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Performance Evaluation of MANET Routing Protocols of with FTP Application Using an Optimized Scalable Simulation Model

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Abstract: MANET A variety of routing protocols for MANETs have been developed by network researchers and designers primarily to improve the performance of MANETs with respect to correct and efficient route establishment between a pair of stations for message delivery. A MANET consists of mobile nodes, a router with multiple hosts and wireless communication devices. Nodes can connect each other randomly and forming arbitrary topologies. Nodes communicate to each other and also forward packets to neighbour nodes as a router. The ability of self configuration of these nodes makes them more suitable for urgently required network connection. For example in disaster hit areas where there is no communication infrastructure. It is greatly desired to have a quick communication infrastructure. MANET is the quick remedy for any disaster situation. MANET is a spontaneous network. It is useful when dealing with wireless devices in which some of the devices are part of the network only for the duration of a communication session. Different protocols have been proposed for MANET. It includes Optimized Link State Routing (OLSR), Ad Hoc On Demand Distance Vector (AODV) and Gathering Based Routing Protocol (GRP). In this paper we present a comparative study of these three protocols viz. OLSR, AODV and GRP using three parameters i.e throughput, delay and network load under FTP traffic.

Keywords- MANET, AODV, OLSR, GRP, OPNET, FTP, HTTP.

1. INTRODUCTION

Mobile Ad hoc Network (MANET) is a collection of independent mobile nodes that can communicate to each other via radio waves. The mobile nodes that are in radio range of each other can directly communicate, whereas others need the aid of intermediate nodes to route their packets. These networks are fully distributed, and can work at any place without the help of any infrastructure. This property makes these networks highly exile and robust.

MANET ROUTING PROTOCOLS

Now we provide an introduction of these three protocols i.e. AODV (Ad hoc On-demand Distance Vector) [1] and OLSR (Optimized Link State Routing)[2],Gathering-Based Routing Protocol (GRP)[3].

A. AODV (Ad hoc On-demand Distance Vector)

Reactive protocols seek to set up routes on-demand. If a node wants to initiate communication with a node to which it has no route, the routing protocol will try to establish such a route. The philosophy in AODV [1,2], like all reactive protocols, is that topology information is only transmitted by nodes on-demand. When a node wishes to transmit traffic to a host to which it has no route, it will generate a route request (RREQ) message that will be flooded in a limited way to other nodes. This causes control traffic overhead to be dynamic and it will result in an initial delay when initiating such communication. A route is considered found when the RREQ message reaches either the destination itself, or an intermediate node with a valid route entry for the destination. For as long as a route exists between two endpoints, AODV remains passive. When the route becomes invalid or lost, AODV will again issue a request. AODV avoids the ``counting to infinity" problem from the classical distance vector algorithm by using sequence numbers for every route. The counting to infinity problem is the situation where nodes update each other in a loop. Consider nodes A, B, C and D making up a MANET as illustrated in figure 3. A is not updated on the fact that its route to D via C is broken. This means that A has a registered route, with a metric of 2, to D. C has registered that the link to D is down, so once node B is updated on the link breakage between C and D, it will calculate the shortest path to D to be via A using a metric of 3. C receives information that B can reach D in 3 hops and updates its metric to 4 hops. A then registers an update in hop-count for its route to D via C and updates the metric to 5. And so they continue to increment the metric in a loop. The way this is avoided in AODV, for the example described, is by B noticing that As route to D is old based on a sequence number. B will then discard the route and C will be the node with the most recent routing information by which B will update its routing table. AODV defines three types of control messages for route maintenance:

RREQ - A route request message is transmitted by a node requiring a route to a node. As an optimization AODV uses an expanding ring technique when flooding these messages. Every RREQ carries a time to live (TTL) value that states for how many hops this message should be forwarded. This value is set to a predefined value at the first transmission and increased at retransmissions. Retransmissions occur if no replies are received. Data packets waiting to be transmitted (i.e. the packets that initiated the RREQ) should be buffered locally and transmitted by a FIFO principal when a route is set.

RREP - A route reply message is unicasted back to the originator of a RREQ if the receiver is either the node using the requested address, or it has a valid route to the requested address. The reason one can unicast the message back, is that every route forwarding a RREQ caches a route back to the originator.

