Comparative Analysis of OLSR, DSR, ZRP Routing Protocols in Mobile Ad-Hoc Networks

N. Durga Prasad[#1], K.Divya[*2]

[#1]*Assistant Professor, Department of Computer Science and Engineering, Gayatri Vidya Parishad College of Engineering (Autonomous), Visakhapatnam, Andhra Pradesh,India.*

[1]dp.prasad10@gvpce.ac.in

[*2]*M.tech Student, Department of Computer Science and Engineering, Gayatri Vidya Parishad College of Engineering (Autonomous), Visakhapatnam, Andhra Pradesh,India.*

[2]divya450@gmail.com

Abstract-**A Mobile Ad hoc Network (MANET) is a network which is formed by a group of wireless mobile nodes (laptops, smart phones, sensors, etc.) without any centralized or stable infrastructure. They mainly operate without base station infrastructure and centralized administration. In a MANET, the nodes are mobile and inter-node connectivity may change frequently during normal operation. Therefore, routing in MANET is a crucial task due to its unstable infrastructure. Several protocols are improved the routing mechanism to find the path between any source node and destination node across the network. This paper mainly focuses on analysis of the three popular routing algorithms Optimized Link State Routing (OLSR), Dynamic Source Routing (DSR), and Zone Routing Protocol (ZRP).The performance analysis is based on different network metrics such as Average End to End delay(s), Average Jitter(s), Throughput and Packet delivery ratio.**

Keywords- **MANETs, Routing Protocol, OLSR, DSR, ZRP.**

I. INTRODUCTION

Mobile Ad-hoc Network (MANET) [1] is an autonomous system of mobile nodes connected by wireless links which forms a communication network modelled in the form of an arbitrary graph. In a MANET, no wired infrastructure exists and the network topology may change dynamically in an unpredictable manner since nodes are free to move. MANETs are basically peer-to-peer multi hop mobile wireless networks where the information packets are transmitted in a store and forward manner from a source to destination, via intermediate nodes as shown in Fig.1

Mobile Ad-hoc Networks (MANETs) are characterized by a multi-hop, dynamic, rapid changing topology. Such networks are designed to provide communication capabilities to areas where no communication infrastructure exist. The important characteristics of a MANETs are

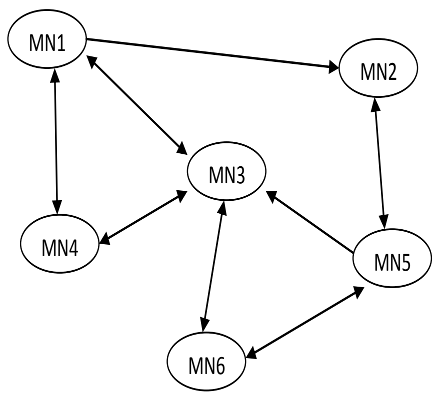


Figure 1. Mobile Ad hoc Network

- *Dynamic Topologies*: Nodes of MANET can move arbitrarily with different speeds, thus the network topology may change randomly and at unpredictable times.
- *Energy Constrained Operation:* Many of the nodes in an ad-hoc network may rely on batteries or other temporary means of energy. For such nodes the most important optimization criteria may be energy conservation.
- *Multi hop routing*: When a mobile node tries to send information to other mobile nodes which is out of its communication range, the packet should be forwarded via one or more intermediate nodes.

- *Security Threats:* Mobile networks are more prone to physical security threats than fixed networks.

Applications of MANETs:

There are several applications to Ad-hoc Networks. Any day-to-day application such as e-mail and file transfer can be considered to be easily deployable within an Ad-hoc Network environment. The Ad-hoc Networks have self-organizing capability which effectively can be used where other technologies either fail or cannot be deployed effectively. Few well known Ad-hoc Network applications are:

- *Military*: MANETs would allow the military to maintain an information network between the vehicles, soldiers and military information head quarter.
- *Collaborative work*: In some business environments, Collaborative computing might be more important where people need to have meetings outside the office environment and information exchange on a given project.
- *Personal area network and Bluetooth:* Personal area network is a short range network where nodes are associated with individuals. MANET such as Bluetooth can simplify the inter communication between various mobile devices such as laptops and mobile phones.

II. ROUTING PROTOCOLS

Routing in MANET is intrinsically different from traditional routing found on infrastructure networks. Routing protocol maintains a routing table to keep information about the linking node and its adjacent nodes. Several routing protocols have been proposed for both wired and wireless networks. They fall into following categories depending on their properties:

- *Table driven (proactive) routing protocol*

Nodes in MANET keep track of routing information to every other node in the network, so that when a packet needs to be forwarded, the route is known and can be used immediately. It experiences minimal delay whenever a route is needed as a route is immediately selected from the routing table.

