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Performance comparison of OLSR, GRP and TORA using OPNET

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Abstract : **A MANET is an autonomous collection of mobile users that communicate over relatively bandwidth constrained wireless links. Since the nodes are mobile, the network topology may change rapidly and unpredictably over time. The network is decentralized, where all network activity including discovering the topology and delivering messages must be executed by the nodes themselves, i.e., routing functionality will be incorporated into mobile nodes.. In this paper routing protocols OLSR, GRP and TORA for mobile ad hoc network are compared on the basis of delay, load, media access delay and throughput.**

Keywords- GRP; MANET; OLSR; OPNET; Routing Protocols; TORA

I. INTRODUCTION

MANET is a dynamic distributed network [1], in which mobile devices with limited energy can move arbitrary. MANET is a self-configurable network without infrastructure in which nodes are free to move randomly, so topology may change and this event is unpredictable [6]. 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 [3] in MANET are OLSR (proactive) and TORA(reactive) and GRP(hybrid) .Proactive protocols are table driven protocols and find routes before they need it. Reactive protocols find the routes when they are needed And finally hybrid routing protocols offer an efficient framework that can simultaneously draw on the strengths of proactive and reactive routing protocols. In this paper, three MANET routing protocols ,OLSR, TORA and GRP are evaluated on the basis of four parameters : delay, load, throughput and routing overhead**.** 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; OLSR , GRP and TORA. Below is a brief description of each protocol:

A. Optimized Link State Routing (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. neighbours of the neighbours). 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].

B .Geographic Routing Protocol(GRP): This schema collects network information at a source node with a small amount of control overheads. According to the collected information, source node can finds routes and continuously transmit data even if the current route is disconnected. The result of this approach is achieving fast transfer with less overhead of control massages [3]. This approach is widely known as hybrid routing protocol, because it can simultaneously use the strengths of reactive routing and proactive routing protocols. A packet that named DQ is used continuously to forward to each node's neighbours until the destination is reached. When it reaches the destination, the destination node broadcasts a network information gathering (NIG) packet to its neighbours. The source node computes the best route according to collected information and then immediately starts to transmit data packets.

C. Temporally Ordered Routing Algorithm(TORA): The TORA is a highly adaptive loop-free distributed routing algorithm based on the concept of link reversal . TORA is proposed to operate in a highly dynamic mobile networking environment. It is source-initiated and provides multiple routes for any desired source/destination pair. The key design concept of TORA is the localization of control messages to a very small set of nodes near the occurrence of a topological change. To accomplish this, nodes need to maintain routing information about adjacent (one-hop) nodes. The protocol performs three basic functions of Route creation, Route maintenance, and Route erasure. The first three elements

collectively represent the reference level. A new reference level is defined each time a node loses its last downstream link due to a link failure. TORA's route erasure phase essentially involves flooding a broadcast clear packet (CLR) throughout the network to erase invalid routes.

III. RELATED WORKS

The performance investigation of reactive and proactive MANET routing protocols, namely AODV, DSR, TORA and OLSR is done by Ashish Shrestha and Firat Tekiner [1]. They have concluded that with regards to overall performance, AODV and OLSR performed pretty well. However, AODV showed better efficiency to deal with high congestion and it scaled better by successfully delivering packets over heavily trafficked network compared to OLSR and TORA. Comparison of OLSR and TORA has been done by Pankaj Palta and Sonia Goyal in [2].They have concluded 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. Simulation and analysis of GRP routing protocol has been done by kuldeep vats, Mandeep Dalal , Deepak Rohila and Vikas Laura [3].Simulation results show that GRP protocol has better performance in terms of delay , total traffic sent and received routing traffic sent and received in packet and bit form ,packet copy, packet created and packet destroyed. Manijeh Keshtgary and Vahide Babaiyan in [4], used OPNET 14.5 for simulation. The simulation study for MANET network under routing protocols AODV, DSR, OLSR, and GRP were deployed using FTP traffic analyzing. These protocols were tested with QOS parameters. From their analysis, the OLSR outperforms others in overall performance and GRP has least media access delay and delay. This result is verified by Kuldeep Vats, Monica Sachdeva and Dr .Krishan Saluja in [5]. They also concluded that OLSR is best in overall performance followed by GRP. Comparison of AODV, TORA and DSR is also done by N.Adam, M.Y Ismail and J. Abdullah [6] in terms of PDR ,delay ,throughput, packets dropped and routing load. AODV is best with minimum delay, packet delivery ratio and maximum throughput whereas TORA is worst.

