Chapter 1: Introduction

A group of connectionless nodes (mobile)or routers that form a short-term network with dynamism lacking of the requirement of any presented network scenario or centralized administration is known as Ad hoc networks [19]. All the nodes and routers move independently and put in order themselves illogically, as a result, the topology changes quickly and randomly. Such a network may function in a separate manner, or may be linked to the Internet. The challenge is implement an adequate routing protocol for Multihop network, mobility of nodes, and big network range grouped with various constraints of device heterogeneity, power consumption, and bandwidth. The Figure 1.1 is an example of mobile ad hoc network.

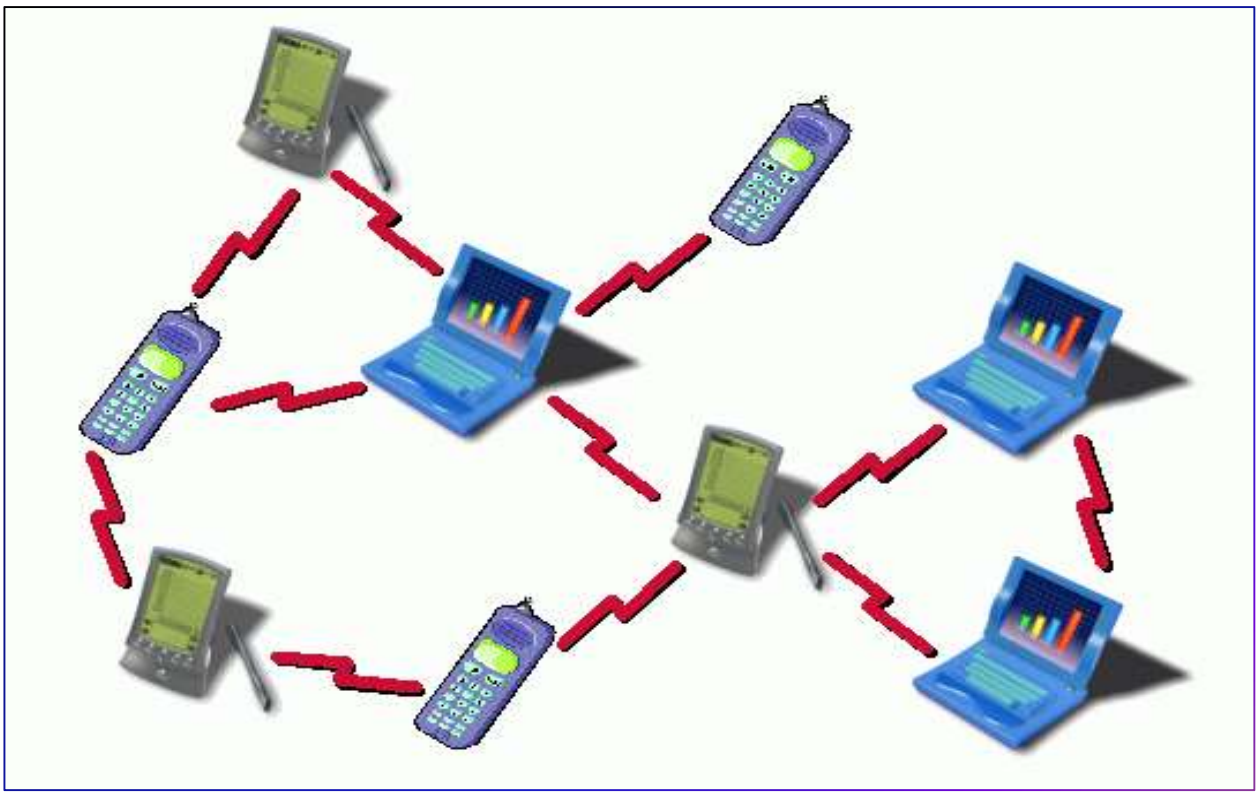

Figure1.1 Mobile ad hoc network

The environment of communication of moving users is not a fixed wired infrastructure, but users want to communicate in this type of situations. For example, a team of researchers on the way to a consultation may get together at the airport and requires to joins the WAN, students may necessitate interacting throughout a lecture, or firefighters call for to join to an ambulance on the way to acalamity sight. In such conditions, a cluster of mobile nodes throughwireless network interfaces can create an impermanent network not including the help of any well-known

communications medium or central administrative node. The idea of making such types network is possible these day because many mobile devices such as mobile phones andlaptops come with high CPU processing power, large storage capacity(HDD) hard disk drives, and high quality sound and image. So a network can be created among students, researcher, and a rescue team member without infrastructure using these powerful devices. Such networks are used in both commercial and military fields, because of its more attractive properties of establish a network without using a pre known infrastructure such example is a base station or central administration.

Internet Engineering Task Force (IETF) formed a network with mobile nodes and named it mobile ad hoc network which is in short abbreviated as MANET [18]. The IETF group builds and grows Mobile Ad hoc Network specifications and use this on Internet. The objective of this group is to carry MANET with thousands of nodes and resolve disputes of wireless networks. Some short of challenges that wireless networking faces are inadequate such as ad hoc range of transmission,unknown terminal problems, information loss because of network transmission problems, mobility-induced path changes, and power consumption constraints. MANET could increase the service range of utilizing networks resources and gives wireless network access into the areas where network or with poor coverage.

To get better performance, the ability of moving nodes should have to become accustomed to changes in performance and always be active toggle gateways when helpful.To improve the forecast of the most excellent taken as a whole performance, a network-layer metrics have a superior impression of the network. Ad hoc networking providessome well features such as simple links to access networks, dynamically changing structure of multihop networks, and direct hop-to-hop communication. An ad hoc network can connectto a wired backbone using gateways. The gateway must has capability to interface with network on both multi hop and wired backbone networks and should be a component of both the local and global ad hoc routing.

1.1 Difference between Cellular and Ad hoc Network

Cellular network is an ad hoc network. The topology of this network can be defined so this is a network with planned infrastructure [15].

There are some differences between cellular and ad hoc network given in table 1.1

Cellular network	**Ad Hoc Wireless Networks**
It is a infrastructure networks	It is a network which infrastructure is not defines previously.
This is a permanent, pre-located cell sites andbase station.	This is dynamic in nature and does not have base station, and has random deployment.
Network topology is static.	Network topologies changes dynamically with multihop.
It provides relatively reliable environment andstable connectivity	It's environment is hostile(noise, losses)and irregular connectivity
Before installing base station a detailed plan is needed	There is no requirement of detailed plan because ad hoc network automatically builds and adapts to variations.
The resources are very costly so very high cost for setup cellular network	It is relatively very cost-effective
It require a big time for setup	No large time require for setup

Table1.1 Difference between cellular and Ad hoc wireless network

1.2 Mobile Ad hoc Network(MANET)

MANET is abbreviation of Mobile Ad hoc Network. It is a group of mobile nodes which moves randomly within the transmission area. There is no central administrator to control activity of node and network. Mobile ad hoc networkcan be called as mobile mesh network. MANET is a network has capability to self configuration. A mobile ad hoc network is a collection of mobile devices, a router which consist multiple system and ad hoc communication devices. The ad hoc communication devices such as transmitters (Tx) which is used to transmit data, receivers (Rx) for receiving data and smart antennas for provide direction to data. These antennas have various configuration device of network can be permanent or mobile. The term mobile node referred to as

a device which is independent from movement constraints and can move I every direction. Some examples of nodes are a mobile phone, laptop, PDA, MP3 player and PC. These nodes help to connect people the cars, in the ships, in the airplanes [18]. Devices can communicate each other arbitrarily and making random topologies. If one cannot able to connect destination node directly then it send the packet to intermediate nodes and these intermediate node can work as router. This type of network is best suited for instant requiring of new connections, this is done because of its self configuration property.

There is a lot of research has been done on mobile ad hoc network but Internet based standards does not completely formed. Request for Comments, experimental identification is used since 2003 [1]. In these RFCs, there is no answer about the routing protocol implementation and deployment.Broad research works are going on several MANET routing protocols. Some routing protocols are used in my thesis work, Ad hoc On-demand Distance Vector (AODV), Temporarily Ordered Routing Algorithm (TORA) and Optimized Link State Routing (OLSR) [1][14]. Along with memory usage of simulator at the time of simulation is also analyzed for each use routing protocols.

1.2.1 Challenges

Topology of mobile ad hoc network changes randomly with time so used network must have capability to deal with this dynamic changes. One main difficulty in Mobile ad hoc network is to design the mobile nodes. These design models should have capability to design the behaviors of Mobile ad hoc network because it has different mobility and transmission ranges of nodes [15].

The cost such devices are very less in costly military vehicles for insensitive conditions. Scientists and researchers main motto is to get better the function quality and reduce the resource which is used in Mobile ad hoc networks through analyzing different topics of communication layers. The analysis work may have theoretical and experimental studies that approved the supremacy of the analysis work. The experimental work have to expensive so it is not affordable to researchers so to test the hundreds of mobile node placed in large areas is another big challenge in mobile ad hoc network: for facing this problem researchers use suitable simulation test beds.

