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Comparative Performance Evaluation of Ad-hoc on Demand Distance Vector Routing (AODV) and Optimized Link State Routing (OLSR) Protocol for Mobile Ad-hoc Networks in NS-2

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ABSTRACT

Some years before Mobile Ad hoc Networks are not so popular. After some period of time wireless mobile network are very popular due to its unique features. Mobile Ad hoc Network is the one of the branch in wireless networks is shortly known as (MANETs). MANET is a collection of available communication devices or nodes that wish to communicate without any fixed infrastructure or pre define organization of available links. This MANETs research program has mainly focused on developing an efficient routing mechanism in such a highly dynamic and resource constrained network [2]. All routing protocols have assumed to be a trusted and safe for environment. This comparative performance evaluation project work is related to various Mobile Ad hoc Networks (MANETs) routing protocols such as Ad-hoc on Demand Distance Vector Routing (AODV), Dynamic Source Routing (DSR) and Optimized Link State Routing (OLSR). On the bases of different routing protocols as mention earlier we can stimulate using network simulator software which generate different graph as result. And then see comparative analysis effects on routing protocol parameters for Mobile Ad-hoc Networks (MANETs) on the bases of various simulation environments such as area, number of node, testing field, traffic load etc. Following parameters are considered for comparative performance evaluations are Routing Overhead, End-to-End Delay, Scalability and Throughput. This comparative performance study mainly performed between Ad-hoc on Demand Distance Vector Routing (AODV) and Optimized Link State Routing (OLSR). This above mentioned work shows that which routing protocols is best among them and study the graphs obtain in Network stimulating software (NS-2) for Mobile Ad-hoc Networks (MANETs) on the bases of comparative performance evaluation parameters. AODV and OLSR comparison gives the result, which routing protocol is superior among them using NS-2 and this work concludes as a result.

Keywords: *Area, AODV, End-to-End Delay, MANETs, Number of Node, Network Simulator 2 (NS-2), OLSR, Routing overhead, Routing Protocols.*

I. INTRODUCTION

Now a day wireless mobile networks is very popular in the networking system. Mobile Ad hoc Networks are new generation of networks offering unrestricted mobility without any underlying infrastructure [1-2]. MANET is a collection of available communication devices or nodes that wish to communicate without any fixed infrastructure or pre define organization of available links. This MANETs research program has mainly focused on developing an efficient routing mechanism in such a highly dynamic and resource constrained network [2]. A mobile ad hoc network is a dynamically self-organizing network without any central administrator or infrastructure support. The nodes in MANETs themselves are responsible for dynamically discovering other nodes to communicate each other [2]. It is composed of mobile terminals that communicate one to the other through broadcast radio transmission.

In MANETs node plays very important role. Without node communication could not happened. Now in Mobile Ad hoc Networks are new generation of networks offering unrestricted mobility without fail of any underlying infrastructure. In ad hoc wireless networks, communicating data is vulnerable to lots of potential attacks due to their unique characteristics of having dynamic topology, limited bandwidth and energy constraints in the protocols [2-5].

Wireless network is so sensitive network as compare to other networks. In ad hoc wireless networks, communicating data is vulnerable to lots of potential attacks due to their characteristics of having dynamic topology, limited bandwidth and energy constraints this are the limitations in this network[1-3]. These negative features in the Ad hoc wireless networks provide the opportunity to the net researchers to do research work in this field. In addition to that MANET can be constructed quickly at a low cost, as it does not rely on existing network infrastructure these are some positive points. Due to this flexibility, a MANET is attractive for applications such as military service, disaster relief, robot networks, emergency operations, casual meetings, vehicle networks, campus networks, maritime communications, and so on.

Basically routing protocols are mainly classified in reactive and proactive routing protocol. Proactive are Table-Driven routing protocol and reactive are On-Demand routing protocols. In proactive routing protocols, each node has one or more tables that contain the latest information of the routes to any node in network. These routing protocols maintain different number of table. Proactive networks are not suitable for large networks because table driven approach for different nodes. Optimized Link State Routing (OLSR) protocol is the example of table driven. In reactive routing protocols, such as the Ad hoc On Demand Distance Vector (AODV) protocol nodes find routes only when required these protocol takes lazy approach to routing and they do not maintain or constantly update their route table with the latest route topology. The route discovery usually occurs by flooding the route request packets through the network and Ad hoc On Demand Distance Vector (AODV) routing protocol is the one of the example.

