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Performance Comparison of AODV, TODV, OLSR and ABR using OPNET

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Abstract- ***A mobile ad-hoc network (MANET) is a self-configuring infrastructure less network of mobile devices connected by wireless links. Each device in a MANET is free to move randomly in any direction and will therefore change its links to other devices rapidly and unpredictably. Mobile devices can communicate with each other without the use of a predefined infrastructure or centralized administration. In this paper routing protocols AODV, TODV, OLSR and ABR for mobile ad hoc network are compared on the basis of delay, network load and throughput. This comparative study shows that OLSR outperforms the rest of three protocols in terms of network load and throughput.***

Keywords- MANET, AODV, TODV, OLSR, ABR, OPNET, routing

I. INTRODUCTION

A mobile ad-hoc network **(**MANET**)** is a self-configuring network of mobile routers (and associated hosts) connected by wireless links—the union of which form an arbitrary topology. The routers are free to move randomly and organize themselves arbitrarily; thus, the network's wireless topology may change rapidly and unpredictably. A collection of wireless mobile nodes can dynamically establish the network in the absence of fixed infrastructure [1]. Because of these characteristics, routing is a critical issue and an efficient routing protocol needs to be chosen to make the MANET reliable [2]. The most popular routing protocols in MANET are AODV (reactive) and TODV (on-demand reactive), OLSR (proactive) and ABR (on-demand). Reactive protocols find the routes when they are needed. On-demand protocols find a route on demand by flooding the network with route request packets. Proactive protocols are table driven protocols and find routes before they need it. In this paper, four MANET routing protocols AODV, TODV, OLSR and ABR are evaluated on the basis of three parameters: delay, network load, and throughput**.** The organization of the paper is as follows. We explain routing protocols in section II, related works are discussed in section III, section IV explains the simulation and performance metrics, section V explains the results of simulations and finally section VI concludes the paper.

II. ROUTING PROTOCOLS IN MANETS

Three routing protocols are considered in this paper namely: AODV, TAODV, OLSR and ABR. Below are a brief description of each protocol:

A. Ad-hoc On-demand Distance Vector Routing Protocol(AODV): AODV [3] is reactive protocol, when a source wants to initiate transmission with another node as destination in the network, AODV use control messages to find a route to the destination node in the network. AODV will provide topology information (like route) for the node. Fig.1 shows the message routing for AODV protocol. Node "A" wants to send messages to another node "F". It will generate a Route Request message (RREQ) and forwarded to the neighbors, and those node forward the control message to their neighbors' nodes. Whenever the route to destination node is located or an intermediate node have route to destination. They generate route reply message (RREP) and send to source node. When the route is established between "A" and "F", node then they communicate with each other.