1.2.2 MANET applications

MANET has various fields of applications. Some of them discussed below.

- **Battlefield:** Soldiers communicate with vehicles using ad hoc network at the time of war. The soldiers use some hand-held devices to communicate with other soldier to transmit information about enemy or some other reason. The vehicle mounted devices can be prepared with battery sources which is reusable rechargeable.
- **Rescue mission:**MANET can be applied in some rescue operation such as fire fighting or in scenarios such as fire fighting or flood rescue operation. MANET is used for these types of rescue operations because it can be implemented very fast. This type of rescue operation uses ad hoc network for communication.
- **Event Coverage:**Mobile ad hoc network is used in such type of scenario like a press conference. In such type of scenario reports needs to share data or file to other reporters. In such type of scenario multimedia data also shared with moving devices like laptop and PDAs, etc.
- **Classroom:** Mobile ad hoc network can be used in classrooms to share data from teacher to students by setting up an ad hoc network using laptops.

1.3 Ad Hoc Routing Protocols

Routing protocols are the set of rule that is used to find the route between source and destination. There are three types of routing in mobile ad hoc network. Reactive Routing Protocols (RRP), Proactive Routing Protocols (PRP) and the third is the combination of these routing protocols known as Hybrid Routing Protocols (HRP) [8].

1.3.1 Proactive Routing Protocols

Proactive routing protocol is the MANET routing protocol in which routes are maintained constantly between each node of the network [20]. Routes are checked periodically manner and if there is any fault then routes are maintained by creating new route. Two main proactive routing protocols are OLSR and DSDV [14].

1.3.1.1 Optimized Link State Routing (OLSR) Protocol

Optimized link state routing protocol (OLSR) is a highly used proactive routing protocol. A table-based approach is used by OLSR routing protocol.

The topological information moves from one to other node in the network regularly. In OLSR, there are two types of node. One is single point relay node and other is multipoint relay node

(MPR). The movement of control traffics in entire network is the primary task of multipoint nodes [20].

An efficient method is used by MPRs nodes to flood the control information throughout the network by decreasing the count of transmission necessity.Selecting the MPRs node is also tough task because when select the node as MPR then we are generally doing that to give information about link state for these MPR nodes. In OLSR, when a node select MPR node then the responsibility of this node is to acknowledge all other node to about this MPR node by control messages which are generated periodically. MPR node responsibility is to provide a suitable and efficient route from source to destination. A node selects MPR node among its neighbor nodes by creating a **symmetrical**links. OLSR sends information from source to destination by using hop-by-hop routing. In this technique every node of the network uses the local information to provide the path for packets. OLSR performance is best for large network as compared with small networks

1.3.1.1.1 Multipoint Relays (MPRs)

MPR nodes decrease the number of retransmission of message within specific reason by which the network overhead goes low. The below figure show the MPR nodes. Each node selects a group of other nodes that are symmetric with this node to its one hop neighbor. These nodes are used to retransmit the message of source node. This group which is selected by node is the set of MPR nodes [15].

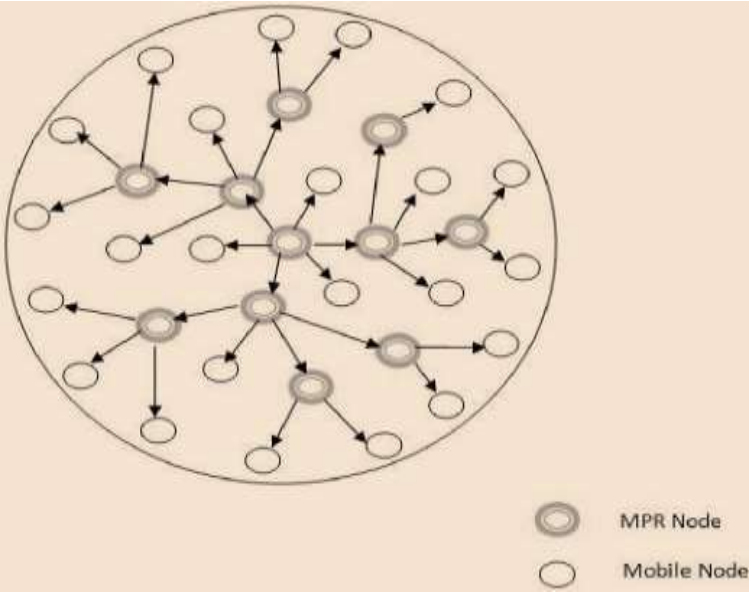

Figure 1.2.OLSR nodes

1.3.1.1.2 Functioning of OLSR routing protocol

Specifically, the core functioning is built by these components.

- **Link Sensing**

Link sensing is the function of OLSR routing protocol to check the link by generatingregularly Hello message over the network. Every interface requires a fresh and separate message.Link sensing describes the connection between **remote interface** and **local interface**. This connection is the link of neighbor node. Hello message exchange can be decrease by receiving the link information from link layer sufficiently

- **Neighbor Detection**

If in the network there are nodes having only single interface then the neighbor set detection is done directly by exchanging the information as a part of link sensing. In this technique, the main address is defined for single interface node will be the address of interface that is only on that node. If the network has nodes with multiple interfaces then in this situation other information is necessary to add with interface addresses with main addresses of nodes.

Multiple Interface Declaration (MID) messages contain this addition information.

- **MPR Selection and MPR Signaling**

MPR nodes are the collection of neighbors nodes of a node and MPR node are used to retransmit the broadcast message. This retransmitted message is received by all MPR's neighboring nodes. MPR nodes are selected after a certain time interval by sending Hello messages.

- **Topology Control Message Diffusion**

Topology control (TC) messages are distributed within the network for the motive to give enough link state data to give permission for path calculation.

1.3.2 Reactive Routing Protocols

Reactive routing protocol is a type of mobile ad hoc network routing protocols. In this routing the path between nodes created only when the communication occurs between nodes. When one node wants to send information to other then route discovery process occurs. This is beneficial for network to reduce overhead of network and it save the unnecessary bandwidth utilization. There are so many reactive routing protocols: ABR (Associativity-Based Routing), AODV, SSR (Signal Stability Routing), TORA, and DSR etc.

AODV is another protocol which is implemented after reducing some disputes of the DSDV protocol. AODV routing protocol reduces the count of route broadcasts by creating paths on demand, as contrasting to preserve a full list of routes as route discovery and path maintenance in DSDV algorithm. Route discovery process is initiated on demand, as in DSR protocol for a route from source to the destination [14].

In TORA, initialization of routing is done by source node so it is also known as source-initiated routing protocol. Routes are created when needed so it is an on-demand routing protocol. This routing protocol is based on the concept of link reversal of the Directed Acyclic Graph (ACG). In addition to being loop free and bandwidth efficient, TORA has the properties of being highly adaptive and quick in route repair during link adaptively and quick in route repair at the time when links between nodes have been failed. When this condition occurs then multiple routes are created for any preferred source–destination pair.

1.3.2.1 Ad Hoc On-Demand Distance Vector (AODV)

AODV is a MANET reactive routing protocol. The routes are created for nodes to send and receive information only when the demand for route in the network by node. It is a novel routing algorithm for the process of mobile ad hoc network. In this special type of routing the intermediate nodes works as router and get routes as it required. This routing protocol is more suited for self configuring networks as in ad hoc network. This provide loop free routing if routes are repaired after links have been failed. AODV do not share routing table data with other nodes in periodic time. AODV reduce the bandwidth requirement for routing the information as compared to the protocol that advertize the routing information on a fixed time interval.

A symmetrical link is used for routing information, between neighboring nodes. AODV routing follows only that path in which all nodes communicate with each other. In this routing a node cannot search and maintain the path of other node until both node will not come to ready for communication.

When mobile nodes want local connectivity with other nodes then each mobile node is responsible to alert of the other nodes in its neighborhood by the use of several techniques, including local (not systemwide) broadcasts known as Hello messages. In this routing, each node has routing tables and these tables of the nodes within the neighborhood are ordered to optimize response time to local movements and offer quick response time for requests for establishment of new routes [10].

AODV routing algorithm has to main function for routing the information in the network.

- Path discovery
- Path maintenance.

1.3.2.1.1 Path Discovery

The first step to forward a packet in the network, the source node checks it table for route information if there is a route information available from source to destination and it is live then it sends information to destination [21]. In case, when the information of routes, are not available then path discovery process followed by nodes.

Path discovery message contains information:

- The sequence number of message broadcasting node and
- A broadcast identification number (ID).

Path discovery in AODV protocol is done by broadcasting the Route Request (RREQ) message and Route Reply (RREP) message [1]. Path discovery is initiated by source node to broadcast these messages to its neighbor nodes. The figure shows the path discovery process.

