Performance Comparison of Wireless Mobile Ad-Hoc Networks on the basis of Various Simulation Parameters

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Abstract - There are new challenges for routing protocols in mobile ad hoc networks(MANET) since traditional routing protocols may not be suitable for MANETs. As such, some assumptions used by these protocols are not valid in MANETs or some protocols cannot efficiently handle topology changes. The Efficient routing protocols can provide significant benefits to mobile ad hoc networks, in terms of both performance and reliability. The most popular Routing protocols are Optimized Link State Protocol (OLSR) Dynamic MANET On-demand (DYMO), Location-Aided Routing (LAR), Landmark Ad-hoc Routing Protocol (LANMAR). Despite the popularity of those protocols, research efforts have not focused much in evaluating their performance when applied to variable bit rate (VBR). In this paper we present our observations regarding the performance comparison of the above protocols in terms of packet delivery, throughput, jitter and end-to-end delay in mobile ad hoc networks. Additional analysis of other proposed protocols WRP, GPSR and FSR.

I. Introduction

Mobile ad hoc networks are a fundamental element of pervasive networks and therefore, of pervasive systems that truly support pervasive computing, where users can communicate anywhere, anytime and on-the-fly. In fact, future advances in pervasive computing rely on advancements in mobile communication, which includes both infrastructure-based wireless networks and non-infrastructure based MANETs. The traditional infrastructure-based wireless networks and non-infrastructure-based MANETs. The traditional infrastructure-based communication model is not adequate for today's user requirements. In many situations the communication between mobile hosts cannot rely on any fixed infrastructure. MANET is characterized as "the art of networking without a network". The network topology of such a system is changeable and unpredictable; therefore, the traditional wireless routing protocols are not application for these networks. The special features of a MANET bring about great opportunities together with severe challenges. Due to their highly dynamic topology, the absence of an established infrastructure for centralized administration, bandwidth constrained wireless links, and limited resources, MANET's are hard to design in terms of efficient and reliable routing.

II. Wireless Ad Hoc Routing Protocols

In this section it describes the protocols that are investigated. Since the advent of Defense Advanced Research Projects Agency (DARPA) packet radio networks in the early 1970s, numerous protocols have been developed for ad hoc mobile networks. Such protocols must deal with the typical limitations of these networks, which include high power consumption, low bandwidth, and high error rates, these routing protocols may generally be categorized as OLSR, DYMO, LAR, LANMAR Protocol.

2.1 Optimized Link State Protocol (OLSR)

Optimized Link State Protocol (OLSR) is a proactive routing protocol that employs an efficient link state packet forwarding mechanism called multipoint relaying. This protocol optimizes the pure link state routing protocol. Optimizations are done in two ways: By reducing the size of the control packets and by reducing the number of links that are used for forwarding the link state packets. The reduction in the size of link state packets is made by declaring only a subset of the links in the link state updates. These subsets of links or neighbors that are designed for link state updates and are assigned the responsibility of packet forwarding are called multipoint relays. The optimization by the use of multipoint relaying facilitates periodic link state updates. The link state update mechanism does not generate any other control packet when a link breaks or when a link is newly added. The link state update optimization achieves higher efficiency when operating in highly dense networks. Figure given below shows the number of messages transmissions required when the typical flooding-based approach is employed. In this case, the number of message transmissions in approximately equal to the number of nodes that constitute the network. The set consisting of nodes that are multipoint relays is referred to as MPRset. Each node (say, P) in the network selects an MPRset that processes and forwards every Link state packet that node P originates.

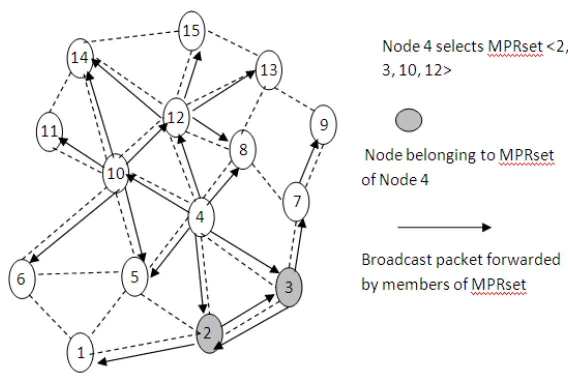


Figure 2.1: Flooding the network by nodes

2.1.1 Selection of Multipoint Relay Nodes

Figure 2.1 shows the forwarding of TC packets using the MPRset of node 4. In this example, node 4 selects the node 2, 3, 10, and 12 as members of its MPRset..