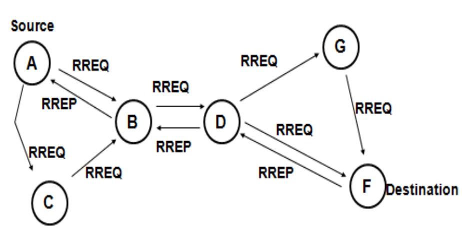

Fig1: Message Routing in AODV

B. *Time On-demand Distance Vector Routing Protocol (TODV):* Time On-Demand Routing Protocol (TODV) is a slighter modification to the existing AODV protocol. TODV uses the time concept based on first come first served basis for path choosing process, hence the name Time On Demand Distance Vector Protocol (TODV). The protocol design presented here suits the MANETS dynamic topology perfectly in finding the best path or route for data communication. The RREQ carries Source Identifier (SID), Destination Identifier (DID) and a Route Node Collection packet (RNC). The SID denotes the source address, DID denotes the destination address and the RNC packet contains the intermediate node IDs address through number of hops as shown in figure 1. That is the RNC packet gives the route definition with total number of hops defined to every node it has visited. As mentioned earlier the limit for RREQ is 3 set for any of the source node, which starts flooding RREQs through the network. Once the RREQ reaches every node, it checks the DID with itself and if not matched forwards further to the next neighboring nodes. In this modified protocol version the RNC packet has different route node collection information. Every node maintains route information about the neighboring nodes. Every RREQ to a destination node generates a Route Reply (RRPLY) packet. The RRPLY packet contains a SID, DID and a RNC packet. Here the notations change, as the SID denotes the destination node address, DID refer to the source node address and RNC again gives the route information it has collected through the RREQ process. In RRPLY DID takes data from RNC to which node it has to pass the RRPLY until it reaches source node. The RRPLY will come from different routes to source node. The first come first served basis is applied here instead of considering the destination sequence number concept. The RRPLY which arrives first, means which takes minimum time to reach source node will be the shortest path in that instance of time; this is because the MANET topology is dynamic in nature. To count the time of every RRPLY that arrives back to source node a clock will be set at the chosen source node. As the next step the path chosen will be considered for data communication between source and destination nodes. Parallely the other alternative routes possible will also be maintained in database, in case if first route is proved to be malicious.

C. Optimized Link State Routing Protocol (OLSR): OLSR is a table driven protocol. It usually stores and updates its routes so when a route is needed, it present the route immediately without any initial delay. In OLSR, some candidate nodes called multipoint relays (MPRs) are selected and responsible to forward broadcast packets during the flooding process. This technique reduces the overhead of packet transmission compared to flooding mechanism [2]. OLSR performs hop-by-hop routing, where each node uses its most recent routing information to route packets. MPR‟s is made in a way that it covers all nodes that are two hops away (i.e. neighbors of the neighbors) as shown in fig 2. A node senses and selects its MPR's with control messages called HELLO messages. Hello messages are used to ensure a bidirectional link with the neighbor. HELLO messages are sent at a certain interval. Nodes broadcast "TC" or Topology control messages to determine it's MPRs [2].

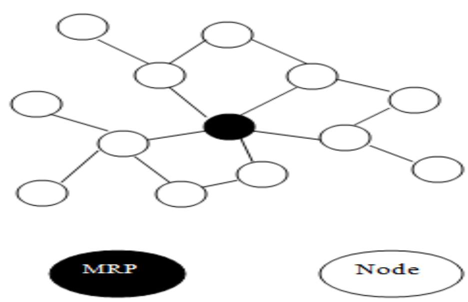

Fig 2: Flooding Packets using MPR

D. Associativity Based Routing Protocols(ABR): The Associativity Based Routing (ABR) protocol is a new approach for routing .ABR defines a new metric for routing known as the degree of association stability. It is free from loops, deadlock, and packet duplicates. In ABR, a route is selected based on associativity states of nodes. The routes thus selected are liked to be long-lived. All node generate periodic beacons to signify its existence. When a neighbor node receives a beacon, it updates its associativity tables. For every beacon received, node increments its associativity tick with respect to the node from which it received the beacon. Association stability means connection stability of one node with respect to another node over time and space. A high value of associativity tick with respect to a node indicates a low state of node mobility, while a low value of associativity tick may indicate a high state of node mobility. Associativity ticks are reset when the neighbors of a node or the node itself move out of proximity. The fundamental objective of ABR is to find longer-lived routes for ad hoc mobile networks. The three phases of ABR are Route discovery, Route reconstruction (RRC) and Route deletion.

