Effect of Scalability on Aodv, Dsr and Zrp Routing Protocols for Manet’s

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Abstract - This paper aims to compare performance of some routing protocols for Mobile Ad-Hoc networks (MANET’s) in different network sizes. A Mobile Ad-Hoc Network (MANET) is a collection of wireless mobile nodes forming a temporary network without using any centralized access point, infrastructure, or centralized administration. Data transmission between two nodes in MANET’s, requires multiple hops as nodes transmission range is limited. Mobility of the different nodes makes the situation even more complicated. Multiple routing protocols especially for these conditions have been developed during the last years, to find optimized routes from a source to some destination. This paper presents the performance evaluation of three different routing protocols (AODV, DSR and ZRP) in variable network sizes. Performance evaluation of AODV, DSR and ZRP is evaluated based on Average end to end delay, Time To Live (TTL) based hop count and Packet delivery ratio.

Keywords: MANETS, AODV, DSR, ZRP.

I. INTRODUCTION

A routing protocol is a protocol that specifies how routers communicate with each other, disseminating information that enables them to select routes between any two nodes on a computer network. Each router has a priori knowledge only of networks attached to it directly. A routing protocol shares this information first among immediate neighbors, and then throughout the network. This way, routers gain knowledge of the topology of the network. An ad hoc routing protocol is a convention, or standard, that controls how nodes decide which way to route packets between computing devices in a mobile ad-hoc network. MANET protocols can be broadly classified into two categories based on transmission: Unicast and Multicast protocols. Unicast protocols send messages to a single network destination host on a packet switching network. AODV, CGSR, DSDV, DSR, OLSR, WRP, ZRP etc are unicast protocols. Multicast protocols send messages to a group of receiver hosts. MRMP, OBAMP, MOLSR, DCMP and ADMR are multicast MANET protocols. In this paper we are using AODV, DSR and ZRP i.e. unicast routing protocols for their performance comparison. We have taken these protocols as these are not combined earlier for such comparison.

An earlier protocol performance comparison was carried out by authors in [10], who conducted experiments with Destination Sequence Distance Vector (DSDV), Temporally-ordered routing algorithm (TORA) along with DSR and AODV. The simulations were quite different for they used a constant network size of 50 nodes, 10 to 30 traffic sources, seven different pause times and various movement patterns on ns2 simulator. DSR and DSDV were simulated and compared to a newly developed Cluster-based Routing Protocol (CBRP) by Mingliang, Tay and Long [11]. The simulations were performed with pause times from 0 to 600 seconds and with 25 to 150 mobile nodes. The focus of their work is set to CBRP, especially how it scales in larger networks and in situations with higher mobility. It can be seen that the packet delivery ratio of DSR falls in a network of 150 nodes, which is good comparable to our results. CBRP performed much better with a delivery ratio always greater then 90 percent and a lower routing overhead than DSR in larger networks.

Performance comparison of AODV and DSR protocol presented in [12] shows AODV outperforms DSR in large networks and high mobility scenarios. The experiments were based on the ns-2 simulator, IEEE 802.11 MAC layer, a radio model similar to Lucent’s Wave LAN radio interface and random waypoint mobility with pause times from 0 to 500 seconds.

In the last few years, there are several researches to evaluate the performance of routing protocols for MANET’s as a function of mobility rate and pause time [7] using ns2(network simulator 2). There is lesser evaluations available using Qualnet simulator [1] which is commercially available and faster than ns2 [3]. We are using Qualnet simulator for comparison evaluation of AODV, DSR and ZRP.

The rest of the paper is organized as follows: Section II describes three concerned protocols i.e. AODV, DSR and ZRP. Section III describes the simulation environment, parameters and simulation results. Lastly work is concluded in section IV.

II. PRELIMINARIES

A. AODV

The Ad Hoc On Demand Distance Vector [2] routing protocol is a reactive routing protocol; therefore, routes
are determined only when needed. Figure 1 shows the message exchanges of the AODV protocol. Hello messages may be used to detect and monitor links to neighbors. If Hello messages are used, each active node periodically broadcasts a Hello message that all its neighbors receive. Because nodes periodically send Hello messages, if a node fails to receive several Hello messages from a neighbor, a link break is detected.