- $MPR(x) \leftarrow \phi$ /* Initializing empty MPRset */
- $MPR(x) \leftarrow$ { Those nodes that belong to $N_1(x)$ and which are the only neighbors of nodes in $N_2(x)$ }
- While there exists some node in $N_2(x)$ which is not covered by MPR(x)

  (a) For each node in $N_1(x)$, which is not in MPR(x), compute the maximum number of nodes that it cover among the uncovered nodes in the set $N_2(x)$.
  (b) Add to MPR(x) the node belonging to $N_1(x)$, for which this number is maximum.

A node updates its MPRset whenever it detects a new bidirectional link in its neighborhood or in its two-hop topology, or a bidirectional link gets broken in its neighborhood.

2.2 Dynamic MANET On-demand (DYMO)

The Dynamic MANET On-Demand (DYMO) protocol is a simple and fast routing protocol for multihop networks. It discovers unicast routes among DYMO routers within the Dynamic 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. The basic operations of the DYMO protocol are route discovery and route management. The following sections explain these mechanisms in more details. The basic operations of DYMO are:

- Route Discovery

- Route Maintenance

2.2.1 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. 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 back off. Data packets awaiting a route should be buffed 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.

2.2.1 Route maintenance

When a data packet is to be forwarded and it cannot be delivered to the next-hop because no forwarding route for the IP Destination Address exists, an RERR is issued shown in figure 2.2. 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.

The DYMO routing protocol is designed for memory constrained devices in mobile as hoc networks (MANETs) as it quickly determines route information dynamically.

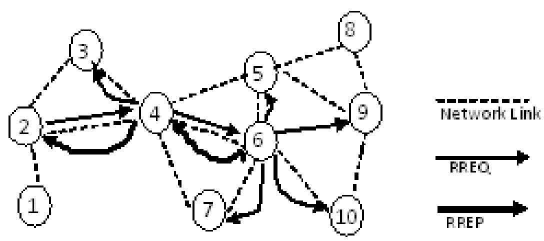


Figure 2.2: Generation and Dissemination of RERR message

2.3 Location-Aided Routing (LAR)

Location-Aided routing protocol (LAR) utilizes the location information for improving the efficiency of routing by reducing the control overhead. LAR assumes the availability of the global positioning system (GPS) for obtaining the geographical position information necessary for routing. LAR designates two geographical regions for selective forwarding of control packets, namely, ExpectedZone and RequestZone. The ExpectedZone is the region in which the destination node is expected to be present, given information regarding its location in the past and its mobility information. In the event of non-availability of past information about the destination, the entire network is considered to be ExpectedZone of the destination. Similarly, with the availability of more information about its mobility, the ExpectedZone of the destination can be determined with more accuracy and improved efficiency. The RequestZone is a geographical region within which the path-finding are forward control packets are permitted to be propagated. This area is determined by the sender of the data transfer session. The nodes decide to forward or discard the control packets based on two algorithms, named LAR1 and LAR2 [1].

In the LAR1 algorithm, the source node (say, S) explicitly specifies the RequestZone in the RouteRequest packet. As per LAR1, as illustrated in Figure above, the RequestZone is the smallest rectangle that includes the source node (S) and the ExpectedZone, the sides of which are parallel to X and Y axes, when the node S is outside the ExpectedZone. When node S is within the ExpectedZone, then the RequestZone is reduced to the ExpectedZone itself. Every intermediate node that receives the RouteRequest packet verifies the RequestZone information contained in the packet and forwards it further if the node is within the RequestZone, otherwise, the packet is discarded.