RERR - Nodes monitor the link status of next hops in active routes. When a link breakage in an active route is detected, a RERR message is used to notify other nodes of the loss of the link. In order to enable this reporting mechanism, each node keeps a ``precursor list'', containing the IP address for each its neighbours that are likely to use it as a next hop towards each destination.

B. OLSR (Optimized Link State Routing)

OLSR [2] is a modular proactive hop by hop routing protocol. It provides the fresh path of destination bases of table driven approach. It is an optimization of pure link state algorithm in ad hoc network. The routes are always immediately available when needed due to its proactive nature. The key concept of the protocol is the use of "multipoint relays" (MPR). Each node selects a set of its neighbour nodes as MPR. Only nodes, selected as such MPRs are responsible for generating and forwarding topology information, intended for diffusion into the entire network. The MPR nodes can be selected in the neighbour of source node. Each node in the network keeps a list of MPR nodes. This MPR selector is obtained from HELLO packets sending between in neighbour nodes. These routes are built before any source node intends to send a message to a specified destination In order to exchange the topological information the Topology Control (TC) message is broadcasted throughout the network. Nodes in the network send HELLO messages to their neighbours. These messages are sent at a predetermined interval in OLSR to determine the link status.

C. GRP (Gathering-Based Routing Algorithm

Gathering-based routing protocol (GRP) [3] combines the advantages of Proactive Routing Protocol (PRP) and of Reactive Routing protocol (RRP). Gathering-based Routing Protocol [9] combines the advantages of Proactive Routing Protocol (PRP) and of Reactive Routing protocol (RRP). Supporting the delay sensitive data such as voice and video but it consumes a great portion of the network capacity. While RRP is not suitable for real-time communication, the advantage of this approach is it can dramatically reduce routing overhead when a network is relatively static and the active traffic is light. However, the source node has to wait until a route to the destination can be discovered, increasing the response time. The goal of the proposed routing protocol (GRP) is to rapidly gather network information at a source node without spending a large amount of overheads. It offers an efficient framework that can simultaneously draw on the strengths of PRP and RRP. The procedures of GRP are described below. A source node broadcasts a destination query (DQ) packet to its neighbours. The DQ packet is continuously forwarded into each node's neighbours until the destination is reached. It is simply implemented by the conventional flooding process of RRP (as in DSR or AODV). That is, the DQ packet plays the same role of route request (RREQ) packet of RRP so that it consists of the address of the source, the destination node's address, and the sequence number. When the DQ packet reaches the destination, the destination node broadcasts a network information gathering (NIG) packet to its neighbours. The structure of NIG packet is similar to that of DQ packet, but it additionally contains link reversal flag (LRF) for resolving deadlock and variable-length payload for recording/gathering the network information. The NIG packet propagates over the entire network by a gathering process.

II. SIMULATION SETUP

We check these protocols by three parameters such as throughput, delay and traffic sent. We used two scenarios i.e. 75 nodes, and 150 nodes.

Table 1.1: Simulation parameters

Statistic	**Value**
Simulator	OPNET 14.5
Routing Protocols	AODV,OLSR and GRP
802.11 data rate	11 Mbps
Node	75, 150
Scenario Size	3.5*3.5 km
Application Traffic	FTP and HTTP

Simulation Time	300 second
Channel Type	Wireless channel
Network Interface Type	Phy/WirelessPhy
Performance Parameter	Throughput, Delay, Network Load, Traffic Sent, Traffic Received

III. RELATED WORK

Manijeh Keshtgary and Vahide Babaiyan in "Performance Evaluation of Reactive, Proactive and Hybrid Routing Protocols in MANET" International Journal on Computer Science and Engineering (IJCSE) vol. 4, pp. 248-254 February 2012 [6]. The researchers have evaluated the performance of four MANET routing protocols using simulations: AODV, OLSR, DSR and GRP. In this research the evaluation metrics are End-to-End delay, network load, and throughput. Most of the papers consider the first three parameters, but here we also consider Jitter, MAC delay.N. Adam et. al "Effect of Node density on performances of three MANET Routing Protocols" International Conference on Electronics Devices, Systems and Applications ICEDSA, IEEE pp 321-325,2010 [7]. This paper evaluates the routing performances of three MANET protocols: dynamic source routing (DSR), ad hoc on-demand distance vector (AODV) and temporally ordered routing algorithm (TORA) protocol. The performances had been analysed using the following metrics: packet delivery ratio, end-to-end delay, packet dropped, routing load and end-to-end throughput. Simulation results also showed that AODV reactive routing protocol is the best suited for given scenario.

