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Comparative Performance Analysis of AODV,DSR,DYMO,OLSR and ZRP Routing Protocols in MANET using Random Waypoint Mobility Model

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Abstract- **In this article, we compare performance of some routing protocols for Mobile Ad-Hoc Networks (MANET's). 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 throughput, TTL Based Average Hop Count, Energy Consumed in Transmit Mode, Energy Consumed in Received Mode, Residual Battery Capacity (in mAhr) and Peak Queue Size (byte).**

Keywords- MANET, AODV, DSR, DYMO, OLSR, ZRP, QualNet version 5.0.

I. 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.

A. 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.

B. 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.

C. AODV

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.

D. OLSR

Optimized Link State Routing (OLSR) [5, 7, 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.

E. ZRP

Zone Routing Protocol (ZRP) [1, 2, 6, 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].

II. 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 I. 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

A. 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 throughput, TTL Based Average Hop Count, Energy Consumed in Transmit Mode, Energy Consumed in Received Mode, Residual Battery Capacity (in mAhr) and Peak Queue Size (byte).

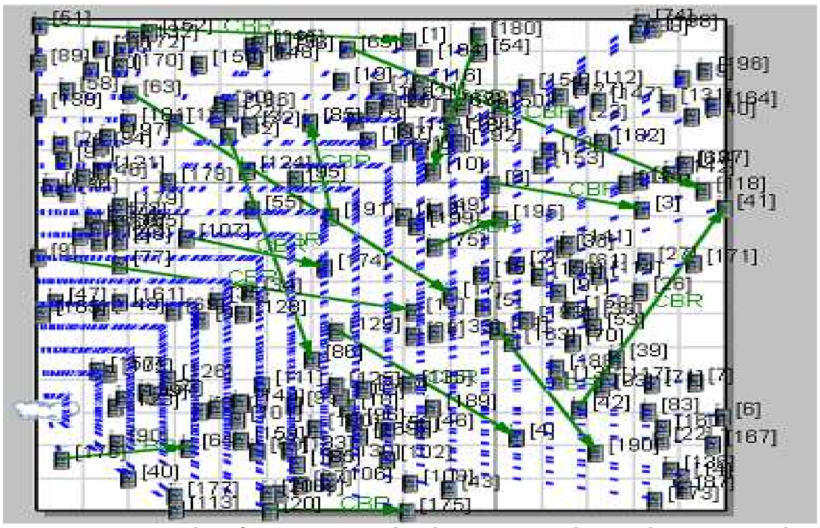

Figure1. Snapshot of 200 Varying Nodes placement network in QualNet 5.0.2 Simulator

B. Performance Metric

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.

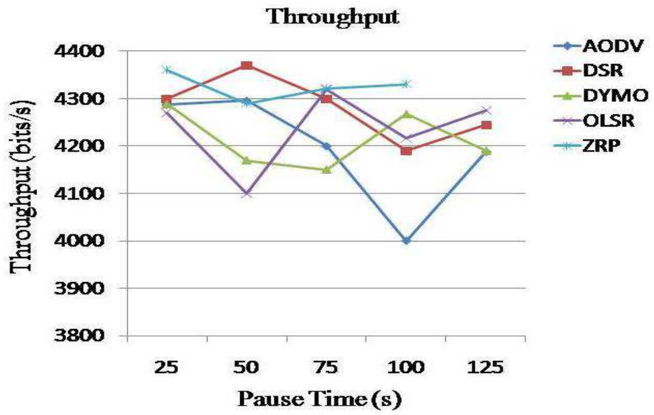

Figure 2 . Throughput for 200 nodes

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.

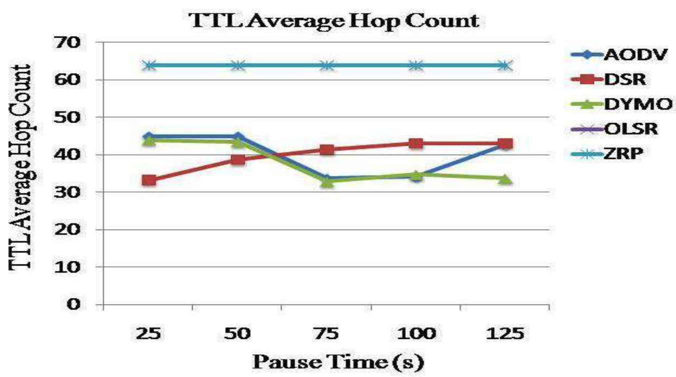

Figure 3. TTL Average Hop Count for 200 nodes

Energy Consumed in Transmit Mode

Total energy (power) consumed (in mJoule) by radio interface in Transmission mode. In figure 4 showing the performance of energy consumed in transmit mode at different pause time 25s, 50s, 75s, 100s and 125s with 200 nodes. OLSR routing protocol consumed largest energy in transmit mode 0.48 at 25s pause time and minimal energy consumed in transmit mode DYMO, AODV and DSR almost zero but ZRP energy consumed more than these routing protocols in transmit mode 0.02.