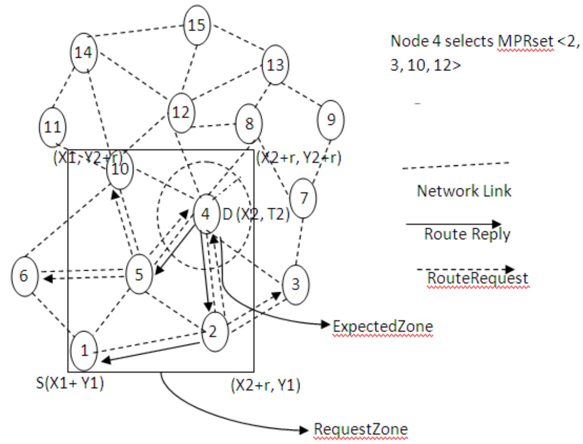


Figure 2.3: RequestZone and ExpectedZone in LAR

2.4 Landmark Ad-hoc Routing Protocol (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. A Landmark node is elected in each subnet, similar to FSR. The key difference between FSR protocols is that LANMAR routing table consists 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's 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 table's entries with smaller sequence numbers are replaced with larger ones.

III. Simulation Environment

The Network simulator used is Qualnet v 5.0 and the simulation parameters are as shown in Table 3.1. It consists of total number of nodes as 40, the Terrain area chosen is 1500 X 1500 the Constant Bit Rate of packet size is 12288, the Simulation time chosen over here is 30s, the mobility is Random way point, most widely used network simulator and freely downloadable. Further increase in these values increases the time taken for completing simulation, to a limit which is not feasible due to various constraints. It shows the performance of various protocols such as OLSR, RIP, DYMO, LAR, LANMAR, and ZRP with respect to throughput, total packets received, Jitter, and End-to-End Delay.

Table 3.1: Simulation Parameters

Parameters	Values
Simulator	QualNet
Version	5.0
Protocols studied	OLSR, RIP, DYMO, LAR, LANMAR, and ZRP

Performance Matrices	PDR, Jitter, End to End Delay, Throughput, Hop Count.
Number of nodes	40 nodes
Simulation Time	30s
Simulation Ares	1500 X 1500
Traffic Load	1 CBR source
Mobility Model	File Mobility, Group Mobility, Random Waypoint Mobility
Energy Model	Mica-Motes
Traffic Type	Constant-Bit Rate
Packet Size	12288 Bytes
Node Placement Model	Random
Battery Model	Linear Model
Antenna Model	Omni direction

IV. Simulation Result and Observation

4.1 Simulation Result

4.1.1 QualNet Scenario Designer

QualNet Scenario Designer is a model setup tool that allows users to set up geographical distribution, physical connections, and the functional parameters of the network nodes. Using intuitive click and drag operations, the user can also define network layer protocols and traffic characteristics down to each node.

4.1.2 QualNet Animator

QualNet Animator offers in-depth visualization and analysis. As simulations are running, users can watch traffic flow through the network and view dynamic graphs of critical performance metrics. Users can also assign jobs to run in batch mode on a faster server and view the animated data later.

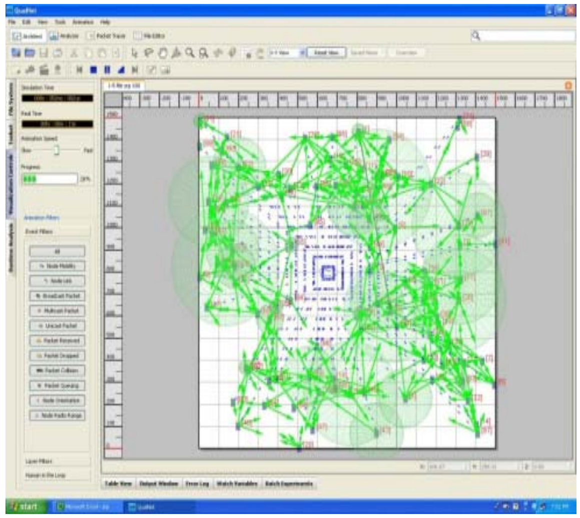


Figure 4.1: QualNet Animator

4.1.3 QualNet Protocol Designer

QualNet Protocol Designer allows users to create a protocol skeleton, plug it into the simulator, and then add it to the GUI for use with QualNet Scenario Designer and Animator. QualNet's protocol models are provided in source form C/C++, arming developers with a solid library on which to build new network functionality.

4.1.4 QualNet Analyzer

QualNet Analyzer is a statistical graphing tool that displays hundreds of metrics. Users can choose to see pre-designed reports or customize graphs with their own statistics.