IV. RESULTS AND DISCUSSION

Delay

The maximum network delay variation for 75 nodes and 150 nodes in different scenario is shown in respectively Fig. 1.1 and 1.2.

It is observed that:

1. The network delay of AODV is higher than GRP and OLSR. The delay of OLSR is well enough but AODV also has good delay especially when the number of nodes is more than 300. It is because the head of each data packet will carry the routing information which will increase the length of packet and the time delay for Processing and queuing. Therefore, the entire network delay of AODV is significantly longer than OLSR and GRP.

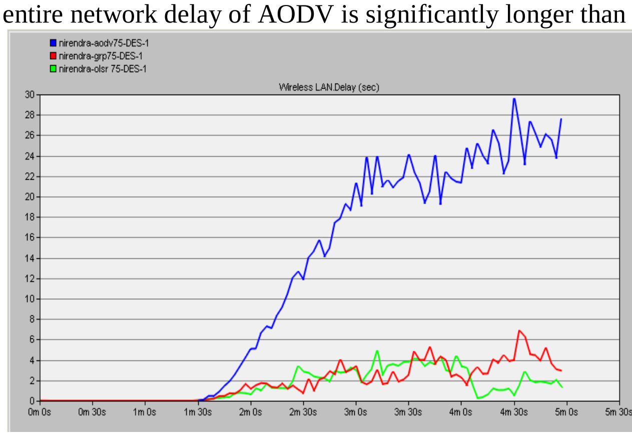

Fig. 1.1: Delay Comparison in Three Routing Protocols with 75 Nodes

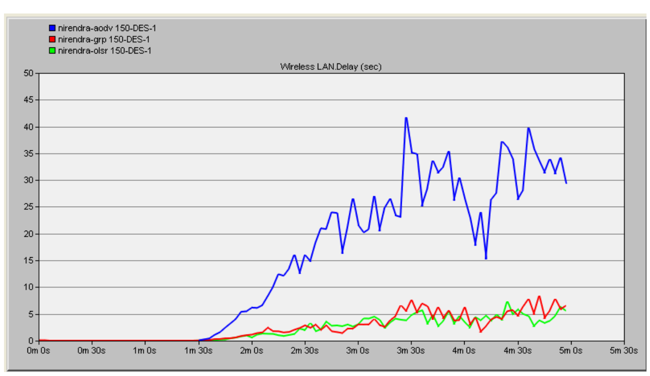

Fig. 1.2: Delay Comparison in Three Routing Protocols with 150 Nodes

2. Peak delay for AODV is 29 sec whereas it is 6 sec and 4 sec for GRP and OLSR respectively.
3. Effect of FTP and HTTP traffic is more significant on AODV for 75 nodes. However, when we see OLSR and GRP at 150 nodes GRP has less delay increase than OLSR and both reaches at almost 7 sec.
4. Thus, we show that OLSR has a better delay performance for fewer number of nodes but both GRP and OLSR behave similarly as the number of nodes increase.

Throughput

Figure 1.3 and 1.4 depicts the throughput of the network with 75 and 150 nodes respectively.
It is observed that:

1. There is huge performance difference of throughput of OLSR with AODV and GRP for 75 nodes. Throughput is defined as the ratio of the total data reaches a receiver from the sender. In Fig. 6.13 with 75 nodes, show the OLSR throughput touches the peak value of 60,000,000 (bit/ sec) and after that start to decrease to reach its constant value which is equal to 25,500,000 (bit/sec).

