by using destination sequence numbers. This makes AODV loop-free.

AODV defines 3 message types:

- **Route Requests (RREQs):** RREQ messages are used to initiate the route finding process.
- **Route Replies (RREPs)**: RREP messages are used to finalize the routes.
- **Route Errors (RERRs):** RERR messages are used to notify the network of a link breakage in an active route.

For example, Node A wants to send message to Node E. A valid route must be created from A to E (figure 2). Node A generates a RREQ message with initial TTL of 1 and broadcast it to its neighbors. The message contains node A's IP address and the IP address of the node E. If node B will send a RREP message back to node A (figure 3). If A sets a special flag in RREQ message, node B will also send a "gratuitous" RREP message to node E. This will be necessary if node B will need to send packets back to A, i.e. TCP connection. RREP messages are unicast to the next hop towards the originator or destination if it is a gratuitous RREP. If A does not receive a RREP message within a certain time, it will re-broadcast the RREQ message with an incremented TTL value (figure 4). Default increment is 2. "Reverse" routes to the originator, in this case, node A is created to send RREQ message. This behavior keeps network utilization down.

Figure 2

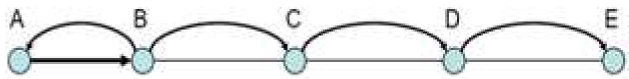

Figure 3

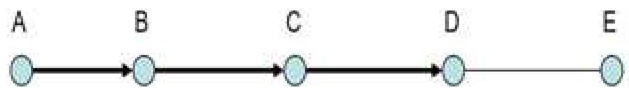

Figure 4

Zonal Routing Protocol (ZRP), as its name implies, is based on the concept of zones. A routing zone is defined for each node separately, and the zones of neighboring nodes overlap. The routing zone has a radius *r* expressed in hops.

ZRP refers to locally proactive routing component as the Intr A-zone Routing Protocol (IARP). The fact that topology of local zone of each node is known can be used to reduce traffic when global route discovery is needed. Instead of broadcasting packets, ZRP uses border-casting. Border-casting utilizes the topology information provided by IARP to direct query request to the border of the zone. The border-cast packet delivery service is provided by the Border-cast Routing Protocol (BRP). BRP uses a map of an extended routing zone to construct border-cast trees for the query packets.

An example, in figure 5, the routing zone of S includes the nodes A-I, but not K. It should however be noted that the zone is defined in hops, not as a physical distance. The nodes of a zone are divided into peripheral nodes and interior nodes. Peripheral nodes are nodes whose minimum distance to the central node is exactly equal to the zone radius *r*. The nodes whose minimum distance is less than r are interior nodes. In figure 5, the nodes A-F are interior nodes; the nodes G-J are peripheral nodes and the node K is outside the routing zone. Note that node H can be reached by two paths, one with length 2 and one with length 3 hops. The node is however within the zone, since the shortest path is less than or equal to the zone radius [5] [6].

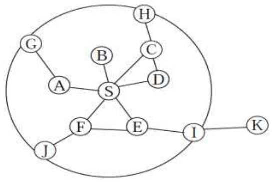

Figure 5: Example Routing Zone with *r*=2

The node S has a packet to send to node X in figure 6. The zone radius is *r*=2. The node uses the routing table provided by IARP to check whether the destination is within its zone. Since it is not found, a route request is issued using IERP. The request is border-cast to the peripheral nodes. Each of these searches their routing table for the destination.

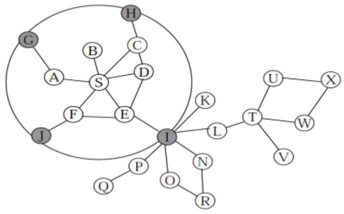

Figure 6: The Routing Zone of Node S

Node I do not find the destination in its routing table. Consequently, it broadcasts the request to its peripheral nodes in figure 7. Due to query mechanisms, the request is not passed back to nodes D, F and S.

