CBR AND TCP BASED PERFORMANCE COMPARISON OF VARIOUS PROTOCOLS OF MANET: A REVIEW

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ABSTRACT

The primary objective of this research work is to study and review the behavior of AODV, TORA and DSDV routing protocols of MANET. In this paper, we will first discuss the various MANET routing protocols and then simulate the environment used for analyzing, evaluating and implementing AODV, DSDV and TORA routing protocols in MANET. Performance of above said protocols will be analyzed based on Packet Delivery Ratio, Average End-to-End Delay and Throughput. We will studythe effect of change in number of nodes on MANET routing protocols. Here, we will analyze and compare the performance of MANET routing protocols based on both CBR and TCP based traffic patterns. We have used the NS-2 simulator for performing various simulations and used awk scripts and java for analyzing the results.

Keywords: Routing, Ad-hoc, Protocol, Simulation, AODV, TORA, DSDV, CBR, TCP, NS-2.

I. INTRODUCTION

Mobile ad-hoc network is a collection of wireless mobile hosts forming a temporary network without the aid of any stand-alone infrastructure or centralized administration. Mobile ad-hoc network have the attributes such as wireless connection, continuously changing topology, distributed operation and ease of deployment. An ad-hoc network is a collection of wireless mobile nodes dynamically forming a temporary network without the aid of any established infrastructure or centralized administration. The system may operate in isolation, or may have gateways to interface with a fixed network. Ad hoc networks have no fixed routers; all nodes are capable of movement and can be connected dynamically in an arbitrary manner. Nodes of these networks, which function as routers, discover and maintain routes to other nodes in the network. The topology of the ad hoc network depends on the transmission power of the nodes and the location of the mobile nodes, which may change with time. Because of these features, the Ad hoc networks are used where wired network and mobile access is either unproductive or not feasible. A few possible examples include: earthquake hit areas, where infrastructure is destroyed, military soldiers in a destructive environment; virtual classrooms, biological detection, tracking of rare animal, space exploration, and undersea operations. A fundamental problem in ad hoc networking is how to deliver data packets among MNs efficiently without predetermined topology or centralized control, which is the main objective of ad hoc routing protocols. Since mobile ad hoc networks change their topology frequently, routing in such networks is a challenging task.

II. ROUTING IN MANET

Major challenges of Routing in MANET protocols includes a node needs to know at least the reach ability information to its neighborhood nodes for determining the packet route. Another major challenge includes dynamic nature of Ad-hoc network routing protocols. As the number of nodes can be large, finding route to the destination requires large and frequent exchange of routing control information among the nodes. As the nodes are mobile in MANET, it includes rote maintenance overhead. Routing in Mobile Ad-hoc Network has been a subject of extensive research over the past several years. Because of the fact that it may be necessary to pass several hops (multi-hop) before a packet reaches the destination, a routing protocol is needed. Ad-hoc routing protocols can be classified based on different criteria.

Adhoc On-Demand Distance Vector (AODV)

AODV is a purely reactive routing protocol. In this protocol, each terminal does not need to keep a view of the whole network or a route to every other terminal. Nor does it need to periodically exchange route information with the neighbor terminals. Furthermore, only when a mobile terminal has packets to send to a destination does it need to discover and maintain a route to that destination terminal. In AODV, each terminal contains a route table for a destination. A route table stores the following information: destination address and its sequence number, active neighbors for the route, hop count to the destination and expiration time for the table. The expiration time is updated each time the route is used. If this route has not been used for a specified period of time, it is discarded.

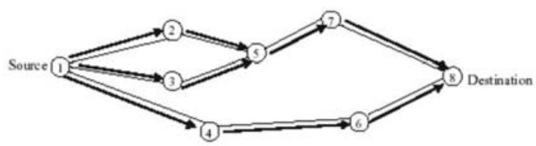

Figure 2.1: Propagation of Route Request (RREQ) packet

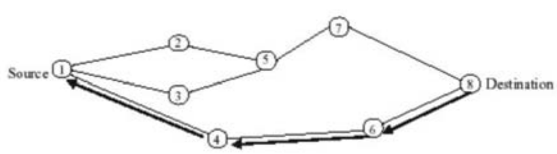

Figure 2.2: Path taken by RREP in AODV

Destination Sequenced Distance-Vector Routing (DSDV)

