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Exploration and Review of MANET Routing Protocols AODV, OLSR and TORA using FTP Traffics

Er. Atul Sharma , Er. Naveen Bilandi
Department of Computer Science & Engineering
DAV University, Jalandhar (Punjab)

***Abstract*— A mobile ad hoc network (MANET) consists of mobile wireless nodes. The communication between these mobile nodes is carried out without any centralized control. MANET is a self organized and self configurable network where the mobile nodes move arbitrarily. The main classes of MANET routing protocols are Proactive, Reactive and Hybrid. In this paper we compare performance of Proactive routing protocol by focusing on Optimized Link State Routing (OLSR) and Reactive Routing Protocol by focusing on Ad Hoc on Demand Distance Vector (AODV) and Temporally Ordered Routing Algorithm (TORA). In this paper our simulation tool is OPNET modeller. The performance of these routing protocols is analysed by three metrics: delay, network load and throughput. This paper presents a performance analysis of three Mobile Ad Hoc Network (MANET) routing protocols – AODV, OLSR and TORA under the ftp traffic. For the behaviour simulation and evaluation of these protocols we used the OPNET Modeller simulation tool. The final evaluation is presented at the end of this paper.**

***Keywords* - MANET, AODV, OLSR, TORA, OPNET Simulator, FTP Traffic**

I. INTRODUCTION

MANET stands for Mobile Ad hoc Network. It is a decentralized autonomous wireless system which consists of free nodes. Nodes communicate with each other without the use of predefined infrastructure. In this network nodes will generate both user and application traffic and carry out network control and routing duties. Mobile Ad hoc Networks have the attributes like wireless connection, different types of topology, distributed operation and some communication protocol. The primary challenge in building a MANET [4][5] is equipping each device to continuously maintain the information required to route traffic. MANET routing protocols are traditionally divided into three categories which are Proactive Routing Protocols, Reactive Routing Protocols, Hybrid. Proactive Routing Protocols [6][7] are also called table driven routing protocols and it constantly maintain the updated topology of the network. Each node in this protocol maintains individual routing table which contains routing information of every node in the network. Reactive Routing Protocol is also called on-demand routing protocol. Reactive protocols do not initiate route discovery by themselves, until they are requested.

Hybrid Routing Protocols can be derived from the two previous ones, containing the advantages of both the protocols. The routing is initially established with some proactively prospected routes and then serves the demand from additionally activated nodes through reactive flooding.

II. AD-HOC ROUTING PROTOCOLS

This section describes the main features of three protocols AODV (Ad hoc On-demand Distance Vector) [1] and OLSR (Optimized Link State Routing) [2], Temporally Ordered Routing Protocols Algorithm (TORA) deeply studied using OPNET14.5.

An ad-hoc routing protocol is a convention, or standard, that it improves the scalability of wireless networks compared to infrastructure based wireless networks because of

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its decentralized nature. Ad-hoc networks are best suited due to minimal configuration and quick operation.