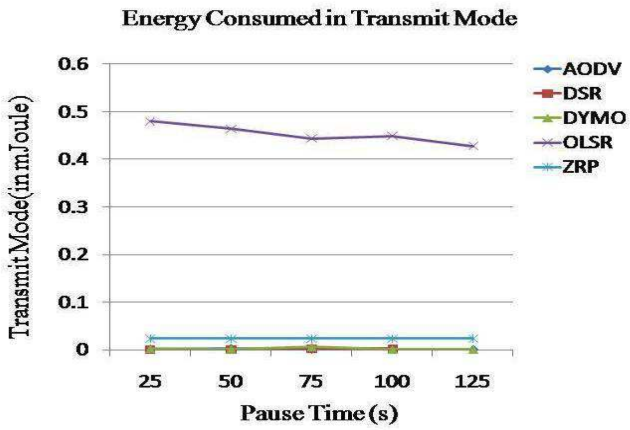

Figure 4. Energy Consumed in Transmit Mode for 200 nodes

Energy Consumed in Received Mode

Total energy (power) consumed (in mJoule) by radio interface in reception mode. In figure 5 showing the performance energy consumed in received mode at different pause time .according to figure showing that DSR, DYMO and AODV zero energy consumed at all pause time but ZRP energy consumed in received mode at 25s, 50s, 57s and 100s pause time constantly energy consumed 0.02 but at 125s pause time increasing fast up to .9 energy consumed in received mode. OLSR routing protocol energy consumed largest at 25s pause time is 1.61 at received mode in energy consumed in received mode but 125s pause time decreasing performance of energy consumed in received mode is 1.41.

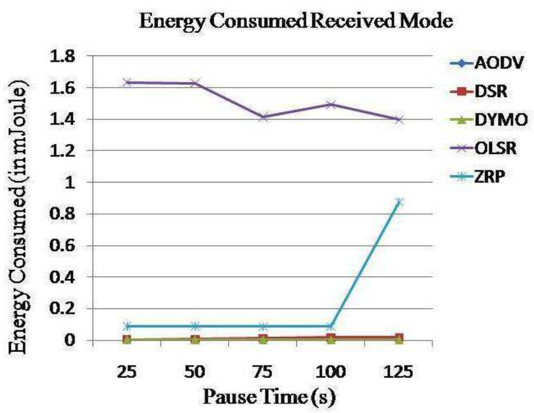

Figure 5. Energy Consumed in Received Mode for 200 nodes

Residual Battery Capacity

This model estimates the remaining service life of the battery at any time in the simulation. One important characteristic of the battery is that some amount of energy will be wasted when the battery is delivering the energy required by the circuit. In figure 6 showing the performance of residual battery capacity at different pause time 25s, 50s, 75s, 100s and 125s pause time with 200 nodes .OLSR routing protocol at 25s pause time residual battery capacity is 1198.68 m Ahr then suddenly increase residual battery capacity at 50s pause time is 1199.8 mAhr after that OLSR routing protocol performance suddenly decease 1198.82 mAhr at 75s pause time and 125s pause time residual battery capacity is 1198.8 mAhr .rest all the protocol DSR, DYMO, AODV and ZRP have same residual battery capacity 1199.16 mAhr at 25s, 50s, 75s, 100s and 125s pause time.

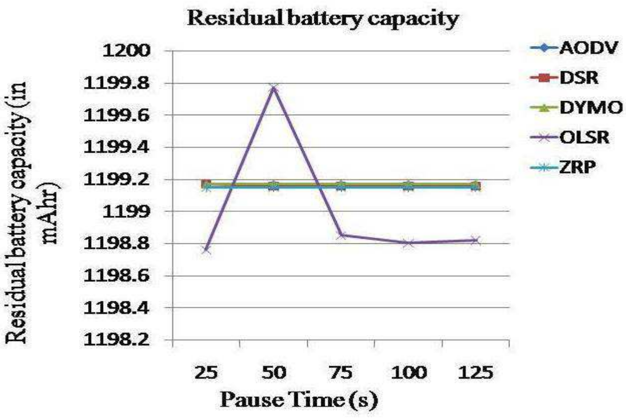

Figure 6. Residual Battery Capacity for 200 nodes

FIFO: Peak Queue Size

Largest number of bytes stored in the queue at any time or the upward bound on this stat would be the queue size itself. Figure 7 showing the performance of peak queue size at different pause time. In this figure AODV, DYMO, DSR and ZRP Routing protocol have same performance at all pause time 25s, 50s, 75s, 100s, and 125s and OLSR routing protocol varying at according to pause time at 25s OLSR peak queue size (bytes) is 20000, at 50s pause time peak queue size (bytes) is 24000, at 75s pause time peak queue size (bytes) is 17000,100s pause time peak queue size (bytes) is 20000 and finally 125s pause time peak queue size (bytes) is 19000.

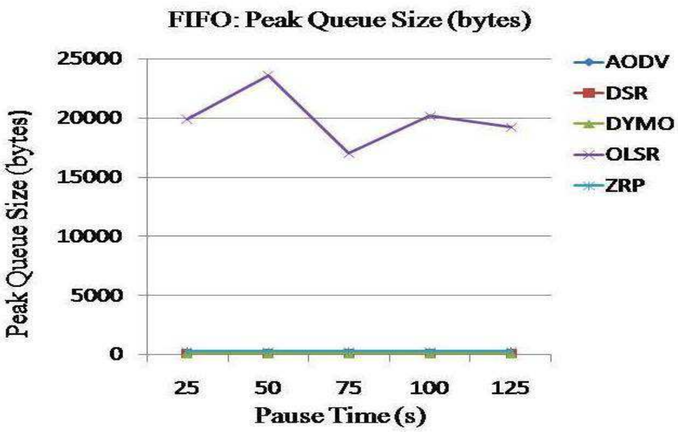

Figure 7.FIFO: Peak Queue Size for 200 nodes

III. 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 throughput, TTL Based Average Hop Count, Energy Consumed in Transmit Mode, Energy Consumed in Received Mode, Residual Battery Capacity (in mAhr) and Peak Queue Size (byte) as performance metrics. Our simulation results shows DSR is the best scheme in terms of throughput OLSR is the worst performance energy consumed in transmit mode, received mode and residual battery capacity while ZRP shows best performance in terms of TTL average hop count .While DYMO shows worst performance of FIFO peak queue size. 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).

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