III. RELATED WORKS

The performance comparison of various routing protocols over MANET namely-AODV, DSR, TORA, OLSR and GRP by varying the number of nodes with FTP and HTTP applications is done by Gagangeet singh aujla and Sandeep singh kang [4] on the basis of throughput, delay, load and data dropped performance metrics. They concluded that results for ftp give the clear picture about the OLSR protocol's best performance in all scenarios whereas the results for http application give the mixed picture. OLSR has highest throughput, least data dropped. TORA has high delay, load, data drop in all scenarios for ftp. DSR shows least throughput. GRP shows least delay. AODV gives highest throughput for http. The performance comparison of MANET routing protocols, namely AODV, DSR, TORA and OLSR is done by Ashish Shrestha and Firat Tekiner [5] which shows the overall performance of AODV and OLSR. However, AODV showed better efficiency to deal with high congestion and it proves better by successfully delivering packets over heavily trafficked network compared to OLSR and TORA. Performance comparison of three routing protocol -AODV, DSDV and TORA under different network size is done by N Vetrivelan, A V Reddy [6] shows that AODV performs well in terms of Average Delay, Packet Delivery Fraction and for Routing Load TORA performs well. In less stressful situation, the Packet Delivery Fraction, the TORA outperforms DSDV and AODV. Comparison of OLSR and TORA is done by Pankaj Palta and Sonia Goyal in [2] which shows that OLSR is better in those scenario where bandwidth is large as OLSR always updated their nodes so large bandwidth is used than TORA on same conditions. Performance comparison of OLSR, GRP and TORA using OPNET are compared on the basis of packets delay, load, media access and throughput by Harmanpreet Kaur and Jaswinder Singh [7].

Comparison of AODV, TORA and DSR is also done by N.Adam, M.Y Ismail and J. Abdullah [8] in terms of PDR, delay, throughput, dropped and routing load. AODV is best with minimum delay, packet delivery ratio and maximum throughput whereas TORA is worst. The simulation study for MANET network under five routing protocols AODV, DSR, OLSR, TORA and GRP were deployed using FTP traffic in [9].These protocols were tested with three QOS parameters. From their analysis, the OLSR outperforms others in both delay and throughput. Mr. L Raja, Capt. Dr. S Santhosh Baboo has done the comparative study of reactive routing protocol AODV, DSR, ABR and TORA [10].

IV SIMULATION PARAMETERS AND PERFORMANCE METRICS

TABLE 1

Maximum Simulation Time	600 seconds
Environment size	10*10 m
No. of nodes	50, 100
Routing protocols	AODV, TODV, OLSR, ABR
Data rate	1 Mbps
Packet size	1024
Speed	10 m/s
Traffic type	FTP (low load)

A. *Simulation model:* The network simulations are implemented using OPNET modeler. OPNET Modeler is commercial network simulation environment for network modeling and simulation. It allows the users to design and study communication networks, devices, protocols, and applications with flexibility and scalability. It simulates the network graphically and gives the graphical structure of actual networks and network components. The users can design the network model visually. The modeler uses object-oriented modeling approach. The nodes and protocols are modeled as classes with inheritance and specialization. The OPNET Modeler architecture consists of three modeling domains: the process, the node, and the network. Within the process modeling domain the developer implements the behavior of various processes, such as e-mail clients, TCP managers, or IP interfaces. The development language is C. In OPNET, the modular implementations of these processes are referred to as process models [4]. The complete specification of an OPNET process model consists of a finite state machine, action statements expressed in C/C++, and configurable parameters. Within the node modeling domain the developer implements the behavior of various network devices, such as clients, servers, switches, or routers. Node models are usually defined via one or more functional elements called modules and by the data flow between them. Within the network domain the developer implements complete network models including individual nodes and interconnecting communication links. It provides a variety of toolboxes to design, simulate and analyze a network topology. MANET toolbox has been used in this work to simulate the network. Components are MANET Station (mobile), application configuration which decides the type of application running in the network, profile configuration for configuring the type of type of profile on the network. Mobility Configuration will decide the mobility model of every node which is selected as random way point for simulation

B. *Performance Metrics:* While comparing four protocols we focus on three performance measures Load, Delay and Throughput.

1. Network load: It is the amount of traffic being carried by the network. It is the total data traffic (in bits/sec) received by the entire wlan from higher layers that is accepted and queued for transmission.
2. Delay: It is the time taken by a packet from the movement it is transmitted on the network by source node to reach the destination node.
3. Throughput: It is the number of packets received by all the destinations over the duration of simulation.