DSDV is a proactive, distance vector protocol which uses the Bellmann -Ford algorithm. DSDV is a hop-by-hop distance vector routing protocol, wherein each node maintains a routing table listing the “next hop” and “number of hops” for each reachable destination. This protocol requires each mobile station to advertise, to each of its current neighbors, its own routing table (for instance, by broadcasting its entries). The entries in this list may change fairly dynamically over time, so the advertisement must be made often enough to ensure that every mobile computer can almost always locate every other mobile computer of the collection. In addition, each mobile computer agrees to relay data packets to other computers upon request. This agreement places a premium on the ability to determine the shortest number of hops for a route to a destination we would like to avoid unnecessarily disturbing mobile hosts if they are in sleep mode. In this way a mobile computer may exchange data with any other mobile computer in the group even if the target of the data is not within range for direct communication.

Temporary Ordered Routing Algorithm (TORA)

TORA is a highly adaptive, efficient and scalable distributed routing algorithm based on the concept of link reversal. TORA is proposed for highly dynamic mobile, multi-hop wireless networks. It is a source-initiated on-demand routing Protocol. It finds multiple routes from a source node to a destination node. The main feature of TORA is that the control messages are localized to a very small set of nodes near the occurrence of a topological change. To achieve this, the nodes maintain routing information about adjacent nodes. The protocol has three basic functions: Route creation, Route maintenance and Route erasure. TORA can suffer from unbounded worst-case convergence time for very stressful scenarios. TORA has a unique feature of maintaining multiple routes to the destination so that topological changes do not require any reaction at all. The protocol reacts only when all routes to the destination are lost. In the event of network partitions the protocol is able to detect the partition and erase all invalid routes.

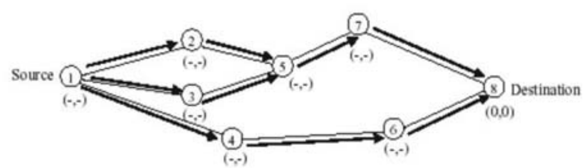

Figure 2.3: Propagation of Query message in TORA

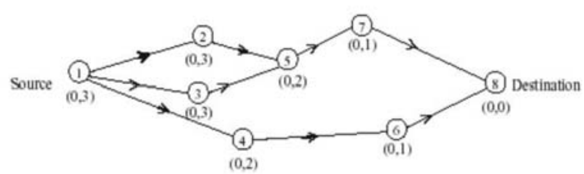

Figure 2.4: Nodes height updated as a result of the update message

III. PROBLEM FORMULATION AND RESEARCH METHDOLOGY [23,24]

The IETF MANET working group mandate was to standardize IP routing protocols in MANETs. The RFC 2501 specifies the charter for the working group. The RFCs still has unanswered questions concerning either implementation or deployment of the protocols. Nevertheless, the working group identifies the proposed algorithms as a trial technology. Aggressive research in this area has continued since then, with prominent studies on routing protocols such as Ad hoc On-demand Distance Vector (AODV), Destination-Sequenced Distance-Vector Routing protocol (DSDV) and Dynamic Source Routing Protocol (DSR). Several studies have been done on the performance evaluation of routing protocols based on CBR traffic pattern using different evaluation methods. Different methods and simulation environments give different results and consequently, there is need to broaden the spectrum to account for effects not taken into consideration in a particular environment.

It is observed that most of the research work is based on CBR traffic pattern whereas most of the traffic approximately 95% on the Internet carries TCP. It is desirable to study and investigate the performance of different MANET routing protocols under both CBR and TCP traffic patterns. In this paper, we will evaluate the performance of Reactive protocols (AODV and TORA) and Proactive protocols (DSDV) of mobile ad-hoc network routing protocols for both CBR and TCP traffic patterns. The performance of these routing protocols is evaluated with respect to various parameters such as average end-to-end delay, throughput and packet delivery ratio. There are many discrete-event network simulators available for the MANET community. Network Simulator-2 (NS-2) is the most used simulator in MANET research as shown in Figure 4.1 that is based on Mobi-Hoc Survey [11].