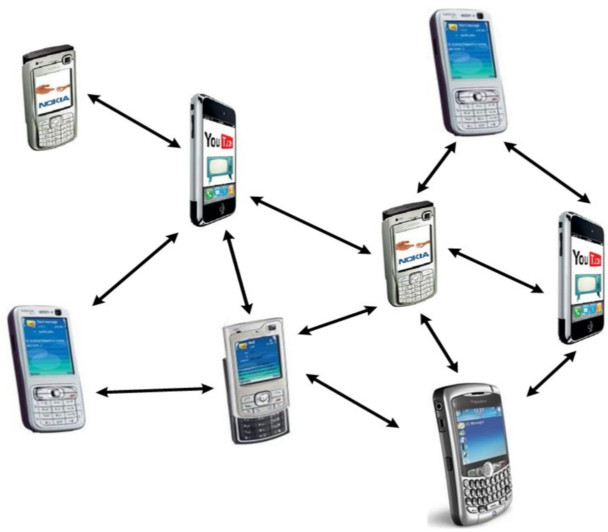

Figure 1: MANET

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

AODV [1] provides a good compromise between proactive and reactive routing protocols. AODV uses a distributed approach which means that a source node is not required to maintain a complete sequence of intermediate nodes to reach the destination [10]. It is also an improvement from DSR by addressing the issue of high messaging overhead and large header packets in maintaining routing tables at nodes, so that packets do not have to store much routing information in the headers. AODV uses a routing table in each node and keeps one to two fresh routes. The incorporated features of AODV include features of DSDV, like the use of hop by hop routing, periodic beacon messaging and sequence numbering. A periodic beacon message is used to identify neighbouring nodes. The sequence numbering guarantees a loop free routing and fresh route to destination. AODV has the advantage of minimizing routing table size and broadcast process as routes are created on demand [9]. The two mechanisms; route discovery and route maintenance of AODV are like those of DSR .AODV is an on-demand routing protocol. The AODV [9] algorithm gives an easy way to get change in the link situation. For example if a link fails notifications are sent only to the affected nodes in the network. This notification cancels all the routes through this affected node. It builds unicast routes from source to destination and that's why the network usage is least. Since the routes are build on demand so the network traffic is minimum. AODV does not allow keeping extra routing which is not in use [10]. If two nodes wish to establish a connection in an ad hoc network then AODV is responsible to enable them to build a multihop route. AODV uses Destination Sequence Numbers (DSN) to avoid counting to infinity that is why it is loop free. This is the characteristic of this algorithm. When a node send request to a destination, it sends its DSNs together with all routing information. It also selects the most favorable route based on the sequence number [10]. There are three AODV messages i.e. Route Request (RREQs), Route Replies (RREPs), and Route Errors (RERRs) when the source node wants to create a new route to the destination, the requesting node broadcast an RREQ message in the network [9]. The RREQ message is broadcasted from source node A to the destination node B. The RREQ message is shown by the black line from source node A to many directions. The source node A broadcasts the RREQ message in the neighbour nodes. When the neighbour nodes receive the RREQ message it creates a reverse route to the source node A. This neighbour node is the next hop to the source node A. The hop count of the RREQ is incremented by one. The neighbour node will check if it has an active route to the destination or not. If it has a route so it will forward a RREP to the source node A. If it does not have an active route to the destination it will broadcast the RREQ message in the network again with an incremented hop count value. The procedure for finding the destination node B. The RREQ message is flooded in the network in searching for finding the destination node B. The intermediate nodes can reply to the RREQ message only if they have the destination sequence number (DSN) equal to or greater than the number contained in the packet header of RREQ.

The intermediate nodes forward the RREQ message to the neighbour nodes and record the address of these nodes in their routing cache. The destination node B replies with RREP message denoted by the dotted orange line, the shortest path from destination B to source A. The RREP reached to the originator of the request. This route is only available by unicasting a RREP back to the source. The nodes receiving these messages are cached from originator of the RREQ to all the nodes.

When a link is failed an RERR message is generated. RERR message contains information about nodes that are not

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reachable. The IP addresses of all the nodes which are as their next hop to the destination.

B. *OLSR (Optimized Link State Routing)*

The OLSR [2][8] protocol is an optimised pure state link algorithm. It is designed to reduce retransmission duplicates and with a proactive nature the routes are always available when needed. It uses hop by hop mechanics when forwarding packets. It is a proactive routing protocol and is also called as table driven protocol because it permanently stores and updates its routing table. OLSR [6][7] keeps track of routing table in order to provide a route if needed. OLSR can be implemented in any ad hoc network. Due to its nature OLSR is called as proactive routing protocol. Multipoint relay (MPR) nodes in the network do not broadcast the route packets. Just Multipoint Relay (MPR) nodes broadcast route packets. These MPR nodes can be selected in the neighbor 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 neighbor nodes. These routes are built before any source node intends to send a message to a specified destination. Each and every node in the network keeps a routing table. This is the reason the routing overhead for OLSR [8] is minimum than other reactive routing protocols and it provide a shortest route to the destination in the network. There is no need to build the new routes, as the existing in use route does not increase enough routing overhead. It reduces the route discovery delay.

C. *(TORA) Temporally Ordered Routing Algorithm*

TORA is a routing algorithm. It is mainly used in MANETs to enhance scalability. TORA is an adaptive routing protocol. It is therefore used in multi-hop networks. A destination node and a source node are set. TORA establishes scaled routes between the source and the destination using the Directed Acyclic Graph (DAG) built in the destination node. This algorithm does not use 'shortest path' theory, it is considered secondary. TORA builds optimized routes using four messages. Its starts with a Query message followed by an Update message then clear message and finally Optimizations message. This operation is performed by each node to send various parameters between the source and destination node. The parameters include time to break the link (t), the originator id (oid), Reflection indication bit (r), frequency sequence (d) and the nodes id (i). The first three parameters are called the reference level and last two are offset for the respective reference level. Links built in TORA are referred to as 'heights', and the flow is from high to low. At the beginning, the height of all the nodes is set to NULL i.e. (-,-,-,-,i) and that of the destination is set to (0,0,0,0,dest). The heights are adjusted whenever there is a change in the topology. A node that needs a route to a destination sends a query message with its route required flag. A query packet has a node id of the intended destination. When a query packet reaches a node with information about the destination node, a response known as an Update is sent on the reverse path. The update message sets the height value of the neighbouring nodes to the node sending the update. It also contains a destination field that shows the intended destination.

