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Comparative Performance Analysis of Two Ad-hoc Routing Protocols

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Abstract. A Mobile Ad-Hoc network is a decentralized wireless network. The network is ad-hoc because it does not rely on a pre-existing infrastructure, such as routers in wired networks or access points in managed (infrastructure) wireless networks. Mobile Ad hoc networking (MANET) is becoming increasingly important in today's world and a number of protocols have been developed. However, a comparison between them is lacking to help determine an optimal one. This study addresses this issue by comparing the relative performance of Ad hoc routing protocols; we compared on-demand and hybrid protocol; temporally ordered routing algorithm (TORA) and Dynamic Source Routing (DSR). This subjected the protocols to identical loads and environmental conditions and evaluates their relative performance with respect to quantitative metrics; throughput, average delay, packet delivery ratio and routing load. From the detailed simulation results and analysis of presented, we use NS-2 simulator for simulation of DSR and TORA protocol and variation occurs in mobility of packets, time interval between the packets sent and packet size of packets sent in throughout the protocols.

Keywords: MANET, Packet Delivery Ratio, Routing Overhead, Throughput, End to End Delay.

1. Introduction

MANET is a kind of wireless ad-hoc network and it is a self-configuring network of mobile routers (and associated hosts) connected by wireless links – the union of which forms an arbitrary topology. The routers, the participating nodes act as router, are free to move randomly and manage themselves arbitrarily; thus, the network's wireless topology may change rapidly and unpredictably. Such a network may operate in a standalone fashion, or may be connected to the larger Internet [9]. MANET routing protocols are classified in three categories. Proactive routing protocols constantly maintain the updated topology of the network. Every node in the network knows about the other node in advance. All the routing information is usually kept in tables [5]. The nodes exchange topology information with each other; they can have route information any time when they needed [11]. It includes DSDV, CGSR, and WRP protocols. Reactive protocols do not initiate route discovery by themselves, until they are requested. These protocols setup routes when demanded [11]. It includes AODV, DSR protocols. Hybrid protocols could be derived from the two previous ones, using some quality of one type and enhancing it with the participation of the other one. For instance, using a reactive protocol, where the route discovery is done only when a communication is requested, and caching the available routes in a case of a link failure, which is an aspect of proactive routing. It includes ZLR and TORA protocol.

2. Background

Lots of work has been done in the area of MANET Routing Protocols. Both AODV and DSR have received a lot of attention in recent times and lot of analysis has done on these protocols. Performance of

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reactive and proactive protocols is analyzed at different mobility, packet sizes, and time interval [1]. The comparison was done with respect to three major protocols: DSDV, DSR and AODV. The simulation results with larger networks pointed out that the performance of ad hoc routing protocols may degrade rapidly especially if there are some bottlenecks in the network. AODV, DSR and TORA protocols are compared and analyzed based on end to end delay and packet delivery ratio [2]. Three protocols AODV, DSDV and I-DSDV were simulated using NS-2 package and were compared in various metrics in different environment; varying number of nodes, speed and pause time. Simulation results show that I-DSDV compared with DSDV, it reduces the number of dropped data packets with little increased overhead at higher rates of node mobility and packet delivery ratio of DSDV is improved at high mobility [5]. In this study, various routing protocols such as Ad hoc On-demand Distance Vector (AODV), Dynamic Source Routing (DSR) and Temporally Ordered Routing Algorithm (TORA), are compared on the basis of their throughput by increasing number of nodes in the network [3]. A comprehensive attempt has been made to compare the performance of two prominent on-demand reactive routing protocols for mobile ad hoc networks: DSR and AODV, along with the traditional proactive DSDV protocol. [4]. Das et. [12] Compared the performance of AODV and DSR using ns-2 simulator.

3. Description of Protocols

3.1 Dynamic Source Routing (DSR)

The DSR network is totally self organizing and self configuring. The protocols is just compose of two mechanisms i.e. route discovery and route maintenance. The DSR regularly updates its route cache for the sake of new available easy routes. In route discovery, it has two messages i.e. route request (RREQ) and route reply (RREP). When a node wishes to send a message to a specific destination, it broadcast the RREQ packet in the network. The neighbor nodes in the broadcast range receive this RREQ message and add their own address and again rebroadcast it in the network. This RREQ message if reached to the destination, so that is the route to the specific destination. The first message reached to the destination has full information about the route. That node will send a RREP packet to the sender having complete route information. This route is considered the shortest path taken by the RREQ packet. The source node now has complete information about the route in its route cache and can starts routing of packets. The route maintenance uses two kind of messages i.e. route error (RERR) and acknowledgement (ACK). The messages successfully received by the destination nodes send an acknowledgement ACK to the sender. If there is some problem in the communication network a route error message denoted by RERR is transmitted to the sender, that there is some problem in the transmission.