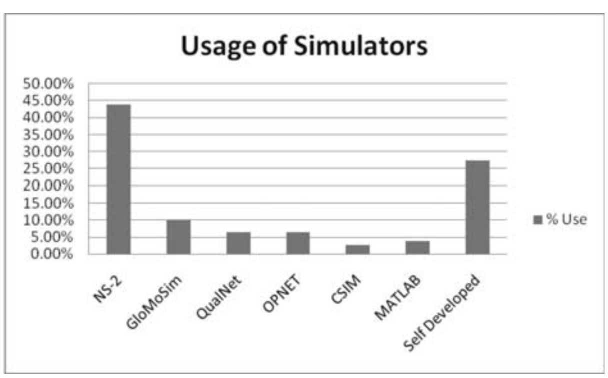

Figure 4.1: Usage of Various Simulators

Simulator we have used to simulate the ad hoc network routing protocols is the Network Simulator-2 (ns-2.29 version) from Berkeley. Nodes in the simulation are moved according to "random way mobility model". The movement scenario files used in simulation are characterized by change in number of nodes, pause time and speed. Simulations are done for different types of traffic patterns i.e. CBR and TCP. Simulations are done for various Reactive protocols (AODV, DSR and TORA) and Proactive protocols (DSDV). The trace files are generated in new trace format of NS2. Trace files are then analyzed by Java Program and awk scripts. The trace file can also be used to visualize the simulation run with Network Animator.

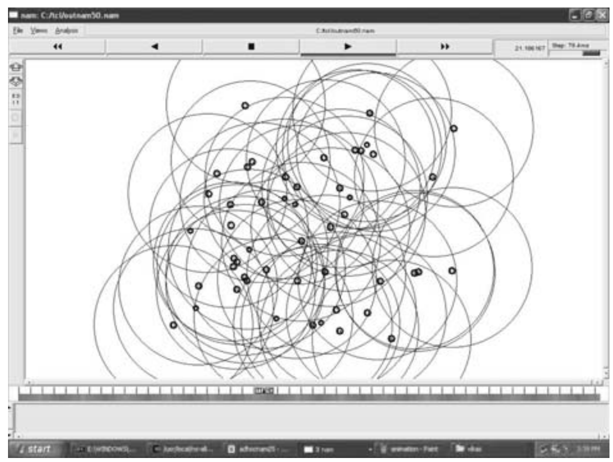

Figure 4.2: Network Animator (NAM)

IV. PERFORMANCE PARAMETERS

Mobile ad hoc networks have several inherent characteristics (e.g. dynamic topology, time-varying and bandwidth constrained wireless channels, multi-hop routing, and distributed control and management). Design and performance analysis of routing protocols used for mobile ad hoc network (MANET) is currently an active area of research. To judge the merit of a routing protocol, one needs metrics—both qualitative and quantitative--with which to measure its suitability and performance. Specifically, this paper evaluates the performance comparison of AODV, DSDV and TORA routing protocols on the following performance metrics: Average end-to-end delay, Packet delivery ratio and throughput.

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. It specifies the packet loss rate, which limits the maximum throughput of the network. The better the delivery ratio, the more complete and correct is the routing protocol.

Average End-To-End Delay

Average End-to-End delay (seconds) is the average time it takes a data packet to reach the destination. This metric is calculated by subtracting “time at which first packet was transmitted by source” from “time at which first data packet arrived to destination”. This includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC, propagation and transfer times. This metric is significant in understanding the delay introduced by path discovery.

Throughput

The throughput of the protocols can be defined as percentage of the packets received by the destination among the packets sent by the source. It is the amount of data per time unit that is delivered from one node to another via a communication link. The throughput is measured in bits per second (bit/s or bps).

V. SIMULATION AND PERFORMANCE ANALYSIS [24,26]

In this paper, we have taken two different scenarios. In the first scenario, traffic pattern is taken as CBR and no. of nodes have been varied and performance comparisons has been made between AODV, DSDV and TORA protocols. In the second scenario, traffic pattern is taken as TCP and no. of nodes have been varied and performance comparisons has been made between AODV, DSDV and TORA protocols. Identical mobility pattern are used across protocols to gather fair results.

