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Design and Performance Analysis of MANET Using Different Routing Protocols (AODV, ZRP, DYMO, OLSR, RIP)

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Abstract: **Wireless Network can be configured in two ways, infrastructure less and infrastructure based. Mobile Ad Hoc Network is self- healing infrastructure less network consisting of mobile devices which are connected wirelessly. Since the nodes are mobile, the network topology may change rapidly over time. The network has no centralized control and all network activity including discovering the topology and delivering messages must be executed by the nodes themselves, i.e., routing algorithms will be incorporated into mobile nodes. In this paper, we analyze the performance of Mobile Ad Hoc Network using different routing protocols namely AODV, ZRP, DYMO, OLSR, RIP . The performance parameters which we analyzed are throughput, average jitter, average end to end delay, energy consumption and network life time using QualNet 5.0 Simulator. The result shows that neither of the protocol is best in all situations. For some parameters one outperforms the other and vice-versa for some other parameters.**

Keywords: **MANET, AODV, ZRP, DYMO, OLSR, RIP, QualNet 5.0**

I. Introduction

A Mobile Ad Hoc Network consists of self organized mobile nodes that form a temporary network. MANET doesn't have any centralized control. In ad-hoc network topology, often, nodes enter and leave the network continuously. Therefore, the topology in the Mobile Ad Hoc Network changes frequently[1]. In MANET the nodes which are in the radio range of each other communicate directly otherwise communication is done through intermediate nodes which are willing to forward message. Hence, Mobile Ad Hoc networks are also called as multi-hop networks. The frequent topology change in MANET is shown in fig. 1 in which node A has to send data to node B through the intermediate nodes via multi-hop wireless link.

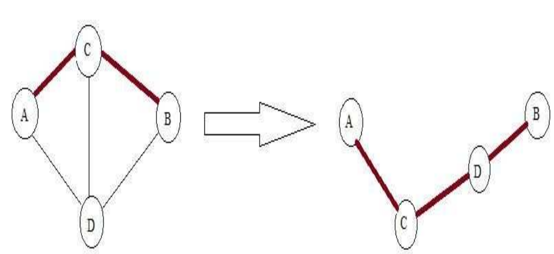

Fig1: Showing toplogy variation in MANET

The nodes in a MANET thus serve as packet source, packet sink as well as router. Nodes must route packets for other nodes to keep the network fully connected. The various features of MANET includes: 1) randomly changing Topologies 2) Energy constrained Operation, as nodes in ad hoc network run on batteries. In MANET, the energy optimization is an important issue.3) Limited Bandwidth: Since Wireless links have lower capacity than wired links, therefore the throughput of wireless communications –reduces due to fading and other interference. 4) Security: Mobile wireless networks generally have higher security risks than wired networks. MANET has its applications in the areas where it is not feasible to set up a wired connection and where infrastructure may not be present like in disaster area or battle field [2].

II. Routing Protocols

Routing protocol is defined as the set of rules which determines the route of message from source to destination in a network. In MANET, there are various routing protocols that are based on the procedure of route discovery. Fig 2 shows the various types of routing protocols:

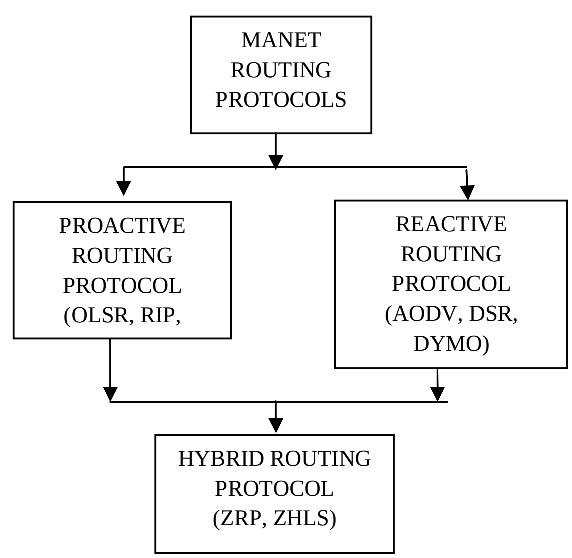

Fig2: Showing protocols in MANET

A. Proactive routing protocol:

These are table driven protocols .Each node in the network maintains a routing table that contain routing information to every other node. The routing table gets updated as the network topology changes. Hence, the nodes maintain consistent and updated view of the network by propagating update messages throughout the network. Proactive protocols are not suitable for a network containing large number of nodes as larger the number of nodes, larger will be the routing table entries.WRP, OLSR, DSDV, RIP, IGRP are various proactive routing protocols.

