The Performance Evaluation of Bellman-Ford and ZRP Routing Protocols in MANETs Using QualNet 5.0 Simulator

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Abstract
Mobile Ad-Hoc Network (MANET) is a collection of mobile wireless nodes, which communicate to each other using a wireless physical medium without having a route to a pre-existing network infrastructure. Mobile means moving and Ad Hoc means temporary without any fixed infrastructure, so mobile ad hoc networks are a kind of temporary networks in which nodes are moving without any fixed infrastructure or centralized administration. The highly dynamic nature of MANET coupled with limited bandwidth and battery power imposes severe restrictions on routing protocols especially on achieving the routing stability. Due to all these constraints, designing of a routing protocol is still a challenging task for researchers. Many protocols are reported in this field but it is difficult to decide which one is efficiently best. In this paper an attempt has been made to evaluate and compare the performance of Proactive routing protocols (Bellman-Ford) and Hybrid routing protocols (ZRP) on different parameters using QualNet 5.0 Simulator. The results show that neither of the protocol is better in all situations. For some parameters one outperforms the other and vice-versa as reported in the paper.

Keywords
MANETs, Bellman-Ford, ZRP, QualNet 5.0 Simulator.

I. Introduction
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. It is an autonomous system in which mobile hosts connected by wireless links are free to move randomly and often act as routers at the same time. A fundamental characteristic of ad hoc networks is that they are able to configure themselves on-the-fly without the involvement of a centralized administrator. Routing is a mechanism which is used to find the path between the source to the destination among randomly distributed nodes (routers). Routing protocol plays an important role to send the data from source to destination that discovers the optimal path between the two communication nodes. Every protocol has its own rules to find the route or maintenance the route. There are various routing protocol proposed by researchers. Routing protocols in MANETs are broadly divided into three categories (based on the Routing Information Update Mechanism) [3-4]: Proactive (table-driven), Reactive (source-initiated on-demand-driven) and Hybrid. The proactive protocols maintain routing information about each node in the network. The information is updated throughout the network periodically or when topology changes. Each node requires to store their routing information. For example: Bellman-Ford Routing Protocol, Destination Sequenced Distance Vector Routing (DSDV), Source Tree Adaptive Routing (STAR).

The reactive routing protocols look for the routes and are created as and when required. When a source wants to send to a destination, it invokes the route discovery mechanisms to find the path to the destination. For example: Ad-Hoc On-demand Distance Vector (AODV), Dynamic Source Routing (DSR), Dynamic MANET On-demand (DYMO).

The hybrid routing protocols are using the best features of both the on-demand and table driven routing protocols. For example: Temporally Ordered Routing Algorithm (TORA), Zone Routing Protocol (ZRP).

This paper is organized as follows: This section describes deeply about Bellman-Ford and ZRP routing protocols. Section II describes brief information about the simulation environment setup used. Section III discusses the results of simulation. Finally we present the conclusion.

A. Overview on Bellman-Ford
Bellman-Ford Routing Algorithm, also known as Ford-Fulkerson Algorithm, is used as an algorithm by distance vector routing protocols such as RIP, BGP, ISO IDRP and NOVELL IPX. Routers that use this algorithm will maintain the distance tables, which tell the distances and shortest path to sending packets to each node in the network. The information in the distance table is always updated by exchanging information with the neighboring nodes. The number of data in the table equals to that of all nodes in networks (excluded itself). The columns of table represent the directly attached neighbors whereas the rows represent all destinations in the network. Each data contains the path for sending packets to each destination in the network and distance/or time to transmit on that path [5]. The measurements in this algorithm are the number of hops, latency, the number of outgoing packets, etc.