3.2 Temporally Ordered Routing Algorithm (TORA)

It is a highly adaptive, proficient and scalable distributed routing algorithm based on the concept of link reversal. Principal feature of TORA is that control messages are localized to a very small set of nodes near the occurrence of a topological change. The protocol has three essential functions: Route creation, Route maintenance and Route erasure. Route creation in TORA is made using QRY and UDP packets. The route creation algorithm starts by setting the height of destination to 0 and for all other nodes to NULL. The source broadcasts a QRY packet with the destination node's id in it. A node with a non-NULL height responds with a UDP packet that has its height in it. A node receiving a UDP packet sets its height is considered upstream and a node with lower height downstream. In this way a directed acrylic graph is constructed from source to the destination. The subsequent formation of route on TORA is done by transferring request from source and receiving reply from destination. During the route creation and maintenance phases, nodes use a height metric to establish a directed acyclic graph (DAG) rooted at destination. During the times of mobility the DAG is broken and the route maintenance unit comes into picture to reestablish a DAG routed at the destination.

4. Simulation Environment

We are using Network Simulator NS2 for simulations of protocols. NS2 is a discrete event simulator targeted at networking research [14]. It provides substantial support for simulation of TCP, routing and multicast protocols over wired and wireless networks. It consists of two simulation tools. The network simulator (ns) contains all commonly used IP protocols. The network animator (NAM) is use to visualize the simulations. Ns2 fully simulates a layered network from the physical radio transmission channel to high-level applications. The Distributed Coordination Function (DCF) of IEEE 802.11 for wireless LANs is used as the MAC layer. Simulation environment consists of 100 wireless mobile nodes which are placed uniformly and forming a Mobile Ad-hoc Network, moving about over a 1200 X 1200 meters area for 100 seconds of simulated time. Nodes move according to "random waypoint" model. In communication model, traffic sources are CBR (Constant Bit Rate).

TABLE1 SIMULATION PARAMETERS

Method	**Value**
Channel type	Channel/Wirelesschannel
Radio propagation model	Propagation/TwoRayGround
Network interface type	Phy/WirelessPhy
MAC type	Mac/802_11
Interface queue type	CMUPriqueue
Link Layer type	LL
Antenna	Antenna/omniAntenna
Maximum packet in ifq	50
Area(mxn)	1200x1200
Simulation Time	100
Routing protocols	DSR and TORA
Number of mobile nodes	100

5. Simulation Results

5.1 Packet Size

Comparing DSR and TORA routing protocol under following quantitative metrics such as Routing load, Throughput, Average delay, Packet delivery ratio. Analysis of packet size has done been under 500, 1000, 1500, 2000 and 2500 bytes. We run the simulator of 100 nodes network for 100 sec. and topology dimension is 1200x1200 m. As shown in Fig.1 throughput of TORA protocol outperforms than DSR. At every variation in packet size performance of TORA is better than DSR protocol. In case of average delay, DSR has less delay than TORA at different variation of Packet size of sending packets from source to destination as shown in Fig.2.

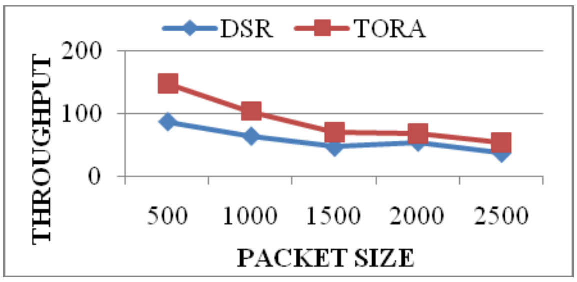

Fig.1

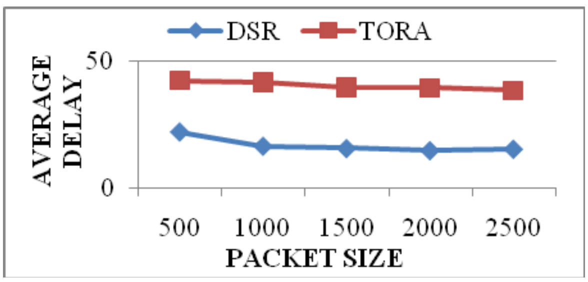

Fig.2

In case of packet delivery ratio, TORA protocol performs well than DSR protocol shown in fig.3. In routing load metrics, as the packet size is less routing load of both protocols is also less but routing load of TORA is much less than DSR protocol which is good protocol as shown in Fig.4.