III. LITERATURE SURVEY

The aim of this paper is to evaluate the performance of Proactive MANET protocols (PMP) and Reactive MANET Protocols (RMP) in OPNET Modeller 14.5 [5]. For all these comparisons we will use FTP traffic to look the effects of the ad hoc network protocols. The project goal is to give an extra source of comparison statistics in the MANET research field. In our simulation we have wireless routing protocols carrying FTP traffic. These simulations performed will have a strong link with the theoretical concepts and also with the expected performance in practical and real time implementations. This study work will give a great benefit in the future research work.

Harminder S. Bindra et al. conclude that in Group mobility model with CBR traffic sources AODV perform better. But in case of TCP traffic, DSR perform better in stressful situation (high load or high mobility). DSR routing load is always less than AODV in all type of traffic. [6]

Priti Garg, et al. analyzed that the results of the both DSR and TORA routing protocol on various mobility, packet size and time interval metrics. The performance metrics to evaluate performance of DSR and TORA routing protocol includes routing load, average delay, packet delivery ratio and throughput. [7]

Muhammad Ahmed Khalid et al. proposed that from all the simulations performed on real-time and non-real-time traffic types which are required for e-Health, It can be concluded that OLSR is the better choice for small and large networks as it has the best performance. The modified version of AODV can be used which have increased performance as compared to the original AODV protocol. [8]

S. R. Birder et al. in their paper they compare the performance of two on-demand routing protocols for mobile ad hoc networks Dynamic Source Routing (DSR) and Ad Hoc On-Demand Distance Vector Routing (AODV). They demonstrate that even though DSR and AODV both are on-demand protocol, the differences in the protocol mechanics can lead to significant performance differentials. The performance differentials are analyzed using varying mobility. [9]

Vishal Sharma, et al. in this paper, [10] the researcher has evaluated the performance of AODV and DSR reactive routing protocols in MANET network using GSM quality voice traffic by calculating matrices such as voice end-to-end delay, network load, throughput and number of hops per route, route discovery time, and voice traffic-sent and -received using OPNET Modeler 14.5. From this paper it is concluded that AODV routing protocol has lowest end-to-end and lower network load as compare to DSR. Also, ADOV has maximum average throughput and traffic received as compare to DSR. The DSR routing protocol does not scale well with large sized networks. Simulation results also showed that AODV reactive routing protocol is the best suited for MANET networks in dense population of nodes, whereas, DSR has very poor QoS in high populated node networks with GSM voice traffic data.

Liu Tie-yuanet.al in their study [11] Present a comparative study on entity mobility models. Firstly, both the advantages and disadvantages of four typical entity mobility models are summarized; these models include the Random Walk model (RW), the Random Way Point model (RWP), the Random Direction model (RD)and the Markov Random Path model (MRP). Secondly, focus on primary parameters of these models, effects of both the speed and the pause time on the performance metric of MANET routing protocols are analyzed. Finally, with the help of the NS-2 simulator, the effect of different entity mobility models on the performance of MANET routing protocols is analyzed.

Manijeh Keshtgary et al. [12] in this paper 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.

R. Mohan et al. in this paper analyze the effect of four mobility models (Reference point Group mobility model, Random Waypoint mobility model, Freeway mobility model and Manhattan mobility model) on two MANET Routing Protocols; DSDV and AODV. The Researcher considered Throughput, Packet Delivery ratio, Packet Drop and End to End delay as Parameters and considered traffic is CBR. Performance of MANNET Routing Protocols was checked by varying Node speed (1-50 m/sec) but fixed Network size (40 nodes).

In AODV Throughput is 80.57%, End to End Delay 23.27%, PDR 72%, and Packet Drop 72.88% under RWPM. Throughput is 83.65%, End to End Delay 0.61%, PDR 82.55%, and Packet Drop 3.88% under RPGM. Throughput is 76.23%, End to End Delay 8.71%, PDR 77.91%, and Packet Drop 18.46% under MGM. Throughput is 82.42%, End to End Delay 21.26%, PDR 79.80%, and Packet Drop 13.42% under FWM.

