Comparative Performance Analysis of Routing Protocols in MANET using Varying Pause Time

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ABSTRACT
A Mobile Ad-Hoc Network (MANET) is a collection of wireless mobile nodes that communicates with each other without using any existing infrastructure, access point or centralized administration. In MANET, due to mobility of nodes network topology changes frequently and thus, routing becomes a challenging task. A variety of routing protocols with varying network conditions are analyzed to find an optimized route from a source to some destination. This article presents performance comparison of five popular mobile ad-hoc network routing protocols i.e. Ad hoc On-demand Distance Vector (AODV), Dynamic Source Routing (DSR), Dynamic MANET on- Demand (DYMO), Optimization Link State Routing (OLSR) and Zone Routing Protocol (ZRP) in variable pause time. We used well known network simulator QualNet 5.0.2 from scalable networks to evaluate the performance of these protocols. The performance analysis is based on different network metrics such as End to End delay (s), Average Jitter (s), First Packet Receive (FPR), Last Packet Receive (LPR), Total Bytes Receive (TBR) and Total Packet Receive (TPR), Throughput and TTL based Average hop count.

Keywords
MANET, AODV, DSR, DYMO, OLSR, ZRP, QualNet version 5.0.2

1. INTRODUCTION
A Mobile Ad-Hoc Network (MANET) is a set of Wireless mobile nodes which form a temporary network communicate with each other without using any existing infrastructure or central administration. Quick and easy deployment of ad-hoc network makes them feasible to use in military, search and rescue operation, meeting room and sensor networks. In MANET, nodes can move randomly thus, each node function as a router and forward packet. Due to high node mobility network topology changes frequently. Therefore, routing in ad-hoc network becomes a Challenging task. Many routing protocols have been proposed for ad-hoc networks such as FSR, AODV,

DYMO LANMAR, LAR1, OLSR, DSR, TORA, ZRP, DSDV, STAR, RIP, etc. The aim of this article is to perform comparative analysis of five routing protocols: Ad hoc on-demand Distance Vector (AODV), Dynamic Source Routing (DSR), Dynamic MANET on- Demand (DYMO), Optimization Link State Routing (OLSR) and Zone Routing Protocol (ZRP) in variable pause time for a constant number of nodes.

1.1 AODV
The Ad Hoc On-demand Distance Vector Routing (AODV) [1, 3, 5, 9] protocol is a Reactive routing protocol AODV only needs to maintain the routing information about the active paths. Routing information is maintained in routing tables at nodes. Every mobile node keeps a next-hop routing table, which contains the destinations to which it currently has a route. A routing table entry expires if it has not been used or reactivated for a pre-specified expiration time. Moreover, AODV adopts the destination sequence number technique used by DSDV [7, 8] in an on-demand way. In AODV, when a source node wants to send packets to the destination but no route is available, it initiates a route discovery operation. In the route discovery operation, the source broadcasts route request (RREQ) packets. A RREQ includes addresses of the source and the destination, the broadcast ID, which is used as its identifier, the last seen sequence number of the destination as well as the source node's sequence number. Sequence numbers are important to ensure loop-free and up-to-date routes. To reduce the flooding overhead, a node discards RREQs that it has seen before and the expanding ring search algorithm is used in route discovery operation. The RREQ starts with a small TTL (Time-To-Live) value. If the destination is not found, the TTL is increased in following RREQs.

1.2 DSR
The dynamic source routing protocol (DSR) [1, 3, 6, 9] is an on demand routing protocol. DSR is simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes. Using DSR the network is completely self-organizing and self-configuring requiring no existing network infrastructure or administration. The DSR protocol is composed of two main mechanisms that work together to allow the discovery and maintenance of source route in the ad hoc network. Route discovery is the mechanism by which a node S wishing to send a packet to a destination node D obtains a source route to D .Route discovery is used only when S attempts to sent a packet to D and does not already know a route to D. Route maintenance is the mechanism by which node S is able to detect .while using a source route to D if the network topology has changed such that it can no longer use it route to D because a link along the route no longer works. When route maintenance indicates a source route is broken. S can attempts to use any other route it happens to know to D or it can invoke route discovery again to find a new route for subsequent packets to D. route maintenance for this route is used only when S is actually sending packets to D.

