OLSRv2 Implementation and Performance Evaluation over OLSRv1 in MANET using QualNet 6.1

Vikas Dahiya, Rohit Sangwan, Dr. Manoj Duhan, Kusum Dalal

Abstract— Mobile ad hoc networks (MANETs) consist of a collection of wireless mobile nodes which dynamically exchange data among themselves without the reliance on a fixed base station or a wired backbone network. All nodes are mobile and can be connected dynamically in an arbitrary manner. All the nodes of these networks behave as routers and take part in discovery and maintenance of routes to other nodes in the network. There are various protocols for handling the routing problem in the ad hoc wireless network environment. The OLSRv2 is being standardized in the IETF MANET working group. OLSR v2 uses the common packet format, which is also standardized in the MANET Working Group. In this paper, OLSR v2 and OLSR v1 details are introduced and then we have implemented the OLSR v2 protocol, which can run as a real-time protocol or in the QualNet 6.1 simulator. OLSR v2 performance is also compared with OLSR v1 for the same scenario. The performance is calculated in terms of metrics like throughput, packet delivery ratio, average jitter and average end to end delay.Don't use all caps for research paper title.

Index Terms— IETF, MANET, OLSRv1, OLSRv2, PDR, MPR, QualNet 6.1.

1 Introduction

The Mobile ad hoc network is one of the emerging trends in wireless communication. In conventional wireless communication [1] there is need of base station for communication between two nodes. Such base station leads to more infrastructure and more cost to communication network. Mobile ad hoc network facilitates communication between nodes without the support of any infrastructure. In general, MANETs are formed dynamically by an autonomous system of mobile nodes that are connected via wireless links without using any centralized administration. Mobile nodes that are within each other's radio range communicate directly via wireless links, while those are far apart rely on the other nodes to relay messages as routers. The nodes mobility in mobile ad hoc networks causes frequent changes of the network topology. The scopes of the ad-hoc network [2] are also associated with dynamic topology changes, bandwidth and energy constrained operation, broadcast nature of the wireless medium, limited wireless transmission range, mobility-induced packet losses and a variety of routing protocols.

The routing protocol, OLSR v1 [3] is being standardized in IETF (Internet Engineering Task Force) MANET working group. The aim of our research work is to analyze the behavior and performance of OLSRv2 [4] routing protocol (OLSRv2-NIIGATA) over OLSRv1-INRIA. The OLSRv2 performance is experimentally evaluated by using 80 nodes simulation scenario in QualNet 6.1 [5] simulator by using CBR connections in between the nodes. Section 2 gives an insight of OLSRv2 and OLSRv1 routing protocols used in this evaluation. In section 3, methodologies of simulation in QualNet 6.1 environment is introduced. In section 4, various performance metrics which have been considered to analyze the different routing protocols are defined and overall performance comparison analysis of OLSRv2 and OLSRv1 routing protocols demonstrated. Finally concluding remarks are given in the Section 5.

- *Vikas Dahiya and Rohit Sangwan are currently pursuing M.Tech. in Electronics and Communication Engineering in DCRUST, Murthal, Sonipat. E-mail: vikasdahiya@gmail.com, rohitsangwan235@gmail.com*
- *Dr. Manoj Duhan is the Chairman and Professor in ECE Deptt, Murthal, Sonipat. E-mail: duhan_manoj@rediffmail.com,*
- *Ms.Kusum Dalal is Asst.Professor in ECE Deptt, Murthal, Sonipat. E-mail: kusumdalal@gmail.com,*

2 Optimized Link State Routing

2.1 OLSRv1-INRIA

Optimized Link State Routing (OLSR) protocol[3], [6] developed by the French National Institute for Research in Computer Science and Control (INRIA), was developed for mobile ad-hoc networks. OLSRv1 operates in a table-driven and proactive manner, i.e. the topology information is exchanged in between the nodes on periodic basis. Its main aim is to minimize the control traffic by selecting a small number of nodes, called as Multi Point Relays (MPR) for flooding the topological information. For route calculation, the MPR nodes are utilized to form an optimal route from a given node to any destination node in the network. OLSRv1 is particularly suited for the large and dense networks. The OLSRv1 generally proposes four types of periodic control messages :

- Hello messages
- Topology Control (TC) messages
- Host and Network Association (HNA) messages and
- Multiple Interface Declaration (MID) messages.

