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Efficient Analysis and Comparative Study of Routing Protocols in wireless AD-Hoc Networking MANET

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***Abstract*— Ad-Hoc networking is a concept in computer communication which means that users wanting to communicate with each other from temporary network.**

With the advent of recent developments in the field of Wireless Communication and Technology, the world has become a very technically sound place. Wireless Networking has completely drifted the communication paradigm which we observe today as they can be very easily deployed and setting them up takes no time. The devices have minimal energy requirements and are easily available in their predetermined ranges to form connections and networks, in order to communicate with each other without any requirement of wires or ducts.

In this research paper the authors analysis and compare to ad-hoc networking method with various parameters of routing protocols. This study addresses this issue by comparing the relative performance of four key Ad hoc routing protocols; Destination-sequenced distance vector (DSDV), Temporally ordered routing algorithm (TORA), Dynamic source routing (DSR) and Ad hoc on-demand distance vector (AODV). This study subjected the protocols to identical loads and environmental conditions and evaluates their relative performance with respect to end-to-end throughput and delay, control packet overhead and route acquisition time.

***Index Terms*— Proactive, Reactive, DSDV, TORA, DSR, AODV, throughput, packet delivery ratio, MANET**

I. INTRODUCTION

A mobile ad hoc network (MANET), which is one form of wireless networks, is an autonomous system of mobile hosts connected by wireless links. There is no static infrastructure such as base stations. Each node in the network also acts as a router, forwarding data packets for other nodes. These ad hoc routing protocols can be divided into two categories: proactive driven routing protocols, consistent and up-to-date routing information to all nodes are maintained at each node. Reactive routing protocols, the routes 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 additionally, because nodes in MANET normally have limited transmission ranges, some nodes cannot communicate directly with each other.

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MANET is a wireless infrastructure less network having mobile nodes. Communication between these nodes can be achieved using multi hop wireless links. Each node will act as a router and forward data packets to other nodes. Mobile adhoc networks are operating without any centralized base station. It uses multi hop relaying. Since the nodes are independent to move in any direction, there may be frequent link breakage. The advantage of MANET is its instant deployment.

II. PROBLEM IDENTIFICATION

The aim of the research work is to provide a comprehensive analysis of various on-demand routing protocols and carry out the comparative study with table driven protocols. The idea is to implement and compare several on-demand routing protocols. The research work is aimed to study the performance of on-demand routing protocols like DSR, AODV and AOMDV under identical traffic load and mobility patterns of Ad hoc network with reference to table driven protocol DSDV,TORA[3].

a. Destination-sequenced distance rector (DSDV): DSDV is a table-driven protocol, wherein each node maintains a routing table listing the “next hop” for each reachable destination.
Every node in DSDV periodically broadcasts its routing table with monotonically increasing even sequence number. When a node B detects that it link to a destination D has broken, it advertises the route to D with an infinite metric and a sequence number one greater than its sequence number for the route that has broken (making an odd sequence number). This cause any node ‘A’ routing packets through ‘B’ to incorporate the infinite-metric route into its routing table until node A hears a route to D with a higher sequence number[5].

b. Temporally ordered routing algorithm (TORA): TORA is an on-demand routing protocol design to provide loop-free and multiple routes (to alleviate congestion) and yet minimize communication overhead by localizing algorithmic reaction to topological changes when possible (to conserve bandwidth and increase scalability). Moreover, it is desirable to detect network partition and delete invalid routes.

In TORA when a node needs a route to a particular destination, it broadcasts a query packet containing the address of the destination. This packet propagates through the network until it reaches either the destination or an intermediate node having a route to the destination. The recipient of the query then broadcasts an update packet listing its height with respect to the destination. As this packet propagates through the network, each node that receives the update sets it height to a value greater than the height of the neighbor from which the update was received. This has the effect of creating a series of directed links from the original sender of the query to the node that initially generated the update[5].

When a node discovers that a route to a destination is no longer valid, it adjusts its height so that it is a local maximum with respect to its neighbors and transmits an update packet. When a node detects a network partition, it generates a clear packet that resets routing state and removes invalid routes from the network.

c. Dynamic source routing (DSR): DSR is an on-demand routing protocol wherein the source determines the ordered list of nodes through which a packet must pass while traveling to its destination. The key advantage of source routing is that intermediate nodes do not need to maintain up-to-date routing information in order to route the packets they forward, since the packets themselves already contain all the routing decisions. This fact, coupled with the on-demand nature of the protocol, eliminates the need for the periodic route advertisement and neighbor detection packets present in other protocols[2].

Whenever a source has a packet to transmit, it checks its route cache for a route to the destination. In case a route is not found then a route request is broadcast across the network. On receiving this request, an intermediate node without a cache route to the destination appends its address to the request packet and rebroadcast it until the request packet reaches the destination.

