Performance Comparison of DSR, OLSR and TORA Routing Protocols

Vasudha Sharma, Sanjeev Khambra

Abstract – A MANET is a mobile ad-hoc network which consists of mobile nodes communicating with each other. Among various routing protocols used in networking, performance comparison of DSR, OLSR and TORA is done. Various performance parameters measured are Throughput, End to End Delay and Packet Delivery Fraction for CBR traffic over UDP connection. The mobility models used are Random Waypoint (RW) and Reference Point Group Mobility (RPGM). During the research it was found that the Reactive protocol DSR gives better performance than the Proactive protocol OLSR and Hybrid protocol TORA. NS-2.35 simulator is used to analyze the result.

Keywords- MANET, DSR, OLSR, TORA, Random Waypoint, RPGM, NS2

1. Introduction

MANET is an ad-hoc network among users wanting to communicate with each other over wireless links. Thus all the nodes of the network act as routers and take part in detection and preservation of routes to other nodes in the network. MANET nodes have wireless transceivers in them with antennas, which may be highly directional (point-to-point) or omni-directional (same in all directions). At any given point in time, depending on positions of nodes with their transmitter and receiver coverage patterns, communication power levels and co-channel interference levels, a wireless connection in the form of a random graph or "ad hoc" network exists among the nodes. This pattern is not fixed and changes with mobility of nodes. The links between mobile nodes may be symmetric or asymmetric. Networks are established using routing protocols DSR, OLSR and TORA. The performance comparison of these protocols using RW mobility model and RPGM model is done using NS2 network simulator. The performance parameters used are Throughput, End to End Delay and Packet Delivery Fraction. Section 2 includes the related work done in this field. Section 3 provides information on routing protocols DSR, OLSR and TORA. The routing protocols RW and RPGM are briefly explained in section 4. The results and discussions of simulations carried on by NS2 on protocols DSR, OLSR and TORA using mobility models RW and RPGM on basis of Throughput, End to End Delay and Packet Delivery Fraction are shown on section 5. Finally, section 6 consists of conclusions drawn and future work in same area.

2. Related Work

Cano et al. [1] studied the effects of RWG, RDG, MGM and SGM mobility models on TCP and UDP data traffic with DSR protocol. Rathore et al. [2] studied the effects of RW , RRW and RD, Column and Pursue mobility models on protocols AODV, DSR , OLSR, FSR and ZRP with performance metrics as control packet throughput, data packet throughput, average latency and average hops.

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Cavalcanti et al. [3] through regression analysis, proposed predictive formulas for three mobility metrics: link duration, node degree and network partitioning, considering a set of random, group, and grid-based mobility models. Bai et.al. [4] observed that mobility pattern influences the protocol performance. Taneja et al. [5] noted that due to the dynamically changing topology and infrastructure less, decentralized characteristics, power awareness and security is hard to achieve in MANETs. Hong et.al. [6] applied RPGM model to two different network protocol scenarios, clustering and routing, to evaluate performance of routing protocols. Timcenko et.al. [7] and Giri et.al. [8] compared performance of many routing protocols with different mobility models with parameters delay and routing overhead. Reddy et.al**.** [9] studied effects of varying MANET Size for simulation for the routing protocols AODV, DSDV and TORA. Kulkarni et.al. [10] proposed a new Group Vehicular mobility model that took the best features of group mobility models like RPGM and applied it to vehicular models. Kumar et.al. [11] studied protocols AODV and OLSR using RPGM mobility model on a national Open Access Research Test bed (ORBIT) for Next Generation Wireless Networks. Sankar et.al.[12] studied the effects of Entity models like Random Waypoint, Gauss Markov and Manhattan Grid and Group models like RPGM and CM to determine their effect on network performance parameters like packet goodput, packet delivery ratio and control overhead using AODV routing protocol. Shoaibet.al.[13] did a study on the performance of various Group mobility models such as RPGM, Column, Nomadic and Pursue Mobility models over the On-demand routing protocol (DSR) using performance metrics like packet delivery ratio, average delay and normalized routing load. The authors related mobility models to realistic scenarios like soldiers performing military drills, road accident due to land slide in hilly areas, students touring Zoo Park with guide, army personnel tracking the terrorist. The authors took three scenarios for group sizes as 1,5,10 and increased the number of nodes to check the performance in different group mobility models. Gupta et.al. [14] compared the performance of AODV, OLSR and TORA based on the performance metrics like packet delivery fraction, end–to–end delay and throughput.

