

## Experimental Analysis of OLSR Routing Protocol and Performance Evaluation Using NS-2 Simulator

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### ABSTRACT

Mobile ad hoc networks (MANETs) is a collection of wireless moving nodes which communicate with each other and exchange data without any fixed base station or without the need of any kind of wired backbone network. These design characteristics make routing in wireless network a critical issue as routing protocols adopted in wireless network is completely different from wired network in which a backbone router determines the routing path. In this paper we discussed a OLSR routing protocol for routing path determination as well as we measured the various performance oriented parameters using NS2 simulator. During the research implementations, we also use trace graph, a open source tool for generation of graphs of various statistics such as end to end delay, jitter, throughput etc. This study presents the sequence of steps which highlight the adoption of OLSR routing based on the number of nodes and statistics generated in simulation environment.

**Keywords** – MANET, OLSR, NS2, Throughput, Delay, Packet Delivery Ratio

### I. INTRODUCTION

A Mobile Ad-Hoc Network (MANET) [1] is the network which contains the mobile nodes which send and receive packets from other nodes through a wireless link as there is no dedicated fixed link between wireless nodes. They can communicate each other directly or with the help of a node which is acting a router between wireless nodes. There is no pre-existing infrastructure or dedicated base station in case of wireless network. Due to mobility of nodes, network topology of MANET may change dynamically without turning to any existing centralized administration [2].

Though wireless systems have existed since the 1980's it is only in recent times that wireless systems have started to make inroads into all aspects of human life. Mobile Ad Hoc Networks (MANETs) are advanced wireless communication networks. Mobile Ad hoc Network is an autonomous system of mobile nodes connected by wireless links. Each node operates as an end system and a router for all other nodes in the network. A mobile Ad hoc Network is a self configuring network of mobile routers connected by wireless links –the union of which forms an arbitrary topology. An Ad hoc network is often defined as an “infrastructure less” network means that a network without the usual routing infrastructure, link fixed routers and routing backbones. [3]

#### 1.1 Properties of MANET Network

Wireless ad hoc networks are formed by a group of mobile users or devices spread over a

certain geographical area. The user or devices forming network “nodes”. The service area of the ad hoc network is the whole geographical area where nodes are distributed. As mobile ad hoc networks are self organized networks communication in ad-hoc networks can generate data for any other node in the networks. The multi hop support makes communication between nodes outside the direct range of each other possible.

#### 1.2 Some Issues in MANET Network

An ad hoc network is a dynamic type of network with similarities and great differences to its parent fixed communication network. The properties of an ad hoc network will define its shortcomings and highlight security challenges [4] [5] [6] [7] [8] [9]. An ad hoc networks, is a spontaneous, self created network which cannot rely on a fixed network infrastructure, and by definition does not. A fixed entity structure such as a base station or central administration is crucial for security mechanisms. The trusted third party member who is expected in traditional networks often defines security services; the absence of such a control entity introduces new opportunities for security attacks on the network. The network instead of relying on a central administrator for network and security service, the network relies upon the nodes for these duties in a self-organized manner. Connectivity is a problem in ad hoc networks as networks are created spontaneously and nodes are mobile. Therefore connectivity between the nodes is sporadic. In ad hoc networks nodes may have no prior relationships with other nodes within

the network. Prior acquaintance between nodes can be seen as pre-trust relationships between nodes. It cannot be assumed that pair wise secrets exist between nodes. Physical vulnerability is a major problem in Mobile adhoc network. Mobile node capture or compromised nodes are of higher probability in ad hoc networks than in traditional wired networks with stationary hosts. Lack of Resources is a problem with a network which has no central administrator to perform network and security tasks, and rather relies upon nodes to accomplish such services. This creates a heavy burden upon nodes to perform their own tasks as well as network tasks therefore nodes will have limited resources compared to fixed wired nodes. Threats or attacks upon the network come from entities known as adversaries, these may include insider and outsider nodes that maliciously attack or threaten the network or the secrecy of the networks content.

### 1.3 Objectives of this study

During this research study and implementation, our main objective was to study the working of OLSR routing protocol and then to measure and analyse the performance of reactive routing protocols in mobile ad hoc network. Keeping this main objective in mind the following objectives are stated:

- Study the various routing protocols and detailed study of OLSR dynamic routing protocol.
- Implementation in simulation environment with varied number of mobile nodes.
- Analytical study and measurement of the performance of OLSR routing.