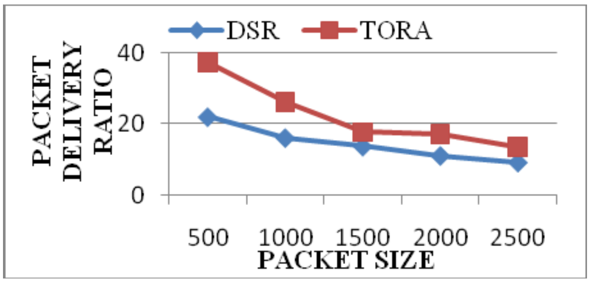

Fig.3

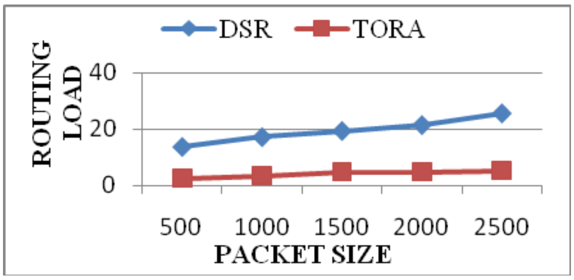

Fig.4

5.2 Mobility

Performance of DSR and TORA has been compared at varying node mobility. Simulation experiments have been conducted for the mobility metrics such as Routing load, Throughput, Average delay, Packet delivery ratio. We run the simulations for 100 sec with nodes mobility 100, 200, 300, 400 and 500 m sec^{-1}. In the presence of High mobility, we have better throughput of TORA protocol than DSR protocol. Throughput of DSR protocol is very less at high mobility as shown in Fig. 5. Average delay metrics, DSR has less delay than TORA protocol therefore; DSR has transmitted packets faster than TORA as shown in Fig 6.

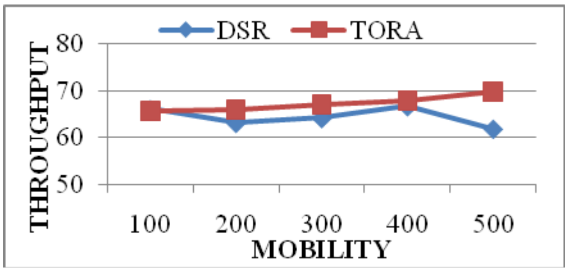

Fig.5

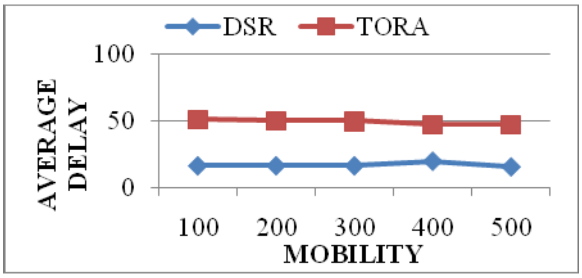

Fig.6

When mobility is varied, packet delivery ratio of DSR at low mobility is more than but after variation of mobility at higher mobility packet delivery ratio of TORA becomes more than of DSR as shown in Fig.7. In comparison of Routing load metrics TORA has less routing load than DSR protocol as shown in Fig.8.