3. Routing Protocols

In MANET routing of data between mobile nodes is the main challenge due to mobility. Routing protocols can be divided based on when and how the routes are discovered into three categories: Table-Driven (Proactive), On-Demand routing (Reactive) and Hybrid.

3.1 **In table-driven (proactive) routing** protocols, each node maintains one or more tables containing routing information of all other nodes of the network. All nodes update their tables from time to time to maintain a reliable and the latest view of the network which helps in link connection and transfer of information. **OLSR** (Optimized Link State Routing) is a proactive protocol based on link state routing in which initially nodes have routing tables which they update from time to time. In OLSR only the nodes chosen as MPRs transmit packets to all other nodes thus reducing traffic significantly. Each node selects an MPR which is one hop away from it. Each MPR node maintains the topology information of network and sends this information from time to time to its neighbour MPRs only.

3.2 **In on-demand (Reactive) routing**, all routes are not maintained at each node, as an alternative the routes are created just when required. When a source node has to send something to a distant node, it starts a route discovery process to find the path to the destination. A route is formed between communicating nodes**. DSR** (Dynamic Source Routing) is a reactive protocol based on link state routing. It has two main working operations for route construction called route discovery and route maintenance. Route discovery operation is used when route between unknown hosts is required. Route maintenance operation is used to monitor wellness of recognized routes and to initiate route discovery again if a route fails.

3.3 **In hybrid routing protocols**, a mixture of proactive and reactive techniques exist. **TORA** (Temporally Ordered Routing Algorithm) TORA is a hybrid protocol which is based on a “link reversal” algorithm. Nodes have routing tables, which helps the sending node to find the route to destination. It discovers multiple routes from source to a destination. A route discovery QUERY packet is broadcasted and propagated throughout the network until it reaches the destination or an intermediate node that has information about how to reach the destination. TORA defines a parameter, called as height which is a measure of the distance of the responding node’s distance up to the required destination node. In the route discovery phase, this parameter is returned to the querying source node in a packet called UPDATE and all the nodes in between update their tables based on this height information. This helps create a DAG (Directed Acyclic Graph) in the network. A path based on the height parameter is established for communication.

4. Mobility Models

The mobility models determine the motion of mobile nodes (MN) in a network. They are mainly of two types: the entity based and group based models. In the entity based models each node is independent of motion of other nodes. It has its own velocity and motion. Various entity based models are- Random Walk, Random Waypoint, Random Direction, Gauss Markov, Manhattan etc. In group based models nodes are part of separate groups. In each group nodes have their own motion within the confines of the group and the motion of the whole group are determined by a group leader. Different group based models are Column Mobility Model, Reference Point Group Mobility model, Pursue Mobility model etc.

4.1 Random Way Point is a simple, commonly-used model in which each node independently chooses its destination randomly within the network boundaries and moves towards the destination with a constant speed. The speed and direction of motion is chosen randomly. After a node reaches its destination it pauses for a specified pause time and then again selects a random direction and random speed to move towards a new destination. The process is repeated for the entire duration of simulation.

4.2 RPGM (Reference point group mobility) model represents the random motion of a group of mobile nodes and their random individual motion within the group. All group members follow a logical group centre that determines the group motion behaviour, which is represented by a group motion vector GM. The motion of the group center/leader completely shows the movement of its related group of MNs, including their speed and direction. Individual MNs randomly move about their own predefined reference points, whose movements depend on the group movement.

