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Performance Evaluation of Routing Protocols (AODV, DSR, OLSR and DYMO) in MANET Considering Mobility Factor

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Abstract- A Mobile Ad hoc NETwork is a kind of wireless ad-hoc network, and is a self configuring network of mobile routers connected by wireless links. MANET is a wireless network without any infrastructure. Therefore routing discovery and maintenance are critical issues in these networks. The main goal of such an ad hoc network routing protocol is to establish correct and efficient route between a pair of mobile nodes. In this paper, an attempt has been made to compare four well known routing protocols (AODV, DSR, OLSR and DYMO) by using performance metrics like throughput, packet delivery ratio (PDR) ,average end to end delay ,mean jitter and packet loss ratio considering mobility factor . A comparative analysis of how mobility of nodes affects the performance of protocols is given in this paper. From the analysis we have drawn a conclusion, which protocol works well in stable condition and which protocol works well when the nodes are highly mobile.

Index Terms: AODV, Average End-to-End delay, DSR, DYMO, MANET, Mean Jitter, OLSR, Packet delivery ratio, Throughput.

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1 INTRODUCTION

Mobile Ad Hoc Networks are independent, self-configuring wireless networks of mobile computing devices without fixed infrastructure. In MANET every node acts as a host and a router at the same time and is free to move randomly and manage itself arbitrarily in the router. In the development of dynamic routing protocol, the challenge is that we can efficiently find routes between two communication nodes. Many routing protocols are available for mobile Ad-hoc networks such as AODV, OLSR, DSR, DYMO, DSDV, CGSR, FSR, GSR, STAR, TORA, WRP, ZRP etc [1][6]. From previous work we find out that DSR and AODV protocols are performing well among the reactive protocol and among the proactive protocol FSR, TORA and OLSR protocols are performing well. Taking knowledge of our findings we have chosen four well performed routing protocols- AODV, OLSR, DSR, and DYMO. We have analyzed the performances of these protocols in different network scenarios. We have analyzed the effects of node mobility on the performance of these protocols.

2 ROUTING PROTOCOLS IN MANET

The MANET routing protocols are divided into three classifications depending on their performance and functionality: Table-driven (Proactive) routing protocols, On-demand (Reactive) routing protocols and Hybrid routing protocols.

Proactive Routing Protocols: The routing data in these MANET protocols is organized in tables stored by each station. In networks utilizing a proactive routing protocol, every node maintains one or more tables representing the entire topology of the network. These tables are updated regularly in order to maintain an up-to-date routing information from each node to every other node. FSR, STAR, GSR, DSDV, OLSR, CGSR and WRP are examples of Proactive Routing Protocols [9].

Reactive Routing Protocols: These routing protocols choose routes to other stations only when they are needed. A route discovery process is lunched when a station wants to communicate with another station for which it does not possess any route table access. Reactive protocols can be classified into two categories, Source routing and Hop-by-hop routing. In Source routed on-demand protocols, each data packets carry the complete

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source to destination address. Therefore, each intermediate node forwards these packets according to the information kept in the header of each packet. This means that the intermediate nodes do not need to maintain up-to-date routing information for each active route in order to forward the packet towards the destination. Therefore, each intermediate node in the path to the destination uses its routing table to forward each data packet towards the destination. AODV, DSR, LAR, TORA, CBRP and ARA are the examples.

Hybrid Routing Protocols: These MANET protocols employ functionality of both the reactive and proactive protocols. Hybrid Routing, commonly referred to as balanced-hybrid routing, is a combination of distance-vector routing , which works by sharing its knowledge of the entire network with its neighbors and link-state routing which works by having the routers tell every router on the network about its closest neighbors. Hybrid routing protocols is a third classification of routing algorithm. DST, ZRP, DDR, ZHLS are the examples.