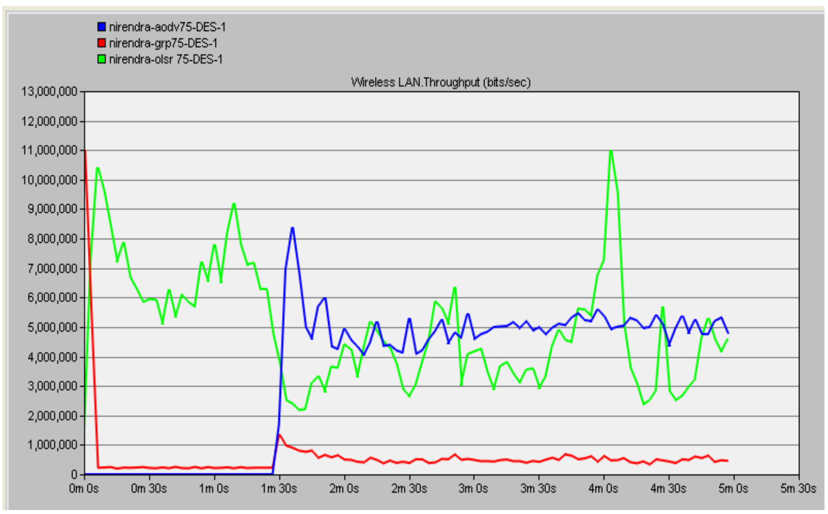

Fig. 1.3: Throughput (bits/sec) Comparison in Routing Protocols with 75 Nodes

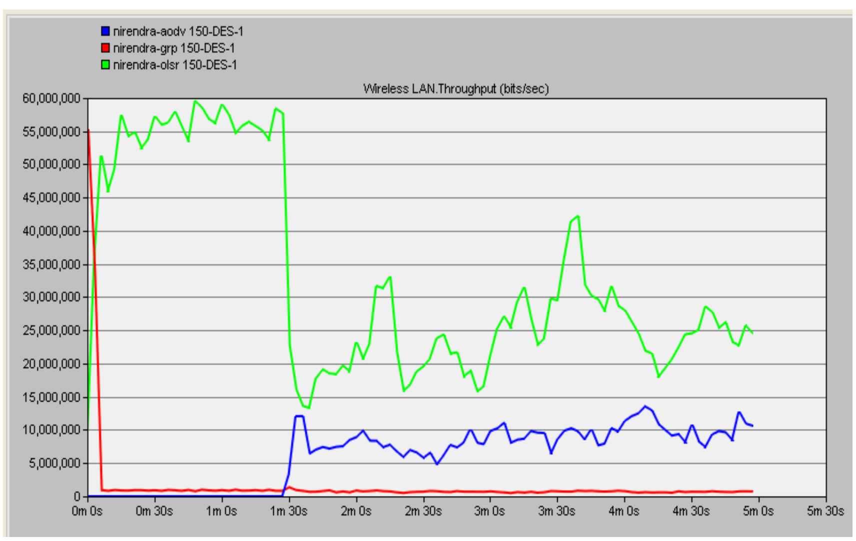

Fig. 1.4: Throughput (bits/sec) Comparison in Routing Protocols with 150 Nodes

2. Now we concentrate at scenario of 150 nodes, again performance of OLSR is better than the rest two. GRP has least throughput value which is nearly equal to 5,000,000.
3. Reason is that traffic handling capability of purpose driven OLSR is better that AODV and Hybrid GRP protocol.

Network Load

The maximum network load variation for 75 nodes and 150 nodes in different scenario is shown in respectively Fig. 1.5 and 1.6.

It is observed that:

1. The network load of AODV and GRP is 0 for 1m30s and then with a sudden increase reaches 13,50,000 (bits/sec). Afterwards it tends to decrease for 75 nodes.
2. In Fig. 1.5, we can see that under the OLSR is more predictable and starting from average it reaches peak rate of 13,00,000 bps.
3. When we increase the number of nodes AODV and OLSR show similar behaviour and give a value of 12,50,000 bps. Whereas GRP suffers with a decrease and runs on average of 5,00,000 bps.