5. Simulation Analysis and Results

In this paper, simulation analysis is carried out using the network simulator NS-2.35[15]. It is a discrete event simulator used in research related to networks. It uses a visual tool called NAM which is Tcl/TK based animation tool for viewing real world packet trace data and network simulation traces. The protocols DSR, OLSR, TORA are taken for comparison of their performance in Random Waypoint and Reference Point Group Mobility Model. The performance parameters are Throughput, End to End Delay and Packet Delivery Fraction. These are explained along with the result of simulation.

Table1.Parameters used in Simulation I

Simulation Parameter	**Value**
Network Simulator	NS-2.35
Routing Protocols	DSR, OLSR, TORA
Mobility Models	RW, RPGM
Simulation Area	700x700 m^2
No. Of Nodes	25,50,75,100
Speed of Nodes	20 – 30 m/s
Pause Time	15 s
Connection type	CBR

Packet Size	512
Data Rate	1 Mbps
Simulation Time	60 s

5.1 Throughput

It is the number of packets passing through a network per unit time. It is measured in bps or data packets per unit time. In RPGM (Fig1), it is seen that OLSR performs better than DSR and TORA because it avoids the extra overhead of communicating with each node since only MPR nodes take part in communication. TORA has worst throughput because due to multiple paths, more traffic control messages are transferred when there is a change in topology. In RW (Fig2), we see that throughput of OLSR rapidly decreases with increase in no. of nodes whereas there is steady decrease in throughput in DSR and TORA.

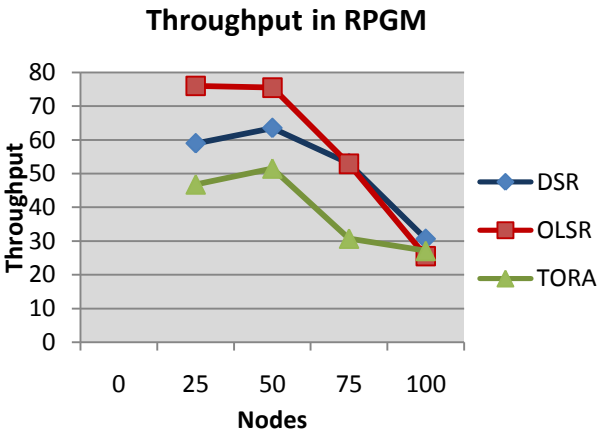

Fig. 1: Throughput in RPGM model

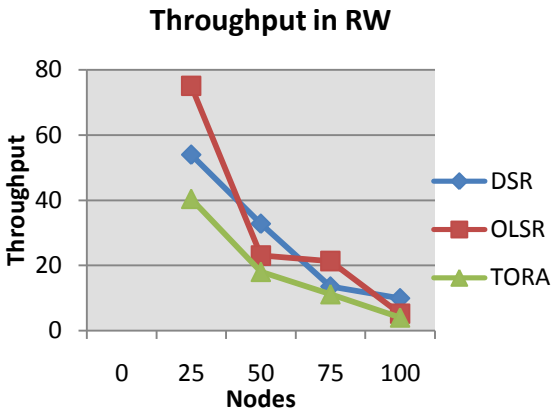

Fig. 2: Throughput in RW model

5.2 End to End Delay

It is the average transmission time taken by data packets to reach from source to destination. If value is large, it means there is congestion in the network and data packets are taking longer to reach the destination than usual. It is observed from the graphs that delay increases with increase in no of nodes. In RPGM (Fig. 3) it is highest for DSR in the starting but with increase in nodes, it becomes higher for TORA. OLSR has the lowest delay. In RW model (Fig. 4), OLSR shows the highest delay while TORA has the lowest delay with increase in no of nodes. TORA has lowest delay because it does not need to discover routes again and again for a destination.