II. WHAT IS WIRELESS NETWORK?

The wireless network is the new emerging technology which allow user to asses information and service electronically in there geographical position. This type of infrastructure network made up of networks with wired and fixed gateways. A mobile host communication with a bridge in network primarily called base station available within communication radius. This area of infrastructure network radius defined in program. This wireless network differentiated on the bases of infrastructure based network and infrastructure less (Ad hoc) networks. In infrastructure based network consist with wired medium and having node base station fixed. In the infrastructure less (Ad hoc) networks nodes are connected without wired and base station is not fixed in this situation. In Ad hoc networks mobile unit that is node can move random geographically while it is communicating. In this ad hoc network all nodes are mobile and can be connected dynamically in random manner. This is bigger advantage of MANETs. When mobile unit goes out of range of one base station then it connects automatically with new base station and start communicating and information exchange happened in between two nodes this information in the form of data packets. The nodes in network function like routers which found and maintain routes to other node. The node in mobile ad hoc network can be cell phone, laptop, PDA and any device to capable of do communication. In short wireless network system is portable system with self-organizing infrastructure.

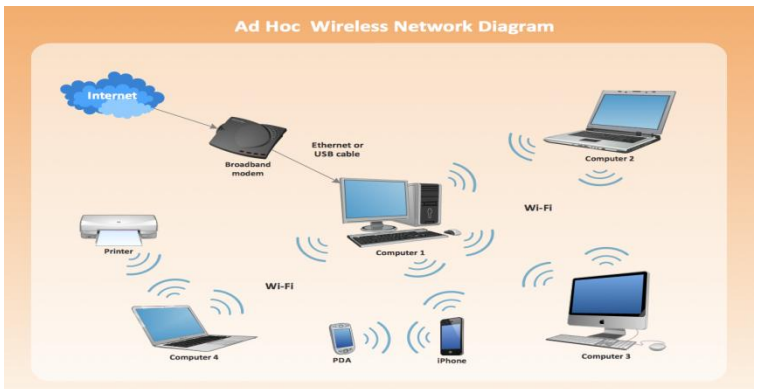

Figure 1. Wireless Ad hoc networks.

2.1 Types of Routing Protocols in MANETs

Basically routing protocols mainly classified in two types such as reactive and proactive routing protocols. In reactive routing protocol, the Ad hoc On Demand Distance Vector (AODV) protocol nodes find routes only when required and Dynamic Source Routing (DSR) is also an on-demand protocol and features similar route discovery as AODV. A source route is appended to all packets and intermediate nodes, and it uses this source route to forward data. In proactive routing protocols, each node has one or more tables that contain the latest information of the routes to any node in network. These routing protocols maintain different number of table. Proactive networks are not suitable for large networks because table driven approach for different nodes and Optimized Link State Routing (OLSR) protocol is the example of table driven.

The routing protocols of MANETs can be classified in two main types. Reactive and Proactive are the main types. Figure 2 shows diagrammatical classification of MANETs along with some relative examples routing protocols.

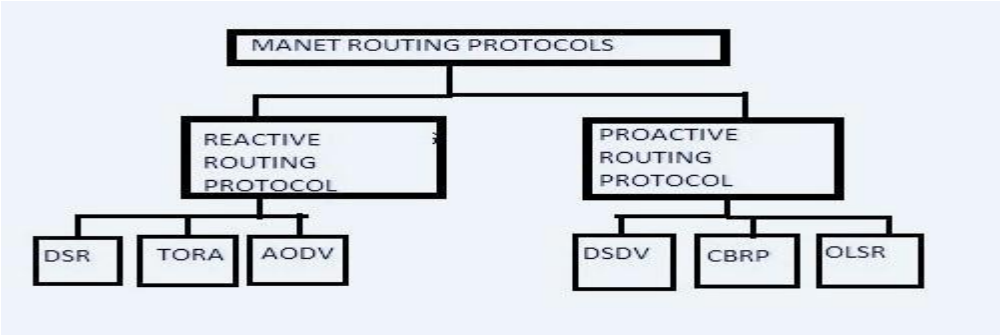

Figure 2. Classification of MANETs Routing protocols [4].

3. Information about Ad hoc On Demand Distance Vector (AODV) routing protocol and Optimized Link State Routing (OLSR) protocol.

3.1 Ad Hoc on Demand Distance Vector Routing (AODV)

AODV is the on demand routing is gives the better performance for the more number of nodes. Path or links are created on demand bases. Reactive routing protocols not maintain the table for path discovery. Ad hoc mobile wireless network is the one of the branch in wireless networks of mobile nodes. Basically routing protocols mainly classified in two types such as reactive and proactive routing protocols. In reactive routing protocol, the Ad hoc On Demand Distance Vector (AODV) protocol nodes find routes only when required and features similar route discovery as AODV and DSR, TORA are some examples. A source route is appended to all packets and intermediate nodes, and it uses this source route to forward data. It is the most important routing protocol in mobile wireless networks. The Ad Hoc On-Demand Distance Vector routing protocol (AODV) is an improvement of the Destination-Sequenced Distance Vector routing protocol (DSDV) [5]. This is the main important functioning of Ad Hoc On-Demand Distance Vector routing protocol (AODV) in MANETs.