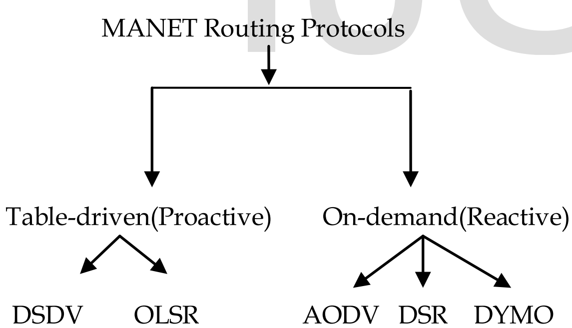

Fig: 1: Examples of MANET routing protocols

2.1 Ad Hoc On-demand Distance Vector (AODV) routing protocol

The Ad hoc On-Demand Distance Vector (AODV) algorithm enables dynamic, self-starting, multi hop routing between participating mobile nodes wishing to establish and maintain an ad hoc network. AODV allows mobile nodes to obtain routes quickly for new destinations, and does not require nodes to maintain routes to destinations that are not in active communication [7]. The Ad Hoc On-Demand Distance Vector (AODV) routing protocol which improves from DSDV is a reactive routing protocol. AODV minimizes the number of required broadcasts by creating routes in an on-demand manner. When a source node desires to send data to other destination node, it needs to initiate a path discovery process to locate the other node. A source node broadcasts a route request (RREQ) packet to its neighbors, which then forward the request to their neighbors, and so on, until the destination is located [3][4].

2.2 Dynamic Source Routing (DSR)

Dynamic source routing (DSR), developed at cmu in 1996, is an on-demand routing protocol which is composed of two main mechanism to allow the discovery and maintain the mobile ad hoc networks. Route discovery is the mechanism which is used to send a packet, source node to destination node with source to destination route. In the DSR when send the data packet from source, it does not know the destination route. In the route discovery, DSR floods Route Request Packet to the network. Each node receives this packet first and its address to it and then forwards the packet to the next node. When the targeted node is available then a route reply message is send back to the source node and a route is established [6]. If destination node is not available or a route is broken and one node detects the failure, then route error message is sent back to the source node or original sender. Route maintenance is the mechanism by which it can able to detect a node send a packet to the destination. In the Route maintenance, DSR provides three successive steps: link layer acknowledgement, passive acknowledgement and network layer acknowledgement. DSR eliminates the need to periodically flood the network with table update messages which are required in a table-driven approach.

The disadvantages of DSR are that the, route maintenance mechanism does not locally repair a broken down link. The connection setup delay is higher than performance degrades rapidly with increasing mobility. The main difference between DSR and AODV is in the way they keep the information about the routes: in DSR it is stored in the source while in AODV it is stored in the intermediate nodes. However, the route discovery phase of both is based on flooding

2.3 Dynamic MANET On-demand Routing (DYMO)

The Dynamic MANET On-demand routing protocol has been proposed by Perkins and chakeres as advancement to the existing AODV protocol. DYMO is a successor of the AODV routing protocol. It operates similarly to AODV, DYMO does not add extra features or extended the AODV protocol, but rather simplifies it while retaining the basic mode of operation. As in the case with all reactive ad hoc routing protocols, it consists of two main operations; one is route discovery and the other is route maintenance. Routes are discovered on-demand when a node needs to send a packet to a destination currently not in its routing table. A route request message is flooded in the network using broadcast and if the packet reaches its destination, a reply message is sent back containing the discovered, accumulated path. The route maintenance occurs when the route to a specific node is broken and there are packets to send to the node at the end of the broken route. Each entry in the routing table consists of these fields: Destination Address, Sequence Number, Hop Count, Next Hop Address, Next Hop Interface, Is Gateway, Prefix, Valid Timeout, and Delete Timeout [5].

The DYMO protocol presents a variety of new features over AODV. The performance evaluation shows that DYMO outperforms AODV as a MANET protocol. The advantages of the protocol can be summarized as follows:

- The protocol is energy efficient when the network is large and shows a high mobility.
- The routing table of DYMO is comparatively less memory consuming than AODV even with Path Accumulation feature.
- The overhead for the protocol decreases with increased network sizes and high mobility.