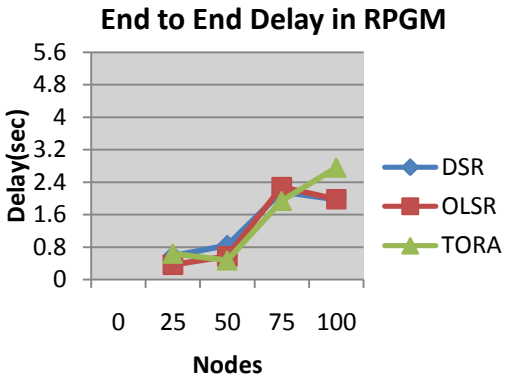

Fig. 3: End to End Delay in RPGM

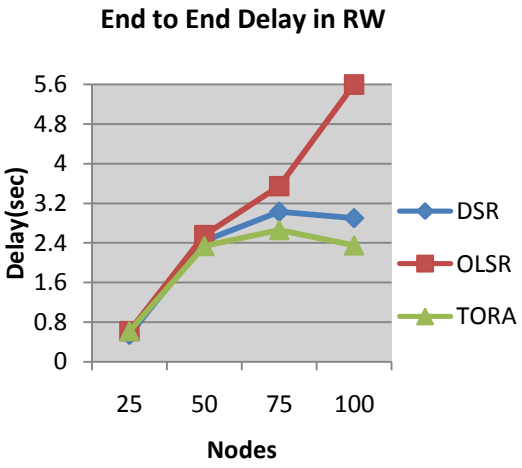

Fig. 4: End to End Delay in RW

5.3 Packet Delivery Fraction

It is the fraction of data packets received at destination to packets sent by the source. In RPGM (Fig.5), PDF slightly decreases with increase in no of nodes.DSR shows more decrease than TORA. PDF for OLSR increases in the end with increase in no of nodes. TORA has best PDF because due to existence of multiple routes from source to destination, it doesn't need to update its routing table on every little movement in traffic. In RW (Fig.6), PDF gradually decreases for all the protocols with increase in no of nodes.

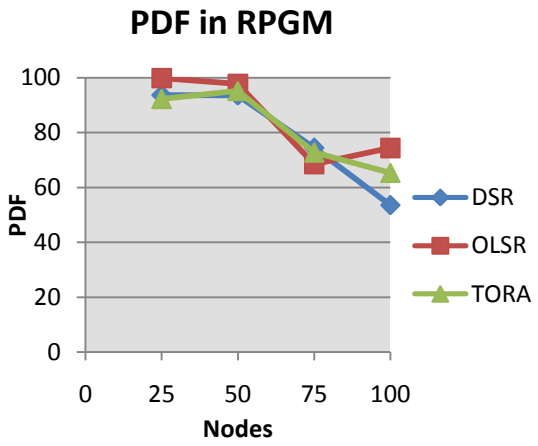

Fig 5: PDF in RPGM

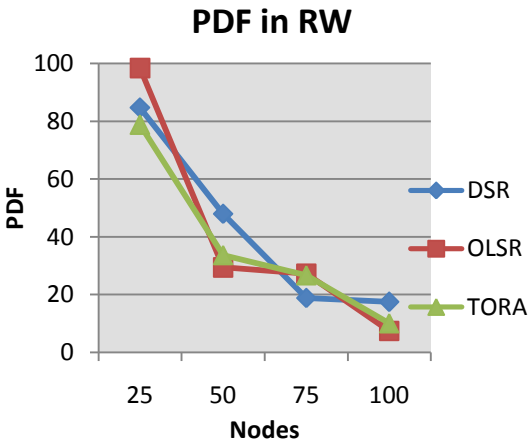

Fig 6: PDF in RW

6. Conclusion and Related Work

From all the performance metrics defined above it is concluded that On- Demand (Reactive) protocols are better for PDF, End to End Delay and Throughput than Table driven (proactive) protocols. The hybrid protocol TORA performs worst and hence is the worst MANET Routing Protocol. DSR performs better than both OLSR and TORA. The mobility model also influences the choice of protocols. DSR performs better in Random Waypoint while OLSR performs average in both. It also shows how increasing the no of nodes decreases the value of each parameter for every protocol in both mobility models.For future work, performance can be measured using different values and parameters under many other mobility models.

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