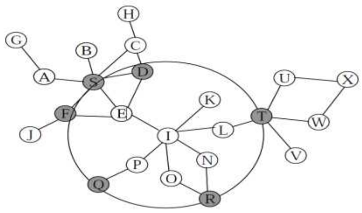

Figure 7: The Routing Zone of Node I

Finally, the route request is received by the node T, which can find the destination in its routing zone, shown in figure 8. Node T appends the path from itself to node S to the path in the route request. A route reply, containing the reversed path is generated and sent back to the source node. If multiple paths to the destination were available, the source would receive several replies.

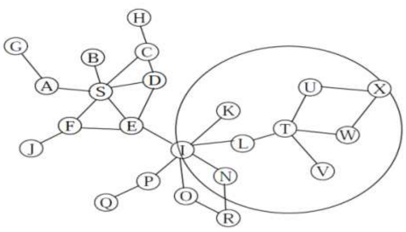

Figure 8: The Routing Zone of Node T

Table 1: Characteristic Summary of AODV and ZRP

Performance Constraints	AODV	ZRP
Category	On-Demand	Hybrid
Protocol Type	Distance Vector	Link Reversal

Table 1: Contd.,

Multicast	Yes	No
Message Overhead	High	Medium
Periodic Broadcast	Possible	Possible
Feature	Only keeps track of next hop in route	Routing range defined in hops

III. METRICS FOR PERFORMANCE COMPARISON

Some important performance metrics can be evaluated

Packet Delivery Ratio

It is the ratio of the packets sent from source to the packets received at destination. PDR is determined as;

$PDR = (P_r/P_s) *100$

Where P_r is the total packets received and P_s is the total packets sent.

End-to-End Delay

This is the possible delay caused by the buffering during route discovery. This is the delay packet send from source to the destination. The average delay is computed as:

$Delay = t_e - t_s$

Where t_e is the packet end time, t_s is the packet start time.

Routing Load

Routing Load is the number of routing control packets transmitted for each data packet delivered at the destination. Routing Load is determined as:

$RL = P_c/P_d$

Where Pc is the total control packets received and Pd is the total packets sent.

IV. SIMULATION SETUP AND RESULTS

The objective of this work is to simulate and analyze the performance evaluation of various routing protocols by using Network Simulator 2 (NS-2). A simulation can be very useful because it is possible to scale the networks easily and therefore to eliminate the need for time consuming and costly real world experiments. While the simulator is powerful tool, it is important to remember that the ability to do predictions about the performance in the real world is dependent on the accuracy of the models in the simulator. The parameters were different for different routing protocols like AODV and ZRP which we have chosen for the simulation so as to evaluate on the basis of some performance metrics such as Packet Delivery Ratio, End-To-End Delay and Routing Load in different scenarios, that is, for 25, 50, 75, 100, 125 and 150 nodes.

Table 2

Parameters	Values
Routing Protocols	AODV, ZRP
No. of Nodes	25,50,75,100,125,150
Channel Type	Wireless Channel

Table 2: Contd.,

MAC type	802.11
Antenna Model	Omni Antenna
Traffic Type	TCP
Radio-Propagation Model	Propagation/ Two Ray Ground
Interface Queue	Queue/ Drop Tai l/ Pri Queue