The remainder of this paper is organized as follows – the next section gives the details about the routing protocols and its classification. In Section 2 describes in detail about reactive routing protocols and its various types and follow it with brief specifics of implementation in section 3. Section 4 consists the conclusion of the research work.

## II. CLASSIFICATION OF ROUTING PROTOCOL IN MANET NETWORK

In network infrastructure, the network layer also known as IP layer is playing the biggest roles, thereby also called backbone of the communication network. In case of wired network, the network nodes are communicating with each other through the dedicated wired link whereas in case of MANET moving node is to successfully transmit data packets from the source to the destination without any kind of fixed or dedicated links between them. Therefore, efficient routing of packets is a primary MANET challenge. On the basis of routing information update mechanism routing protocol for ad-hoc wireless network can be classified into three categories [10] [11] Fig. 1 shows basic classification of routing protocol:

### 2.1 The routing protocol for MANET is classified as [13]:

- Table driven (proactive ) routing protocol
- On-demand (reactive) routing protocol
- Hybrid routing protocol

#### Table Driven routing protocol:

The table driven approach is very similar to the connectionless approach where there is no dedicated mechanism when and how frequently the packets should be forwarded and when that route is desired for sending of packets. It completely relies on the underlying protocol in communication [11]. Here, a route to every other node in ad hoc network is always available, regardless of whether or not it is needed.

#### On-demand driven routing protocols:

These protocols try to eliminate the conventional routing tables and consequently reduce the need for updating these tables to track changes in the network topology. In the On-Demand approach, when a node desires a route to a new destination, it will have to wait until such a route can be discovered i.e. routes are discovered whenever a source node have packets to send [10] [11] and maintain it until either the route is no longer desired or it becomes inaccessible, and finally remove it by route deletion procedure.

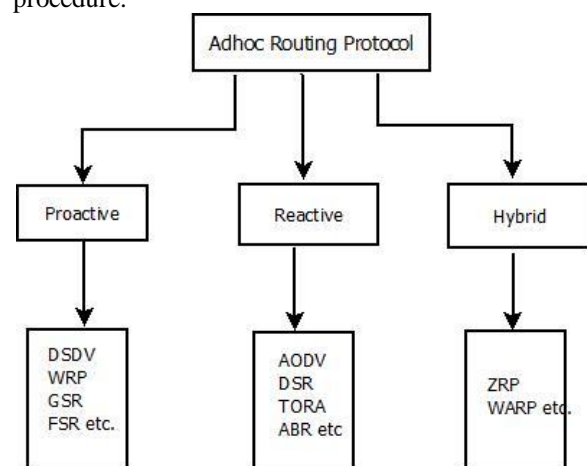


Figure 1: Classification of Routing Protocols in Mobile Ad-hoc Networks

#### Hybrid routing protocol:

Both of the routing protocols known as proactive and reactive protocol are working best in different scenarios [10] [12], hybrid method uses both. These protocols combine the best good features of reactive and proactive protocol. It is used to find a balance between both protocols. Proactive operations are restricted to small domain, whereas, reactive protocols are used for locating nodes outside those domains. Examples of hybrid protocols are:

- Zone Routing Protocol, (ZRP)

- Wireless Ad hoc Routing Protocol, (WARP)

## 2.2 Tools and Techniques used:

### NS-2 Simulator

NS (version 2) is an object-oriented, discrete event driven network simulator developed at UC Berkely written in C++ and OTcl (Tcl script language with Object-oriented extensions). It implements network protocols such as TCP and UPD, traffic source behavior such as FTP, Telnet, Web, CBR and VBR, router queue management mechanism such as Drop Tail, RED and CBQ, routing algorithms such as Dijkstra, and more. NS also implements multicasting and some of the MAC layer protocols for LAN simulations [14].

### Trace graph:

Trace graph is third party software helps in plotting the graphs for NS2 and other networking simulation softwares. Trace graph when opened, it opens 3 windows [15]

- one window to select the trace file (.tr) that was created by NS2 (depending on the size of the trace file, the processing time also varies)
- Second window is the main window in which you can see the graphs for various performance characteristics like throughput, End to End Delay, jitter, etc in 2D and 3D facility. Even it can plot the histograms too.
- Third window is nothing but the Simulation Information Windows, that you can see the packet loss, packet delivery; end to end delay for the total network, information about the intermediate nodes, source and destination nodes.