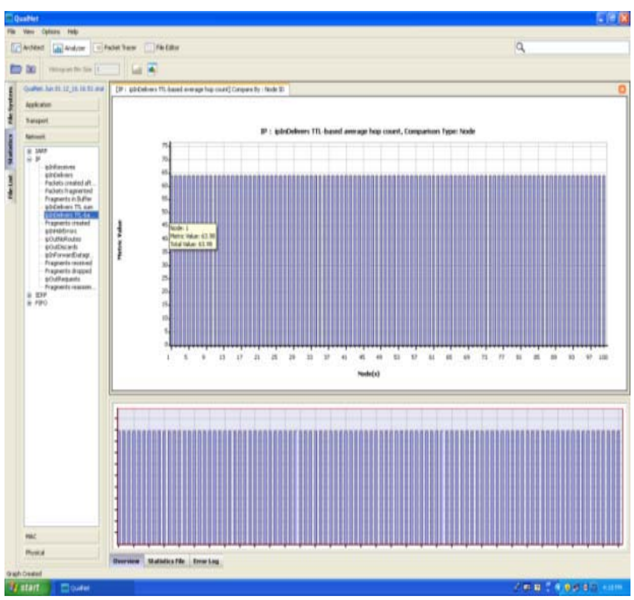
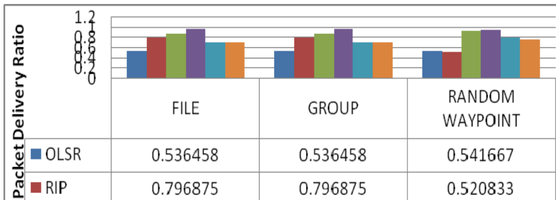


Figure 4.2: QualNet Analyzer

4.2 OBSERVATION

4.2.1 Packet Delivery Ratio

Figure 4.3 shows on-demand routing protocols DYMO and LAR give the highest packet delivery ratio. They are constantly efficient for every mobility model. OLSR is least effective during all mobility models among all the routing protocols.

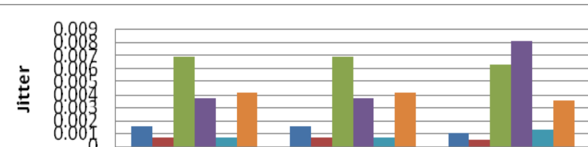


	FILE	GROUP	RANDOM WAYPOINT
OLSR	0.536458	0.536458	0.541667
RIP	0.796875	0.796875	0.520833
DYMO	0.885417	0.885417	0.927083
LAR	0.979167	0.979167	0.953125
LANMAR	0.703125	0.703125	0.802083
ZRP	0.697917	0.697917	0.760417

Figure 4.12: Packet Delivery Ratio Vs Mobility Model

4.2.1.1 Average Jitter

DYMO shows the consistent and worst jitter in effect of all mobility models. LAR's performance degrade at random way point mobility model. RIP shows the minimum jitter and is most efficient protocol. OLSR and LANMAR also perform well and shows minimal amount of jitter. ZRP shows consistent average amount of jitter in effect of all mobility models



	FILE MOBILITY	GROUP MOBILITY	RANDOM WAYPOINT MOBILITY
OLSR	0.001571016	0.001571016	0.001061344
RIP	0.000635662	0.000635662	0.000470926
DYMO	0.006814079	0.006814079	0.006314173
LAR	0.003733734	0.003733734	0.008084512
LANMAR	0.000654067	0.000654067	0.001317213
ZRP	0.004139232	0.004139232	0.003521075

Figure 4.3: Jitter Vs Mobility Model

4.2.1.2 Average End-to-End Delay

DYMO gives the highest end to and delay at file and group mobility when decreases at random way point. However the LAR protocol shows an average amount of delay at file and group but increases with a greater amount at random way point. At RIP also value of delay decrease in effect of random way point as compare to file and group mobility. LANMAR gives the least value of delay at all mobility models. It is the most efficient protocol. OLSR and ZRP's efficiency is also good.