Ad Hoc on Demand Distance Vector routing protocol (AODV) mainly come under the reactive protocols. Reactive protocols discover routes only when needed. When node wants to communicate with another node then it checks its existing information with destination route node. If this checking is positive then communication established between source and destination node and further data exchange is going to be happened. RREQ request from source to destination show in diagram given in Figure 3 which forms discovers the path towards destination. After sending RREQ packet request to destination then destination node send back the RREP packet request send back to source this shown in Figure 4. These RREP packets decide the shortest routing path between sources to destination. Figure 5 shows the whole scenario happened while RREQ and RREP packet request move in network.

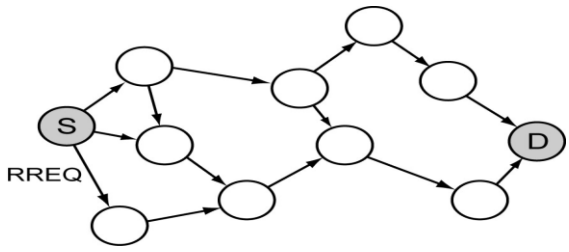

Figure 3. A RREQ Source to Destination path generation

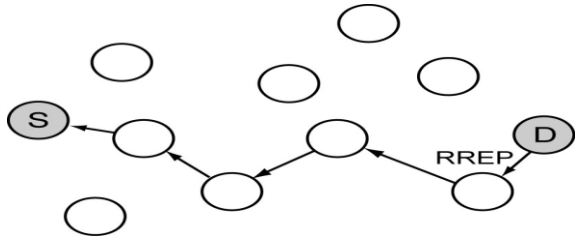

Figure 4. A RREP Packet send back to Source.

Advantages:

- On demand type give the supporting for large no of network.
- Need lower delay for connection setup.
- Table is not created for the path discovery in the network.
- It creates the routes on-demand basis.
- Shortest path can be found in ad hoc network.
- Destination sequence numbers are used to find the latest route to the destination.
- AODV tries to minimize the number of required broadcasts.

Disadvantages:

- Periodic route formation creates unnecessary bandwidth consumption.
- Does not follow the unidirectional links.

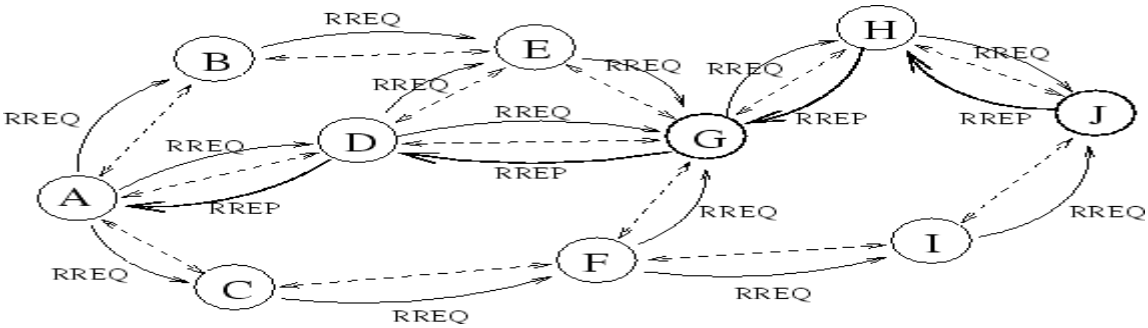

Figure 5. RREQ and RREP packet request.

3.2 Optimized Link State Routing (OLSR) protocol

Optimized Link State Routing Protocol popularly known as (OLSR) is come under proactive routing protocol, so routes in network are always immediately available when needed. OLSR is an optimized version of a pure link state protocol. Due to this proactive nature finding shortest path is very easy. So the topological changes cause the flooding of the topological information to all available hosts in the network. OLSR uses two kinds of control messages: Hello and Topology Control (TC). TC message are used for broadcasting information about own advertised neighbors which include at least the MPR selector list. Hello message are used for finding the information about the link status and the host neighbors. The proactive characteristic of the protocol provides that the protocol has all the routing information to all participated hosts in the network. To reduce the possible overhead in the network protocol uses Multipoint Relay (MPR). The idea of MPR is to reduce flooding of broadcast by reducing the same broadcast in some region in network [8]. The drawback of OLSR protocol requires each host periodically to send the updated topology information throughout the entire network. This increases the protocols bandwidth usage.