Process adopted during the implementation: Following diagram depict the process of the implementation. For problem stated above as implementation of OLSR routing protocol using NS2, we have created the ubuntu Linux based environment on which we had installed the required packages such tracegraph, ns2 etc.

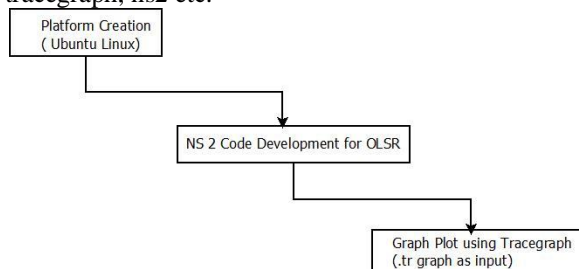


Figure: Process of Implementation

## III. PERFORMANCE EVALUATION AND RESULTS

- **Simulation Parameters:** Following table depict the various simulation parameters
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Simulation Parameters	Values
Network Type	Mobile Ad Hoc
Connection Pattern	Radio-propagation
Packet size	512 bytes
Duration	50s
Connection Type	CBR/UDP
Simulation Area ( sq.m)	600
No. of Nodes	5,10,15,25,30

Table 1: Simulation Parameters

## IV. RESULTS AND ANALYSIS

During the course of implementation of this research, an attempt was made to compare the performances of OLSR routing protocol based on various node scenarios and positions under the same simulation environment. For all the simulations, the same movement models were used, the numbers of traffic sources are varied, the maximum speed of the nodes was set to 20m/s and the packet size is fixed to 512 bytes. The area of simulation is 600 sq.m

For the experimental significance, here we only discuss the experimental results of simulation of 5 nodes only. The simulations environment is the same for other nodes of 10,15,25,30 no. of nodes. The diversity of the experiments is more as we increase the number of nodes in a simulation environment.

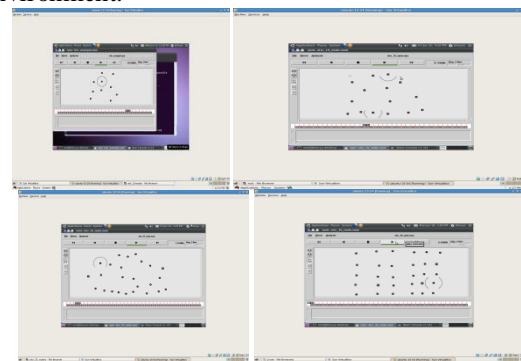


Figure 2: Simulation of 10, 15, 25 and 30 nodes

Figure 3 depicts the OLSR simulation environment with 10, 15, 25 and 30 numbers of nodes as well as Sending and Receiving Packets. We have depicted only the few simulation environment but we have made the simulation for large number of nodes such 100,200 etc. Our main motivation is to study the impact of number of nodes on overall performances of the OLSR routing protocols because with the increase of number of nodes in a wireless network also increase the congestions, noise in the network.

Figure 4 depicts the throughput of sending packets with respect to total simulation time in 10 nodes simulation environment. Total simulation time is 50 sec, we have run the simulation script which implements the OLSR routing protocol for a period of 50 seconds.

Similarly as throughput of sending packets vs simulation times has been depicted above, figure 5

represent the Throughput of receiving packets during the simulation time. X-axis represents the total simulation time and Y-axis represents the throughput obtained during that simulation time. As we have run the simulation for a complete duration of 50 seconds. The throughput or network throughput is the average rate of successful message delivery over a communication channel.

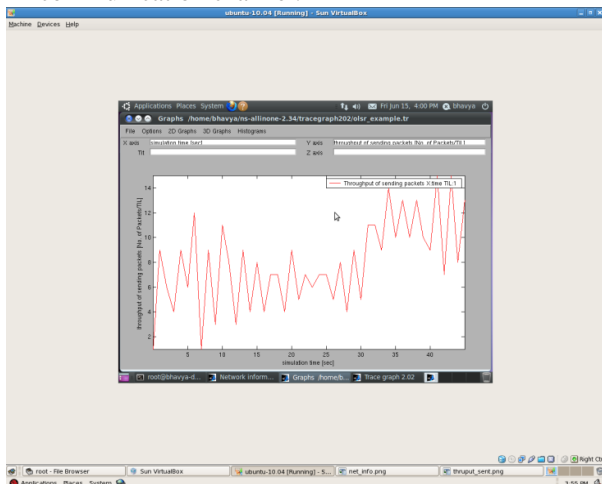


Figure 3: Throughput of sent packets vs Simulation time in 10 nodes

This data may be delivered over a physical or logical link, or pass through a certain network node. The throughput is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second or data packets per time slot. The system throughput or aggregate throughput is the sum of the data rates that are delivered to all terminals in a network.