B. Reactive routing protocol:

These protocols are demand driven and are initiated by a source. The reactive routing protocol operates in two steps:

1) Route discovery
2) Route maintenance

In route discovery process, routes are discovered by the source node when demanded. Source node first checks its route cache for the available route from said source to the destination and if the route is not present it initiates route discovery process. The source node, in the packet, has the address of the destination and the neighboring nodes.

Since, the topology of MANET changes frequently; therefore, it is needed to maintain the broken links for successful communication. Route maintenance mechanism works on it and handles the route breaks [3].

C. Hybrid routing protocols:

These protocols use both proactive and reactive routing mechanism. Initially the network is established by proactive routing mechanism, then, the demand for additional nodes is served through reactive routing mechanism. Most of the hybrid routing protocols are based on zones which means nodes visualize network as portioned [4].

III. An Overview of Routing Protocols Used

A. AODV

The Ad hoc- on Demand distance vector (AODV) routing protocol provides unicast, multicast as well as broadcast wireless communication. The source node (node that wants to communicate) in AODV initiates route discovery. The route is required to maintain a path between source and destination. It follows route request. Whenever source wants to communicate, it sends data to an unknown destination by broadcasting RREQ (Route Request) packet. The nodes receiving RREQ, if not the destination, broadcasts this RREQ and also create reverse entry to the source in their routing table entry. If the intermediate node receiving RREQ is the destination, it sends back RREP [5].

The RREP packet is sent to the source hop-by hop. Each intermediate node receiving RREP packet creates a forward entry to the destination in its routing table. Once the RREP is received and route is discovered, source can start sending its data to the destination. In case if multiple RREPs are received, the node checks for minimum hop count or maximum sequence number.

As data flows from the source to the destination, intermediate nodes updates their routing table with current route information. If the nodes encounter broken links during transmission, the effected node sends RRER message to other nodes in the route and invalidates that route entry from its routing table. In case if source node again requires that route, it re-initiates the route discovery process.

B. ZRP

The Zone Protocol Routing uses hybrid approach for routing. It uses both Proactive and Reactive Protocol. The term zone used in this protocol defines as each node has a zone associated with it. Each node has it routing zones that are overlapping. Before sending the request, the source node checks whether the destination node is in its zone or not. This information is provided by Intra-zone Routing Protocol (IARP). ZRP uses reactive protocol if the destination is out of its zone. ZRP broadcast route requests throughout the network by flooding RREP. The routing in ZRP in done into two ways:

a) Intra zone routing: In this first packet is send from source to its peripheral node which is within its zone.

b) Inter zone routing: In this, packet is send from peripheral nodes towards destination node outside its zone.

Each node (say A) uses ZRP and sends a HELLO message to its neighbor (say **B**) and waits for its reply. If the neighbor does not reply then the node considers it (B) to be out of its zone. The zone notification message dies after k hops, i.e., after reaching the node´s neighbours at a distance of k hops. This message keeps on forwarding until the hop count reduces to zero. If the destination is within the routing zone of source, the routing is completed in the intrazone routing phase. Otherwise, source sends the packet to the peripheral nodes of its zone through bordercasting to reach the packets to its destination. Like in other protocols, each node maintains its routing table by updating itself with route information[4,10].

C. RIP:

Routing Information protocol is the standardized distance vector protocol .In this protocol the router used to exchange information with its adjacent routers. The router using RIP send out its routing table contents to it adjacent router in every 30 seconds using typical distance vector rules.When the router recieves routing updates about some changes in routing table or new entries, it update its routing table to reflect the change or new route.In the routing table destination, next hop to destination and metric is present[6].The metric indicates number of hops to the destination. A hop count is used to measures the distance between the source and a destination . Each hop is assigned from source to destination with metric value,usually with 1. RIP routers maintain only the best route to a destination.Router calculates its path whenever it detects a link failure or route failure. Each router received a routing update message whichh includes an update to its tables and then transfer the change to others.