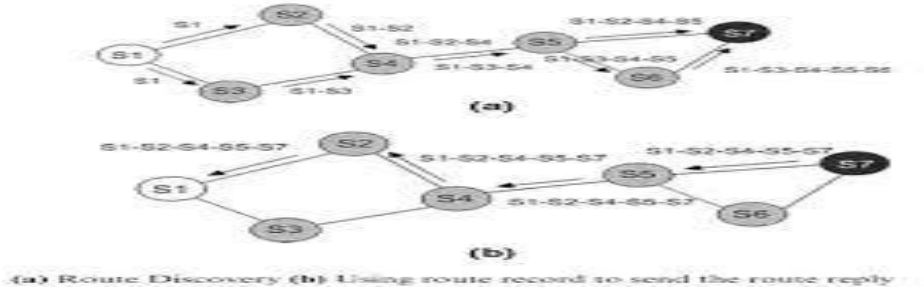

Figure 6. OLSR path discovery route S1 source to S7 destination

Advantages:

- This is useful for the large network due to its table proactive approach.
- Throughput is high.
- End-to-End delay is less.

Disadvantages:

- OLSR protocol requires each host periodically to send the updated topology information throughout the entire network.
- Scalability is high.
- Increase the protocols bandwidth usage.

IV. PROJECT SCENARIO IN NS-2

Our project work is done in the network simulating environment. For the simulation of the developed system latest version 2.35 of NS-2 has been used in this project work. This setup is done on the windows operating system, for doing this primarily we have to install Oracle VM virtual box on windows 7 computer. Then Oracle VM virtual box give the platform of LINUX operating system to run Ubuntu 12.04 (32 bit) in this virtual system to do actual simulation of project operation NS-2 network simulating software. Some project scenario is given below.

4.1 Scenario

- Antenna model used is Omni Antenna.
- Radio propagation model used is Two-Ray Ground.
- Nodes are moving at constant random speed.
- Nodes are being generated randomly at random position.
- Topology of 1000*1000 is taken for simulation.
- Nodes are generated at random time as if few nodes are entering into the topology.
- Movement is linear and node speed is constant for a simulation.

4.2 Node characteristics

- Nodes in the network are random moving they are mobile in nature.
- Channel type: wireless
- MAC type: 802_11
- Link Layer Type: Logical Link (LL) type
- Network Interface type: wireless
- Queue type: Drop-Tail

4.3 Matrix

The following different performance matrices are evaluated the behavior of AODV, OLSR routing protocols which came under wireless network of mobile ad hoc networks (MANETs). For this work below mentioned parameters taken into consideration.

[1] Throughput.

[2] End-to-End Delay.

[3] Scalability.

[4] Routing Overhead.

Table 1. Simulation Parameters for NS-2

PARAMETERS	VALUES
Simulator	NS-2 (version- 2.35)
Routing protocols	AODV and OLSR
Number of mobile node	60

Channel type	Channel/ wireless channel
Network interface type	Phy/ wireless phy
Mac type	Mac/ 802_11
Antenna	Antenna/ Omni antenna
Maximum pack in ifq	50
Area (M*M)	1000*1000
Source type	UDP/ TCP
Mac 802_11 RTS Threshold	3000
Link layer type	LL
Simulation time	80 sec.

4.4 Actual project environment

The Network simulator is a name for series of discrete event network simulators, specifically **ns-1**, **ns-2** and **ns-3**. All of them are discrete-event network simulator.it is tool in which wireless networks simulation can be done due genuine limitations to high cost of implementation, area limitations, etc. In 1996-97, ns version 2 (ns-2) was initiated based on a refactoring by Steve McCanne. Use of Tcl was replaced by MIT's Object Tcl (OTcl), an object-oriented dialect Tcl [2]. The core of ns-2 is also written in C++, but the C++ simulation objects are linked to shadow objects in OTcl and variables can be linked between both language realms. Simulation scripts are written in the OTcl language, an extension of the Tcl scripting language [2-4].

At presently, ns-2 consists of over 300,000 lines of source code, and there is probably a comparable amount of contributed code that is not integrated directly into the main distribution (many forks of ns-2 exist, both maintained and unmaintained). It runs on GNU/Linux, FreeBSD, Solaris, Mac OS X and Windows versions that support Cygwin. It is licensed for use under version 2 of the GNU General Public License [6-7]. This is the basic information related to NS-2.