Hello messages are periodically exchanged within the one-hop neighborhood to obtain the neighborhood information. By using this neighborhood information, each node in the ad hoc network selects a subset of one-hop away neighbors known as the MPR nodes set. In the MPR set, all two-hop away neighbors are reachable through any member of the MPR set. The topology control (TC) messages are generated and retransmitted for flooding the topological information in the whole network only through the MPR nodes. Also, HNA and MID messages are relayed only by MPR nodes. Hence, OLSRv1 optimizes the control traffic overhead by minimizing the size of the MPR nodes set. A MPR member generates and retransmits the topology control messages. Such messages provide each node in the network with sufficient link-state information to allow route calculation. The MID messages are generated by an OLSRv1 node with multiple OLSRv1 interfaces to notify other OLSRv1 nodes about its interfaces participating in the OLSRv1 routing domain. Apart from these OLSRv1 control messages, a node associated with OLSRv1 MANET and non-OLSRv1 MANET periodically issues Host and Network Association (HNA) messages notifying the connected non-OLSRv1 Networks. The HNA messages are also flooded throughout the OLSRv1 domain by the MPR nodes so that the external routes are learned by all of the OLSR nodes.

2.2 OLSRv2-NIIGATA

Optimized Link State Routing Protocol version 2 (OLSRv2) [4], [6] is an update to OLSRv1 as published in RFC3626. As compared to RFC3626, OLSRv2 protocol retains the same basic mechanisms and algorithm. It also provides an even more flexible and simplified signaling framework and formatting of the messages being exchanged. Also, OLSRv2 accommodates both the IPv4 and IPv6 addresses in a compact fashion.

OLSRv2 developed for mobile ad hoc networks, is a table driven, proactive protocol i.e. it exchanges the topology information with other nodes of the network regularly. Each of the node selects a set of its neighbor nodes as "Multi Point Relays" (MPRs). The nodes which are selected as MPRs are then forwards control traffic intended for diffusion into the entire ad hoc network. The Multi Point Relays (MPRs) provide an efficient mechanism for flooding control traffic by reducing the number of transmissions required. The nodes which acts as MPRs also have a special responsibility when declaring link state information in the network. The only requirement for OLSRv2 to provide the shortest path routes to all of the destinations is that MPR nodes declare link-state information for their MPR selectors. The additional available link-state information can be utilized further for redundancy. The nodes that have been selected as MPRs by some neighbor node(s) announces this information periodically in their control messages. So a node announces to the network that it has reachability to the nodes which have selected it as an MPR. Hence, as well as being used to facilitate efficient flooding, Multi Point Relays are also used for route calculation from any given node to any destination node in the network. A node selects MPRs from among its one hop neighbors having "symmetric", i.e., bi-directional linkages. So selecting routes through MPRs automatically avoids the problems associated with data packet transfer over unidirectional links . The OLSRv2 protocol is developed to work independently from other protocols. Likewise, OLSRv2 protocol makes no assumptions about the underlying link-layer. However, OLSRv2 may use its link-layer information and notifications as and when available and applicable. It mainly uses two basic types of control packets as stated below:

1) Hello Messages:

HELLO messages in OLSRv2 serve to:

- discover links to adjacent OLSR nodes
- advertise neighbors and hence discover 2-hop neighbors
- single MPR selection
- advertise own interfaces which participate in MANET
- perform bidirectional check on the discovered links

The HELLO messages are emitted regularly, thereby allowing nodes to continuously track changes in their local neighborhoods. The OLSRv2 protocol applies Neighborhood discovery protocol for HELLO messages to continuously update information repositories describing the node's 1-hop and 2-hop neighbors. The neighborhood discovery protocol using HELLO messages uses generic multi-message packet format in order to for carry MANET routing protocol signals.