If any intermediate node has a cache route to the destination then it will discard the request and will send route reply back to the source. Otherwise, the destination will send a route reply to the source containing the route from the source to the destination. When the reply packet reaches the source a connection is established and all subsequent packets contain the complete route in the packet header.
If any link on a source route is broken, the source node is notified using a route error (RERR) packet. The source removes any route using the link from its cache and initiates a new route discovery if this route is still needed.

d. Ad hoc on-demand distance vector (AODV): AODV is essentially a combination of DSR and DSDV. It borrows the basic on-demand mechanism of route Discovery and Route maintenance from DSR, plus the use of hop-by-hop routing, sequence number and periodic beacon from DSDV. When a source S needs a path to some destination D, it broadcasts a route request message enclosing the last known sequence number to that destination. The Reference [3] proposes that an effective MANET routing protocol must be equipped to deal with the dynamic and unpredictable topology changes associated with mobile nodes, whilst also being aware of the limited wireless bandwidth and device power considerations which may lead to reductions in transmission range or throughput. This is expanded upon by [2] who propose that in addition to these core requirements; MANET routing protocols should also be decentralized, self-healing and self-organizing and able to exploit multi-hopping and load balancing, these requirements ensure MANET routing protocols ability to operate autonomously.

Route request is broadcasted across the network until it reaches a node that has a route to the destination with the destination sequence number higher than that enclosed in the request. Each node that forwards the route request creates a reverse route for itself back to node S. when the route request reaches a node with a route to D, that node generates a route reply that contains the number of hops necessary to reach D and the sequence number for D most recently seen by the node generating the reply. Each node that participates in forwarding this reply back forward the originator of the route request (node S) creates a forward route to D. The state created in each node along the path from S to D is hop-by-hop state that is, each node remembers only the next hop and not the entire route as would be done in source routing.

In order to maintain routes, AODV normally requires that each node periodically transmit a NETWORK message, with a default rate of once per second. Failure to receive three consecutive NETWORK message from a neighbor is taken as an indication that the link to the neighbor in question is down.

When a link goes down, any upstream node that has recently forward packets to destination using that link is notified via an unsolicited route reply containing an infinite metric for that destination. Upon receipt of such a route reply, a node must acquire a new route to the destination using route discovery.

III. RELATED WORK

A number of routing protocols have been proposed and implemented for MANETs in order to enhance the bandwidth utilization, higher throughputs, lesser overheads per packet, minimum consumption of energy and others. All these protocols have their own advantages and disadvantages under certain circumstances. The major requirements of a routing protocol was proposed by Belding-Royer, E.M. and C.K. Toh et al.[4] that includes minimum route acquisition delay, quick routing reconfiguration, loop-free routing, distributed routing approach, minimum control overhead and scalability.

MANET Routing Protocols possess two properties such as Qualitative properties (distributed operation, loop freedom, demand based routing & security) and Quantitative properties (end-to-end throughput, delay, route discovery time, memory byte requirement & network recovery time). Obviously, most of the routing protocols are qualitatively enabled. A lot of simulation studies were carried out in the paper [2] to review the quantitative properties of routing protocols.

A number of extensive simulation studies on various MANET routing protocols have been performed in terms of control overhead, memory overhead, time complexity, communication complexity, route discovery and route maintenance[6][4]. However, there is a severe lacking in implementation and operational experiences with existing MANET routing protocols. The various types of mobility models were identified and evaluated by Tracy Camp et al. [6] because the mobility of a node will also affect the overall performance of the routing protocols. A framework for the ad hoc routing protocols was proposed by Tao Lin et al. [3] using Relay Node Set which would be helpful for comparing the various routing protocols like AODV, OLSR & TBRPF [7].

The performance of the routing protocols OLSR, AODV and DSR was examined by considering the metrics of packet delivery ratio, control traffic overhead and route length by using NS-2 simulator. The performance of the routing protocols OLSR, AODV, DSR and TORA was also evaluated with the metrics of packet delivery ratio, end-to-end delay, media access delay and throughput by also using OPNET simulator.

The existing routing protocols in MANETs can be classified into three categories. the classification along with some examples of existing MANET protocols.

a) Proactive (Table-Driven) Routing Protocols

In this family of protocols, nodes maintain one or more routing tables about nodes in the network. These routing protocols update the routing table information either periodically or in response to change in the network topology.

b) Reactive (On-Demand) Routing Protocols

For protocols in this category there is an initialization of a route discovery mechanism by the source node to find the route to the destination node when the source node has data packets to send. When a route is found, the route maintenance is initiated to maintain this route until it is no longer required or the destination is not reachable.

c) Hybrid Routing Protocols

Both of the proactive and reactive routing methods have some advantages and shortcomings. In hybrid routing a combination of proactive and reactive routing methods are used which are better than the both used in isolation. It includes the advantages of both protocols.

IV. SIMULATION & RESULT

Simulation- All the protocols were implemented using NS simulator. The chapter describes the simulation environment, which contains introduction, general structure, and architecture of NS-2 simulator and sample simulation scripts. Simulation study also contains mobility generation models to provide node mobility.