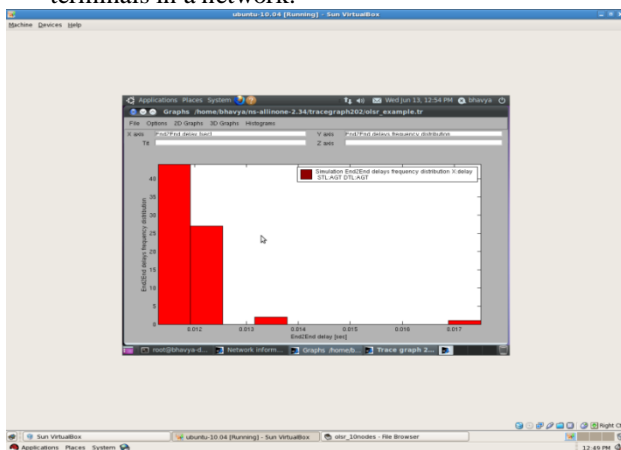


Figure 4: End to End delay: Frequency Distribution

Figure 4 depicts the frequency distribution of end to end delay. In statistics, a **frequency distribution** is an arrangement of the values that one or more variables take in a sample. Each entry in the table contains the frequency or count of the occurrences of values within a particular group or interval, and in this way, the table summarizes the distribution of values in the sample [13]

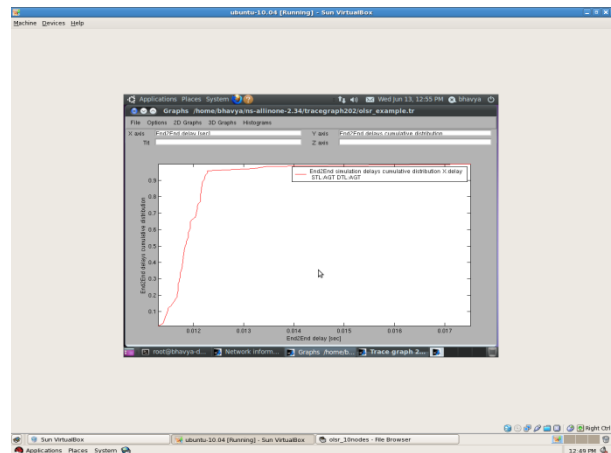


Figure5: End-to-End delay: Cumulative Distribution

Similarly figure 5 depict the cumulative distribution of end to end delay describes the probability that a real-valued random variable  $X$  with a given probability distribution will be found at a value less than or equal to  $x$ . In the case of a continuous, it gives the area under the probability density function from minus infinity to  $x$ . Cumulative distribution functions are also used to specify the distribution of multivariate random variables.