There are some general processes of creating a simulation in ns-2 as per several steps. These steps are as follows:

- Topology definition: to ease the creation of basic facilities and define their interrelationships, ns-2 has a system of containers and helpers that facilitates this process.
- Model development: models are added to simulation (for example, UDP, IPv4, point to-point devices and links, applications); most of the time this is done using helpers.
- Node and link configuration: models set their default values (for example, the size of packets sent by an application or MTU of a point-to-point link); most of the time this is done using the attribute system.
- Execution: simulation facilities generate events, data requested by the user is logged.
- Performance analysis: after the simulation is finished and data is available as a time stamped event trace. This data can then be statistically analysed with tools like R to draw conclusions.
- Graphical Visualization: raw or processed data collected in a simulation can be graphed using tools like Gnuplot, matplotlib or XGRAPH [5].

4.5 Information to Nam file

NAM is a Tcl/TK based animation tool for viewing network simulation traces and real world packet traces. A network animator that provides packet-level animation and protocol-specific graphs to aid the design and debugging of new network protocols have been described. Taking data from network simulators (such as ns) or live networks, NAM was one of the first tools to provide general purpose, packet-level, and network animation, before starting to use NAM, a trace file needs to create [7]. This trace file is usually generated by NS. Once the trace file is generated, NAM can be used to animate it. A snapshot of the simulation topology in NAM for 60 mobile nodes is shown in figure 7. Which is visualized the traces of communication or packets movements between mobile nodes.

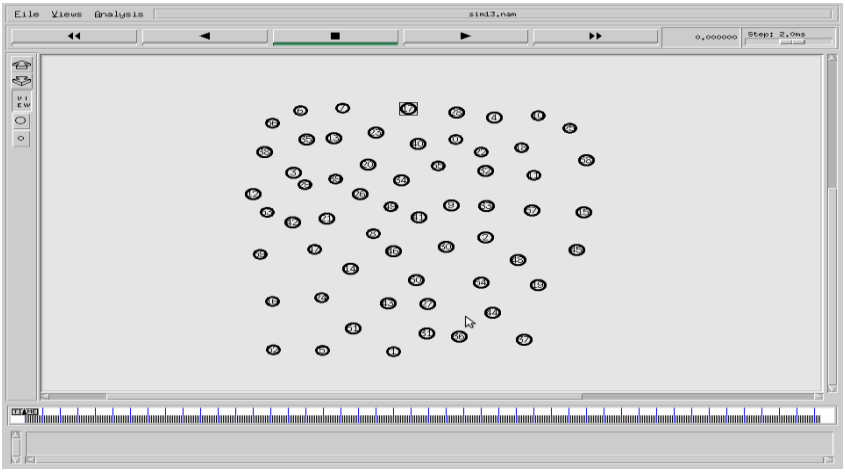

Figure 7. Nam window snapshot for random mobile nodes.

V. INFORMATION TO SIMULATION MODEL

The objective of this project is to performance evaluation of two routing protocols for mobile ad hoc networks by using an open source network simulation tool called NS-2. Two routing protocols: AODV and OLSR have been considered for performance evaluation in this project work. The simulation environment has been conducted with the LINUX operating system, because NS-2 works with Linux platform only. This gives the diagrammatical flow related to project.

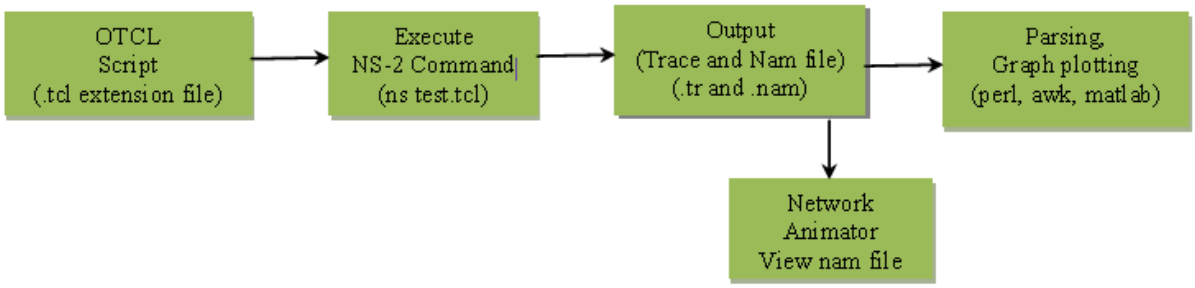

Figure 8. Simulation overview [5]

Whole simulation study is divided into two part one is create the node that may be cell phone, internet or any other devices i.e. NS-2 output. It's called NAM (Network Animator) file, which shows the nodes movement and communication occurs between various nodes in various conditions or to allow the users to visually appreciate the movement as well as the interactions of the mobile nodes and another one is graphical analysis of trace file (.tr).