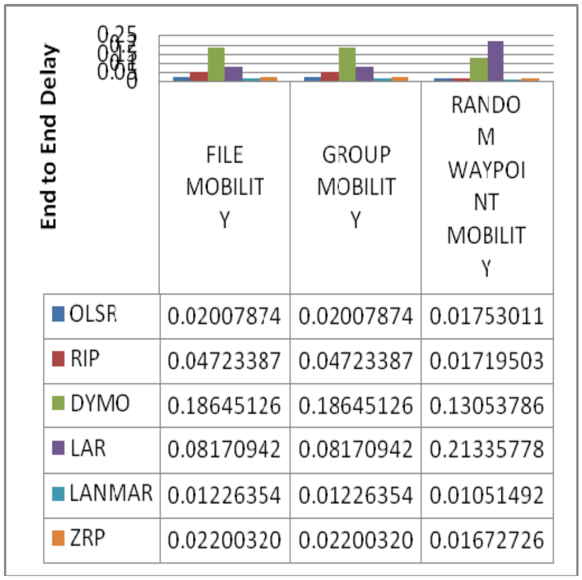


Figure 4.4: End-to-End delay Vs Mobility Model

4.2.1.3 Throughput

Throughput of RIP and LAR is highest at file and group mobility but at the random way point performance of RIP decreases whereas LAR remains constant.

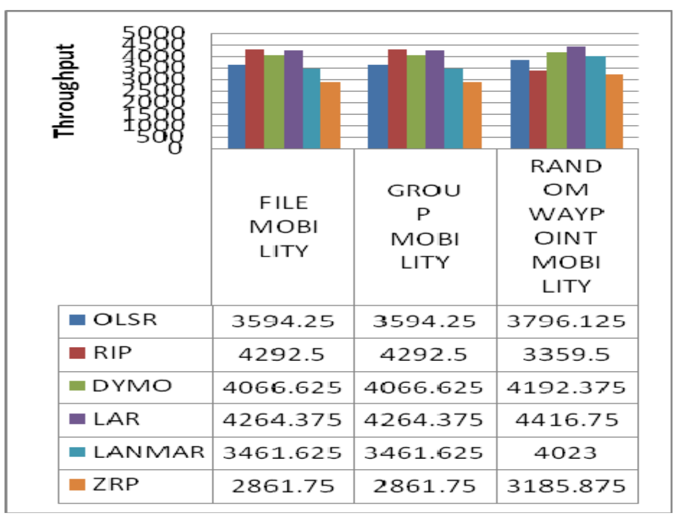


Figure 4.5: Throughput Vs Mobility Model

4.2.1.4 Observation Tables

Table 4.1: Performance for varying mobility model

	OLSR	DYMO	LAR	LANMAR
Packet Delivery Ratio	Worst	Best small difference with LAR	Most efficient Constantly high	Good

Jitter	Good	Worst Constantly High	God at file & group but higher at random way point	Most efficient
Delay	Constantly Good	Good	Most efficient	Good increases At random way point
Throughput	Constantly Good	Good	Most efficient	Good increases at random way point

V. CONCLUSION

In our simulation work performance compassion of different protocols is done. Comparison of different kind protocols proactive, reactive and hybrid is done and presented in the function of varying mobility model and network size. We have take six protocols under consideration proactive protocols: OLSR, RIP; Reactive protocols: DYMO, LAR; Hybrid Protocols: LANMAR, ZRP. As in the Mobile Ad Hoc Network devices are not fixed and they move their position very rapidly. The network topology in such a network keeps changing randomly. On the other hand Scalability is a very important factor for mobile ad-hoc network, as it determines if a protocol will function or fail when the number of mobile users increases. We used QualNet 5.0 Simulator, which is commercial and said to be faster than ns-2 for instance.It can be observed that reactive routing protocols are suited for application where average jitter and throughput are very critical, ZRP, LAR and OLSR being the location based protocol need sufficient time to establish route discovery and route maintenance hence for large range mobile applications they are best suited. OLSR is suited for large and dense mobile networks, where traffic is random and sporadic between several nodes rather than being almost exclusively between a small specified set of nodes.

VI. FUTURE WORK

The proposed work relates to incorporating the analysis and performance of routing protocols in the MANET environment using QualNet 5.0 .The proposed protocol was simulated on the computer system. The primary future scope of the proposed work can be to implement this protocol in real environment and to confirm the simulation results. The proposed protocol has been an extension to the conventional AODV protocol, the mobility model and other proposed strategies can also be incorporated in the other routing protocols such as DSR, TORA etc. While performing the experimental studies in the MATLAB environment. The work can be extended by studying the mobility modal with increasing no. of nodes in other routing protocols like as WRP, GPSR FSR, CGSR, ABR, and LANMAR. In the zone based routing, different mobility modal can be used within and outside the clusters. It is also possible to use only within cluster using any mobility computation.

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