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Performance Analysis of DYMO, LANMAR, STAR Routing Protocols for Grid Placement model with varying Network Size

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Abstract

A Mobile Ad hoc networks (MANETs) are self organized wireless networks which are able to connect on a wireless medium without the use of a infrastructure or any centralized administration. Due to the absence of infrastructure, nodes may move frequently and the topology may change dynamically. The mobile nodes perform both as a host and a router forwarding packets to other nodes. Routing in these networks is highly complex. Due to moving nodes, many routing protocols have been developed. Performance of each protocol is depending on their working in different conditions. In this paper a detailed simulation based performance analysis is performed on the mobile ad hoc routing protocols-Dynamic MANET on-demand (DYMO), Landmark Ad hoc routing (LANMAR), Source Tree Adaptive routing (STAR) in Grid placement model with varying network size using QualNet 5.0.1 simulator.

1. Introduction

A mobile ad-hoc network (MANET) is a collection of nodes, which have the possibility to connect on a wireless medium and form an arbitrary and dynamic network with wireless links. That means that links between nodes can change during time, new nodes can join the network, and the other nodes can leave the network [1]. Mobile Ad-hoc networks are self-organizing and self-configuring multihop wireless networks where, the structure of the network changes dynamically. This is mainly due to the mobility of the nodes. Nodes in these networks utilize the same random access wireless channel, cooperating in a friendly manner to engaging themselves in multihop forwarding. The nodes in the network not only act as hosts but also as routers that route data to/from other nodes in network [3]. The applications of the adhoc network are vast. It is used in areas of Sensor networks for environmental monitoring, Rescue operation in remote areas, Remote construction sites, and Personal area Networking, Emergency operations, Military environments, Civilian environments.

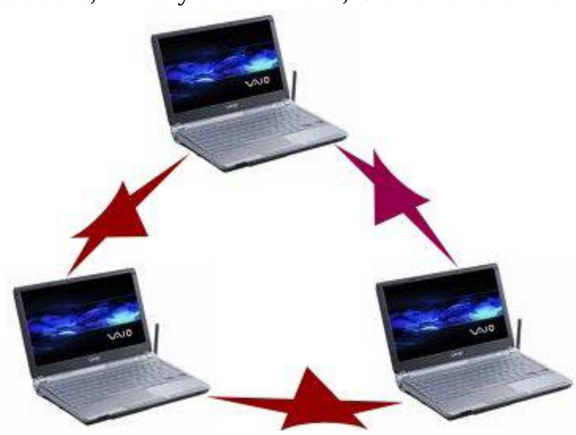

Figure 1:- Ad-hoc network

A key issue in MANETs [13] is the necessity that the routing protocols must be able to respond rapidly to topological changes in the network. At the same time, due to the limited bandwidth available through mobile radio interfaces, it is imperative that the amount of control traffic, generated by the routing protocols is kept at a minimum. The traditional routing mechanisms and protocols of wired network are inapplicable to Ad hoc network, thus the need to use a dynamic routing mechanism in Ad hoc networks [4].

The rest of this paper is organized as follows. Section 2 briefly describes the Ad-hoc routing protocols. Section 3 discuss Grid placement model. Section 4 presents Simulation environment. Section 5 gives Result and analysis. Section 6 presents Conclusion and Future work. Section 7 References.

2. Ad-hoc routing protocols

Ad-hoc routing protocols can be divided into three categories, Proactive (Table driven) routing protocol, Reactive (On demand) routing protocol and Hybrid routing protocol. Figure 2 shown Classification of Ad-hoc routing protocol.

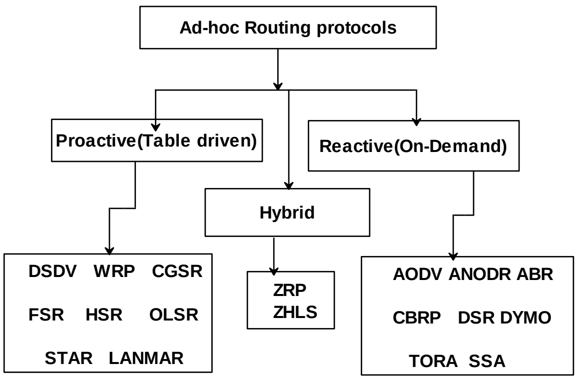

Figure 2:- Classification of Ad-hoc routing protocol

2.1. Proactive (table driven) routing protocols

Proactive routing protocols maintain information continuously. Typically, a node has a table containing information on how to reach every other node and the algorithm tries to keep this table up-to-date. Change in network topology are propagated throughput the network [5].

2.2. Reactive (on demand) routing protocols

On demand protocols use two different operations to Route discovery and Route maintenance operation. In this routing information is acquired on-demand. This is the route discovery operation. Route maintenance is the process of responding to change in topology that happen after a route has initially been created [5].