V. RESULTS

A. Delay:

Fig 3 and 4 shows delay for 50 and 100 nodes respectively. AODV has the maximum delay in case of 50 nodes and it gradually increases in case of 100 nodes. ABR delay increases abruptly when number of nodes increases to 100 nodes at 26 sec point and then decreases. TODV delay decreases with increase in number of nodes because of its time concept for calculation of sequence number which reduces complexity of finding a neighbor node.

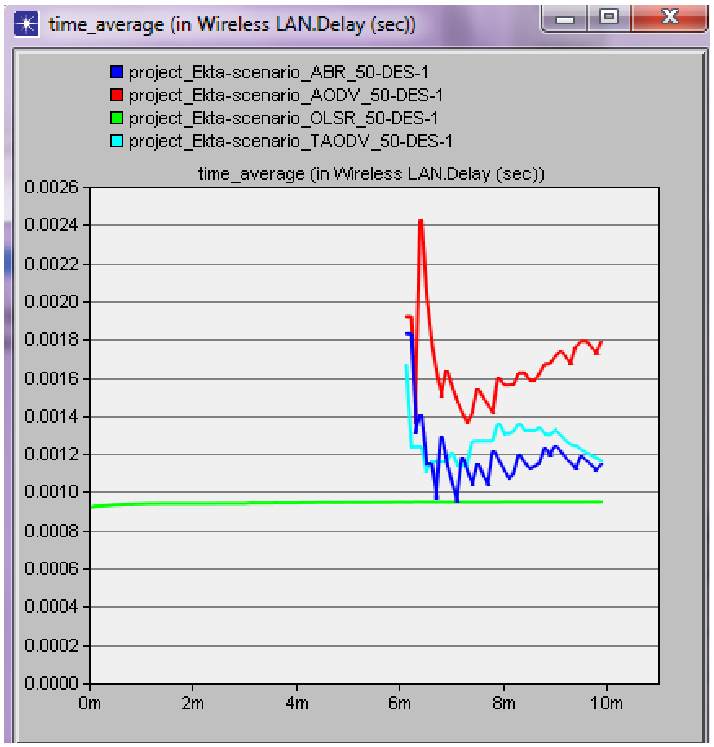

Fig 3: Delay (50 nodes)

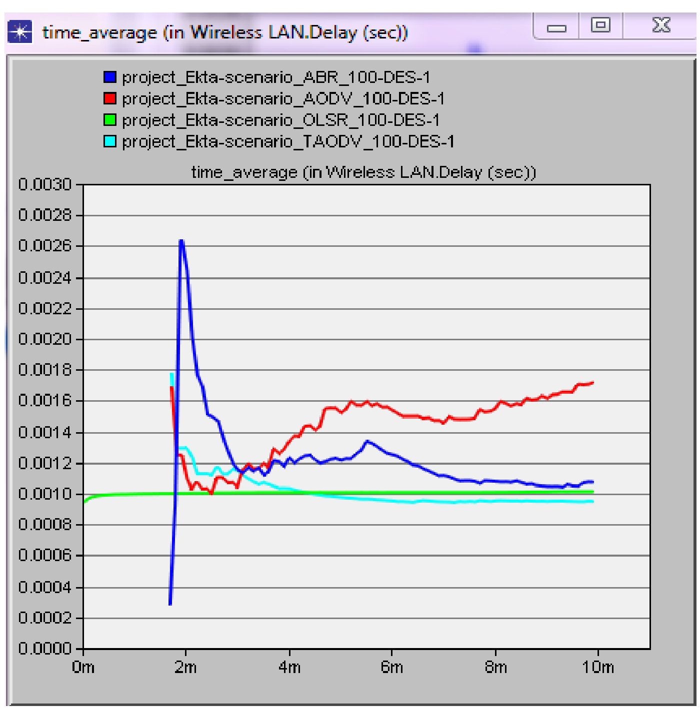

Fig 4: Delay (100 nodes)