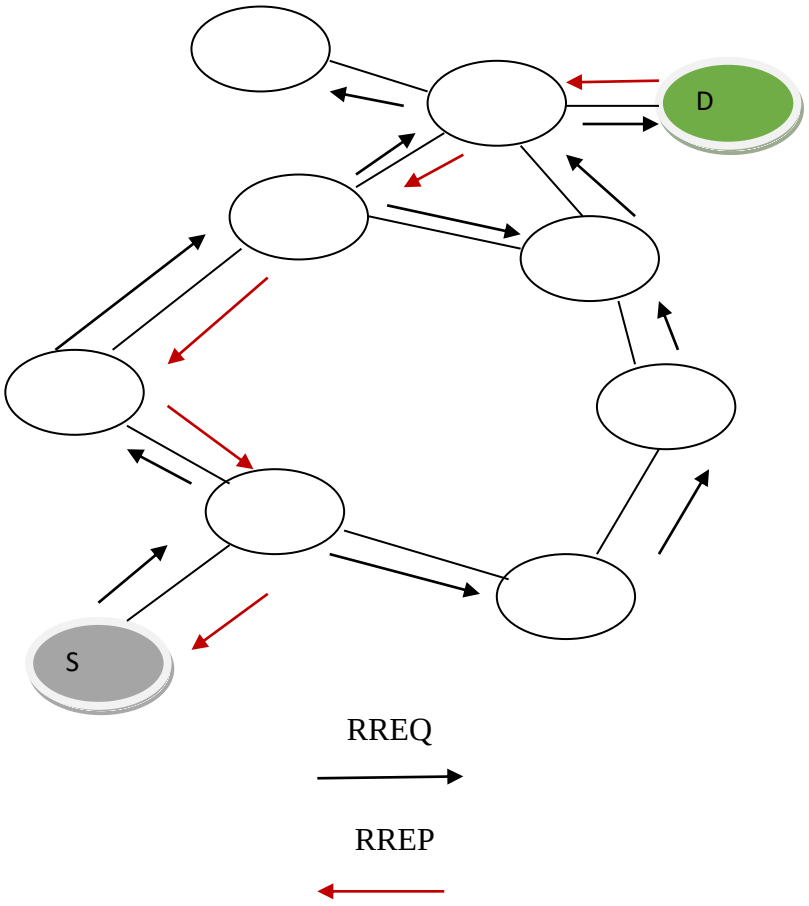

Figure 1.3: Connection establishment from source to destination in MANET using AODV

- **Reverse-Path Setup**

In AODV routing at the time of path discovery each node set a path in reverse to that node form where the request comes. RREQ message travel from multiple nodes and it create an opposite path automatically between source and destined node. For this process each node records the address of each neighbor node form where the 1st RREQ message received. This process takes time to set up a reverse path. So reply message get late to reach the source node.

- **Forward-Path Setup**

In AODV forward path is set by comparing the destination sequence number which is attached by source and which is stored in the intermediate node table. In this process the intermediate node which receives the RREQ message get the destination sequence number high from that value which is stored in its table then this node not replies but broadcast this message to other nodes. RREP message generated only when the node has the destination sequence number either equal or greater the number which is in the RREQ message. RREP message comes to the source node using reverse path setting. In this process each intermediate node updates its table for a route to destined node.

1.3.2.1.2 Path Maintenance

Path maintenance is other core function of AODV routing protocol. In ad hoc network, node moves randomly here and there. If the movement of node is not in the active session then this can not affect any path that is linked with destination. On the other hand if node moves in active session then it definitely affect the path then this node will have to reinitiate the path discovery from source to destination to create a new and fresh route from source to destination. In case when either intermediate node or destination nodes are in motion then a special type of route reply message is send to the source nodes. Hello messages are broadcasted in a regular time interval to check the symmetric links and for investigating the direct link failures.

Link failure is investigated if the packet is forwarded to the destination and it will fail so there it can be know that there is a fault in this route. If the route failure is detected then the node which detects the route failure broadcast a message to all other node by increasing the sequence number of the node with whom the link is broken. This message is propagated until all active nodes are not notified about this link failure.

1.3.2.2 Temporally Ordered Routing Algorithm (TORA)

TORA is a reactive routing protocol and it is also known as distributed routing protocol. This routing protocol is used for transmitting IP datagram among mobile or multi hop ad hoc networks. The technique used for TORA routing protocol is not based on distance vector and link state routing techniques. It is a **link reversal** algorithm. This algorithm is planned as temporally ordered sequence of distributing computational information. Every computation contains the information about the sequence of intended reversal links [15].

This protocol gives good result in a big and congested mobile ad hoc network. It is an adaptive routing protocol and it is very efficient and scalable in nature.

This algorithm' feature are -

- This algorithm can be used in distributed environment.
- There is no loop formation at the time of information exchanging between nodes.
- This routing implements multiple paths for decreasing the frequency usage when topologies are changes and reduce the burden of the network.
- It creates the path very fast before altering the topology.

In this routing, it is not necessary the path between source and destination is shortest path. It also does not maintain the route for all pair of source and destination at all times. TORA is createdto reduce the effect of topological changes. This protocol is designed to propagate the control message at the rate by which topology is changes.

TORA includes a secondary method, which permits important control message spread like a means of rare path optimization and soft-state path confirmation. This type of message distribution happens at very low rate and it is free from to changing the topology of networks. TORA is also a loop free routing protocol and it maintains the information of neighboring nodes.TORA follows near about same procedure as DSR routing protocol. When the source want to send information then the route is created from source to destination. In TORA not a single route is used for transmitting information. It provides multiple routes. It minimizes the communication overhead.

TORA works on the three basic functions:

- Creating routes,
- Maintaining routes and
- Erasing routes.

In TORA routes are created from source to destination using sequence of directed links.The route is created only when a node which does not have a direct link to destination.

This method is nothing only providing direction links from source to destination in undirected network. In creation of route a Query-Reply process is adapted that provides a DAG (Direct Acyclic Graph). This DAG graph gives the route for source node to connect with destination node. This DAG is known as destination –oriented DAG.

In route maintenance routes are created again within a finite time as the topology changes. This means the destination oriented DAG is recreated within constant time.

"Maintaining routes" refers to reacting to topological changes in the network in a manner such that routes to the destination are reestablished within a finite time—meaning that its directed portions return to a destination-oriented DAG within a finite time. TORA creates an algorithm to detect the partition of network.

The third function of TORA is erasing routes. In this function the invalid routes are deleted or erased. When the network partition is detected the there are some invalid routes are mark as undirected and these route should be erased.

TORA has three different control packets.

QRY (query): it is used for route request.

UPD (update): this is used for creating route as well as in route maintenance.

CLR (clear): this is used for erasing an invalid route.

1.4 Application Level Traffic for Network

There is a number of application traffic used in transferring information over internet like E-mail, File, Web pages, and audio and videos. Some applications are discussed here.

1.4.1 E-mail-

E-mail stands for electronic mail. E-mail is a means of communication over internet and has its own format and styles. It is used by people who can call up or write a letter to important person then he can write an email to that person.

In E-mail people can send picture as well as text individually or combining them and other.

In e-mail system, there is message transfer agents that are responsible for sending and receiving e-mail messages. They are also responsible for running the email servers.

In e-mail system**SMTP** (**Simple Mail Transfer Protocol**) is used as protocol to transfer e-mail over network.

There are **mailing lists** that are created by message transfer agents. In this mailing list the same copy of an e-mail is present that is transfer to an e-mail address.
There is a Mailbox which is used to store the incoming e-mails and notifications. Mailboxes are maintained by email servers.

1.4.2HTTP— HyperText Transfer Protocol

HTTP is a protocol that is used for web contents and applications. This protocol is standard for accessing and sending information related to web over network. HTTP is specified in RFC 2616.
HTTP runs over TCP (transmission control protocol). It is a request-reply based protocol in which client sent request and server reply for that request.

HTTP is a protocol which runs on the application layer of OSI. HTTP is linked with web. HTTP protocols are used to download the Antivirus software's update. It is used to get project files by developers.

1.4.3 VOICE

This is seen previously to send multimedia data over network is a big challenge like voice over IP and video-on-demand to every computer.

The traffic generated by audio and video over network require a large bandwidth. Today voice is propagated over internet so that companies down their cost of telephone bills. Voice data transferred over internet network

1.4.4 FTP – File Transfer Protocol

As the name suggest that FTP is used for transferring file over network. The protocol used in sending and receiving files from one computer to another or computer to server is File Transfer Protocol.

File transfer protocol software packages are comes in various varieties. FTP provides the security using encryption of your file over network. FTP protocol uses two type of message.

GET and PUT message: this message are used to initiate the connection between sender and receiver. CONTROL message: it is used to carry actual data from sender to receiver.