2.3. Hybrid routing protocols

Hybrid routing protocols are a new generation of protocol, which are both are Proactive and Reactive in nature. Most hybrid protocols proposed to date are zone based, which means that the network is partitioned or seen as a number of zones by each node. Normally, Hybrid routing protocols for MANETs exploit hierarchical network architectures.

2.4. Dynamic manet on-demand (dymo)

The Dynamic MANET On-Demand (DYMO) protocol [14] is a simple and fast routing protocol for multihop networks. It discovers unicast routes among DYMO routers within the network in an on-demand fashion, offering improved convergence in dynamic topologies. To ensure the correctness of this protocol, digital signatures and hash chains are used [6]. The basic operations of the DYMO protocol are route discovery and route management. The following sections explain these mechanisms in more details [3].

2.4.1. Route discovery process

When a source needs to send a data packet, it sends an RREQ to discover a route to that particular destination shown in figure 3. After issuing an RREQ, the origin DYMO router waits for a route to be discovered. If a route is not obtained within RREQ waiting time, it may again try to discover a route by issuing another RREQ. To reduce congestion in a network, repeated attempts at route discovery for a particular target node should utilize an exponential backoff . Data packets awaiting a route should be buffered by the source's DYMO router. This buffer should have a fixed limited size and older data packets should be discarded first. Buffering of data packets can have both positive and negative effects, and therefore buffer settings should be administratively configurable or intelligently controlled. If a route discovery has been attempted maximum times without receiving a route to the target node, all data packets intended for the corresponding target node are dropped from the buffer and a Destination Unreachable ICMP message is delivered to the source [3].

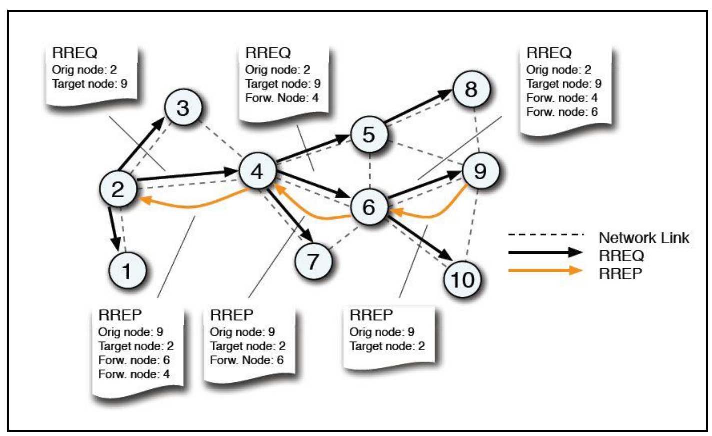

Figure 3:- DYMO Route discovery

2.4.2. Route maintenance

When a data packet is to be forwarded and it can not be delivered to the next-hop because no forwarding route for the IP Destination Address exists, an RERR is issued shown in figure 4. Based on this condition, an ICMP Destination Unreachable message must not be generated unless this router is responsible for the IP Destination Address and that IP Destination Address is known to be unreachable. Moreover, an RERR should be issued after detecting a broken link of a forwarding route and quickly notify DYMO routers that a link break occurred and that certain routes are no longer available. If the route with the broken link has not been used recently, the RERR should not be generated.

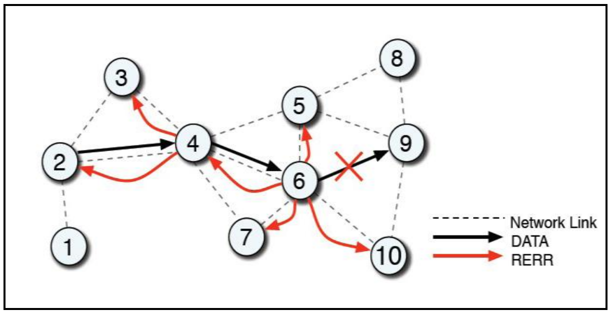

Figure4:-Generation and dissemination of RERR messages

2.5. Landmark ad-hoc routing (lanmar)

This protocol combines properties of link state and distance vector algorithm and builds subnets of groups of nodes which are likely to move together [15]. A Landmark node is elected in each subnet, similar to FSR. The key difference between FSR protocol is that LANMAR routing table consist of only the nodes within the scope and landmark nodes whereas FSR contains the entire nodes in the network its table. During the packet forwarding process, the destination is checked to see if it is within the forwarding node's neighbor scope. If so, the packet is directly forwarded to the address obtained from the routing table. On the other hand, if the packet's destination node is much farther. The packet is first routed to its nearest landmark node. As the packet gets closer to its destination, it acquires more accurate routing information, thus in some cases it may bypass the landmark node and routed directly to its destination. The link state update process is again similar to the FSR protocol. Nodes exchange topology updates with their one-hop neighbors. A distance vector, which is calculated based on the number of landmarks,is added to each update packet. As a result of this process, the routing tables entries with smaller sequence numbers are replaced with larger ones[6].