- *On – demand (reactive) routing protocol*

Reactive protocol approach is to discover routes to destination on demand. A node doesn't need a route to destination is maintained until a packet for the destination is arrived. Reactive protocols consume less bandwidth than Proactive protocols, but experience a long delay for discovering a route to destination node.

- *Hybrid routing protocol*

Hybrid protocol is a protocol which combines merits of both Proactive and Reactive approaches. Such Hybrid protocols offer means to switch dynamically between Proactive and Reactive parts of protocol. For instance, Proactive protocols could be used between networks and Reactive protocols inside the networks or vice versa.

A. OLSR (Optimized Link State Routing)Protocol

Optimized Link State Routing [2] is a well-known Proactive Routing Protocol. OLSR can support both static and mobile network configurations and has good scalable properties. Being a Proactive protocol, OLSR maintains the routing information of all the nodes in the network which causes flooding of control messages. OLSR reduces the size of control packets, instead of all links, it declares only subset of links with its neighbors who are the *multipoint relay selectors.* it minimizes flooding of this control traffic by using only the selected nodes, called *multipoint relays,* to diffuse its messages in the network.

The use of Multipoint Relays(MPR)[3] decreases the flooding of control messages by reducing the duplicate retransmission of messages. Every node in the network selects a set of nodes in its neighborhood, which retransmits its packets. . This set of selected neighbor nodes are called multipoint relays of that node. The neighbors of any node N which are not in its MPR set, read and process the packet but do not retransmit the broadcast packet received from node N.

In OLSR, each node periodically broadcasts two types of messages: HELLO messages and Topology Control (TC) messages. A HELLO message contains two lists in which one list includes the addresses of the neighbors for which there exists a valid bi-directional link and the other list includes the addresses of the neighbors from which control traffic is heard but bidirectional links are not confirmed. Upon receiving HELLO message, a node examines list of addresses, if its own address is in the list, it is confirmed that bidirectional communication has been established with the sender. HELLO messages also allow each node to maintain information describing link between neighbor node and nodes which are two-hop away. The set of nodes among the one-hop neighbors with a bi-directional link are chosen as multipoint relays (MPRs). Only these nodes forward topological information about the network [4].

On the reception of HELLO messages, each node maintains a neighbor table which contains one-hop neighbor information, their link status information and a list of two hop neighbors. Each node also maintains a set of its neighbors which are called the MPR Selectors of the node. When these selectors send a broadcast packet, only its MPR nodes among its entire neighbors forward the packet. The MPR nodes periodically broadcast its selector list throughout the network. The smaller set of multipoint relay provides more optimal routes. The path to the destination consists of a sequence of hops through the multipoint relays from source to destination. A TC message contains the list of neighbors who have selected the sender node as a multipoint relay and is used to diffuse topological information to the entire network. Based on the information contained in the neighbor table and the TC message, each node maintains a routing table which includes destination address, next-hop address, and number of hops to the destination [5].

Advantages and Limitations: OLSR is a flat routing protocol and it does not require central administrative system to handle its routing process. The link is reliable for the control messages, since the messages are sent periodically and the delivery does not have to be sequential. This protocol is best suitable for high density network and does not allows long delays in the transmission of the packets.

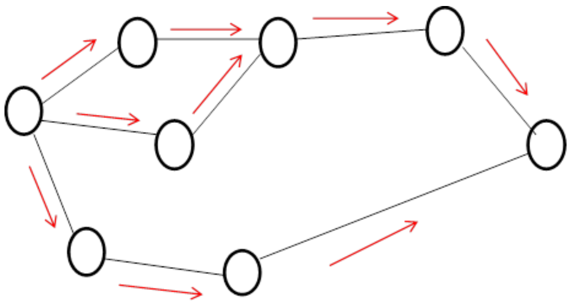
However, as a limitation this protocol needs that each node periodically sends the updated topology information throughout the entire network, this increase the protocols bandwidth usage. But the flooding is minimized by the MPR's, which are only allowed to forward the topological messages.

B.
C.

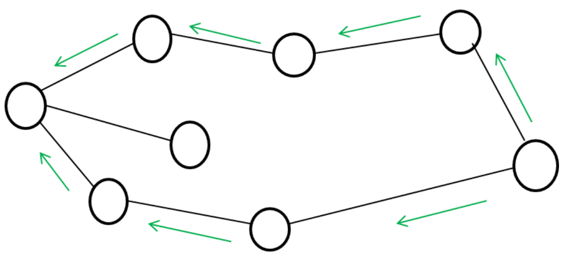
B. DSR (Dynamic Source Routing) Protocol

Dynamic Source Routing(DSR)[5] Protocol is an ondemand protocol. It is designed to limit the bandwidth consumed by routing packets in ad-hoc wireless networks. DSR is based on the concept of source routing algorithm to discover routes. This means that every node just need to forward the packet to its next hop specified in the header and need not check its routing table as in table-driven algorithm.