1.3 DYMO

The Dynamic MANET On demand (DYMO) [2, 3, 12] is a reactive or on demand, multihop, unicast routing protocol that not update route information periodically. The DYMO is a small memory stores routing information and generated Control Packets when a node receives the data packet from route path. The basic operations of Dynamic MANET On demand source router generates Route Request (RREQ) messages and floods them for Destination routers for whom it doesn't have route information. Intermediate nodes store a route to the originating router by adding it into its routing table during this dissemination Process. The target node after receiving the RREQ responds by sending Route Reply (RREP) Message. RREP is sent by unicast technique towards the source. An intermediate node that receives the RREP creates a route to the target and so finally it reaches to originator. Then Routes have been established between source and destination in both directions .The DYMO nodes monitors link over which traffic is flowing in order to cope up with dynamic network topology. A Route Error (RERR) message is generated when a node receives a data packet for the destination for which route is not known or the route is broken. Is RERR notifies other nodes about the link failure. The source node reinitiate route discovery quickly as it receives this RERR .Hello messages are used by all nodes to maintain routes to its neighbor nodes The sequence numbers are used in DYMO to make it loop free. These sequence numbers are used by nodes to determine the order of route discovery messages and so avoid propagating stale route information.

1.4 OLSR

Optimized Link State Routing (OLSR) [5, 7, and 8] is a proactive routing protocol where the routes are always available when needed. OLSR is an optimized version of a pure link state protocol. The topological changes cause the flooding of the topological information to all available hosts in the network. To reduce the possible overhead in the network protocol multipoint relays (MPR) [7, 8] are used. Reducing the time interval for the control messages transmission brings more reactivity to the topological changes. OLSR uses two kinds of the control messages namely hello and topology control. Hello messages are used for finding the information about the link status and the host's neighbours. Topology control messages are used for broadcasting information about its own advertised neighbors, which includes at least the MPR selector list.

1.5 ZRP

Zone Routing Protocol (ZRP) [1, 2, 6, and 11] combines the advantages of both reactive and pro-active protocols into a Hybrid scheme, taking advantage of pro-active discovery within a node's local neighborhood, and using a reactive Protocol for communication between these neighborhoods. In a MANET, it can safely be assumed that the most Communication takes place between nodes close to each other. The ZRP is not so much a distinct protocol as it provides a framework for other protocols. The separation of a nodes local neighborhood from the global topology of the entire network allows for applying different approaches - and thus taking advantage of each technique's features for a given situation. These local neighborhoods are called zones each node may be within multiple overlapping zones, and each zone may be of a different size. The ``size" of a zone is not determined by geographical measurement, but is given by a radius of length, where is the number of hops to the perimeter of the zone. By dividing the network into overlapping, variable-size zones, the Zone Routing Protocol consists of several components, which only together provide the full routing benefit to ZRP. Each component works independently of the other and they may use different technologies in order to maximize efficiency in their particular area. Components of ZRP are IARP [10], IERP [11] and BRP [7, 8].

2. SIMULATION ENVIRONMENT AND PERFORMANCE EVOLUTION SETUP

We carried out simulations on QualNet 5.0.2 simulator [14] and defined the parameters for the performance evaluation of AODV, DSR, DYMO, OLSR and ZRP routing protocols under different pause time using Random Waypoint Mobility Model. The simulation parameters are summarized in table 1.

Table 1 Simulation Parameter

SIMULATION PARAMETERS

Simulation Parameters	Values
Dimension of space	1500*1500
Minimum velocity (v min)	0 m/s
Maximum velocity (v max)	20 m/s
No. of nodes	200
Simulation Time	900 sec
Traffic Sources	CBR
Item size	512 bytes
Source data pattern	4 packets/sec
Node Placement Strategy	Random Waypoint Model
Pause time	25s, 50s, 75s, 100s, 125s
No. of simulations	25
Routing Protocol	AODV,DSR,DYMO,OLSR ,ZRP

2.1 Random Waypoint mobility model

In random waypoint mobility model, the nodes randomly selects a position, moves towards it in a straight line at a constant speed that is randomly selected from a range, and pauses at that destination. The node repeats this, throughout the simulation. In the simulation, Constant Bit-Rate (CBR) [14] traffic flows are used with 4 packets/second and a packet size of 512 bytes. To evaluate the performance of routing protocols, we used four different quantitative metrics to compare the performance of AODV, DSR, DYMO, OLSR and ZRP routing protocol. They are End to End delay (s), Average Jitter (s), First Packet Receive (FPR), Last Packet Receive (LPR), Total Bytes Receive (TBR) and Total Packet Receive (TPR).