B. Overview on Zone Routing Protocol (ZRP)
Zone Routing Protocol or ZRP [6] was the first hybrid routing protocol with both a proactive and a reactive routing component. ZRP was first introduced by Haas in 1997. ZRP is proposed to reduce the control overhead of proactive routing protocols and decrease the latency caused by routing discover in reactive routing protocols. In ZRP, the distance and a node, all nodes within-hop distance from node belongs to the routing zone of node. ZRP is formed by two sub-protocols, a proactive routing protocol: Intra-zone Routing Protocol (IARP) [7] is used inside routing zones and a reactive routing protocol: Inter-zone Routing Protocol (IERP) [8] is used between routing zones, respectively. A route to a destination within the local zone can be established from the proactively cached routing table of the source by IARP; therefore, if the source and destination is in the same zone, the packet can be delivered immediately. Most of the existing proactive routing algorithms can be used as the IARP for ZRP.

II. Simulation Environment Setup
Various researchers have evaluated the performance of routing protocols [9-11] on different simulators such as NS2, Glomosim, MATLAB but we used QualNet 5.0 Simulator [12]. In QualNet
simulator, a specific network topology is referred to as a scenario. A scenario allows the user to specify all the network components and conditions under which the network will operate. For the purpose of simulation different scenarios were created for different number of nodes (20, 25 and 30). The following parameters were configured as shown in Table 1.

<table>
<thead>
<tr>
<th>Physical Layer Protocol</th>
<th>802.11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Routing protocol</td>
<td>Bellman-Ford, ZRP</td>
</tr>
<tr>
<td>Fading Model</td>
<td>Rayleigh</td>
</tr>
<tr>
<td>Shadowing Model</td>
<td>Constant</td>
</tr>
<tr>
<td>Energy Model</td>
<td>Linear</td>
</tr>
<tr>
<td>Battery power</td>
<td>Simple Linear</td>
</tr>
<tr>
<td>Area</td>
<td>1500 X 1500</td>
</tr>
<tr>
<td>Mobility</td>
<td>Random way point</td>
</tr>
<tr>
<td>Mobility Speed</td>
<td>0-30mps</td>
</tr>
<tr>
<td>Data Link Layer</td>
<td>802.11.DCF</td>
</tr>
<tr>
<td>Application Layer</td>
<td>CBR Traffic</td>
</tr>
</tbody>
</table>

In fig. 1, a scenario with 30 nodes is shown. The nodes were randomly distributed in 1500 X 1500 unit area. The nodes 1, 2, 3, 4, 7, 8, 9, 10, 16, 20 (as Source) and 30, 13, 14, 18, 29, 26, 15, 17, 22, 24 (as Destination) were connected and 1KB data was transmitted. The simulation was run for 30 seconds. The routing protocols taken were Bellman-Ford and ZRP and a comparison of the following parameters have been done.

**III. Results & Discussion**

Number of Periodic/Regular updates sent: The numbers of periodic updates are quite similar in both Bellman-Ford and ZRP, as shown in fig. 1(a) and fig. 1(b).

Number of update Packets/Messages received: In Bellman-Ford, the numbers of update packets are more as compare to ZRP, as shown in fig. 1(c) and fig. 1(d).

From the above graphs which are generated on different parameters, we can see the comparison of both Bellman-Ford and ZRP routing protocols (see Table 2).
Table 2: Comparison of Bellman-Ford and ZRP Routing Protocol (on 30 Nodes Placement)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Bellman-Ford</th>
<th>ZRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Periodic/Regular updates sent</td>
<td>Quite Similar</td>
<td>Quite Similar</td>
</tr>
<tr>
<td>Number of update Packets/Messages received</td>
<td>More</td>
<td>Very Less</td>
</tr>
<tr>
<td>Routing Scheme</td>
<td>Proactive</td>
<td>Hybrid</td>
</tr>
</tbody>
</table>

IV. Conclusion

In this paper, the comparison of routing protocols Bellman-Ford and ZRP has been presented after their simulation on the QualNet 5.0 Simulator. The main characteristics have been presented and a thorough evaluation has been carried out for ZRP against Bellman-Ford. Regrettfully ZRP was not up to the task and it performed poorly throughout all the simulation sequences, hence putting itself out of competition. Bellman-Ford performed well in most of the network sizes (better than ZRP).

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References


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