A systematic performance study of three routing protocol for ad hoc networks Ad hoc On Demand Distance Vector (AODV), Destination Sequenced Distance Vector (DSDV), and Temporally Ordered Routing Algorithm (TORA) under different network size is done by N Vetrivelan, A V Reddy [7]. It was concluded that AODV performs well in terms of Average Delay, Packet Delivery Fraction. As far as Routing Load concerns TORA performs well. In less stressful situation, the Packet Delivery Fraction, the TORA outperforms DSDV and AODV. The simulation study for MANET network under five routing protocols AODV, DSR, OLSR, TORA and GRP were deployed using FTP traffic analysing in [8].These protocols were tested with three QOS parameters. From their analysis, the OLSR outperforms others in both delay and throughput.

IV. SIMULATION PARAMETERS AND PERFORMANCE METRICS

Table I

Maximum simulation time	900 seconds
Environment size	1000*1000
No. of nodes	15,50,100,150
Mobility	Random waypoint
Routing protocols	OLSR,GRP,TORA
Data rate	1 Mbps
Packet size	512
Speed	10 m/s
Traffic type	FTP

A. Simulation model

The network simulation are implemented using OPNET modeller. OPNET Modeler is commercial network simulation environment for network modelling 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 modelling approach. The nodes and protocols are modelled as classes with inheritance and specialization. The development language is C. It provides a variety of toolboxes to design, simulate and analyze a network topology, routing protocols on the basis of various network parameters. MANET toolbox has been used in this work to simulate the network. Components used for designing of the network are MANET_Station (mobile), application configuration which decides the type of application running in the network, profile configuration for configuring the type of profile on the network. Mobility configuration will decide the mobility model of every node which is selected as random waypoint for this simulation. Attributes of workstation will set the routing protocol used for the simulation.

B. Performance metrics

While comparing three protocols we focus on four performance measures Load, Delay, Media Access Delay and Throughput.

1. Load : It is the amount of traffic being carried by the network.
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. Routing Overhead: It is the amount of routing traffic sent over a network.
4. Throughput: It is the no. of packets received by all the destinations over the duration of simulation.

V. RESULTS :

A. Load

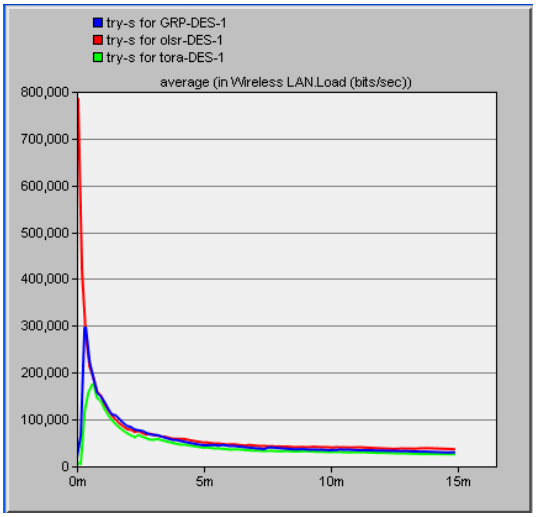

Fig 1: Load (15 nodes)

As depicted in the Fig 1-4, maximum load is of OLSR followed by TORA .GRP has the least load in all of the traffic conditions. For OLSR the routing load takes the peak at initial stage of the simulation with the drastic rise and drops down slowly as the simulation progresses. This is simply because of the constant mobility of the node; there is a frequent change in the link state and this result in the change in MPR node due to random mobility. This is in turn results in periodic broadcast of 'hello' message and Topology Control (TC) messages in order to discover neighbourhood nodes. In addition, OLSR is a link state protocol which uses a table driven approach. Therefore, it generates more communication overhead and takes more maintenance time which adds to the overall load in the network. On the other hand, TORA limits the communication overhead to the node area in order to increase the bandwidth utilisation. In addition, due to the link reverse algorithm employed within TORA, link failures are localised to certain area of the topology which in return improves the performance of the network