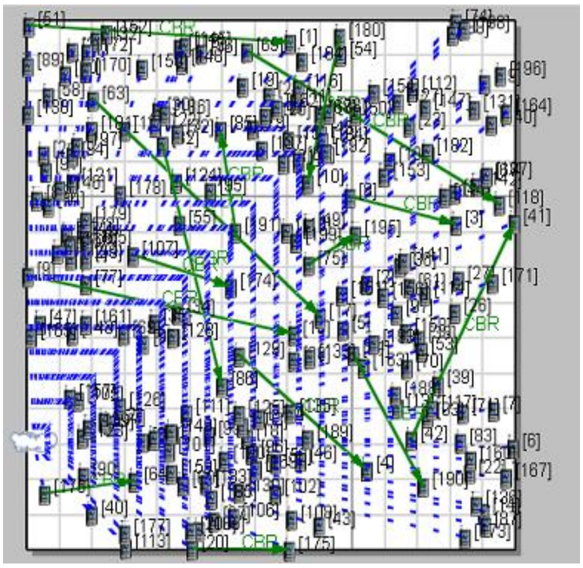

Fig.1 Snapshot of 200 Varying Nodes Placement network in QualNet 5.0.2 Simulator.

2.2 Performance Metric

- **End to End delays**

The average end-to-end delay of a data packet is the time interval when a data packet generated from Constant Bit Rate source completely received to the application layer of the destination**.** Average delay for packet transmission between client and server (seconds).figure 2 showing the performance of end to end delay at variable pause time 25s, 50s, 75s, 100s and 125s with varying 200 nodes random placement. Routing protocols ZRP and OLSR have largest end to end delay (s) is .42 and small delay is .15 but largest as compeered to other protocol AODV, DSR and DYMO routing protocols .DYMO is end to end delay (s) .1 and small delay is .025 .AODV have smallest end to end delay .002 but DSR have more than end to end delay is .025.

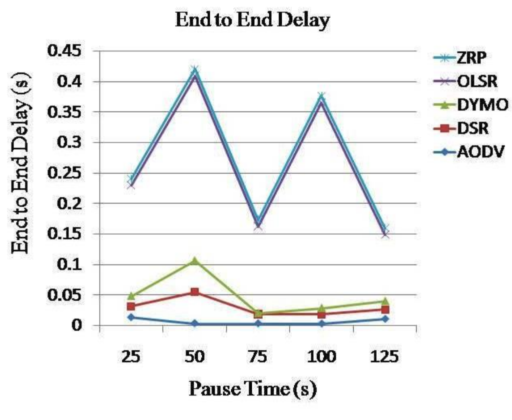

Fig. 2 End to End delays (s) for 200 nodes

- **Average Jitter (s)**

Jitter is the difference between the expected time of arrival of a packet and the actual time of arrival. Jitter is caused primarily by delays and congestion in the packet network. Jitter causes discontinuity in the real-time voice stream. To minimize the delay variations, a jitter buffer are implemented which temporarily stores arriving packets. Figure 3 showing the performance of average jitter (s) at different pause time. OLSR and ZRP routing protocol gives largest average jitter .25 and .24 as compared to other routing protocols DYMO, DSR and AODV .AODV gives smallest average jitter as compared to DYMO and DSR routing protocol. AODV is .002 DSR is .0025 and DYMO is .0035.

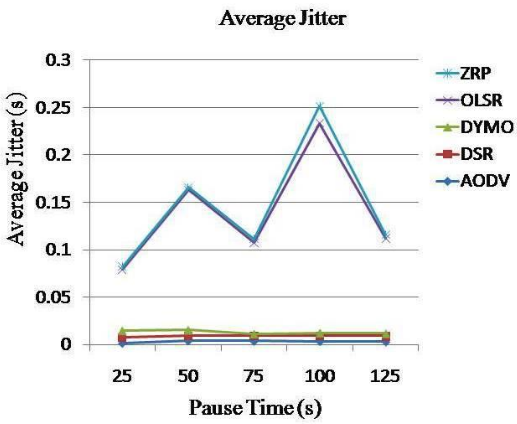

Fig. 3 Average Jitter (s) for 200 nodes

- **First Packet Receive (bytes)**

Time when first packet was received in seconds by Constant bit rate CBR figure 4 showing the performance of first packet receive on receiver server Taken all receive packet in terms of percentage at variable pause time 25s, 50s, 75s, 100s and 125s for 200 nodes . In figure 4 ZRP routing protocol almost receive 100 % first packet at entire pause time taken. OLSR receive 82 % at 25s pause time and 75 % at 50s,75s,100s and 125s pause time, DYMO give 29% at 25s pause time and 50s, 75s, 100s and 125s pause time receive first packet 50%. AODV and DSR receive 15% and 20% at 25s pause time and 24 % and 25% at 50s pause time receive first but 75s, 100s and 125s pause time receive constantly first packet 25% same protocol like AODV, DSR and DYMO.