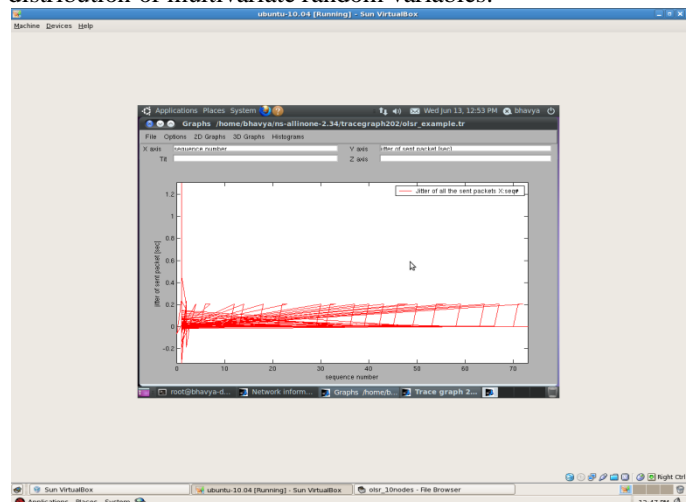


Figure6: Jitter sent on all nodes

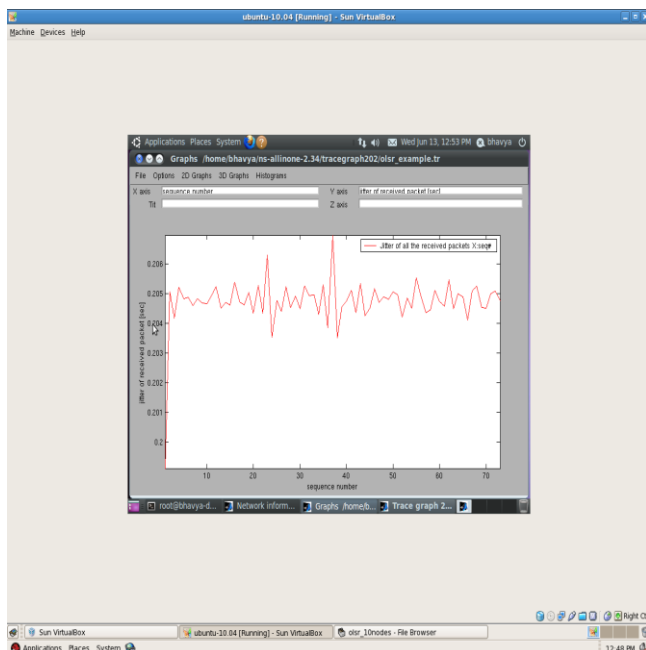


Figure7: Jitter received on all nodes

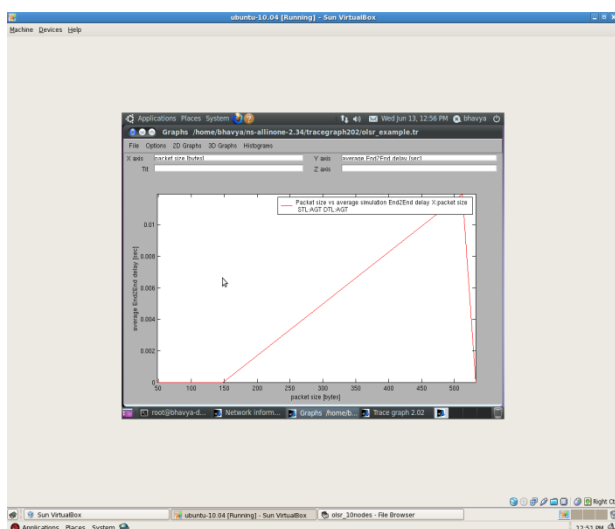


Figure8: Avg End to end delay

In the above figures, we have only displayed the results graph for 10 nodes in simulation environments, similarly we can show results for other simulation environment of 15,25, 20 number of nodes. Our scope of the research was to study the performances of the OLSR routing protocol by varying the number of nodes in simulations. During the course of this research study, we have found the following findings:

- Congestion increases with the increase of number of wireless nodes.
- As we increase the number of nodes for performing the simulation of OLSR protocol, number of sent and delivered packet changes, which in turn changes the throughput and avg. end to end delay.

## V. CONCLUSION

In this work we evaluated the four performance measurement of OLSR routing protocol i.e. packets sent and received, jitter, end-to-end delay, throughput, cumulative and frequency distribution of sent and received packets with different number of nodes. OLSR routing protocol was simulated with 5,10,15,25 and 30 nodes moving randomly in an area of within the network range 600 sq m. The performance of OLSR protocol through a network different size carried out a comparative analysis of the performance and found it had better performance in all aspects in a network.

From results reported above, we concluded that as we increase the number of nodes for performing the simulation of OLSR protocol, number of sent and delivered packet changes, which in turn changes the throughput and avg. end to end delay. The OLSR protocol is the better solution for high mobility condition. The OLSR protocol is more efficient in networks with high density and highly sporadic traffic. But the best situation is when there are a large number of hosts. OLSR requires that it continuously has some bandwidth in order to receive the topology update messages.

In future, utilizing these performances we can design such a protocol that can be suitably provide data integrity as well as data delivery in highly random mobility network better QoS applications. In our research study, we have considered a packet of data of 512 bytes and minimum packet size is 48 bytes but in multimedia application, we should have packet bigger. So, our future work will consist of studying multimedia traffic on this protocol and queue management, as well as finding a solution for supporting different data stream.

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