Figure 8 Simulation overview depicts the overall process of how a network simulation is conducted under NS-2. Output files such as trace files have to be parsed to extract useful information. The parsing can be done using the *awk* command (in UNIX and LINUX, it is necessary to use gwak for the windows environment) or Perl script. Trace files contain the traces of event that can be further processed to understand the performance of the network. The results have been analyzed using Excel or Matlab. A software program which can shorten the process of parsing trace files (Xgraph and TraceGraph) has also been used in this project. However, it doesn't work well when the trace file is too large. To generate trace file and nam file, we call tcl script in CYGWIN command shell. By varying the simulation parameter shown in table 1, we can see the graphical variation between various performance metrics like Routing Overhead, End-to-End Delay, Throughput and Scalability.

5.1 Actual project NAM windows in project

Following various Nam windows are taken on actual run time of project with some time interval to show the working of nodes on that time period. Nam window shows original view of run time project on screen with node activity. This Nam window is user define, space is created accordingly in object program file. In this project proj.tcl is program file. These images are gives the actual feel of simulation happened that time.

Below table give some indications related to color and diagrams available in simulation window.

Table 2. Indicative parameter for simulating nam window in NS-2

Sr.no	Parameters	Indication to images
1	Number in circle	Node
2	Node in green circle	Source node
3	Node in red circle	Destination node
4	Black Square	Packet loss
5	Black dotted lines	Packet transmission between nodes

This figure 9 shows the initial image of NAM window at time of 0 sec.

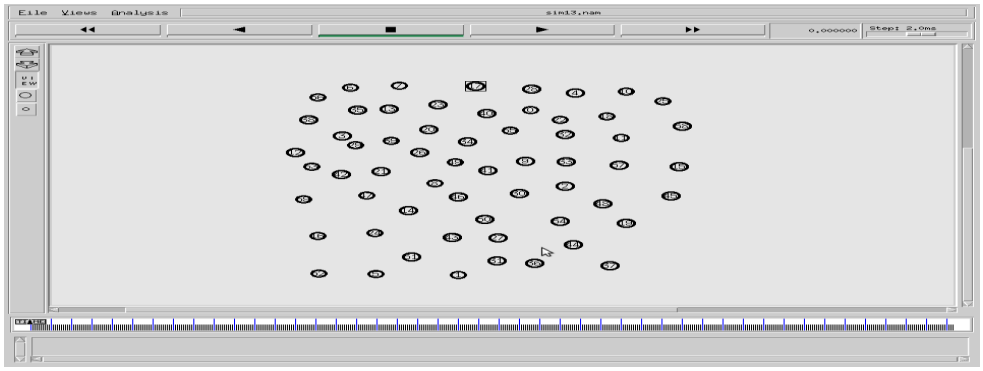

Figure 9. Initial time nam window at (o sec.) time

This figure 10 shows the image of NAM window at time 11 sec.

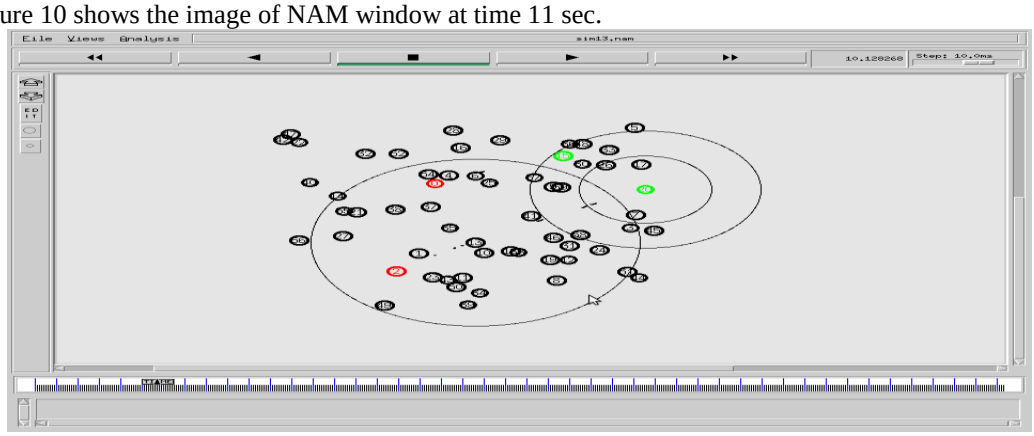

Figure 10. Nam window with (11 sec.) time

This figure 11 image shows at time of 31 sec interval.