2) TC messages (Topology Control messages) :

TC messages in OLSRv2 serves to:

- inject addresses of hosts and networks for which they may serve as a gateway to the entire network
- inject link-state information into the entire network
- it allow nodes with multiple interface addresses to ensure that nodes within two hops can associate these addresses with a single node for efficient MPR Set determination

The topology control (TC) messages are emitted regularly, thereby allowing nodes to continuously track global changes in the network. A topology control (TC) message must contain:

- a message TLV CONTENT_SEQUENCE_NUMBER
- a message TLV VALIDITY_TIME
- one or more address blocks along with the associated address block TLVs.

The first (mandatory) address block is a Local Interface Block. Other (optional) address blocks contain 1-hop neighbor’s interface addresses and/or host or network addresses for which this node may act as a gateway. The purpose of OLSRv2 is to determine the Routing nodes set, which may be used to update IP's Routing Table and thereby providing "next hop" routing information for IP datagrams. In order to accomplish this, the OLSRv2 protocol uses a number of protocol sets:

- **Topology Information Base**: The topology information base stores the information required for the generation and processing of topology control (TC) messages.
- **Neighborhood Information Base :** The neighborhood information base stores the information about the links between local interfaces and interfaces on adjacent nodes.

3 Simulation Environment Set Up

3.1 QualNet 6.1

The simulator used in our paper is QualNet 6.1 [5], which is developed by Scalable Network Technologies, USA. The simulation is running based on discrete event scheduler i.e the simulation is not performed in a constant time flow. QualNet is implemented using a TCP/IP network model which is similar to layered architecture. QualNet is a high-fidelity modeling tool that can be used for wired and wireless networks of tens of thousands of nodes. The application layer takes place of traffic generation and application level routing. Numerous traffic generator models and application level routing protocols have been implemented in QualNet. It supports different Traffic generators like HTTP, MCBR, CBR, FTP, VoIP, TELNET, VBR etc. FTP (File Transfer Protocol) is generally used to simulate transferring files between server and client while CBR (Constant Bit Rate) is used for simulating fixed-rate uncompressed multimedia traffic.

3.2 DESIGNING OF SIMULATION SCENARIO

The network simulator used for network simulation is QualNet 6.1 and the simulation scenario is shown in fig. 1. It consists of total number of nodes as 100, the Terrain area chosen is 1500 m *1500 m, the Constant Bit Rate of packet size is 512 and the mobility is Random way point, most. It shows the performance of OLSR v2 and OLSR v1 with respect to application layer model. The nodes are connected via CBR connections. The various parameters considered for simulation scenario setup are listed in table 1

Table 1. Parameters considered for simulation set up

S.No.	Parameter	Value
1.	Simulator	QualNet Version 6.1
2.	Terrain Size	1500 x 1500 m²
3.	Antenna model	Omni-directional
4.	No of nodes	100
5.	Radio Type	802.11b
6.	Data size	512 bytes
7.	Data Rate	2Mbps
8.	Mobility Model	Random Way Point
9.	Channel Frequency	2.4 GHz
10.	Traffic Source	Constant Bit Rate
11.	Pause time	30s
12.	Nodes speed	Min.=2m/s, Max.=20m/s
13.	Position granularity	1.0
14.	Battery model type	Residual life Estimator
15.	Routing Protocols	OLSR v2 and OLSR v1
16.	Battery models	Duracell AA(MX-1500)

3.3 SNAPSHOT OF RUNNING SCENARIO

CBR is chosen over TCP because the protocol is much simpler which makes the results easier to analyze. Furthermore, it seems to be best practice to use CBR for ad hoc simulations. The traffic scenarios are generated randomly,. The objective of these simulations is to compare the standards of OLSR v2 and OLSR v1.