B Network load:

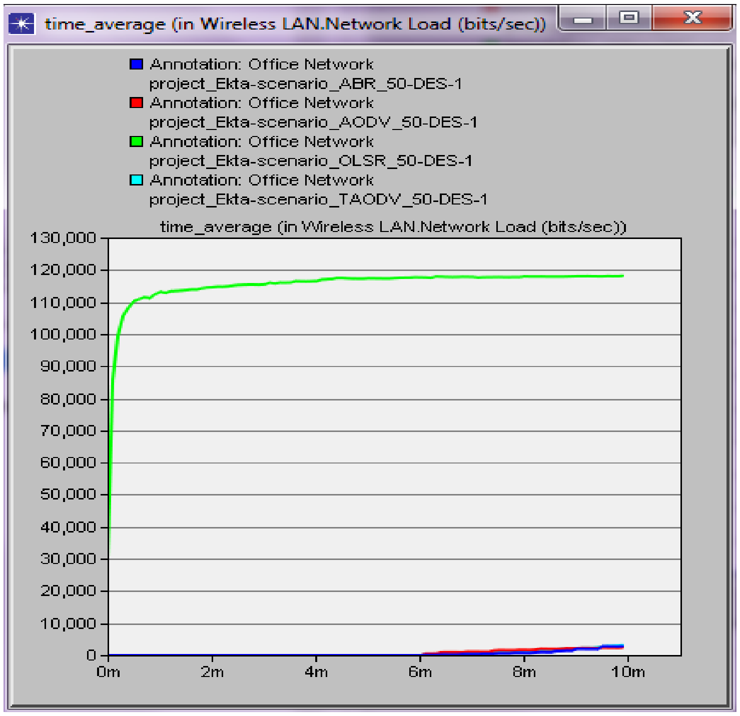

Fig 5: Network load (50 nodes)

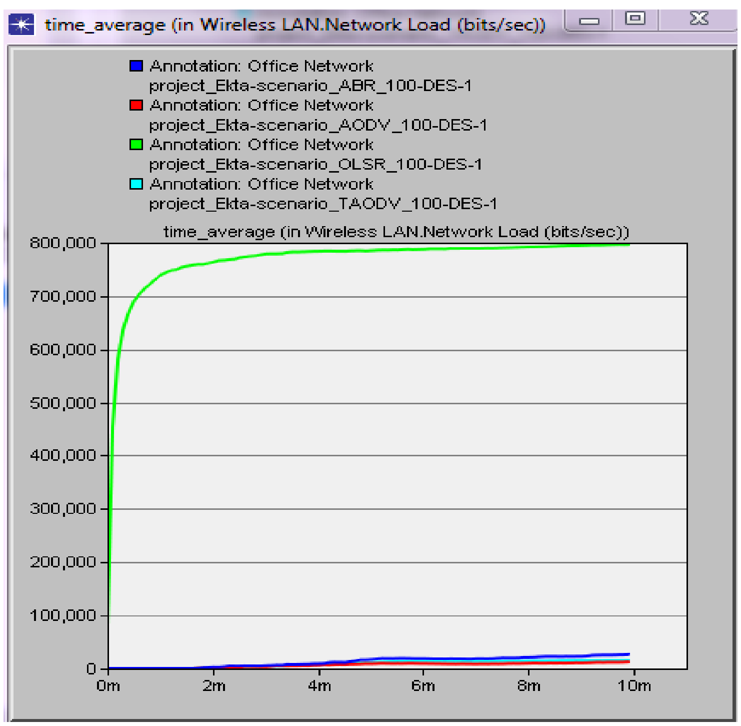

Fig 6: Network load (100 nodes)

Fig 5 and 6 shows the network load for 50 and 100 nodes respectively. OLSR has the maximum load for both the scenarios. Load for OLSR increases abruptly for both the scenarios and attain a constant line after attaining the highest position. This is because the mobile network causes changes in link state. These changes results in broadcasting of control messages ie Hello messages (for finding link status and hosts neighbor) and Topology Control (TC) to discover neighborhood nodes. OLSR's table-driven approach increases overhead due to frequent updates and maintenance of network. But TODV limits the overhead due to its first come first served basis concept where the RRPLY for whichever nodes arrives first means the minimum time to reach source node will be the shortest path in that instance of time.