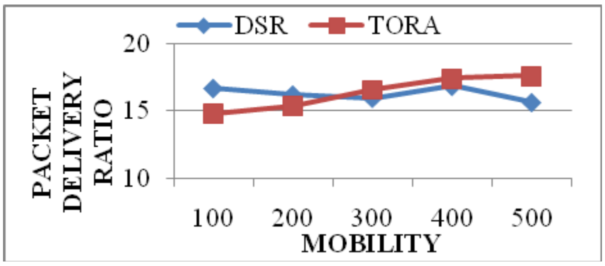

Fig. 7

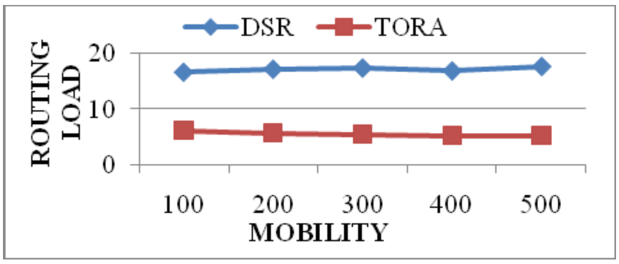

Fig.8

5.3 Time Interval

Performance comparison of DSR and TORA routing protocol at varying time internal between packet sending, we calculated various quantitative metrics such as Routing load, Throughput, Average delay, Packet delivery ratio. Variation of time interval has done under 0.005, 0.010, 0.015, 0.020 and 0.025 sec. We run the simulations for 100 sec. Throughput of TORA protocol performs well than DSR protocol as shown in Fig.9. But Average Delay in transmission of packets in DSR protocol is less than TORA protocol as shown in Fig.10.

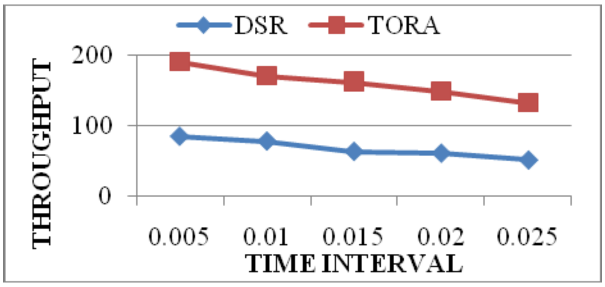

Fig.9

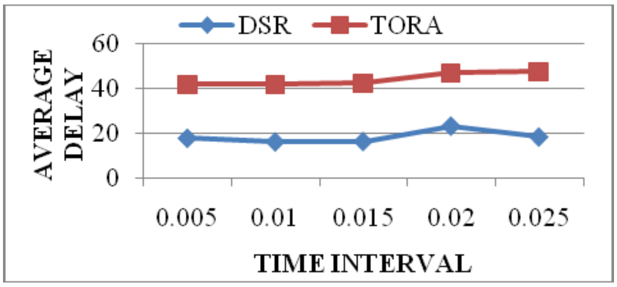

Fig.10

At time interval variation between packets sending, packet delivery ratio of TORA protocol is more than DSR protocol as shown in Fig.11. and Routing load of TORA protocol is performes well which upgrades the performance of the TORA protocol as shown in Fig.12.

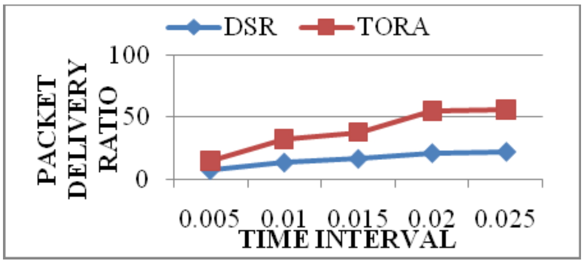

Fig.11

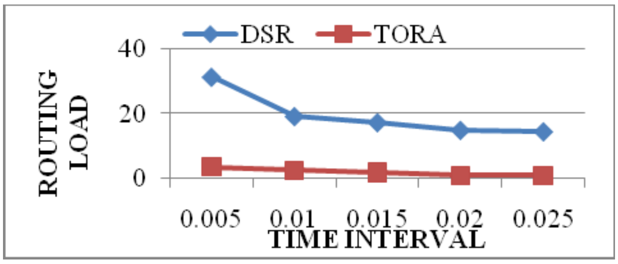

Fig.12

6. Conclusions

The results of the both DSR and TORA routing protocol on various mobility, packet size and time interval metrics have been analyzed. The performance metrics to evaluate performance of DSR and TORA routing protocol includes routing load, average delay, packet delivery ratio and throughput to. Performance of TORA protocol at mobility variation of nodes has better throughput, packet delivery ratio and routing load than DSR protocol. But average delay of DSR is less as compared to TORA. High mobility results in frequent link failures but qualitative metrics throughput, routing load and packet delivery ratio outperforms at High mobility of TORA protocol. The overhead involved in updating all the nodes with the new routing information in TORA. Variation in time interval results better throughput, packet delivery ratio and routing load of TORA protocol but average delay is less in DSR than TORA. At packet size variation routing load, packet delivery ratio and throughput of TORA outperforms. However, since all experiments in this paper are done using mobile nodes, it is considered as a factor that caused a high delay that impacted on the TORA performance. Performance of TORA is much better than DSR protocol. The TORA discovers new route faster and more effectively to the destination when the old route is broken as it invokes route repair mechanism locally also high route cache hit ratio in TORA.

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