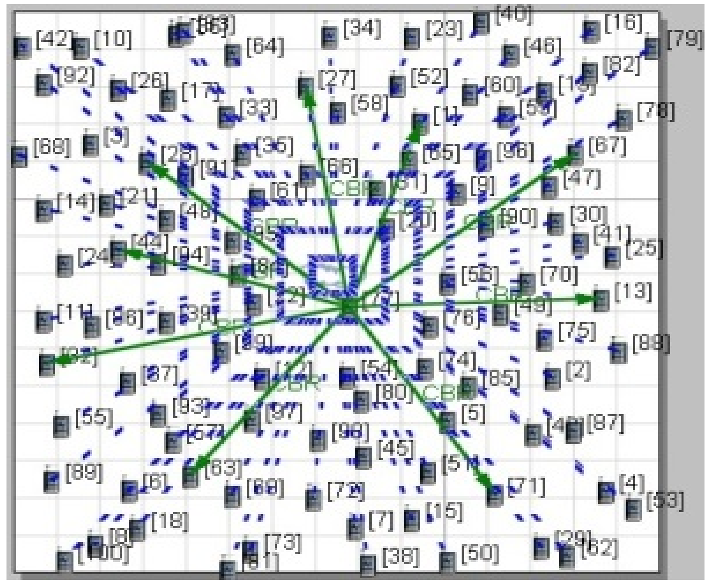

Figure 1. Snapshot of simulation scenario applying CBR between various nodes.

4 PERFORMANCE METRICS & SIMULATION RESULTS

There are several different metrics[7], [8] that can be applied to measure the ad hoc routing protocols performance. The following metrics are used for the performance evaluations of OLSR v2 and OLSR v1 protocols for mobile ad hoc networks:

1) Throughput (bits/s) : It [9] is the measure of the number of packets successfully transmitted to their final destination per unit time. As shown in fig. 2. The throughput of OLSRv2 is comparatively higher than that of OLSRv1. Hence in terms of the number of data packets delivered at the destination node per unit time, OLSRv2 shows a superior performance.

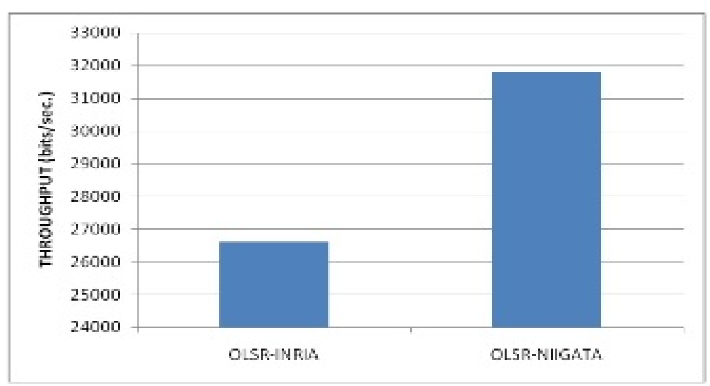

Figure 2. Throughput for OLSRv1 (INRIA) and OLSRv2 (NIIGATA)

2) Packet Delivery Ratio : Packet delivery ratio is calculated by dividing the number of packets received by the destination through the number of packets originated by the application layer of the source i.e. the CBR source.

Data packet delivery ratio of OLSRv1 is higher as compared to OLSRv2 as observed from fig. 3 and hence for the sake of reliable delivery of data packets the OLSRv1 protocol provides good results.

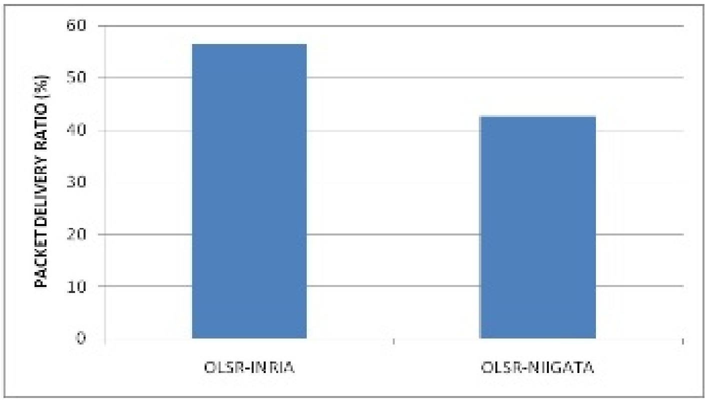

Figure 3. Packet Delivery Ratio for OLSRv1 (INRIA) and OLSRv2 (NIIGATA)