When a source has data to transmit to an unknown destination, it broadcasts a Route Request (RREQ) for that destination. At each intermediate node, when a RREQ is received a route to the source is created. If the receiving node has not received this RREQ before, is not the destination and does not have a current route to the destination, it rebroadcasts the RREQ. If the receiving node is the destination or has a current route to the destination, it generates a Route Reply (RREP). The RREP is unicast in a hop-by-hop fashion to the source. As the RREP propagates, each intermediate node creates a route to the destination. When the source receives the RREP, it records the route to the destination and can begin sending data. If multiple RREPs are received by the source, the route with the shortest hop count is chosen. As data flows from the source to the destination, each node along the route updates the timers associated with the routes to the source and destination, maintaining the routes in the routing table. If a route is not used for some period of time, a node cannot be sure whether the route is still valid; consequently, the node removes the route from its routing table.

If data is flowing and a link break is detected, a Route Error (RERR) is sent to the source of the data in a hop-by-hop fashion. As the RERR propagates towards the source, each intermediate node invalidates routes to any unreachable destinations. When the source of the data receives the RERR, it invalidates the route and reinitiates route discovery.

The AODV protocol is loop-free and avoids the counting to infinity problem by the use of sequence numbers. This protocol offers quick adaptation to mobile networks with low processing and low bandwidth utilization. The weaknesses of AODV include its latency and scalability. An important feature of AODV is the maintenance of time-based states in each node: a routing entry not recently used is expired.

B. DSR

Routing protocol Dynamic Source Routing (DSR) is an entirely on-demand ad hoc network routing protocol composed of two parts: Route Discovery and Route Maintenance [6]. When a node has a packet to send to some destination and does not currently have a route to that destination in its Route Cache, the node initiates Route Discovery to find a route. The source node transmits a ROUTE REQUEST [7] packet as a local broadcast, specifying the target and a unique identifier. If it is recently received REQUEST, node discards the REQUEST. Otherwise, it appends its own node address to a list in the REQUEST and rebroadcasts the REQUEST. When the ROUTE REQUEST reaches its target node, the target sends a ROUTE REPLY back to the initiator of the REQUEST, including a copy of the accumulated list of addresses from the REQUEST. When the REPLY reaches the initiator of the REQUEST, it caches the new route in its Route Cache. The mechanism by which a node sending a packet along a specified route to some destination detects if that route is broken is called Route Maintenance.

The Source lists the complete sequence of nodes from source to destination in the header of the packet. Each node along the route forwards the packet to the next hop indicated in the packet’s header, and attempts to confirm that the packet was received by that next node. If, after a limited number of local retransmissions of the packet, a node in the route is unable to make this confirmation, it returns a ROUTE ERROR to the original source of the packet, identifying the link from itself to the next node is broken. The sender then removes this broken link from its Route Cache; for subsequent packets to this destination, the sender may use any other route to that destination in its Cache, or it may attempt a new Route Discovery for that target if necessary.

C. ZRP

The Zone Routing Protocol [5], 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, $\rho$, expressed in hops. The zone thus includes the nodes, whose distance from the node in question is at most $\rho$ hops. ZRP refers to the locally proactive routing component as the IntrA-zone Routing Protocol (IARP). The globally reactive routing component is named InterEr-zone Routing Protocol (IERP). IERP and IARP are not specific routing protocols. Instead, IARP is a family of limited-depth, proactive link-state routing protocols. IARP maintains routing information for nodes that are within the routing zone of the node. Correspondingly, IERP is a family of
reactive routing protocols that offer enhanced route discovery and route maintenance services based on local connectivity monitored by IARP.

The fact that the topology of the 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 a concept called bordercasting. Bordercasting utilizes the topology information provided by IARP to direct query request to the border of the zone. The bordercast packet delivery service is provided by the Bordercast Resolution Protocol (BRP). BRP uses a map of an extended routing zone to construct bordercast trees for the query packets.

A node that has a packet to send first checks whether the destination is within its local zone using information provided by IARP. In that case, the packet can be routed proactively. Reactive routing is used if the destination is outside the zone.

The reactive routing process is divided into two phases: the route request phase and the route reply phase. In the route request, the source sends a route request packet to its peripheral nodes using BRP. If the receiver of a route request packet knows the destination, it responds by sending a route reply back to the source. Otherwise, it continues the process by bordercasting the packet. In this way, the route request spreads throughout the network. If a node receives several copies of the same route request, these are considered as redundant and are discarded. The reply is sent by any node that can provide a route to the destination. To be able to send the reply back to the source node, routing information must be accumulated when the request is sent through the network. The information is recorded either in the route request packet, or as next-hop addresses in the nodes along the path. In the first case, the nodes forwarding a route request packet append their address and relevant node/link metrics to the packet. When the packet reaches the destination, the sequence of addresses is reversed and copied to the route reply packet. The sequence is used to forward the reply back to the source. In the second case, the forwarding nodes records routing information as next-hop addresses, which are used when the reply is sent to the source. This approach can save transmission resources, as the request and reply packets are smaller. The source can receive the complete source route to the destination. Alternatively, the nodes along the path to the destination record the next-hop address in their routing table.