1.5 Aims and Objectives

Our aim and objective in this master thesis is to analyze the performance of AODV, OLSR and TORA mobile ad hoc network routing protocols against different applications such as E-mail, Ftp, Http and voice. The performance of routing protocols is analyzed with three performance metrics delay, network load and throughput. In this thesis our objective is analyze the memory usage of routing protocols with different applications. This analysis gives the result about which routing protocol is best with which application with medium level of mobile nodes. For analyzing we create a scenario with 70 nodes and one WLAN work station.

1.6 Research Questions

In mobile ad hoc network, the problem is that to choose routing protocols that gives best reliability and work efficiently for different traffic over network. The major questions occur for the analyzing of these problems.

First question arise that which mobile ad hoc network routing protocol gives most appropriate performance in MANET? This question's answer will provide the whole performance of each MANET routing protocol.

Second question is that what is the performance metrics to analyze the network routing protocols? In conclusion we deal with the most important key differences in these MANET routing protocols.

Third question arises about the performance. What is the performance of these routing protocols with different application of network? The answer gives the result to use suitable routing protocols with appropriate traffic.

Fourth question arise that what is the memory performance with these types of applications using the different routing protocols. This question's answer gives the solution for memory management to in routing protocols and analyzing the queue size for particular resources of routing.

To solve all problems we create a scenario of 70 mobile nodes and set same parameter for all these routing protocols. The performance analysis of these MANET routing protocols are evaluated with respect to delay, throughput and network load. We choose three routing protocols AODV, OLSR and TORA. The simulation is done on these fixed parameters using OPNET modeler 14.5 to evaluate the result.

1.7 Scope of the thesis

As we know that there are two categories of MANET routing protocols first one is reactive routing protocol and second is proactive routing protocol. Hybrid routing protocols are derived from taking merits of reactive and proactive routing protocols. This thesis, analyses the three ad hoc routing protocols in which one is proactive routing protocol i.e. OLSR and other two are reactive routing protocol i.e. AODV and TORA.

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The main work of this thesis to analyze the behavior of different routing protocols against different network traffic i.e. E-mail, Ftp, Http and voice when the network is created. We see that how these mobile ad hoc network routing protocols influence the network performance, and see the behavior of these routing protocol with different traffic in this network. The concern about design of these routing algorithms and analyzing the ad hoc protocols will not be our area of research work. These routing protocols are discussed above in short of detail. The pause time of each simulation is fixed. The variation of pause time is not our concern because it is not necessary to put variation in pause for our work. This thesis work is not to analyze the energy consumption of each MANET routing protocols.

1.8 Thesis structure

In this thesis we study the Mobile ad hoc network and its routing protocols. This thesis contains five chapters. Each chapter has its own importance. First chapter is the introduction which tells about the Ad hoc network and special focus on MANET and its routing protocols. This chapter

also contains aims objectives and some related problem.Second chapter is literature review which includes the previous study of MANET and related research work has been done. Third chapter is report on proposed work. In this chapter we provide detailed structure of our work and give simulation study. Fourth chapter is the overall study of practical work of my thesis. In this chapter analysis and result is discussed of my proposed work on the basis of some performance metrics and memory usage. Fifth chapter is conclusion and future work which gives the conclusion of my work and some related work for researcher in future.

Chapter 2: Literature Review

This chapter includes the Literature review and related work. In this chapter we study the research work that has been done over Mobile ad hoc routing protocols. This chapter also contains the study about performance analysis of wireless network routing protocols by researcher.

2.1 Related Work

There is a lot of work has been done on the research of evaluating the performance of various routing protocol of wireless network using NS2 simulator. Different strategy and methods are applied to evaluate the performance of mobile ad hoc routing protocol with different environment and each provides the different results.

A different type of simulator is used to analyze the different routing protocols, the simulator name is QUALNET [7]. The author evaluates AODV, DSR and OLSR routing protocol using this simulator and provide result that AODV outperforms over OLSR and DSR in medium and low density of node. OLSR and DSR show best performance in high density of nodes. The author wrote that AODV shows best performance in low and medium node density but in high node density both OLSR and DSR outperforms.

2.2 Review of Literature on Routing Protocol Performance

C. Murthy and B. Manoj

Ad hoc network is the group of moving devices and these devices uses the unguided media to communicate each other's. The implementation of this type of network is very easy and can be implemented any place and any condition. This is possible because these types of networks are infrastructure less and there is no need for central administration [24].

E. Alotaibi andB. Mukherjee

In this paper a general study about routing algorithm for wireless network is presented. There is a lot of difference between wired routing and wireless routing. Wireless routing has its own paradigms and challenges. In wireless routing channel characteristics changed time to time. Another problem is interference which affects the transmission of information from source to destination [25].

In the starting some basic routing algorithms are designed to control traffic of wireless network. Early stage routing protocols are DSR and AODV.Hence, the study of wireless routing algorithm is necessary to overcome from the above given problems. This paper compare some routing protocols and give result which routing protocol is best suited for wireless network.

K. Gupta and H. Sadawarti

This paper contains the various types of ad hoc routing protocol and their brief explanation. In this paper author evaluates the routing protocol after comparing their characteristics.

The ad hoc routing protocols are of three types:

-Routing through source node (reactive or on-demand),

-Routing by table-driven approach (pro-active),

-Hybrid protocols.

Path discovery and path maintenance are different for each routing protocols. Designing the routing protocol is a big challenge for the purpose of providing security in routing protocols. This paper taxonomy is helpful in choosing correct routing algorithms for their work [22].

This paper provide conclusion about entire characteristics and features of all ad hoc routing protocols and this paper compare the routing protocols with different performance parameter and gives result which routing protocol is best suited in vast network. There is a lot of work can be done on the security and changing topology of ad network because no protocol is fully secured.

S. Chellathurai *et al.*

MANET is very big area for research and we can see that a lot of work has been done in this area. The main area of research in MANET is routing and security. Mobile ad hoc network does not have any type of infrastructure or any centralized administration so an efficient and fast routing protocol strategy is required. There is one more challenging task in ad hoc network that is the issue of mobility and limited resource.

The improvement of routing protocol is required for efficient routing. Determining the performance of a routing protocol is very tough task under different topology and different network scenario. The conclusion of this paper is to analyze the different characteristics and functionality of already routing protocol [9].

T.Singh *et al.*

In this paper the performance of already present routing algorithms are compares bytheir limitations, functionality, characteristics and benefits. This paper concludes that DSR performance is best for these constraints. In this paper it is also conclude that DSR has low routing overhead than Ad hoc on demand distance vector (AODV). End to end packet delay is high in AODV routing protocol. High mobility of node gives less PDF (packet delivery fraction) for DSDV routing protocol. When mobility goes high then DSR performance goes low because route change occurs very fast. If the node is overloaded the route failure can be occur. The node can go in dead condition if the energy of node goes low. This problem of energy can be solved by sending energy packets to that node which has less energy or can be maintained by recording the energy level of that relaying node [3].

O. Tonguz, G. Ferrari

Wireless communication has many fields on which research can be done. Mobile ad hoc networking is one of them. This field is also provides a large number of area for work. Some areas are like ad hoc network used in military, sensor network for environment, biomedical network and ad hoc network for car based system etc.

Ad hoc networking is a new area in wireless communications that is going to prevail in the subsequently a small number of decades. MANET technology has good application for both military and civilian if both field has good understanding this technology. Such as military ad hoc networks, car-based ad hoc networks etc. The performance of wireless network's physical layer strongly depends on higher layer performance of physical layer boundaries and capabilities. Ad hoc wireless network provide an experimental model for communication between physical layer and higher layers [4].

J. Wang *et al.*

This paper is a study of security on routing algorithms. This paper gives a secure routing algorithm overview named as Secure Destination-Sequenced Distance-Vector (SDSDV) routing protocol for ad hoc network. This routing protocol is derived from DSDV protocol. In SDSDV protocol all node give importance for two one-way hash chains for each node in the network. AL (alteration) field and accumulation (AC) field are used to carry hash chain values. These two fields are added at each entry of the update packets [5] [26].

If elements of these fields are used in proper way then path can be saved from random changes. SEAD (Secure Efficient Distance Vector) protocol has evaluated already in literature a full protection on network [5].

Maan*et al.*

Mobility is the key concept of Mobile ad hoc network which provide a wide range of difference from other wireless and wired network. Routing protocols of mobile ad hoc network are designed I such way that throughput and packet delivery ratio is high to the network and end to end delay, energy consumption and routing load for protocols are low.

MANETs is, therefore, to attain best standards of concert parameters beneath arrangement of different scenarios where nodes are established on dissimilar kinds of mobility that vigorously alter the network topology. This paper objective is to compare various existing routing protocols and evaluate the performance of each routing protocols under mobility models using NS2 network simulator [6].

Chapter 3: Proposed Work

3.1 Analysis ofdifferent Proactive and Reactive Protocols

This chapter describes the scenario of MANET routing protocols. This chapter also describes the different performance parameter metrics which is used in the analysis.