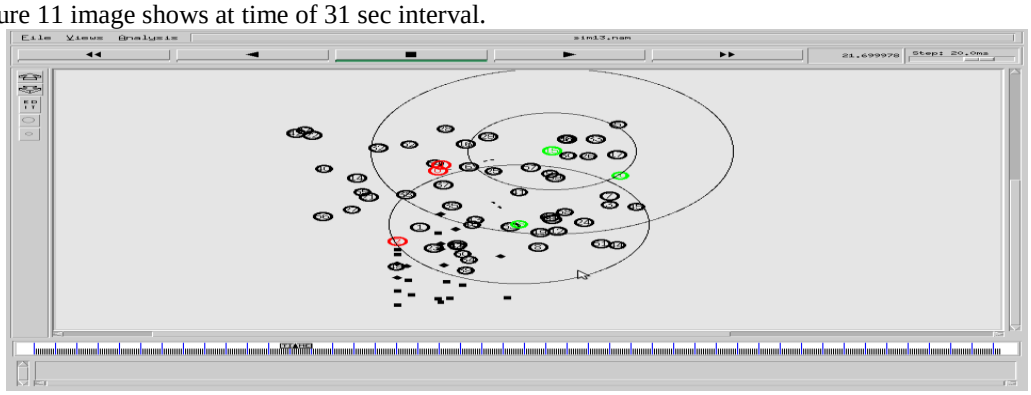

Figure 11. Nam window at (31 sec.) time

Figure 12 at interval of 80 sec. is the last window. This following NAM window which show all packet data transmission and packet losses in the actual scenario.

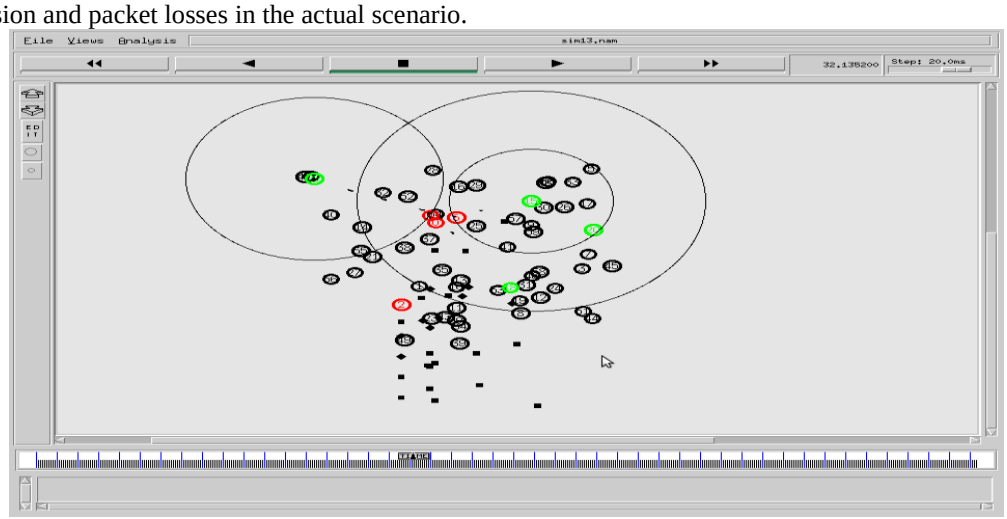

Figure 12. Nam window at (80 sec.) time

IV. RESULT IN GRAPHICAL MANNER

That's below graphs are plotted by collecting actual output data obtained in run time simulation. This output data can be converted in various graphs for observation purpose by using Microsoft excel Tool in windows.

[1] **Throughput-** Throughput is the number of packets that is passing through the channel in a particular time period. As per the observation when graph shows the high reading at the particular time period. That shows the higher is the throughput better is the particular Routing Protocol. Unit of this throughput is Kbps.

Throughput = Total received Bytes / Elapsed Time

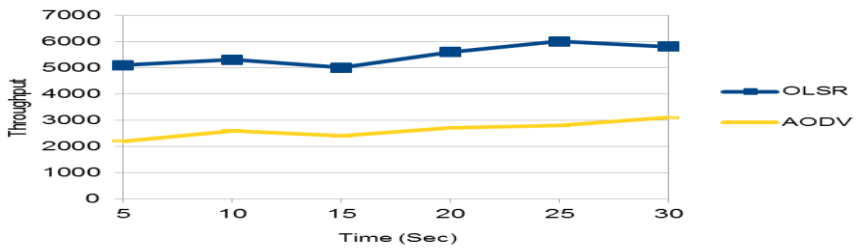

Figure 13. Throughput Vs. Time (Sec.)