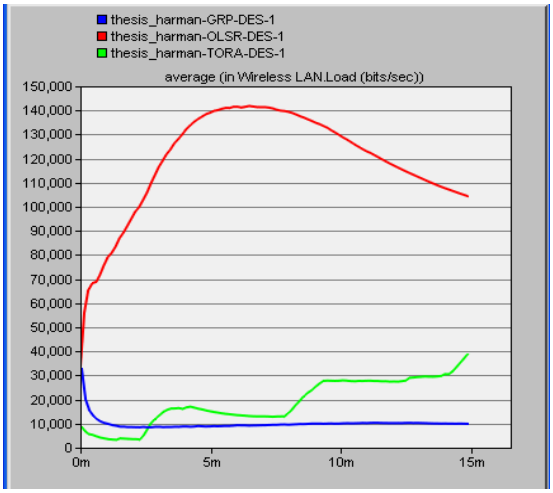

Fig 2 :Load (50 nodes)

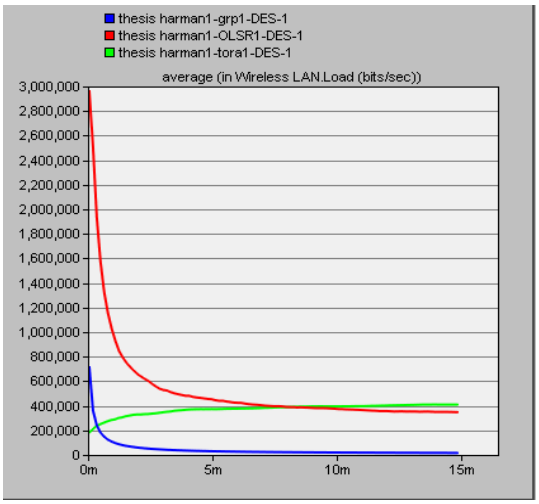

Fig 3: Load (100 nodes)

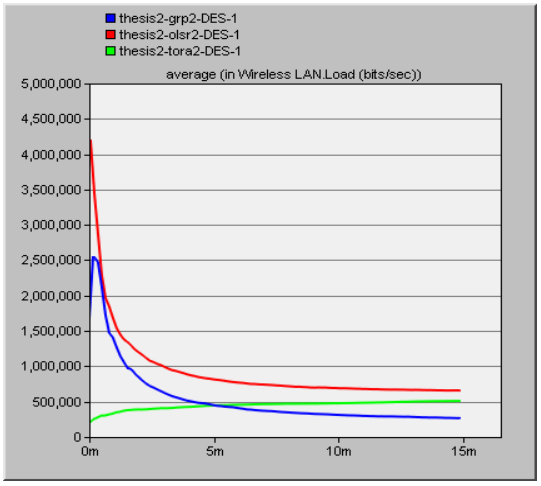

Fig 4: Load (150 nodes)

B. Routing Overhead:

OLSR has the highest Routing overhead in all scenarios whereas least routing overhead is of TORA at 15 nodes. However, as the traffic volume is increased, GRP has minimum routing overhead and TORA has medium overhead .

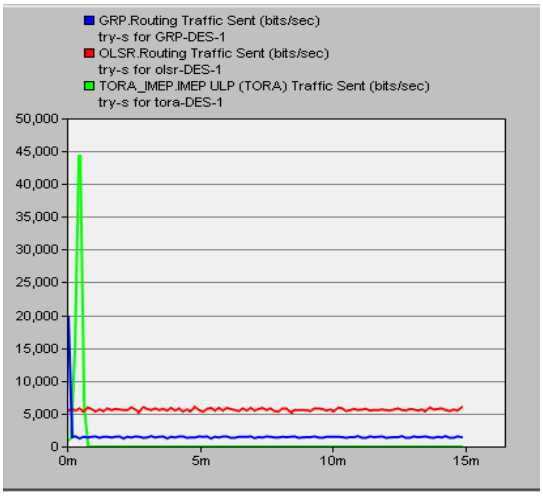

Fig 5: Routing Traffic Sent (15 nodes)

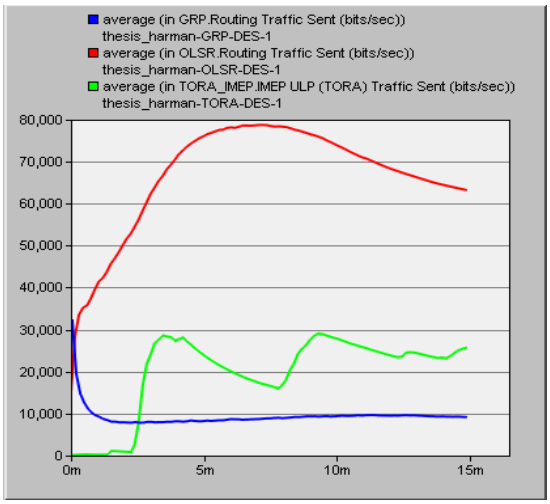

Fig 6: Routing Traffic Sent (50 nodes)