2.6. Source tree adaptive Routing (star)

The STAR [16] protocol is based on the link state algorithm. Each router maintains a source tree, which is a set of links containing the preferred paths to destinations. This protocol has significantly reduced the amount of routing overhead disseminated into the network by using a Least overhead routing approach (LORA) to exchange routing information. It also supports Optimum routing approach (ORA) if required. This approach eliminated the periodic updating procedure present in the Link State algorithm by making update dissemination conditional. As a result the Link State updates are exchanged only when certain event occurs. Therefore STAR will scale well in large network since it has significantly reduced the bandwidth consumption for the routing updates while at the same time reducing latency by using predetermined routes. However, this protocol may have significant memory and processing overheads in large and highly mobile networks, because each node is required to maintain a partial topology graph of the network (it is determined from the source tree reported by its neighbors), which change frequently may as the neighbors keep reporting different source trees[7].

3. Grid placement model

The Grid can be viewed as a distributed, high performance computing and data handling infrastructure, that incorporates geographically and organizationally dispersed, heterogeneous resources and provides common interfaces for all these resources, using standard, open, general purpose protocol and interfaces[8].

In Grid placement model the mobile nodes are placed as shown in the Figure 5.

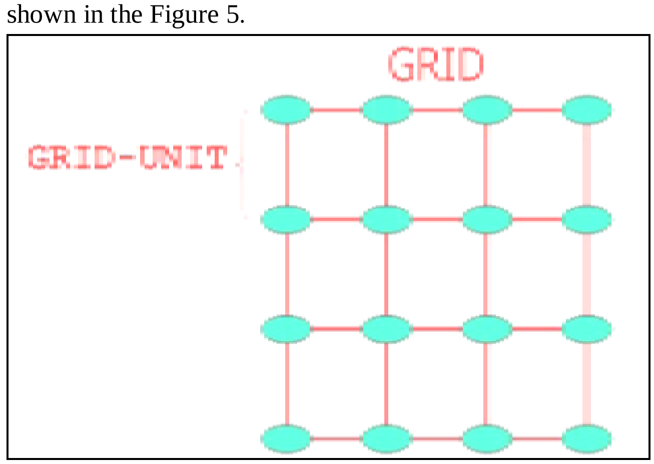

Figure 5:- Grid Placement Model

Node placement starts at (0, 0) and the nodes are placed in a Grid format with each node a GRID-UNIT away from its neighbor [10].GRID-UNIT must be specified numerically, with the unit in meters or degrees, depending on the value of COORDINATE-SYSTEM [1].

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4. Simulation environments

Simulation is done using QualNet5.0.1 simulator. Constant bit rate (CBR) traffic sources are used. The source-destination pairs are spread random waypoint model in a rectangular field with 1500m × 1500m field whereas network size is varied as 20,40,60,80,100,120 and 140 nodes. The pause time, which affects the Relative speeds of the mobile hosts, is kept constant at 30s.Maximum speeds varied at 0-10m/s. Simulation are run for 100 simulated seconds. We studied the performance of DYMO, LANMAR and STAR protocols. The performance metrics that we evaluated are Average Jitter, Average End to End Delay, Throughput and Packet Delivery Ratio.

Table1: Parameter Values

Parameters	Values
Terrain Range	1500m×1500m
Traffic type	CBR
No. of Nodes	20,40,60,80,100,120 and 140
Mobility Model	Random Way Point with 30s pause time
Simulation Time	100s

4.1. Performance metrics

(4.1.1) Average jitter : Average Jitter [11] is the variation (difference) of the inter-arrival times between the two successive packets received.

(4.1.2)Average end to end delay: Average End to End Delay [11]can be defined as a measure of average time taken to transmit each packets of data from Source node to Destination node.

(4.1.3)Throughput: Throughput [11] is the measure of the number of packets successfully transmitted to their final destination per unit time.

(4.1.4) Packet delivery ratio (pdr) : Packet Delivery Ratio [12] is defined as the ratio of the number of data packets successfully delivered to those generated by the source.

Packet Delivery Ratio = (Received packets/Sent Packets)*100

5. Results and analysis

5.1. Average jitter

As can be observed from figure 6, the Average Jitter is very less in STAR. In DYMO it is less at less number of nodes and is more at high number of nodes. In LANMAR the Average Jitter is less at less network size but increases with higher network size.