In this chapter simulation design of network also discussed.

3.1.1 Performance Parameters

Performance parameters are the entity that is used to analyze the performance of the network. Here we use three types of parameter to analyze the performance of routing protocols with different traffics. These parameter values are different in whole the network analysis process.We use these three different parameters are such as throughput, network load and delay. Routing protocols are used to search a route from source to destination. Control messages are sent by source node. Efficiency of internal algorithm of routing protocols is measured by control message counts. If routing protocols has high end to end delay then this protocol is not efficient as compared with that which has low end to end delay. For network load, the routing protocol that shows less network load has better performance than which has high network load [17]. The routing protocol with high throughput is more efficient than which has low throughput.

3.1.1.1 Delay

Delay is the time duration from the time when packet is generated by source and accepted by destination. In this time duration packet moves across the network.Delay is measured in second at the time of simulation. Hence all the delays of network are known as packet end-to-end delay, such as transmission time and buffer queues. Latency is other name given to delay. Latency meaning is same as delay. Voice application is sensitive to packet delay. So the voice needs a less average end-to-end delay in the network. The File Transfer Protocol is forbearing to a confident stage of end-to-end delays. Some activities increase the network delay. Delay is a computation ofa routing protocol that tells about how these protocols adapts to a variety of constraints in the network to provide reliability of the MANET routing protocol. There are different types of delay such as queuing delay (QD) which is not included as the network delay concern with this[16], propagation delay (PD), processing delay (PRD) and transmission delay (TD).

Assume if we have N number of mobile nodes then total end-to-end delay can be find by taking the average values of whole packets, network configuration and source destination pairs.

3.1.1.2 Network Load

Network load is the total load of network which is delivered to WLAN layers from other higher layers in every wireless local area network nodes [23]. Network load is measured in bits per second (bps). Network feels load on it when a lot of data delivered by source the destination does not have as such capability to receive the data with same rate so that it is hard to manage this load by network so it is known as network load. A network can be efficient if it handle the high traffic coming from higher layer easily. For improving the network performance, there are many methods have been evolved.

Mobile ad hoc routing packets are affected by high traffic on the network. Because of high traffic, delivery of packet is affected so that packet reaching to the channel takes more time [27]. The result is collision of control packets increase. Network load is shown in the below figure 3.1.

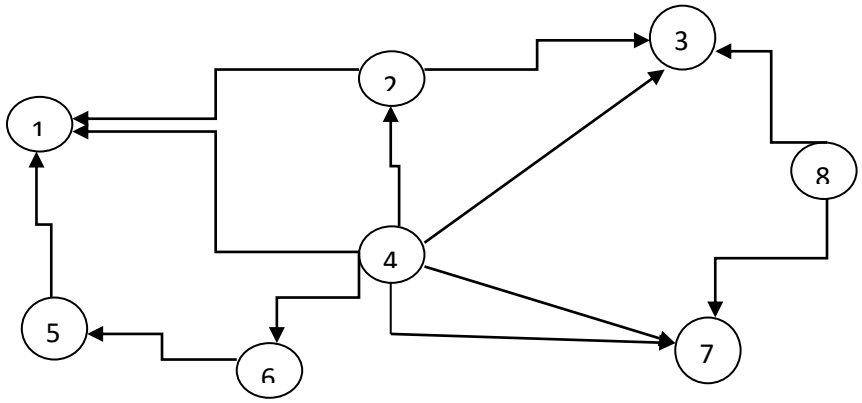

Figure 3.1Network Load

3.1.1.3 Throughput

Throughput is also measured in bits per second (bps). The definition of throughput can be given as it is the ratio of total data that isreceived by receiver to data send by sender. Throughput is the time duration by which receiver receives last message [11]. There are some factors that influence the throughput as; if the topology changes randomly in the network then reliability of communicating nodes affected, bandwidths are limited in the network, the nodes have limited

energy [11]. If throughput is high then the network efficiency is also high. The mathematical representation of throughput is given below.

Throughput = (Number of Delivered Packet*Packet Size)/Total Duration Of Simulation Time

3.2 Simulation Tool

Today computer networking is also the field of research because every organization has network of fixed or mobile devices. This field grows exponentially. Itis therefore essential for institutes and universities to recommend networking courses to students. Because of several obstacles it is not possible for a institute or university to provide different types of networks to its students. A network simulator is the solution of this type of problem which is available free or not more costly. OPNET Modeler is kind of network simulator that gives the tools for designing, modeling, simulating and data mining and analyzing network with suitable cost. OPNET Modeler has capability to simulate different types of networks that are connected together. The students can easily analyze the network nodes and effect of their activity and these results are so clear and visible to students. The activities of network such as link failure, packet losses, bit errors, data message and, control/routing message flows etc can be visible with suitable speed.

In this research work, we are simulating a MANET network using OPNET modeler v14.5 [2]. OPNET stands for Optimized Network Engineering Tool. OPNET modeler has several feature tocreate networks and its applications e.g. planning, network engineering, network operation, performance management, research and development (R&D). OPNET modeler v14.5 is planned for structuring communicating node,protocols, technologies, and to simulate the performance of such technologies. Optimized Network Engineering Tools are used in academic research like measurement and enhancement of ad hoc network such as Universal Mobile Telecommunication System (UMTS), Worldwide Interoperability for Microwave Access (Wi-MAX) and Wi-Fi. Designing and evaluating mobile ad hoc network protocols, examination of optical network, and development in the center network technologies like Internet Protocol v6, MPLS, and battery power managing schemes in wireless sensor network [2]. In these days, Optimized Network Engineering Tool is very helpful software in research areas. Four steps are used to understand the working of OPNET modeler. The initial step is the modeling that means to form network model. The second step is to choosing and selecting statistics for analyzing results. The 3rd step is

simulation which means to run scenario of the network. The 4th is the last step and named with view and analyze results. All these steps are followed by researcher for every scenario. Below figure 3.2 shows the flow diagram of activity which is done by people.

3.2.1 Building Model for network

For building network model you have to run OPNET modeler 14.5.After running the OPNET modeler 1st step is to create a blank scenario from the start-up wizard window. After doing this a project editor work space is generated for designing the model. The network can be design by two way first it available automatically and the other method design it manually. In 1st method the topology is generated with rapid configuration automatically. In 2ndmethod different types of object as required dragged from object palette window on the workspace. In this simulator there are few existing network scenario which can be used by network designer directly from the computer hard drive. But ad hoc network designed by the user it can be imported [12]. When the designing of network is finished then node configuration will be started. Node configuration can also be done by same as network modeling using automatic or manual method. In automatic node configuration all the parameters of node predefined. User can define it own parameter for each node manually.

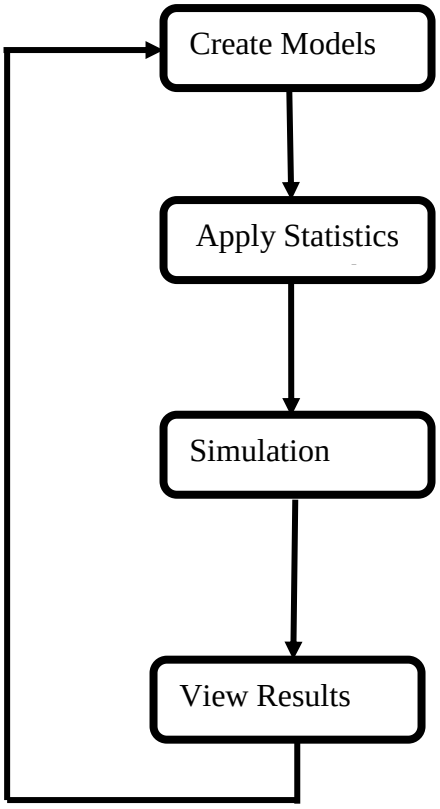

Figure 3.2 Flow diagram of simulation process

3.2.2 Simulation results and Statistics

Simulation results are the result that is generated after running the network scenario. These results are represented in the graphical manner. In OPNET modeler, there are two types of statistics available. One is global statistics and other is object statistics. In global statistics, statistics data are collected from whole network. In object statistics, statistics data are collected from particular nodes as user want. User can see the object statistics with their choice. The result of these statistics are viewed and analyzed.

To see the result of scenario, it is very easy. There are two methods for seeing result. First go to project editor workspace and right click on the workspace a select panel will opened, choose from there to view result. The other method is to see result, go DES tab shown above and click on that tab. A select menu will be seen; select go on result and after that select view result. After doing this correctly result Browser window is opened as shown in figure 3.3.