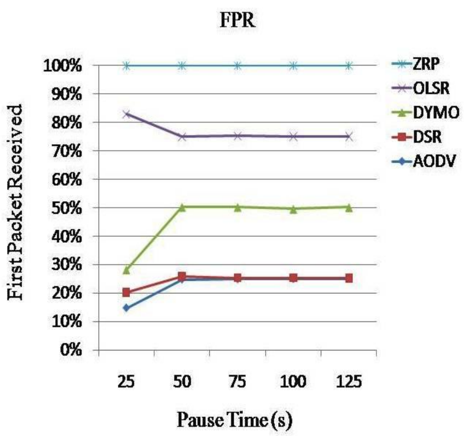

Fig. 4 First Packet Receive (bytes) for 200 nodes

- **Last Packet Receive**

Time when last packet was received in seconds by Constant bit rate CBR figure 5 showing the performance of last packet receive at different pause time for varying 200 nodes. AODV receive only 20 packet at 25s pause time but 125s pause time packet receive increase up to 120, DSR receive only 40 packet at 25s pause time but 125s pause time packet receive increase up to 220, DYMO receive only 60 packet at 25s pause time but 125s pause time packet receive increase up to 350, OLSR receive only 80 packet at 25s pause time but 125s pause time packet receive increase up to 460 and ZRP receive only 100 packet at 25s pause time but 125s pause time packet receive increase up to 600.ZRP received largest packet at 125s pause time is 600 packet receive but AODV only receive 120 packet and in case of 25s pause time AODV is on 20 packet receive but ZRP receive 100 packet.

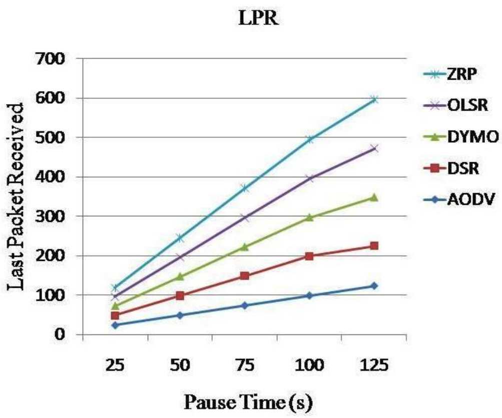

Fig. 5 Last Packet Receive (bytes) for 200 nodes

- **Total Packet Receive**

Total number of packet was received at server in figure 6 showing the performance of total packet receive at different pause time is 25s, 50s, 75s, 100s and 125s for 200 nodes. AODV total packet receive 25 packet at all pause time, DSR is 48 packet receive at 25s pause time but increasing these packet up to 125 at 100s and 125s pause time ,DYMO receive 68 packet at 25s pause time but 100s and 125s pause time DYMO packet increase up to 145,OLSR receive packet 75 at 25s pause time up to 170 at 100s and 125s pause time but in case of ZRP receive largest packet at 25s pause time 100 and 125s pause time receive packet is 190 as compared to all case .

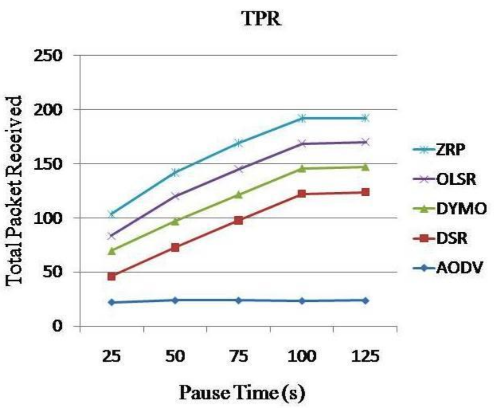

Fig. 6 Total Packet Receive for 200 nodes

- **Total Bytes Receive (bytes)**

Total number of bytes received at server in figure 7 showing the performance of total bytes receives at variable pause time for 200 nodes OLSR routing protocol total bytes receive 7750 at 25s pause time and 125s pause time total bytes receive is 11000, DSR receive total bytes at 25s pause time 11000, 100s and 125s pause time receive 51000 but in case of DYMO, AODV and ZRP routing protocol receive same bytes at different pause time is 11000. Figure 7 DSR receive largest bytes is 51000 and smallest total bytes receive is 7750.