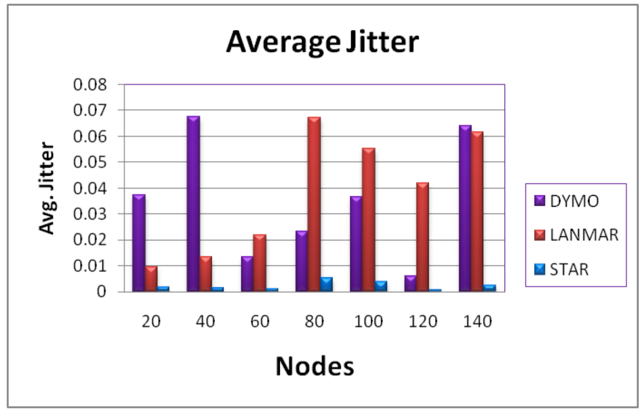

Figure 6:- Variation of Average Jitter

5.2. Average end to end delay

As can be observed from Figure 6, Average End to End Delay is less in STAR. In DYMO average end to end delay slowly increases with network size. LANMAR showing highest average end to end delay in Grid placement and increases with network size.

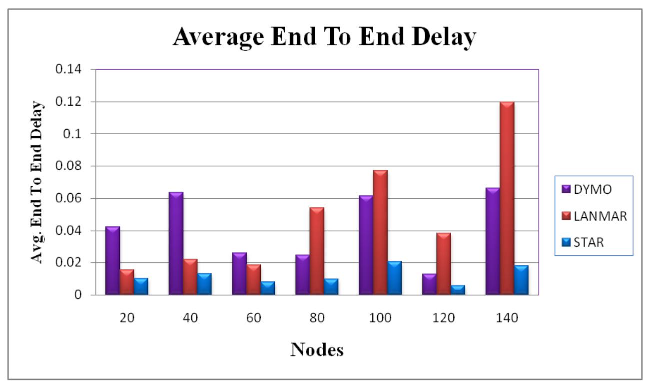

Figure 7:- Average End to End Delay

5.3. Throughput

As can be observed from Figure 8, At network size of 100, Throughput is more in DYMO where STAR and LANMAR performing poorly. But at network size of more than 100 DYMO and STAR are performing well compared to LANMAR. Overall Throughput in DYMO protocol for all network size is high compared to LANMAR and STAR.

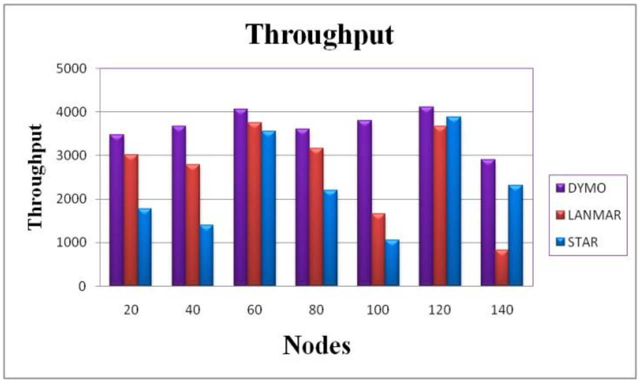

Figure 8:- Throughput

5.4. Packet delivery ratio (pdr)

As can be observed from Figure 9, Packet Delivery Ratio is more in DYMO and LANMAR compared to STAR protocol with network size is less(below 80 nodes). But at network size more than 80 nodes LANMAR performing poorly. Packet Delivery Ratio in LANMAR protocol is high with less network size but les with high network size. PDR is almost same as network size of 120 nodes. Overall DYMO performing well compared to STAR and LANMAR protocol.

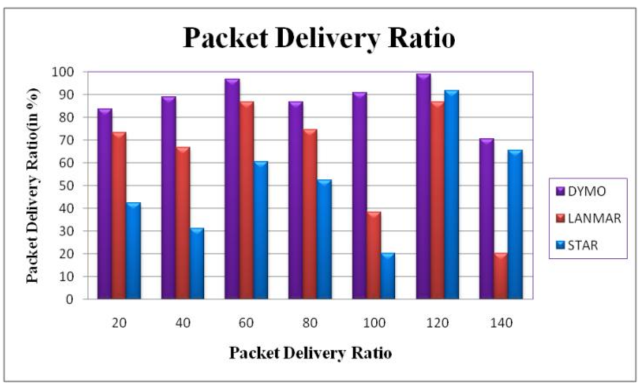

Figure 9:- Packet Delivery Ratio

6. Conclusion and future work

In our simulation, the performance of DYMO, LANMAR, and STAR in Grid placement model is evaluated for different network sizes, using QualNet5.0.1 simulator. From different analysis of graph and simulation, we can conclude that DYMO protocol in Grid placement is giving higher throughput and packet delivery ratio when STAR protocol is giving less Average End to End Delay and Average Jitter.

In future this method of research can be extended to other Proactive and Reactive routing protocols such as DSDV, WRP, CGSR, FSR, OLSR, ZRP, ABR, TORA, SSA,RDMAR and LAR1. We can also extend this research to other placement model such as Uniform and Random.

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