Effect of Mobility

To analyze the effect of mobility, pause time was varied from 0 seconds (high mobility) to 100 seconds (no mobility) as 0s, 10s, 20s, 30s, 40s, 50s and 100s. The numbers of nodes were taken as 100 and the maximum number of connection as 0. The simulation results were stored in text files and the results were analyzed using 'C++' program and trace analyzer under various mobility condition. Results were plotted between pause time and six different performance evaluation metrics as follows-

Pause time Vs Throughput
Pause time Vs Packets dropped
Pause time Vs end to end delay
Pause time Vs Routing Overhead
Pause time Vs Packet delivery ratio
Pause time Vs Optimal length

Sample results for Pause time Vs Throughput are given in Fig 4.1(a-b) and Table 4.2 (a-b)

Table 4.1(a): Pause Time Vs Throughput

	Throughput (bits/sec)			
Pause Time Sec	**DSR**	**DSDV**	**AODV**	**TORA**
0	12578	10567	12890	9564
10	12890	10874	13466	10579
20	13567	11789	14123	10892
30	14201	12456	14657	11577
40	14678	13897	15230	12201
50	14907	14321	15789	12687
100	15301	14967	15901	1379

Fig 4.2(a): Pause Time Vs Throughput

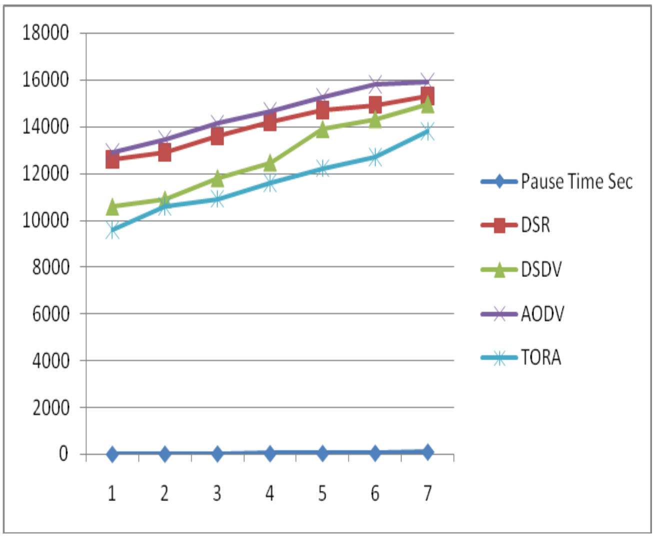
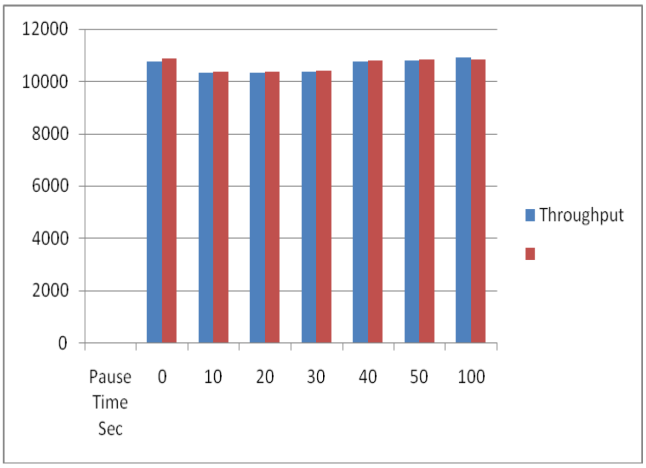


Table 4.1(b): Pause Time Vs Throughput

	Throughput	
Pause Time Sec	AODV	AOMDV
0	10765	10879
10	10340	10345
20	10343	10367
30	10367	10398
40	10768	10806
50	10798	10827
100	10918	10848

Fig 4.2(a): Pause Time Vs Throughput



V. CONCLUSION

A large number of different kinds of routing protocols are practiced in mobile Ad hoc networks. The use of a specific routing protocol in mobile Ad hoc network depends upon number factors including size of the network, load, mobility requirements, routing overhead and end-to-end delay. In recent years on-demand routing protocols have attained more attention in mobile Ad hoc networks as compared to other routing schemes due to their potential flexibility in deployment and efficiency in terms throughput. They are able to organize themselves dynamically with lower memory overhead and lower bandwidth requirement than table driven protocols.

In the present research we have implemented and carried out comprehensive analysis and comparison of unipath on-demand routing protocols (DSR, DSDV,AODV,TORA) and multipath on-demand routing protocol (AOMDV) using NS-2 simulator.

VI. FUTURE WORK

Ad hoc networking is a boiling concept in personal communications worldwide research is going on in this area and many issues still have to be addressed. We focused on concepts like unipath and multipath routing protocols with respect to their performance in the mobile Ad hoc network. Multipath routing is a step towards achieving a network with better Quality of Service. However there are many more issues related to routing that could be subjected to further research studies. The present research work can be extended to design and develop new routing protocols to meet the following additional desirable features.

Robust Scenario- A routing protocol must work with robust scenarios where mobility is high, nodes are dense, area is large and the amount of traffic is more.

Routing Overhead – Routing messages will utilize most of the precious bandwidth of Ad hoc networks; a new protocol has to be devised to reduce the routing overhead still further compared to AOMDV.

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