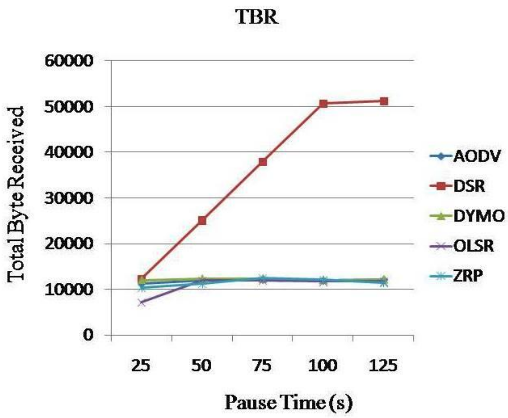

Fig. 7 Total Bytes Receive (bytes) for 200 nodes

- **Throughput (bits/s)**

The throughput is defined as the total amount of data a receiver receives from the sender divided by the time it takes from the receiver to get the last packet. The throughput is measured in bits per second (bit/s or bps).figure 2 showing the performance throughput result according to different pause time interval taken at 25s pause time give same performance throughput 4290 routing protocol AODV,DYMO,OLSR,at 50s pause time DSR have 4370 and ZRP is 4230 ,at 75s DYMO give the 4150 throughput and 100s pause time AODV and DYMO give same throughput 4000 and ZRP is 4330 . entire performance AODV gives small throughput as comapared to other routing protocol and DSR gives largest throughput 4370.

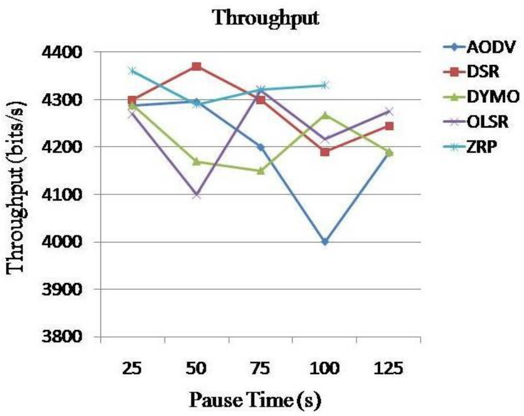

Fig.8 Throughput for 200 nodes

- **TTL Based Average Hop Count**

Hop count is the number of hops a packet takes to reach its destination. An expanding ring search starts by sending an RREQ with a smaller TTL and resends it with increasing TTL if a response is not received. The full TTL search sends the initial and subsequent RREQs using the net diameter value as TTL. An expanding ring search starts by sending an RREQ with a smaller TTL and resends it with increasing TTL if a response is not received. The full TTL search sends the initial and subsequent RREQs using the net diameter value as TTL. Figure 3 showing the performance TTL average hop count at different pause time 25s, 50s, 75s, 100s and 125s at 200 varying nodes placement strategy.ZRP and OLSR give the constant TTL Average hop count performance all pause time .DSR performance increase continuously at different pause time started with 31 TTL average hop count at 25s pause time ends with 42 TTL average hop count at 125s pause time. AODV and DYMO have almost same performance constant at 25s and 50s pause time then decrease suddenly at 75s and 100s pause time. At 100s pause time AODV increase 42 TTL average hop count but DYMO performance constant.

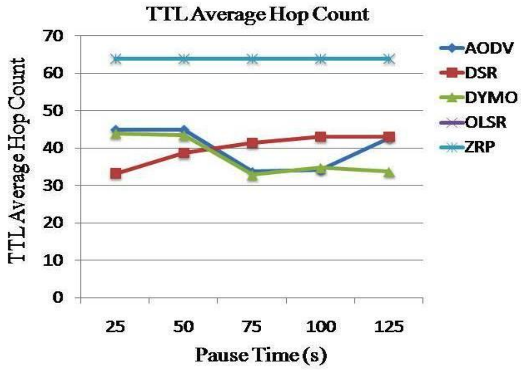

Fig.9 TTL Average Hop Count for 200 nodes

3. CONCLUSION

In this article, we examine the performance differences of AODV, DSR, DYMO, OLSR and ZRP routing protocol for mobile ad-hoc networks in variable pause time. We measure the End to End delay (s), Average Jitter (s), First Packet Receive (FPR), Last Packet Receive (LPR), Total Bytes Receive (TBR), Total Packet Receive (TPR), Throughput and TTL based Average hop count as performance metrics. Our simulation results shows DSR is the best scheme in terms of total bytes receive ZRP is the best performance total packet receive, last packet receive and first packet receive but ZRP shows worst performance in terms of end to end delay While AODV best shows end to end delay, throughput and average jitter but in case of First Packet Receive, Last Packet Receive. Total Bytes Receive**.** In future, different node placement strategy, more sources traffic, additional metrics such as packet delivery ratio, average packet size of routing packets and normalized routing overhead may be used in Mobile ad hoc network (MANET),energy consumed transmit mode , receive mode and residual battery capacity.

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5. AUTHOR'S PROFILE

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