3) Average End-to-End Delay: It [9] signifies the average time taken by packets to reach one end to another end i.e. source to destination. Once the time difference between every CBR packet sent and received is recorded, dividing the total time difference over the total number of CBR packets received gives the average end-to-end delay for the received packets. As observed in fig. 4, the average end to end delay is lesser in OLSRv2 as compared to OLSRv1, hence it is obvious that the time at which the first packet received will be smaller in OLSRv2 as compared to OLSRv1.

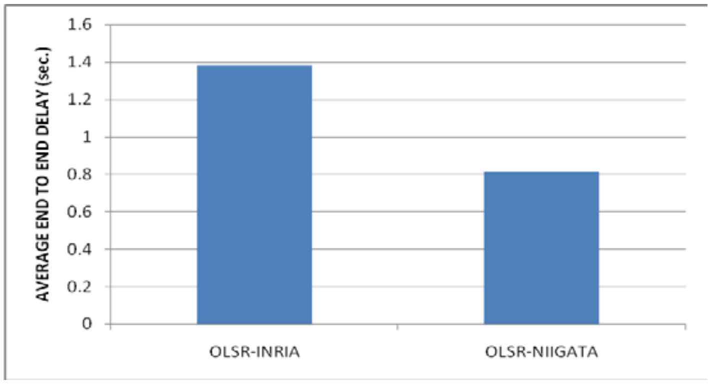

Figure 4. Average End to End Delay for OLSRv1 (INRIA) and OLSRv2 (NIIGATA)

4) Average Jitter : It signifies the packets from the source will reach the destination with different delays. The packet's delay varies with its position in the queues of the routers along the path between source and destination and this position can vary unpredictably. From fig. 5, it is clear that the average jitter in case of OLSRv2 is smaller than OLSRv1 i.e. there will be less time variation between arrivals of packets for OLSRv2 which is the desired condition.

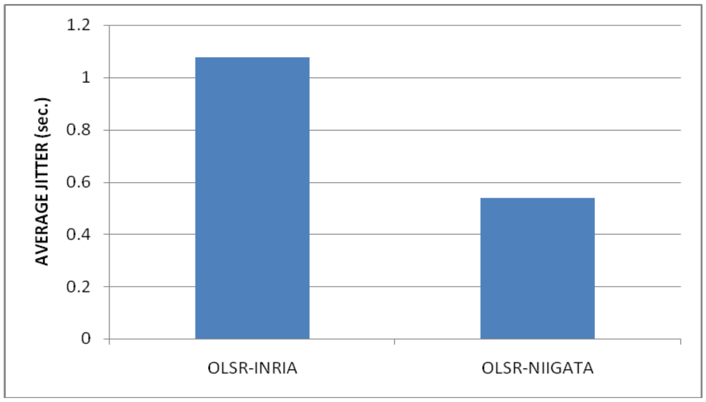

Figure 5. Average Jitter for OLSRv1 (INRIA) and OLSRv2 (NIIGATA)

5) Total Charge Consumed : It specifies the total charge consumed [6] by the nodes at the end of simulation. It is measured in mAh. The fig. 6. Shows that OLSRv2 consumes lesser charge for the same simulation scenario. Hence in terms of charge consumption the OLSRv2 protocol proves to be better than OLSRv1.