The DYMO protocol [7], however, does not perform well with low mobility. The control message overhead for such scenarios is rather high and unnecessary. Another limitation lies in the applicability of the protocol as stated in the DYMO Draft which states that DYMO performs well when traffic is directed from one part of the network to another.

2.4 Optimized Link State Routing Protocol (OLSR)

Optimized Link State Routing (OLSR) protocol permanently stores and updates its routing table. It keeps track of routing table in order to provide a route if needed. OLSR may optimize the reactivity to topological changes by reducing the maximum time interval for periodic control message transmission [2]. Furthermore, as OLSR continuously maintains routes to all destinations in the network, the protocol is beneficial for traffic patterns where a large subset of nodes are communicating with another large subset of nodes, and where the [source, destination] pairs are changing over time. OLSR uses two kinds of the control messages namely hello and topology control. Hello messages are used to find the information about the link status and the host's neighbors [9]. Topology control messages are used for broadcasting information about its own advertised neighbors, which includes at least the MPR selector list.

3 SIMULATION ENVIRONMENTS

3.1 Mobility Model

Mobility model describes changes in the stations velocity and acceleration over time and their movement. Basic parameters related to node movement are mobility speed, number of nodes, sending rate, pause time, number of connections, simulation duration. Mobility models can be categorized in two types group and entity models [10]. The motions of mobile stations in entity models are independent from each other, but in group models the movements of stations are dependent on each other.

3.2 Simulation Parameters

We have used NS-2 (version- 2.34) as a simulator to model and simulate our scenario architecture [11]. We have designed various scenarios with number of nodes 40, node speed from 0 m/s to 40 m/s, and pause time ranging 0s to 195s deployed in field configuration of 500x500 m^2. In the scenario TCP (Transmission Protocol) connection was used and data traffic of File Transfer Protocol (FTP) was applied between source and destination. Each simulation was carried out for 200 seconds.

Parameter	Value
Platform	Ubuntu LTS 12.04
Simulator	NS-2.34
Routing Protocols	AODV, OLSR, DSR & DYMO
Simulation Space	500x500 m^2
Traffic Type	FTP
Packet Size	512 bytes
Antenna Type	Omni antenna
Propagation Model	Two Ray Ground
Mobility Model	Random Waypoint Mobility
Simulation Time	200s
Number of Nodes	40
Pause Time	2s to 195s
Node Velocity	0 m/s to 40 m/s

Table1: Simulation Parameters

3.3 NS-2.34 and Patches

The network simulations have been performed using network simulator NS-2. The NS-2 is software used to simulate discrete event for networks. It simulates events such as sending, receiving, dropping and forwarding packets. The ns-allinone-2.34 integrates simulation for MANET routing protocols as AODV and DSR. The simulation of protocols OLSR and DYMO are based on the work as ns-allinone-2.34 with installation of their patches.

Although NS-2.34 can be implemented on different Operating Systems, for this article, we select a Linux platform i.e. Ubuntu LTS 12.04, as Linux provides development tools that can be employed with the simulation. To run a NS-2.34 simulation, the user must write the OTCL simulation script. NS-2 gives a visual presentation of the network by tracing stations movements and events and writing them in a file named as Network Animator file (or NAM file) [10][11]. UM-OLSR patch has been applied to NS 2.34. This patch is applied for the implementation of the OLSR protocol. NS does not have the OLSR protocol in-built to perform simulations and hence the patches had to be applied. UM-OLSR complies with IETF RFC 3626 and supports all functionalities of OLSR plus the link-layer feedback option. After the patch was applied, the NS 2.34 code was configured, builds and tested for conducting successful simulation. The performance parameters are graphically visualized.

3.4 Performance Metrics

Throughput: Throughput is the average rate of successful packet delivery from source to destination during simulation [8]. It is in fact a measure of the effectiveness of a routing protocol measured in bits/second. It should be high for better performance in routing protocol.

Throughput = (Number of packets sent * 8 * data packet size) / Simulation Time

Packet delivery ratio (PDR): It is defined as the ratio of number of packets received by the destination to the number of packets originated by the source (TCP and CBR).It should be high for better performance in routing protocol.