DSR protocol does not require periodic "hello" packet transmissions. The source node broadcasts "RREQ" packets to all its neighbors. Each neighboring node in turn rebroadcasts the packets to its neighbors if it does not receive the packet before or if it is not the destination node, provided that the Time To Live(TTL)- has not been exceeded. Each "RREQ" carries a sequence number generated by the source node and the path it has traversed. When the packet reaches the destination node, it sends a reply packet "RREP" back to sender. This reply packet contains the route to that destination. The destination node chooses the best route received first and stores the other routes for future reference. In DSR the intermediate nodes need not to maintain up to date routing information in order to route the packets that they forward. On the other hand, whenever a link breaks, the "RERR" packet propagates to the original source, which in turn initiates a new route discovery process.



(a)



(b)

Propagation of (a)RREQ and (b) RREP

Route maintenance: Route maintenance can be accomplished by two different processes:

i). *Hop-by-hop acknowledgement* at the data link layer allows an early and retransmission of lost or corrupt packets.

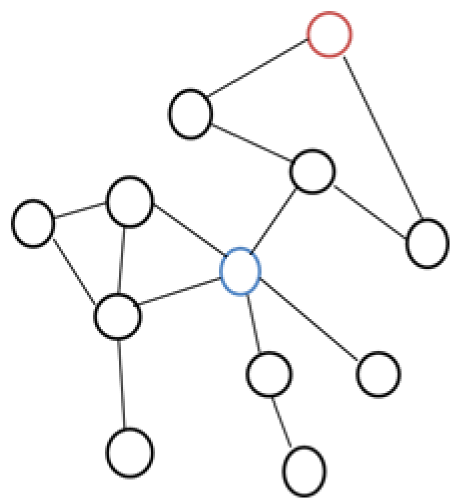
ii). *End-to-end acknowledgement* may be used if wireless transmission between two hosts does not work equally well in both directions. As long as a route exists by which the two end hosts are able to communicate, route maintenance is possible.

Advantages and limitations of DSR: One of the main benefits of DSR protocol is that there is no requirement for maintaining routing table to send a given data packet as the entire route is stored in the packets header.

The limitation of DSR protocol is that this is not scalable to large networks and even requires processing resources than most other protocols. In order to obtain the routing information, each node must spend lot of time to process any control data it receives, even if it is not the targeted recipient.

C. *ZRP (Zone Routing Protocol)*

ZRP [7] combines the advantages of both reactive and pro-active protocols into a hybrid protocol, taking advantage of pro-active discovery within a node's local neighborhood, and using a reactive protocol for communication between these neighborhoods. ZRP protocol provides framework to other protocols. The ZRP divides the entire network into overlapping zones of variable size. Each node may belong to multiple overlapping zones. The zone size is defined by a radius which is evaluated in terms of number of hops. Each zone contains two type of nodes: peripheral nodes and interior nodes. Peripheral nodes are nodes that located at the boundary of zone and interior nodes are located within the zone radius except boundary node. ZRP consists of several components such as IARP, IERP and BRP, which only together provide the full routing benefit to ZRP. The IntrAzone Routing Protocol (IARP) is a proactive routing protocol used inside routing zones to improve the performance of existing globally reactive routing protocols. For routes belongs to the same zone, IARP proactively uses source node routing table information to deliver packet immediately. The IntErzone Routing Protocol (IERP) is the reactive routing component of the Zone Routing Protocol. IERP is used to communicate between nodes of different zones and the route discovery process is only initiated on demand. The IERP takes the advantage of the local routing information provided by the IARP. When there is request for a route beyond the local zone, global route discovery is required. IERP uses bordercasting, an approach in which the node does not submit the query to all local nodes, but only to its peripheral nodes to minimize delay in global route discovery. The Bordercast Resolution Protocol (BRP) is used to direct route request generated by global reactive IERP to the peripheral nodes and utilizes the topology information provided by IARP to direct query request to the border of the zone.



An example of a routing zone for node S of radius 2 is shown in figure. The nodes in black color belong to the routing zone of S, but not node in red color. The nodes which are in corner are called peripheral nodes because hop distance from S is equal to radius of the routing zone.

Advantages and Limitations:

ZRP tries to combine the advantages of reactive and proactive routing protocols. With properly configured zone radius, ZRP may exceed both proactive routing protocols and reactive routing protocols.