Test Scenario 1

In the first scenario, We have chosen the simulation based on CBR traffic pattern. Parameters of this scenario are summarized in table 5.1. CBR sources are used that started at different times because we want to get a general view of how routing protocol behaves.

Table 5.1. Simulation Parameters for Test Scenario 1

Simulation Parameter	Value
No. of nodes	25, 50, 75, 100
Speed	20 m/s
Simulation time	50 sec
Pause Time	5 sec
Environment Size	1000 × 1000
Packet Size	512 bytes
Traffic Type	CBR
Packet Rate	4 packet/sec

Test Scenario 2

In the second scenario, We have chosen the simulation based on TCP traffic pattern. Parameters of this scenario are summarized in table 5.2.

Table 5.2. Simulation Parameters for Test Scenario 2

Simulation Parameter	Value
No. of nodes	25, 50, 75, 100
Speed	20 m/s
Simulation time	50 sec
Pause Time	5 sec
Environment Size	1000 × 1000
Packet Size	512 bytes
Traffic Type	TCP
Packet Rate	4 packet/sec

VI. PERFORMANCE COMPARISION [26]

Performance of AODV, TORA and DSDV protocols is evaluated under both CBR and TCP traffic pattern.

Average end-to-end Delay

Average end-to-end Delay of proactive routing protocols (DSDV) is less as compared to reactive routing protocols (AODV and TORA) in any kind of traffic pattern i.e. either CBR (Figure 6.1) or TCP (Figure 6.2). Average end-to-end Delay is also remains almost constant in DSDV whereas it varies in the case of AODV and TORA protocols with respect to change in number of nodes.

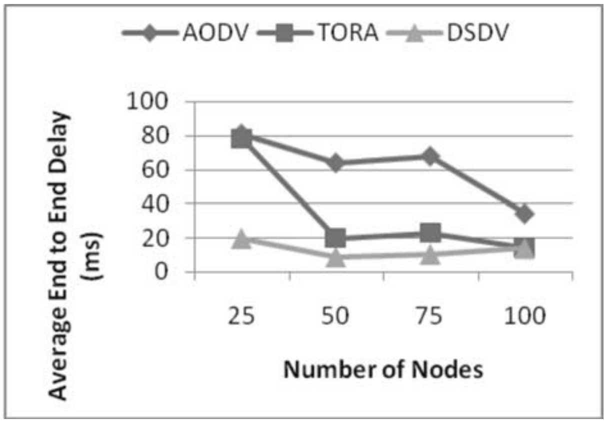

Figure 6.1 Average End to End Delay for CBR Traffic Pattern

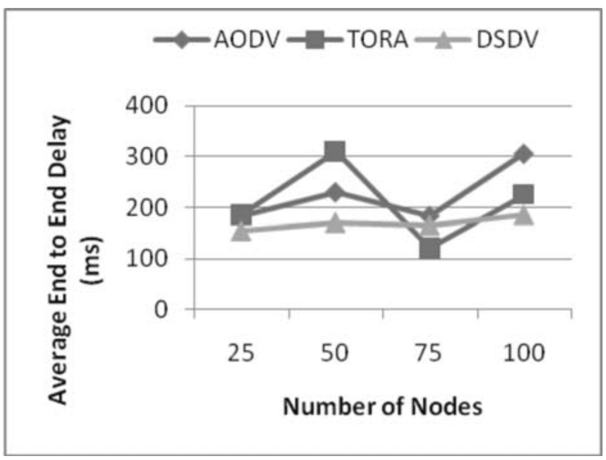

Figure 6.2 Average End to End Delay TCP Traffic Pattern

Packet Delivery Ratio

In case of CBR traffic Reactive protocols deliver almost all the originated data packets converging to 100% delivery whereas Proactive protocols (DSDV) Packet Delivery Ratio is approx 50% (Figure 6.3). Reactive protocols perform better than the proactive protocols in case of CBR traffic pattern. In the case of TCP traffic pattern (Figure 6.4), Packet delivery ratio of AODV protocols remains almost constant whereas it changes rapidly for TORA and DSDV protocols irrespective of the network load.