Packet Delivery Ratio= received packets/sent packets*100%

Packet loss ratio (PLR): It is defined as the ratio of difference between sent and received packets to the number of packets originated by the source. It should be low for better performance in routing protocol.

Packet loss ratio= ((sent-received)/sent)*100%

Mean Jitter: Jitter is the variation in delay by different data packets that reached the destination. The amount of allowable jitter is highly dependent on the application. If jitter is low better is the performance of routing protocol. Jitter should be small for high performance in routing protocol.

Average End-to-end Delay: Average end-to-end delay defines how long it takes for an entire message to completely arrive at the destination from the time the first bit is sent out from the source [3]. It is average of latency for route discovery, interface queues, propagation delay and retransmission delay.

4 SIMULATION RESULT AND ANALYSIS

The results after simulation are viewed in the figures according to the performance of routing protocols based on the varying the mobility (speed and pause time). Simulation results are viewed on parameters like Packet Delivery Ratio, throughput, Average End to End Delay, Mean jitter and Packet loss ratio.

4.1. Packet Delivery Ratio versus Mobility:

From Figure-2, we note that AODV protocol has the lowest Packet Delivery Ratio compared to other protocol (DSR, OLSR and DYMO). DSR and OLSR demonstrate good performance. Overall, DSR gives the best result when the node mobility is high.

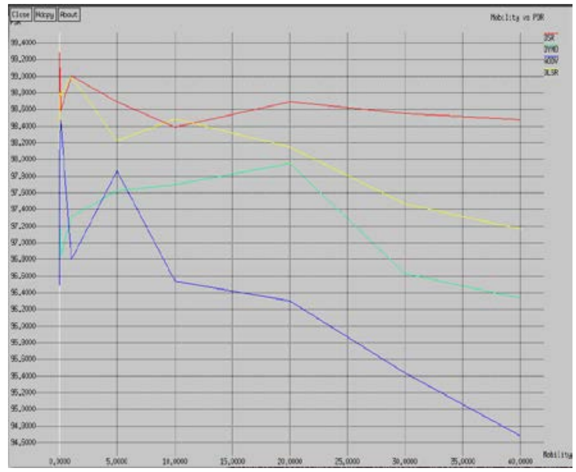

Fig 2: PDR (%) versus mobility

4.2. Throughput versus Mobility:

Figure-3 shows that DYMO demonstrates the lowest Average Throughput compared to other protocols. OLSR, AODV and DSR give a good performance. OLSR gives the best performance for throughput. Here we find that if you consider throughput OLSR performs well in highly mobile network.

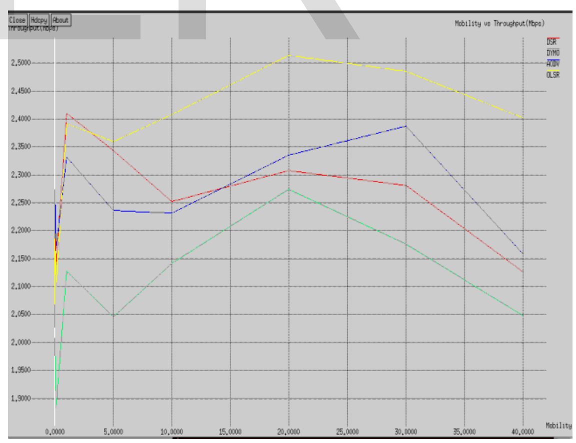

Fig 3: Throughput versus Mobility

4.3. Average End to End Delay Versus Mobility:

Figure-4 shows that DSR protocol has the highest value of Average End to End Delay (low performance) compared to other protocols. From this figure, we see that AODV, DYMO and OLSR are giving almost similar result for Average End to End Delay. But in precise AODV shows best performance for mobile network.