[2] **End-to-End Delay-** In which specific packet is transmitting from source node to destination node and calculating the difference between send time and received time is called End-to-End Delay. In this case if value in graph shows less value this is the better Routing Protocol among them. Many factors like route discovery, queening propagation and transfer time gives the performance of delay.

End-to-End Delay = (Received time – Send time) / Data packets received

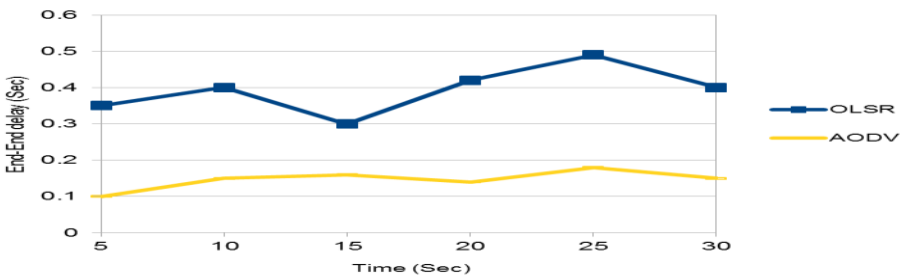

Figure 14. End-to-End delay Vs Time

[3] Scalability- Scalability is called as the ability of network to handle the node in network. It is just handling the node in given network system. Higher the value of in scalability that protocol is superior among the two.

Scalability = Ability to handle the node

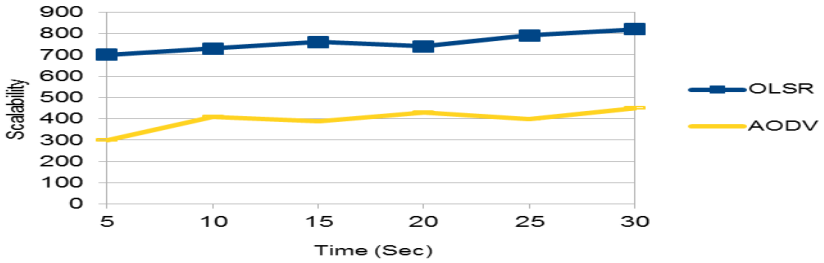

Figure 15. Scalability Vs Time

[4] **Routing Overhead**- Routing Overhead is one of the performance parameter which gives the analytical study of protocols by using such parameters we can able to tell which on is good. If value of the graph is high that shows the better performance of routing protocol. Basically Routing Protocol is the performance parameter to find the best shortest routing path in between two consecutive nodes.

Routing Overhead = find shortest path between the two consecutive node.

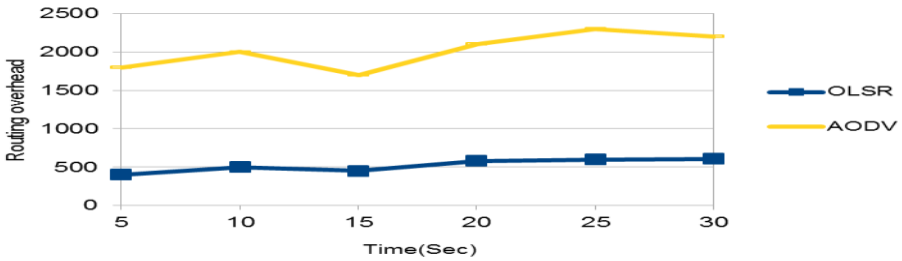

Figure 16. Routing Overhead Vs Time (Sec.)

VII. CONCLUSION

Finally we can make conclusion of this project on the observation, graph obtained in actual run time simulation. Comparative performance evaluation work organized between AODV and OLSR routing protocols in Network Simulator (NS-2) specifically in network simulator 2.35 versions. According to the throughput definition Figure 13 shows OLSR routing protocol is good as compared to AODV. Based on End-to-End delay concept Figure 14 give the clear indication that AODV has lesser value reading as compare to OLSR therefore AODV is having good End-to-End delay. Observing scalability concept in Figure 15 OLSR has capability to handle more number of nodes as compere to AODV protocol in this situation OLSR is the best. Figure 16 shows the output graph of Routing Overhead as graph of higher value give the better routing protocol, according to this concept AODV is the best among them. By observing all resultant graphs of AODV is good for some parameters and OLSR less effective. Project in Network Simulator conclude that AODV routing protocol is best as compare to OLSR routing protocol in this evaluation work.

VIII. ACKNOWLWDGEMENTS

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