C. Throughput:

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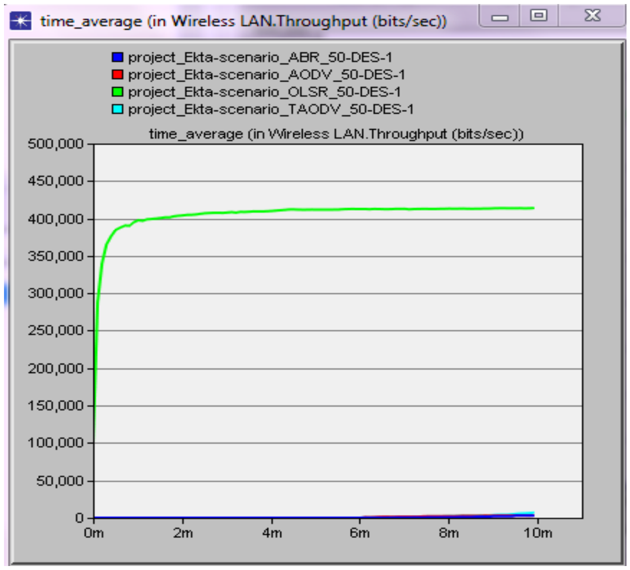

Fig 7: Throughput (50 nodes)

Fig 7 and 8 shows the throughput for 50 and 100 nodes respectively. OLSR has the maximum throughput in both the scenarios regardless of maximum load followed by TODV. AODV throughput decreases with increase in number of nodes because it keeps the information of one active node only.

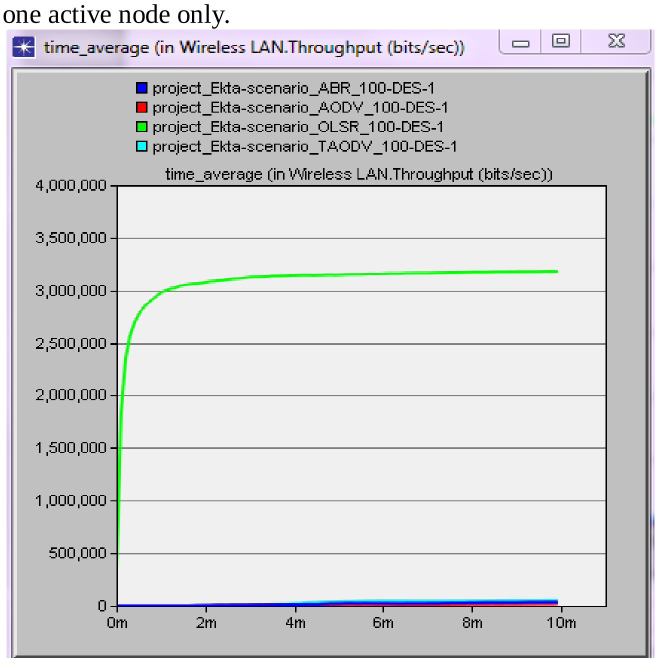

Fig 8: Throughput (100 nodes)

VI Conclusion

In this paper performance of four routing protocols was analyzed. OLSR performs best in terms of network load and throughput. AODV performs worst in terms of load and throughput. ABR's performance was consistently good in terms of load and throughput. TODV's performance was consistent for the three parameters. In summary, we can say that OLSR was best as compared to AODV, TODV, and ABR in type of traffic taken into consideration for simulation because of its maximum throughput.

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