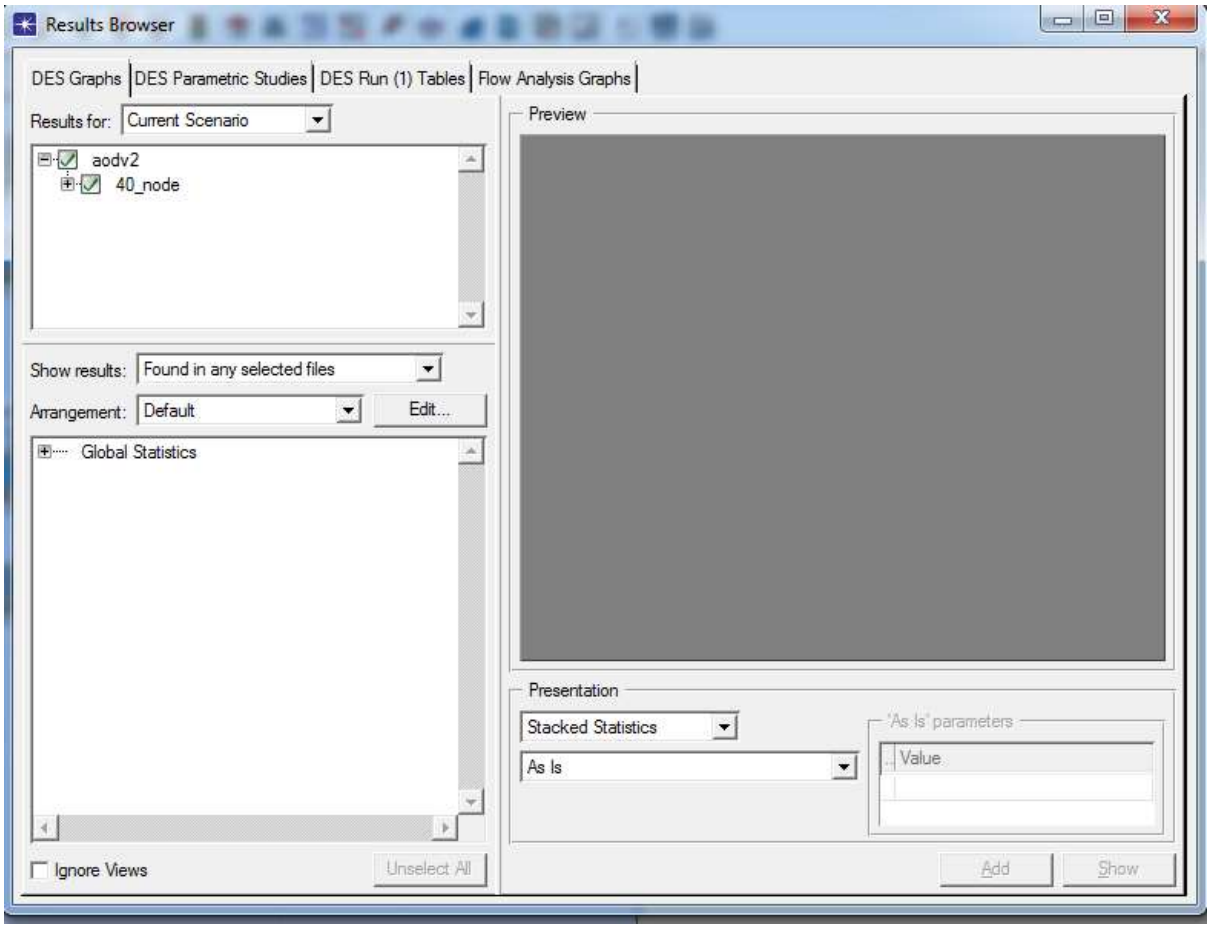

Figure 3.3OPNET results browser

3.3 Simulation environment

We are using OPNET modeler version 14.5 to generate mobile ad hoc network scenario. In this thesis only one scenario of 70 mobile nodes created for all three different type of routing protocols. The scenario of our simulation is shown in figure 4.4 below. In this scenario we can see 70 mobile nodes, WLAN wireless server (fixed), application definition, profile definition and mobility definition nodes are place single project editor workspace. This scenario is same for AODV, OLSR and TORA with different application level traffics.

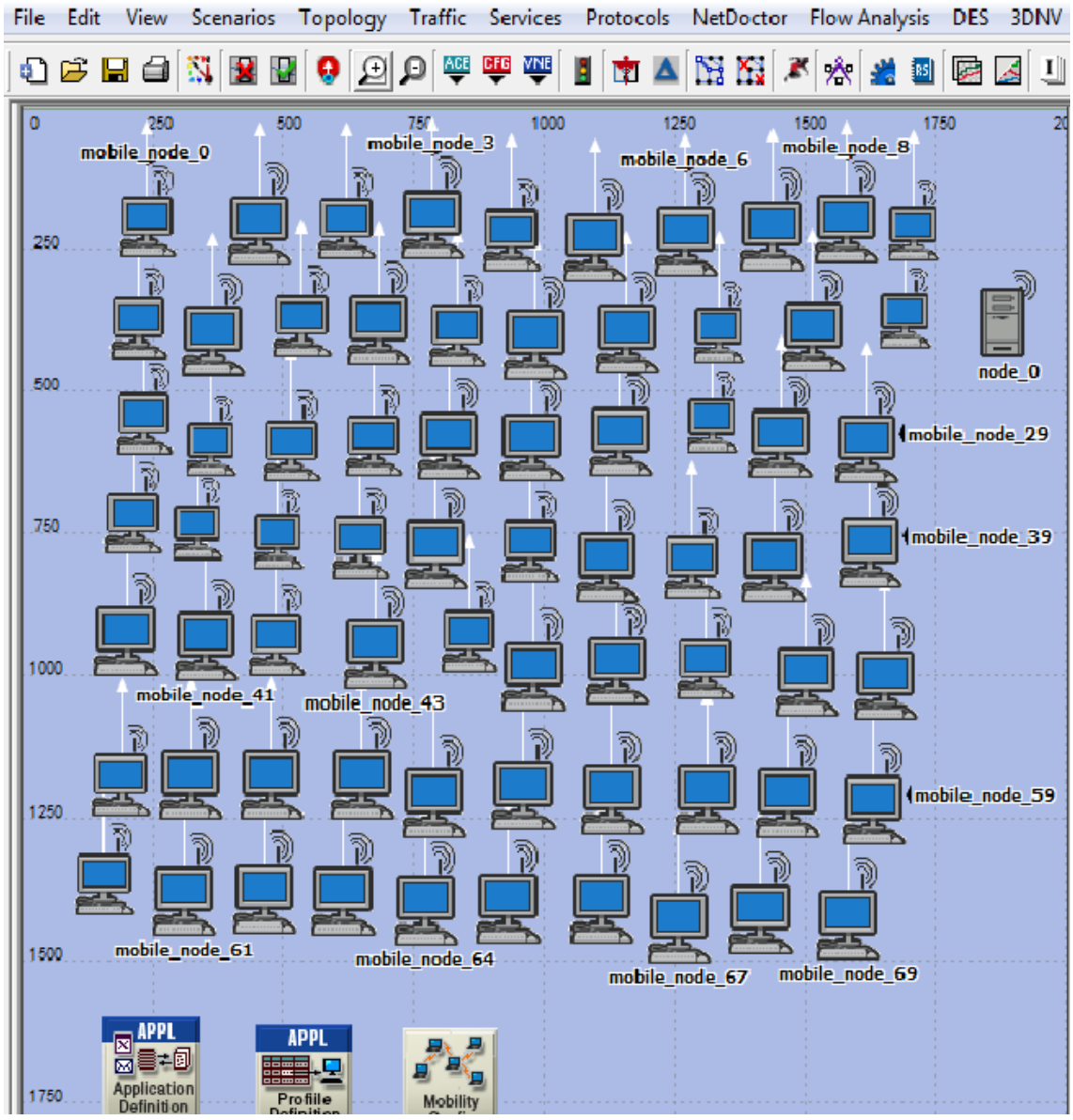

Figure 3.4Scenario for simulation

In this scenario we modeled a campus network of 2000m X 2000m. All the nodes move this limited area. We analyze the behavior of AODV, OLSR and TORA with different traffics such as E-mail, FTP, HTTP and voice.

PARAMETER	VALUE
Simulator	OPNET 14.5
Area	2000X2000(m)
Number of nodes	70 node
Mobility model	Random way point
Application Traffic	HTTP,FTP,E-MAIL Voice
Packet reception power threshold	-95
Simulation time	360 sec
Address mode	IPv4(auto assigned)
Start time offset	Constant(100 sec)
Pause time	Constant(10 sec)
Speed	50 (m/s)
Data rate(bps)	11 Mbps
Transmit power	0.005 W
Buffer size(bits)	256000

Table 3.1 Simulation parameter for above scenario

We simulate this scenario and get multiple graphs for delay, network load and throughput for every traffic and routing protocols. The parameters are selected for this scenario is shown above in table 3.1 [13].