D. DYMO

The Dynamic MANET On-demand DYMO is sucessor of AODV. Its operation is similar to AODV,it doesnot add any new features but rather simplifies it. The basic

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operations of Dynamic MANET On demand source router generates Route Request (RREQ) messages and floods these meassages throughout the network for destination routers for whom it doesn't have route information. The RREQ initially contains the address of theoriginator and target destination.

The routing information is stored by intermediate nodes store to the originating router by adding them into its routing table . Each entry in the routing table consists of the fields such as:Destination address , sequence number, hop count,next hop address, next hop interface, Timeout. The target node when received the RREQ,it responds by sending Route Reply (RREP) message. RREP is sent by unicast technique to the source. The intermediate nodes who received the RREP creates a route to the target and ulimately it reaches to originator[3,6].

The Routes between source and destination is established in both directions. When RREQ is sent by the source, the source node will wait upon the the reception of an RREP message from the target node. If no RREP is received within RREQ Wait time, the node then search for another route by issuing another RREQ. A Route Error (RERR) message is generated by a node whenever it receives a data packet from the destination for which route is not known or for which the link is broken. The released RRER messages notifies other nodes about the link failure. The source node again initiates the route discovery quickly as it receives RERR . The order of route discovery is determined by sequence numbers used by nodes and avoid the propagation of stale route information[11].

E.. OLSR

The Optimized Link State Routing protocol is a proactive routing protocol and also known as link state protocol. "OLSR" uses two kinds of control packets: "hello" packets and "TC" packets."Hello" packets are used to compute the multipoint relays of a node. The meaning of multipoint realys is to avoid the flooding of packets by minimizing the retransmission in the same region. "Hello" packets are broadcasts in one hop. A "hello" sent by a packet contains the list of nodes in its neighbourhood. "TC" packets are broadcasted by source node in the whole network. "TC" packets broadcasted by a node contain the list of its neighbors[9].

OLSR performs routing only hop by hop . A node uses its information which it received recently to route the packets to its destination. How nodes communicate via hello messages is described as;when a node A receives a hello packet from a neighbor node B, this node sets in its neighbour table node A with a status "Asymmetric". When node B send its next hello packet, B will send in its hello packet that node A is his neighbour and update table with status "Asymmetric". On the reception of hello packet from B, A will update its neighbour table B with the status "Symmetric". A will then send a hello packet in which B will appear with the status "Symmetric" and B will update the status of A in its neighbour table and will register it as "Asymmetric"[7,9].

IV. Simulation Architecture

The objective of this work is to simulate and analyze the performance evaluation of various routing protocols such as AODV, DYMO, ZRP, RIP, OLSR etc using QualNet 5.0 simulator. Through simulation it is possible to scale the networks easily and hence eliminate the need for time consuming and costly real world experiments. The performance analysis of the various protocols is done on the basis of various parameters such as Jitter, end to end delay, energy consumed, network life time, throughput. The architecture design is shown below in the figure:

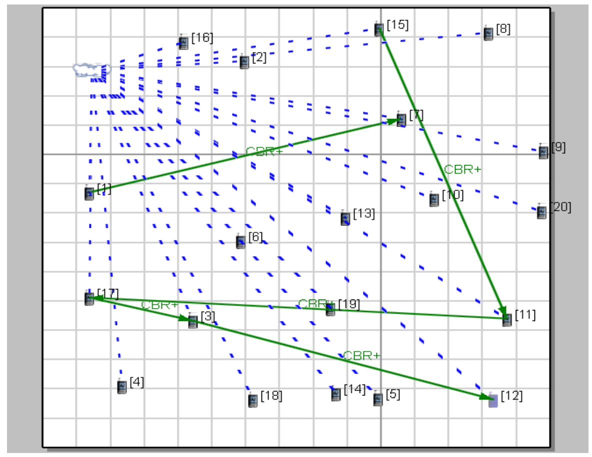

Fig 3: Design scenario

Here, Ad Hoc network is formed by considering one cloud and 20 nodes distributed at random positions in 1500 x 1500 unit area. The wireless link is connecting nodes and the cloud. CBR connections are provided between nodes as shown .The simulation time is set at 300 seconds. The working model of the scenario so formed by taking ZRP protocol as an example is shown in the figure below:

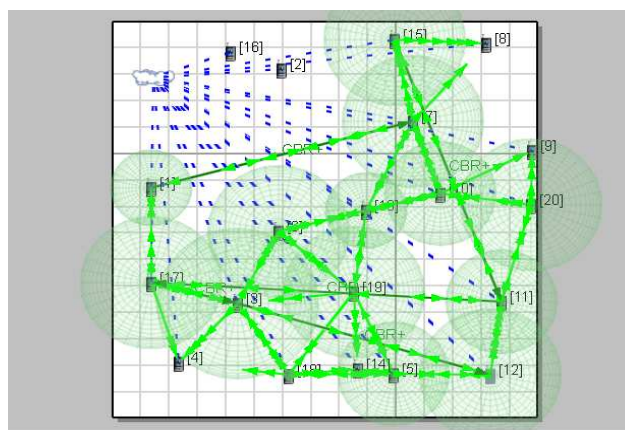

Fig 4: ZRP animation scenario

Table V. Simulation Parameters*:*

Parameters	Value
Physical layer protocol	802.11b
Routing protocol	AODV, ZRP,DYMO,RIP,OLSR
Energy model	Mica Motes
Battery power	Linear
Area	1500x1500

Channel frequency	2.4GHz
Antenna model	Omni directional
Fading model	None
Shadowing model	Constant
MAC protocol	802.11
Maximum no. of packets	2048
Minimum no. of packets	512

VI. Simulation Result Analysis of AODV, ZRP, RIP, OLSR, WRP Protocols

A. Average Jitter:

Jitter is defined as a variation in the delay of received packets. The sending side transmits packets in a continuous stream and spaces them evenly apart. Because of network congestion, improper queuing, or configuration errors, the delay between packets can vary instead of remaining constant, as shown in the figure. This variation causes problems for audio playback at the receiving end. Playback may experience gaps while waiting for the arrival of variable delayed packets.

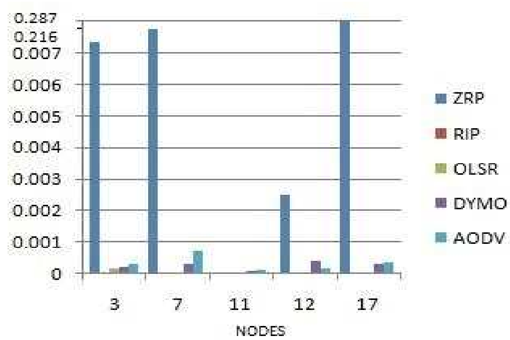

Fig 5: Comparison of average Jitter

Analysis: As it can be analyzed from the fig. that average jitter for RIP is low than other protocols.

B. Average End-To-End Delay:

It is the average time taken by the packet to reach the destination. It also includes the delay in the route discovery process and the queue in the data transmission process.

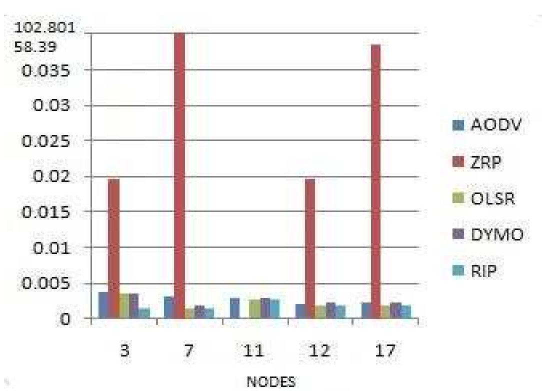

Fig 6: Comparison of average end to end delay

Analysis: As shown in the fig. ZRP has highest average end-to-end delay.

C. Throughput:

It refers to how much data can be transferred from one location to another in a given amount of time. It is the ratio of data received to data demanded.

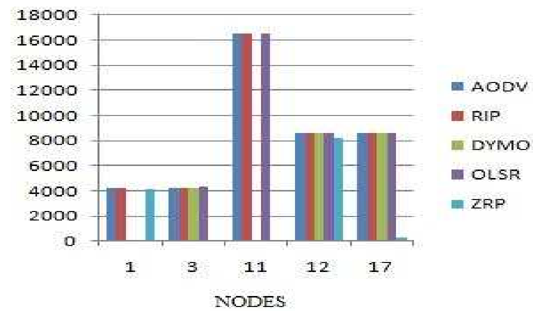

Fig 7: Comparison of throughput on server nodes.