In ZRP, the knowledge of the local topology can be used for route maintenance. Link failures and sub-optimal route segments within one zone can be bypassed. Incoming packets can be directed around the broken link through an active multi-hop path. Similarly, the topology can be used to shorten routes, for example, when two nodes have moved within each other’s radio coverage. For source-routed packets, a relaying node can determine the closest route to the destination that is also a neighbor. Sometimes, a multi-hop segment can be replaced by a single hop. If next-hop forwarding is used, the nodes can make locally optimal decisions by selecting a shorter path.

### III. PERFORMANCE EVALUATION

We carried out simulations on Qualnet simulator. The simulation parameters [4] are summarized in Table 1.

<table>
<thead>
<tr>
<th>Table 1: Parameters for simulation evaluation</th>
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<tr>
<td>No. of nodes</td>
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<td>Dimension of space</td>
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<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td>Source and Destination position</td>
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<tr>
<td>Minimum velocity (v min)</td>
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<tr>
<td>Maximum velocity (v max)</td>
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<tr>
<td>Simulation Time</td>
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<tr>
<td>Data traffic</td>
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<tr>
<td>Item size</td>
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<td>Source data pattern</td>
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<td>Mobility model</td>
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<td>Starting time</td>
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<td>Pause time</td>
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<tr>
<td>Total simulation time</td>
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<td>No. of simulations</td>
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The network is designed using Random waypoint model with different network sizes i.e. varying number of nodes, area sizes and source and destination nodes. We are compiling the results using one simulation due to long simulation times especially in ZRP and the application between the randomly chosen source and destination is Constant Bit Rate (CBR) traffic.
The metrics used to measure the performance of AODV, DSR and ZRP are average end to end delay, average TTL based hop count and packet delivery ratio.

A. Average End to End Delay

End-to-end delay indicates duration a packet takes to travel from the CBR source to the application layer of the destination. The average delay from the source to the destination’s application layer is shown in figure 3. According to our simulation results delay for AODV and ZRP is always below 0.2 seconds while in case of DSR delay remains below 0.1 seconds but after increasing no. of nodes from 100 to 200 it reaches 1.6 seconds. Best performance is shown by ZRP having lowest end to end delay with a maximum delay of .05 sec.

B. TTL based average hop count

Hop count is the number of hops a packet takes to reach its destination. Figure 4 shows our simulation results for TTL based hop count. The results are a bit weird: for ZRP the average hop count remains constant while for DSR it shows a gradual increase in hop count with the increase in no. of nodes. Moreover, if we compute the AODV graph, the hop count first decreases and then increases.

C. Packet Delivery Ratio

Packet delivery ratio is calculated by dividing the number of packets received by the destination through the number of packets originated by the application layer of the source (i.e. CBR source). The better the delivery ratio, the more complete and correct is the routing protocol. It specifies the packet loss rate, which limits the maximum throughput of the network. The packet delivery ratio is shown in figure 4. DSR and AODV perform much better than ZRP. ZRP delivers only 40 percent of all CBR packets initiated by the source when no of nodes reach 100. While AODV and DSR delivers almost 90 percent of packets but they also shows gradual decrease in delivery ratio with increase in no of nodes. AODV shows best performance with minimum 80 percent delivery ratio as shown in figure 5.

IV. CONCLUSION

Performance comparison of three different routing protocols (AODV, DSR, and ZRP) for mobile Ad-hoc networks is presented as a function of different network sizes. Three performance metrics are average end to end delay; average TTL based hop count and packet delivery ratio. AODV shows best results in measuring end to end delay; average TTL based hop count and packet delivery ratio. AODV delivers almost 90 percent of transmitting packets while DSR performs best with minimum number of hops in comparing TTL based hop count. Moreover, results show ZRP is not suitable for larger networks as it crashes when number of nodes increases from 200. This work may be extended for analyzing the behavior of these protocols in heterogeneous networks with many more metrics for evaluation.

REFERENCES