Chapter 4: Analysis and Results

4.1 Analyzing Results

In this chapter we will discuss about the behavior of mobile ad hoc network routing protocols with different traffics. We will also analyze the memory usage by each routing protocol in different situations. We will analyze AODV, OLSR and TORA routing protocols with E-mail, FTP, HTTP and voice. We select three performance metrics for analysis delay, throughput and network load. The result of simulation is shown in graphical for which can be average or as is. In this thesis we use a scenario of 70 mobile nodes and use this scenario for different cases.

4.1.1 Simulation and setup of scenario

The scenario in figure 4.1 can be set by using these objects and parameters. In this scenario 70 mobile nodes are placed in workspace using object palette. Mobile nodes are chosen because we have to make mobile ad hoc network. On fixed Wireless LAN server is used to replying for each requests. The server and mobile nodes are assigned IPv4 addressing (auto). The area of nodes mobility is 2000mX2000m. The application definition node is selected for generating the traffic in the network. We use HTTP, FTP, voice and E-mail traffic for each routing protocols.Profile definition is taken for processing these traffics throughout the network range. Mobility definition is used to define the movement of nodes in the network. The parameters are set according to the requirement. We analyze the network with high load. For deploying these setting on the scenario we choose protocol tab and go for Deploy Defined Application. In this scenario random mobility was set for mobile nodes. AODV, TORA and OLSR are analyzed using three performance parameter of network i.e. throughput, delay network load.

4.1.2 Analyzing simulation with E-mail traffic

For analyzing the routing protocols with email traffic in the scenario we change the application definition with email traffic and change the profile configuration also with respect to e-mail. The scenario made under the OPNET modeler 14.5. We chose delay, network load and throughput as DES statistics parameter and run this scenario for 360 second. After simulation we see the graph and save this result for calculation.

MANET routing protocols are analyzed by using these graphs statistical values and comparing the result of these protocols. The results are found very helpful in the statistical analysis of these routing protocols performance.

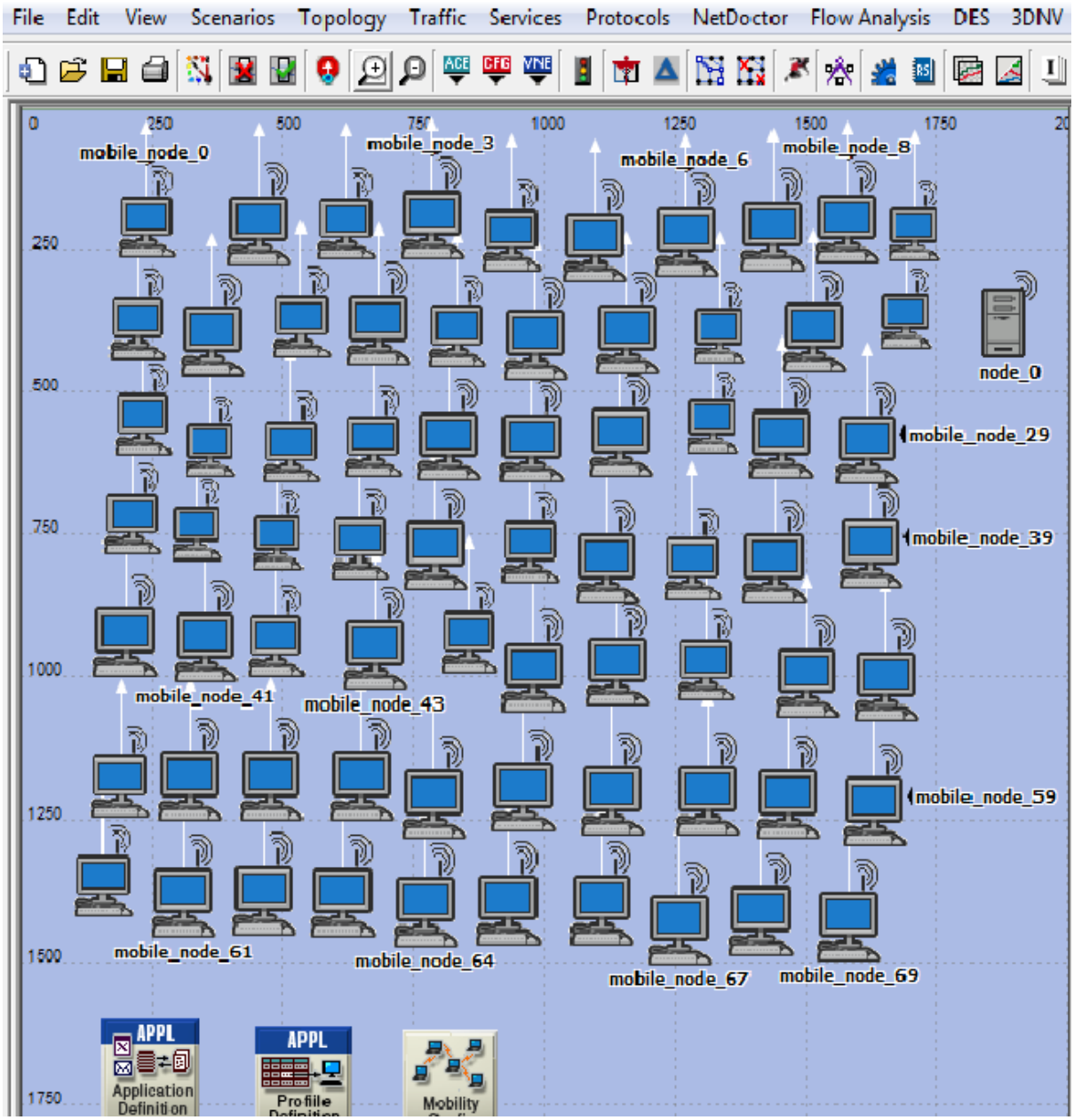

Figure 4.1: Simulating 70 nodes

4.1.2.1 AODV, OLSR and TORA performance with E-mail

The graph which is shown below is the graph of delay, network load and throughput. In this graph we compare the graph with e-mail traffic among these three routing protocols. The graphs are the average time function for each protocol. In this section we measure first delay then network load and at the end throughput. Minimum delay and network load is required to show good performance. Throughput should be high for network performance.

- **Delay**-The delay analysis graph is shown below in figure 4.2. In this graph X-axis measure the time in minute and Y-axis gives the delay time in seconds.

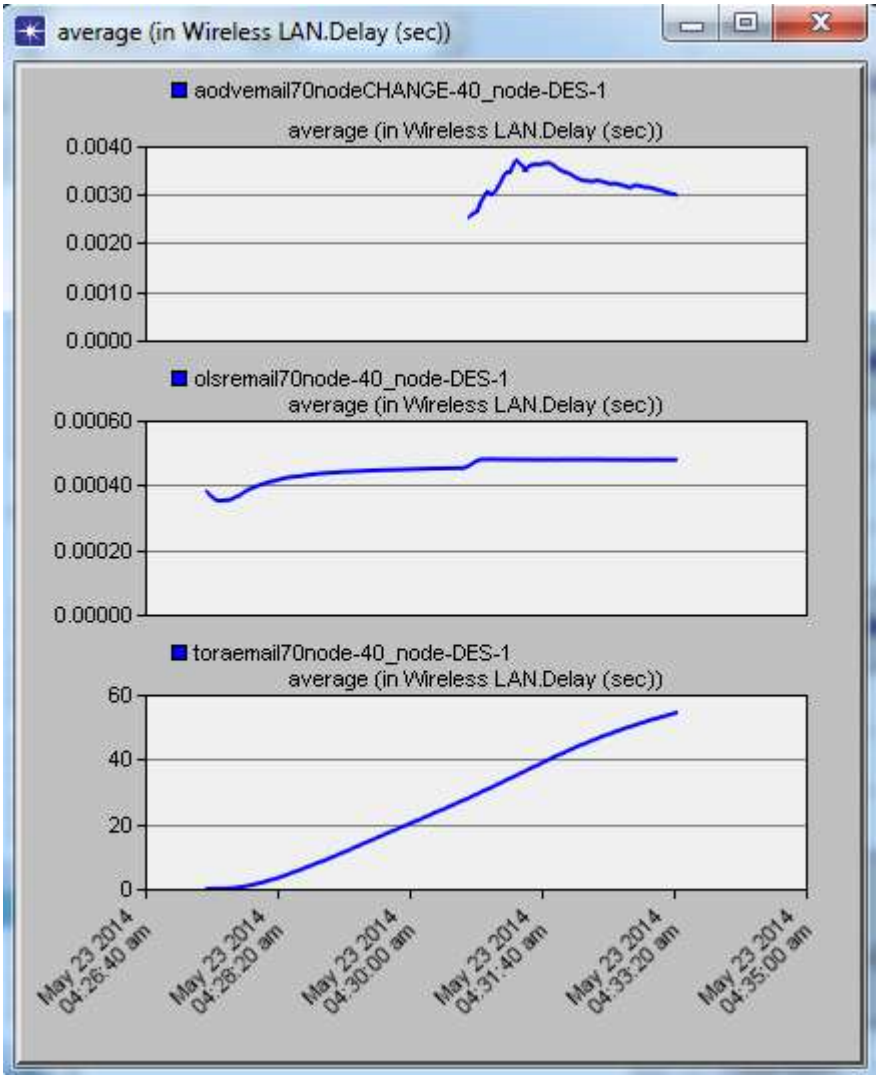

Fig 4.2 Delay with E-mail

We can analyze from the graph that delay is maximum for TORA routing protocol and minimum in OLSR routing protocol with e-mail traffic. So the result can be concluded that OLSR is best suited routing protocol with respect to email traffic.