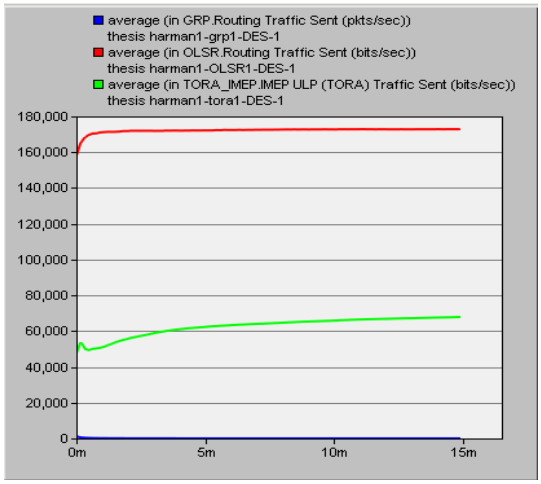

Fig 7: Routing Traffic Sent (100 nodes)

C. Delay

Fig 10 to 13 shows delay for 15,50,100 and 150 nodes respectively. TORA takes maximum time to sent packets to the destination. OLSR delay increases as the of nodes increases.This is because OLSR divides the nodes into MPR set and MPR selector set. GRP has the minimum delay when number of nodes are maximum.

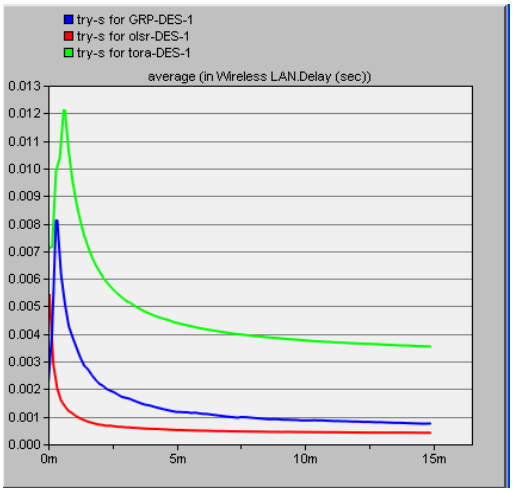

Fig 8: Delay (15 nodes)

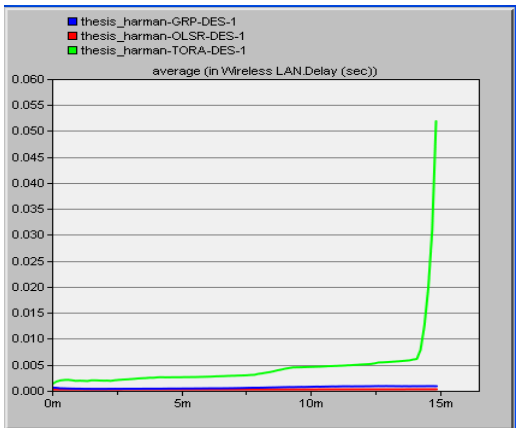

Fig 9:Delay (50 nodes)

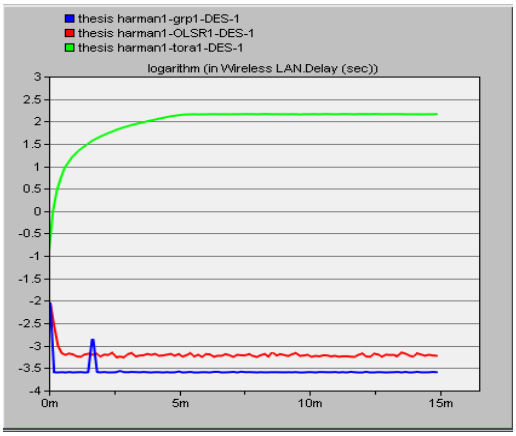

Fig 10: Delay (100 nodes)

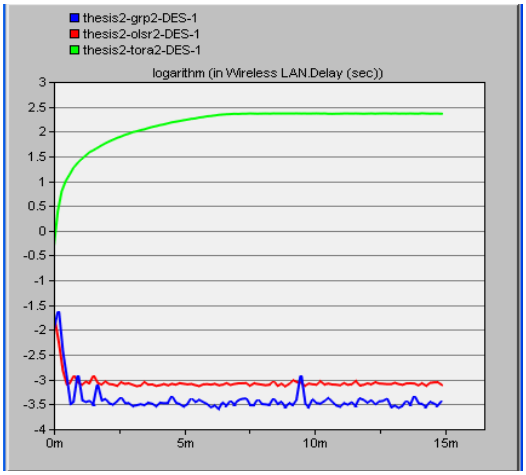

Fig 11: Delay (150 nodes)