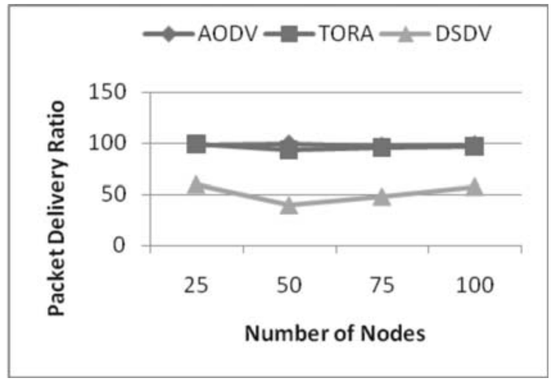

Figure 6.3 Packet Delivery Ratio for CBR Traffic Pattern

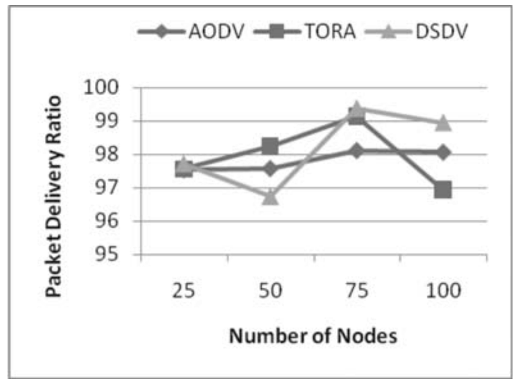

Figure 6.4 Packet Delivery Ratio for TCP Traffic Pattern

Throughput

In case of CBR traffic pattern throughput of AODV and TORA protocols is almost same and is better than as compared to DSDV protocols. In case of CBR traffic, throughput remains almost constant for all three protocols irrespective of number of nodes. In case of TCP traffic, throughput changes rapidly with respect to change in the number of nodes.

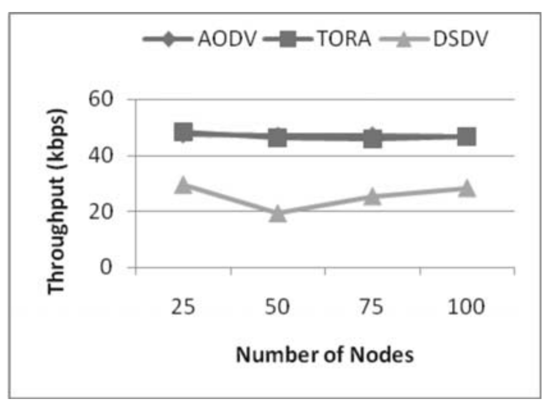

Figure 6.5 Throughput for CBR Traffic Pattern

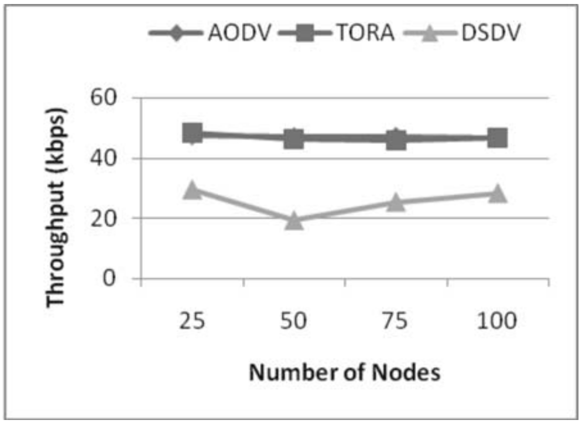

Figure 6.6 Throughput for TCP Traffic Pattern

VII. CONCLUSIONS & FUTURE WORK

This study was conducted to study the behavior of various routing protocols of MANET and to evaluate the performance AODV, TORA and DSDV protocols of MANET based on CBR and TCP traffic. These routing protocols were compared in terms of Packet delivery ratio, Average end-to-end delay and Throughput when subjected to change in no. of nodes. Simulation results show that Reactive protocols better in terms of packet delivery ratio and average end-to-end delay. Future work will be to evaluate the performance of these protocols by varying the speed, pause time. Performance can also be analyzed for other parameters like Jitter, Routing Overhead. Performance of MANET routing protocols can be evaluated on the basis of various mobility patterns. Behavior of other routing protocols like DSR, OLSR can also be studied in the future work.

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