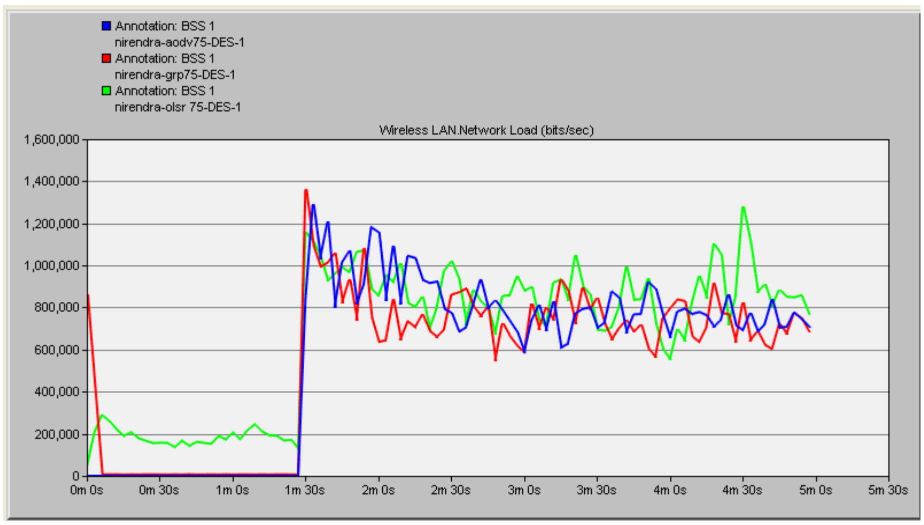

Fig. 1.5: Network Load (bits/sec) Comparison in Three Routing Protocol with 75 Nodes

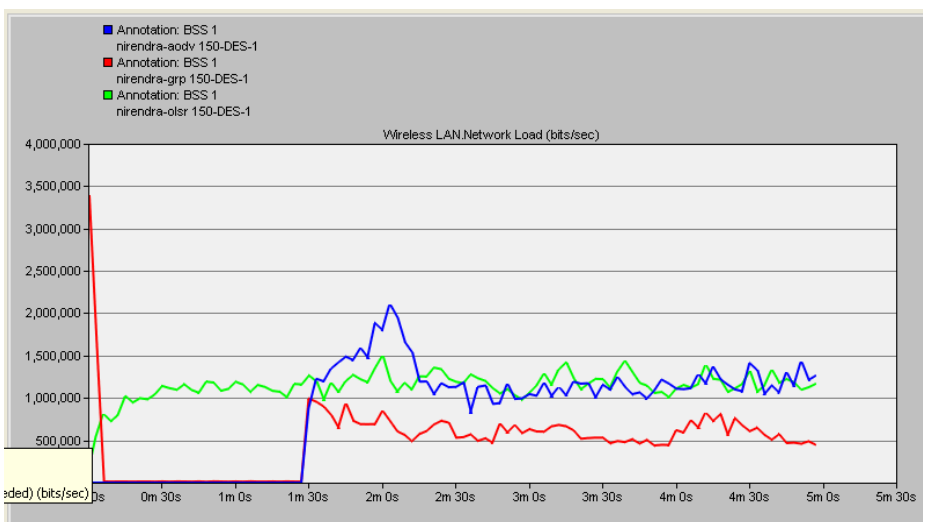

Fig. 1.6: Network Load (bits/sec) Comparison in Three Routing Protocol with 150 Nodes

4. The reason is that the routing mechanisms of the three protocols are different in which OLSR is based on purpose-driven, AODV is on-demand and GRP is based on Hybrid source routing.
5. Thus performance of OLSR and AODV is equal for high density but OLSR is better fit for smaller network.

V. CONCLUSION

The simulation study of our thesis consisted of three routing protocols AODV, OLSR and GRP deployed over MANET using FTP and HTTP traffic analysing their behaviour with respect to five parameters i.e. delay, network load, throughput. Our motive was to check the performance of these three routing protocols in MANET in the above mentioned parameters. The selection of efficient and reliable protocol is a critical issue. From the entire above figures 1.1, 1.2, 1.3, 1.4, 1.5, 1.6 the behaviours of all the routing protocols in different numbers of mobile nodes, it can be seen that which routing protocol perform well. From the above analysis of routing protocols, the OLSR outperforms the two AODV and GRP protocols in terms of delay, network load and delay in 75 and 150 mobile nodes. OLSR performs better in handling FTP traffic in smaller networks and when the node density is increased OLSR performance falls less slowly.

The study of these routing protocols shows that the OLSR is better in MANET according to our simulation results but it is not necessary that OLSR perform always better in all the networks, its performance may vary by varying the network. At the end we came to the point from our simulation and analytical study that the performance of routing protocols vary with network and selection of accurate routing protocols according to the network, ultimately influence the efficiency of that network in magnificent way.

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