Analysis: It can be analyzed from the graph that AODV, OLSR and DYMO have comparable throughput where as RIP has slightly highest.

D. Energy Consumption:

In MANETS, energy consumption is an important issue as mobile nodes operate on limited battery resources. Here energy consumption in both transmits and received mode is compared.

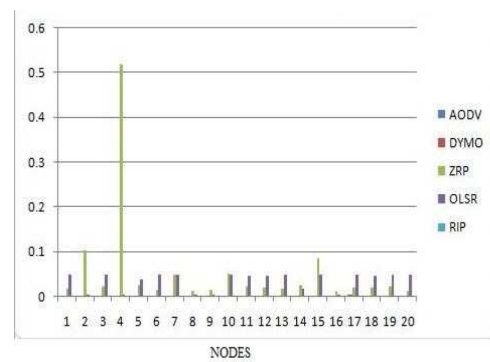

Fig 8: Energy consumption by nodes in transmit mode

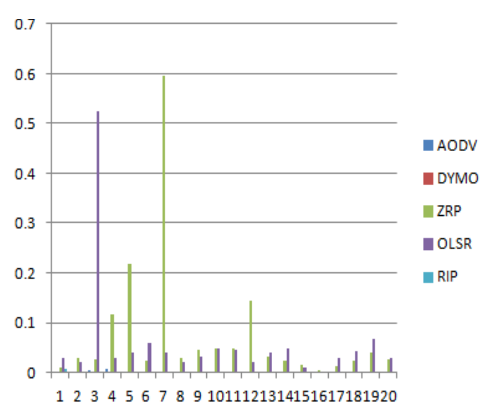

Fig 9: Energy consumption in received mode.

Analysis: ZRP is having high energy consumption at both transmit and receive mode; hence it is not suitable for low battery resources.

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E. Network Life Time:

It is the amount of time for which a wireless sensor network would be fully operative.

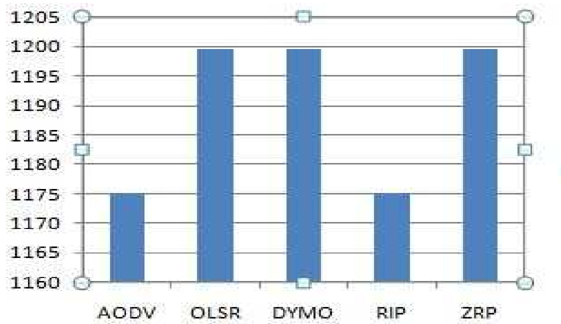

Fig 10: Network Life Time using different protocols.

Analysis: OLSR has the maximum Network Lifetime.

Table VI. Comparison of Parameters in MANET Using Different Protocols:

Protocols	AODV	DYMO	OLSR	RIP	ZRP
End To End Delay	Medium	Medium	Medium	Low	High
Energy Consumed In Reception	Low	Low	Less than ZRP	Low	High
Jitter	Medium	Low	Low	Lowest	High
Throughput	High	High	High	High	Low
Energy consumed in transmission	Low	Low	Less than ZRP	Low	High
Network Life Time	Medium	Medium	High	Medium	Medium

VII. Conclusions

This paper enlightens the performance of various proactive, reactive, and hybrid routing protocols like AODV, DYMO, OLSR, RIP and ZRP in MANET. We have analyzed the performance of these routing protocols on the basis of Performance Matrices Average Jitters, Average End to End delay(s), Throughput (bits/s) , Energy consumed in transmit and receive mode , and Network Life Time using Qualnet 5.0 network simulator. These performances taken according to apply constant bit rate (CBR) of nodes from source to destination. All the CBRs have starting time 1 sec from source and 25 sec end time from the destination nodes. The simulation time of the scenarios of all protocols is set at 300sec to complete of the process. From the result it can be observed that RIP is suitable for applications where Jitter and Throughput are critical parameters. It can also be observed that ZRP is not suitable in applications having limited energy sources.ZRP and DYMO have highest Network Life Time. AODV, DYMO and OLSR provide comparable results in terms of throughput and average end-to-end delay. Hence, to conclude any single protocol is not good in all scenarios, it depends on the required parameters.

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