Packet Delivery Ratio

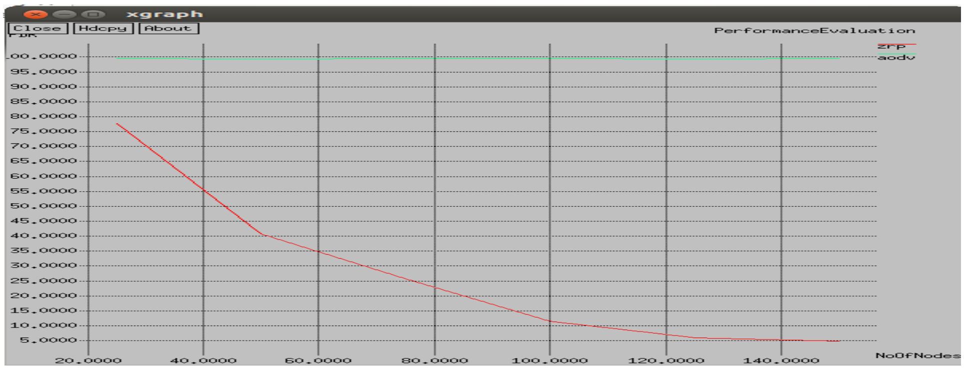

Figure 9: Comparison of AODV and ZRP on Basis of Packet Delivery Ratio with 25, 50, 75, 100, 125 and 150 Nodes

End-to-End Delay

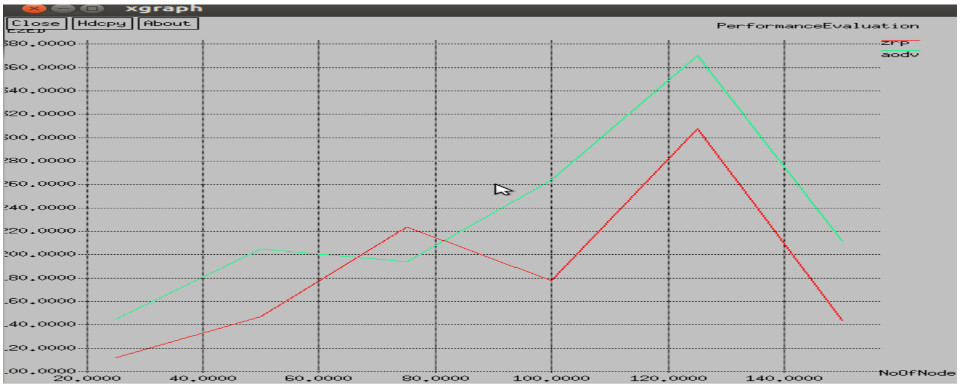

Figure 10: Comparison of AODV and ZRP on Basis of End-to-End Delay with Different Number of Nodes

Routing Load

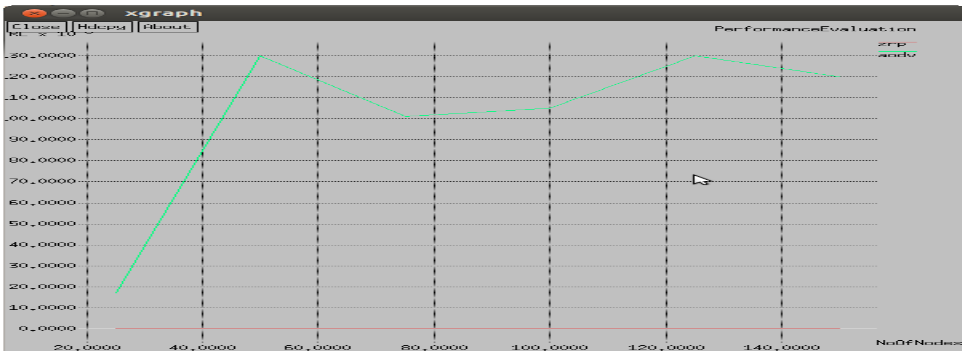

Figure 11: Comparison of AODV and ZRP on Basis of Routing Load with Different Number of Nodes

V. CONCLUSIONS

This paper evaluated the performance of AODV and ZRP using ns-2. Comparison was based on the Packet Delivery Ratio, End-To-End Delay, Routing Load in AODV and ZRP. We conclude that, AODV gives better performance in Packet Delivery Ratio. ZRP gives better performance in End-To-End Delay and Routing Load. The future enhancement is that we would conduct the simulations in Vehicular Ad-hoc Networks (VANETS) and sensor networks.

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