D. Throughput

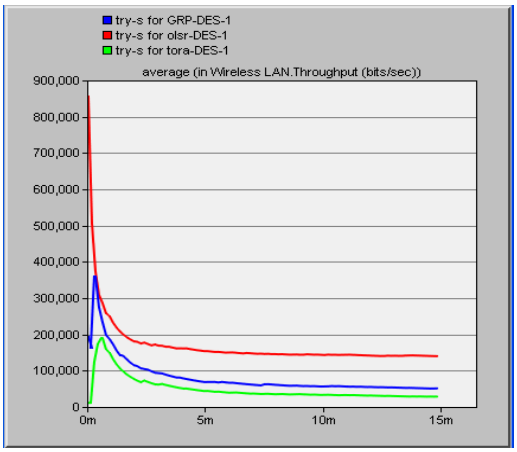

Fig 12: Throughput (15 nodes)

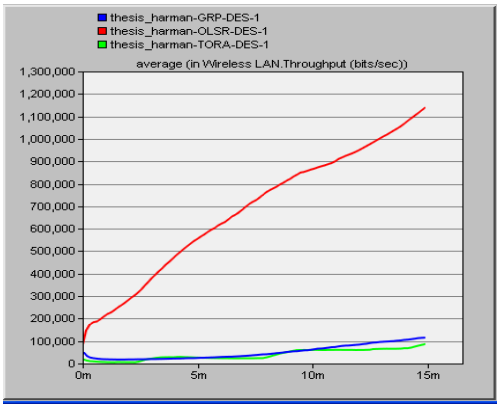

Fig 13: Throughput (50 nodes)

OLSR has maximum throughput in every scenario regardless of high routing overhead and delay, followed by GRP. TORA on the other hand performs the worst case although it minimizes the control overhead generation by localising the nodes. This is because, TORA constantly produces unwanted overhead due to its "Route Adaptation" feature (i.e. to update path information and route establishment with change in topology results).

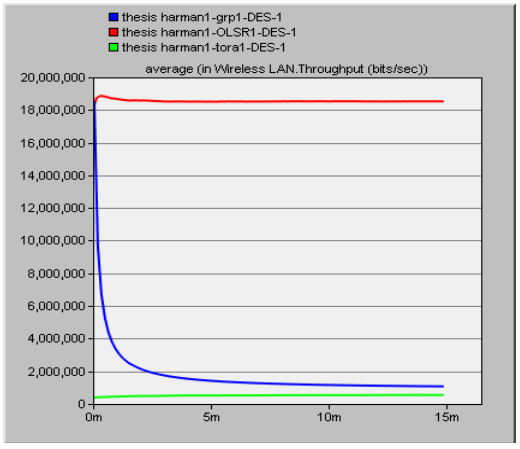

Fig 14: Throughput (100 nodes)

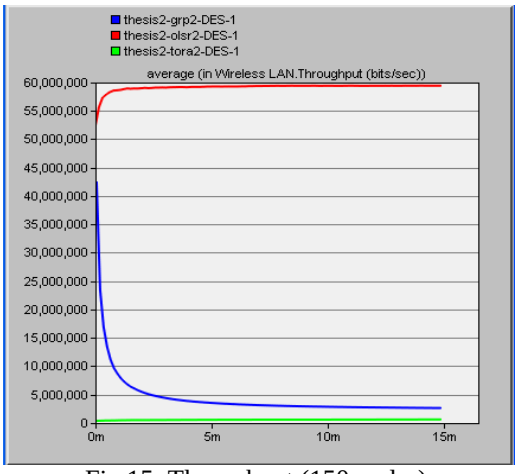

Fig 15: Throughput (150 nodes)

VI. CONCLUSION

In this paper, performance of three routing protocols namely OLSR, GRP and TORA was analyzed .OLSR performs best in terms of load and throughput.GRP performs best in terms of delay and routing overhead. TORA is the worst choice when we consider any of the four performance parameters . In summary, we can say that OLSR is best as compared to GRP and TORA in all traffic volumes since it has maximum throughput.

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