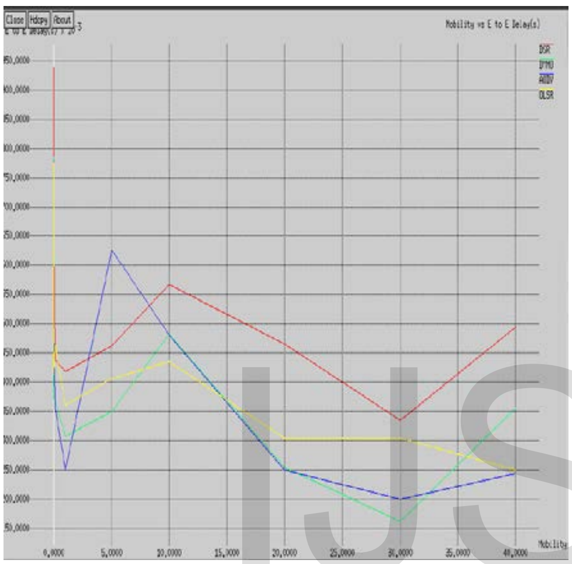

Fig 4: Average End to End Delay Versus Mobility

4.4. Mean Jitter Versus Mobility:

In this figure-5, we get the better result in DSR than other protocols because there is minimum delay in DSR. Delay in the delivery of packet from source to destination is called jitter. And the minimum delay in jitter is best suited for our result. Our graph shows, DSR has minimum value of jitter with the different speed because it make a route between nodes only when it is required by source route. Whereas in OLSR, AODV and DYMO respectively give maximum value of jitter because the sender of packet determines the whole path from the source to destination nodes. So, here these protocols respectively show the low performance.

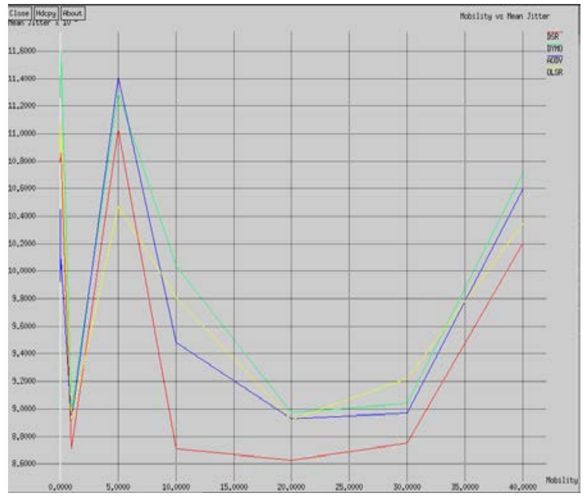

Fig 5: Mean Jitter versus Mobility

4.5. Packet Loss Ratio versus Mobility:

When packet loss ratio is low then we get the better performance. In figure-6, DSR gives the best performance when mobility of nodes increases. Because while increasing the mobility the packet loss is low. AODV gives the lowest performance. DYMO and OLSR give average performance.

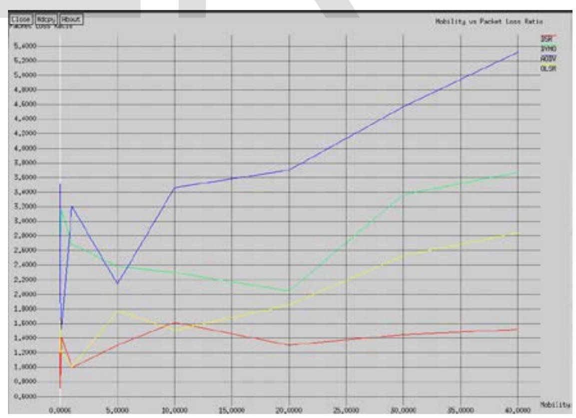

Fig 6: Packet Loss Ratio versus Mobility

5 CONCLUSION

In the research paper we mainly analyzed the performance of three on demand routing protocols- AODV, DSR and DYMO and one table driven protocol OLSR considering the mobility factor. Our main goal is to determine which protocol works fine in dynamic network and which protocol works fine in static or semi static network. This will help to select right protocol according to network scenario. We observe that, for highly dynamic network, OLSR performs well in terms of throughput; AODV performs well in terms of Average End to End Delay. But overall DSR shows the best performance among the four protocols we have analyzed.

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