The Overall comparison of AODV Performance Metrics and the Mobility Models clearly states that, Throughput for AODV is good with RPGM while it is bad with MGM Model; Average End to End Delay is low in RPGM while it is high in RWPM and freeway Model. PDR is good in RPGM and Bad in RWPM. Packet Drop is low in RPGM than RWPM, MGM, and Freeway Models. Finally it is clear that RPGM is Stable with the Performance Metrics of AODV Routing Protocol.

In DSDV is 71.25%, End to End Delay 10.66%, PDR 38.80%, and Packet Drop 64.57% under RWPM. Throughput is 82.21%, End to End Delay 1.63 %, PDR 88.06%, Packet Drop 4.90% under RPGM. Throughput is 68.94%, End to End Delay 20.34%, PDR 36.79%, and Packet Drop 75.80% under MGM. Throughput is 74.76%, End to End Delay 14.96%, PDR 62.99%, and Packet Drop 47.90% under FWM

IV. PERFORMANCE PARAMETERS

OPNET modeler 14.5[6][7] is used to investigate the performance of routing protocols AODV and OLSR with varying network sizes, data rates, and network load. We evaluate three parameters in our study on overall network performance. These different types of parameter show the different nature of these Protocols, the parameters are throughput, delay and network load.

A. *Throughput*

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Throughput is defined as; the ratio of the total data reaches a receiver from the sender. The time it takes by the receiver to receive the last message is called as throughput [9]. Throughput is expressed as bytes or bits per sec (byte/sec or bit/sec).

B. *Delay*

The packet end-to-end delay is the time of generation of a packet by the source up to the destination reception. So this is the time that a packet takes to go across the network. This time is expressed in sec. Hence all the delays in the network are called packet end-to-end delay [11], like buffer queues and transmission time. Sometimes this delay can be called as latency; it has the same meaning as delay.

$$d_{end\text{-}end} = N[d_{trans} + d_{prop} + d_{proc}]$$

Where

$d_{end\text{-}dend}$ = End to end delay

d_{trans} = Transmission delay

d_{prop} = Propagating delay

d_{proc} = Processing delay

Suppose if there are n number of nodes, then the total delay can be calculated by taking the average of all the packets, source destination pairs and network configuration.

C. NETWORK LOAD

Network load represents the total load in bit/sec submitted to wireless LAN layers by all higher layers in all WLAN nodes of the network [10]. When there is more traffic coming on the network, and it is difficult for the network to handle all this traffic so it is called the network load.

V. CONCLUSION

In most of the studies, the major drawback is that the performance evaluation is done on the basis of traffic patterns such as CBR, VBR ,Telnet and but for the use of real time application FTP provides a better and more efficient way of optimum resource utilization.

From the extensive review and simulation results, in this paper we found that OLSR shows the best performance in terms of throughput, load. Moreover, Random Way Point Model outperforms Random Walk Model for all three routing protocols i.e. AODV, OLSR and TORA. 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. Further study could also look at voice over IP traffic for the evaluation of MANETs under the same conditions as the ones used in this paper.

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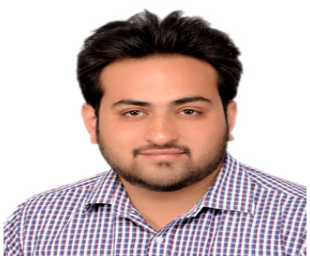
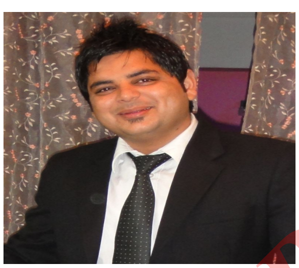


Er. Atul Sharma completed his B.Tech. in Computer Science & Technology from Guru Nanak Dev University, Amritsar, Punjab (India) in 2013 and pursuing M.Tech in Computer Science & Technology from DAV University Jalandhar, Punjab (India). He has a work experience of six months in RMSI Pvt. Ltd Noida (A CMMi level 5 assessed and ISO 9001:2008 certified company) as Intern (Software) in Land Information Management Business Unit. He has a vast knowledge in the field of DBMS, Wireless Data network, Software Engineering, Network Security, and Operating System.



Er. Naveen Bilandi received his Bachelor degree in Computer Science from the University of Rajasthan and Master degree in Computer Science from NIT Jalandhar, Punjab (India) respectively in 2008 and 2012. From 2012 to 2013 he worked as Assistant Professor in DAVIET Jalandhar, Punjab (India) and from 2013 till now working as a coordinator of CSE department at DAV University Jalandhar, Punjab (India). He has a vast experience in the field of Wireless Data Network, Computer Networking, DBMS, Network Security and Cryptography. His major fields are Mobile ad-hoc networks and current research interests include routing protocol and QoS of multimedia for MANET.

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