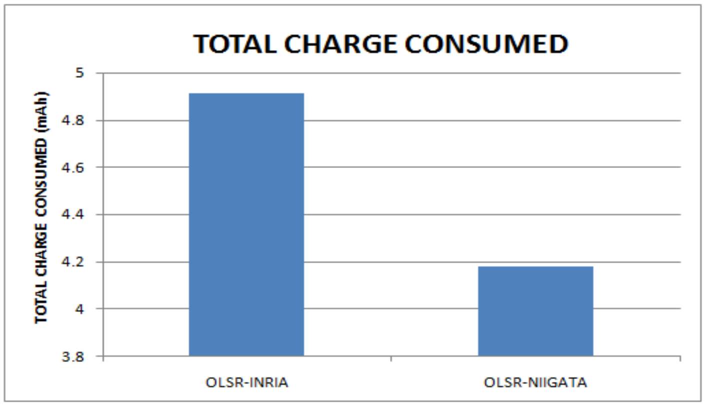

Figure 6. Total Charge Consumed for OLSRv1 (INRIA) and OLSRv2 (NIIGATA)

5 Conclusion

The performance of OLSRv2 is evaluated by using the QualNet 6.1 simulator with the 100 nodes simulation scenario. We compared OLSRv2 performance to OLSRv1 performance in terms of parameters like terms of metrics like throughput, packet delivery ratio, average jitter and average end to end delay and total charge consumed. The simulation results shows that the OLSRv2 throughput is much higher the same as the OLSRv1 throughput. Further the average end to end delay and average jitter are much smaller for OLSRv2 as compared OLSRv1 and hence OLSRv2 gives more favorable results. In addition, the simulation results shows that the total charge consumption is lesser for OLSRv2 for being implemented for the same scenario and traffic as compared to OLSRv1 and hence in terms of durable performance of battery, the OLSRv2 improves the overall network performance.

ACKNOWLEDGMENT

We are thankful to Dr. Manoj Duhan, Chairman & Professor, Department of Electronics and Communication Engineering, Deenbandhu Chhotu Ram University of Science and Technology, Murthal (Sonepat) and Ms. Kusum Dalal , Assistant Professor, Department of Electronics and Communication Engineering, Deenbandhu Chhotu Ram University of Science and Technology, Murthal (Sonepat) for their support, insightful guidance, enthusiasm, encouragement and being the constant source of inspiration.

REFERENCES

[1] Dr. F. Scott, Dr. A. Luiz, Dr. J. Ira and Dr. P. Charles, "Mobile Ad hoc network Routing Protocols Methodologies and Applications", *Department of Computer Engineering ,Blacksburg Virginia*, March 19, 2004.

[2] Mohamed I. Youssef, Mohamed M. Zahra and Amr M. Hassan, "Evaluation of ad-hoc Routing Protocols in Real Simulation Environments", *The 2006 International Conference on Computer Engineering and Systems*, pp. 288 – 293, 2006.

[3] T. Clausen and P. Jacquet, "Optimized Link State Routing Protocol (OLSR)", *IETF RFC 3626,* October 2003.

[4] T. Clausen, C. Dearlove, P. Jacquet, "The Optimized Link State Routing Protocol version 2", *IETF Internet Draft*, draft-ietf-manet-olsrv2-10, September 2009.

[5] Qualnet 6.1 details : www.scalable-networks.com.

[6] QualNet documentation, "QualNet 6.1 Model Library:Wireless", http://www.scalablenetworks.com .

[7] S.Azad, A.Rahman and F.Anwar, "A Performance Comparison of Proactive and Reactive Routing Protocols of Mobile Ad-hoc Network (MANET)", *Journal of Engineering and Applied Sciences* vol. 2, 891-896, May 2007.

[8] M.Subramanyabhat, D.Swetha and J.T. Devaraju, "A Performance Study of Proactive, Reactive and Hybrid Routing Protocols using Qualnet Simulator", *IJCA,* Vol. 28, No.5, August 2011.

[9] A.B. Malany, V.R.S. Dhulipala, RM.Chandrasekaran, "Throughput and Delay Comparison of MANET Routing Protocols", *Intl. Journal Open Problems Comp. Math.,* Vol. 2, No. 3, Sep 2009.