The potential disadvantage is that since hierarchical routing is used, the path to a destination may be sub-optimal. Furthermore, since each node has higher level topological information, memory requirement is greater.

III. METRICS FOR PERFORMANCE COMPARISON

MANET has number of qualitative and quantitative metrics that can be used to compare ad hoc routing protocols. The table I illustrates the comparison of OLSR, DSR and ZRP routing protocols. This paper has been considered the following metrics to evaluate the performance of ad hoc network routing protocols.

1. *Average End-to-end Delay*:

This metric represents average end-to-end delay and indicates how long it took for a packet to travel from the source to the application layer of the destination. It includes all possible delay caused by buffering during route discovery latency, transmission delays at the MAC, queuing at interface queue, and propagation and transfer time. It is measured in seconds.

2. *Packet Delivery Ratio:*

Packet Delivery Ratio is defined as the ratio of the number of delivered data packet to the destination. This illustrates the level of delivered data to the destination. It specifies the packet loss rate, which limits the maximum throughput of the network.

3. *Throughput:*

It is the measure of the number of packets successfully transmitted to their final destination per unit time. It is the ratio between the numbers of received packets vs. sent packets.

4. *Average Packet Jitter*:

It is the ratio of transmission delay of the current packet and the transmission delay of the previous packet. Jitter can be calculated only if at least two packets have been received

IV. COMPARATIVE STUDY OF OLSR, DSR, ZRP

The following tables compare OLSR, DSR, ZRP protocols under different scenarios with different performance metrics.

Under low Pause time and low Traffic			
Performance Metrics	OLSR	DSR	ZRP
Category	Proactive	Reactive	Hybrid
End-to-End delay	Low	Moderate	Low
Packet delivery ratio	High	High	High
Throughput	Good	Better	Average
Jitter	Low	Low	Low
Communication overhead	High	Low	Average

Table 1. Routing performance under low pause time

Under low pause time (which effects mobility of the nodes) and low traffic conditions ZRP out performs the other two protocols.

High Pause time and High Traffic			
Performance Metrics	OLSR	DSR	ZRP
End-to-End delay	Low	Low	High
Packet delivery ratio	Average	Low	Low
Throughput	Good	Average	Average
Jitter	Low	Low	Average

Table 2. Routing performance under high pause time/mobility

V. CONCLUSION

This paper presents the comparative study and performance analysis of various ad hoc routing protocols (OLSR, DSR and ZRP) on the basis of end-to-end delay, packet delivery ratio, throughput, and jitter performance metrics. The study of these routing protocols shows that OLSR is more efficient in high density networks with highly sporadic traffic. OLSR requires that it continuously have some bandwidth in order to receive the topology updates messages.

REFERENCES

[1] Mario Gerla, Carla-Fabiana Chiasserini, Kenichi Mase, Eytan Modiano, and Jason Red, “Mobile Ad Hoc Wireless Networks” in JOURNAL OF COMMUNICATIONS AND NETWORKS, VOL. 6, NO. 4, DECEMBER 2004

[2] T. Clausen and P. Jacquet, “Optimized Link State Routing Protocol (OLSR),” The Internet Engineering Taskforce RFC 3626, Oct 2003.

[3] S. Y. Cho, and C. Adjih, “Optimized Multicast based on MultipointRelaying,” Proc.International Conference on Wireless Internet, pp. 42-46,Jul. 2005

[4] P. Jacquet, P. Muhlethaler, T. Clausen, A. Laouiti, A. Qayyum, and L. Viennot, "Optimized Link State Routing Protocol for Ad Hoc Networks," inProc.of IEEE International Multi Topic Conference on Technology for the 21st Century, 2001, pp. 62- 68.

[5] Qutaiba Razouqi ,Ahmed Boushehri, Mohamed Gaballah Lina Alsaleh, "Extensive Simulation Performance Analysis for DSDV, DSR and AODV MANET Routing Protocols," in 27th International Conference on Advanced Information Networking and Applications Workshops, 2013.

[6] DavidB.JohnsonDavidA.Maltz “ Dynamic Source Routing in Ad hoc Networks” in the book MobileComputing,editedbyTomaszImielinskiandHankKorth,KluwerAcademicPublishers,1996

[7] Dinesh Singh, Ashish K. Maurya, Anil K. Sarje,” Comparative Performance Analysis of LANMAR, LAR1, DYMO and ZRP Routing Protocols in MANET using Random Waypoint Mobility Model”,

[8] Zygmunt J Haas, Marc R. Pearlman, and Prince Samar, "TheZone Routing Protocol (ZRP) for Ad Hoc Networks", draftietf-manet-zone-zrp-04.txt,july,2002