- **Network Load –** The below graph shown in time and bits per second. X-axis represents time and Y- axis give the network load in bits per sec.

  In this graph the network load are maximum for TORA routing protocol and minimum

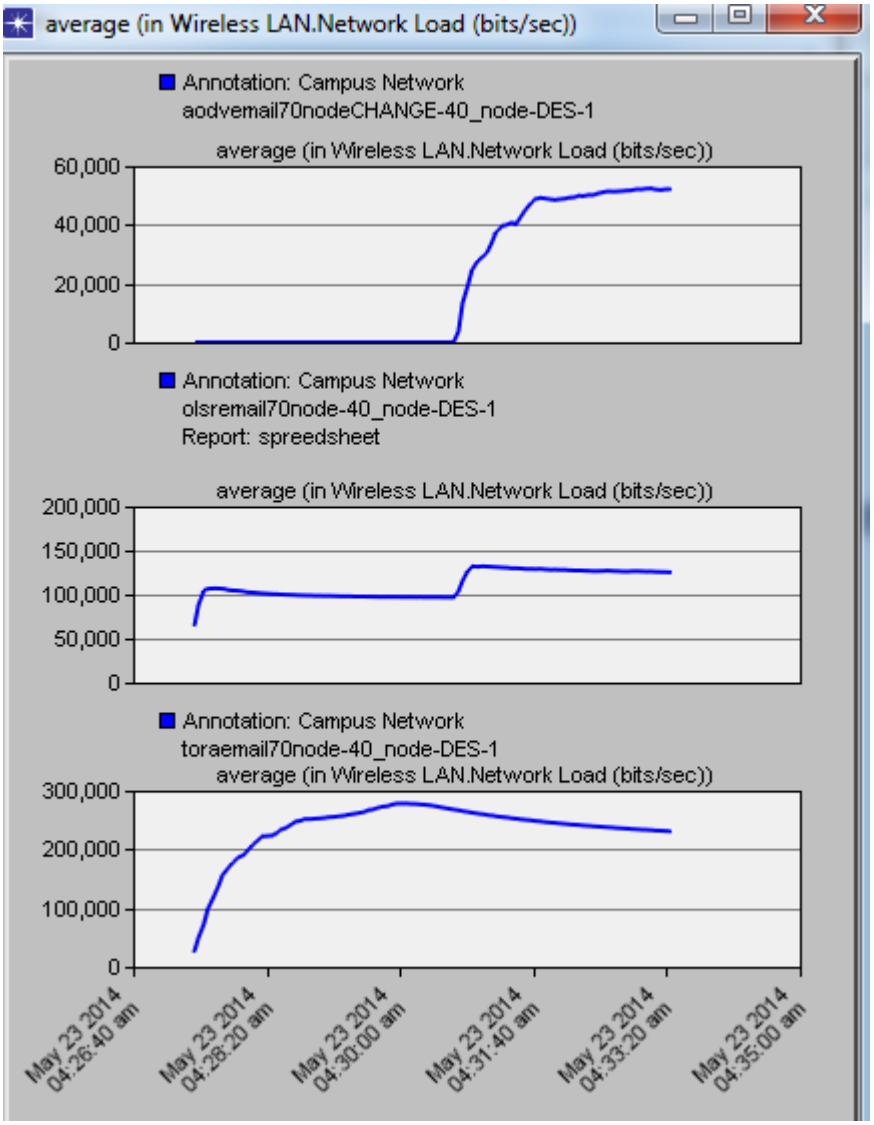

Figure 4.3 Network Load with E-mail

with AODV routing protocol. So less network load is beard by AODV routing protocol using email traffic.

- **Throughput-** The number of packets received by receiver correctly is called throughput.

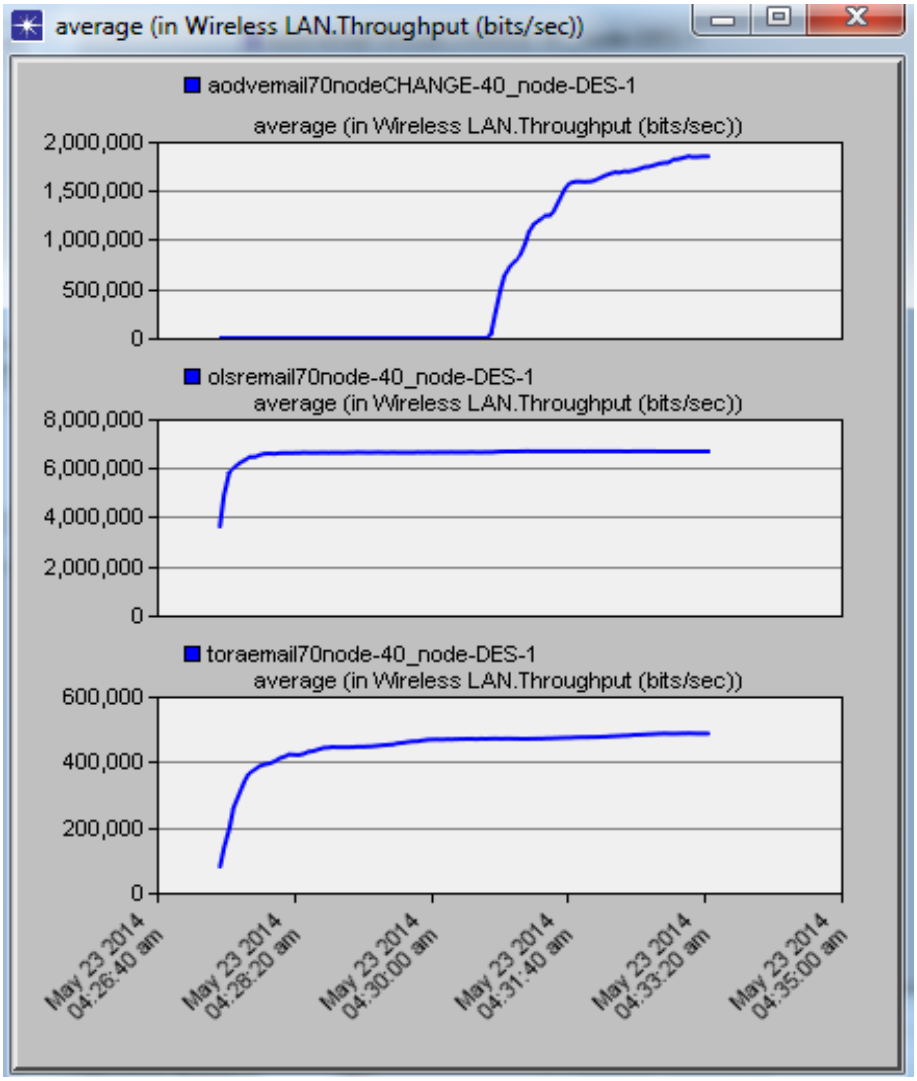

Figure 4.4 Throughput with E-mail

From the above graph it can be seen that throughput is maximum for OLSR routing protocol and minimum in TORA algorithm. So OLSR has best performance in the network carrying email traffic.

- **Analyzing results of delay, network load and throughput for e-mail-**

  In this table the maximum values are given for different performance parameters with respective protocols. The peak value is high for delay in TORA, for network load in TORA and peak value is high for OLSR throughput. So OLSR has best performance over AODV and TORA routing protocols.

Routing Protocols/Parameter	Delay (max) Sec	Network Load (max) Bits/sec	Throughput (max) Bits/sec
AODV	0.00371	52,382.037	1,850,771.759
OLSR	0.000479	131,995.932	6,689,616.225
TORA	54.4637	278,180.148	487,107.129

Table 4.1 Statistic data for routing protocol with E-mail

4.1.2.2 AODV, OLSR and TORA performance with FTP traffic-

In this section we analyze the routing protocol against Ftp traffic using same performance parameter as we have used above.

- **Delay-** delay graph is shown in figure 4.5 for Ftp traffic use for different routing protocols. By this graph it can be analyzed that the delay is maximum in TORA routing protocol and minimum in OLSR routing protocol. As we know that proactive routing protocol has less delay to transmitting packets. This is because of table driven approach of route discovery. So OLSR is best suited routing protocol for handling email as well as FTP traffic with respect to delay.

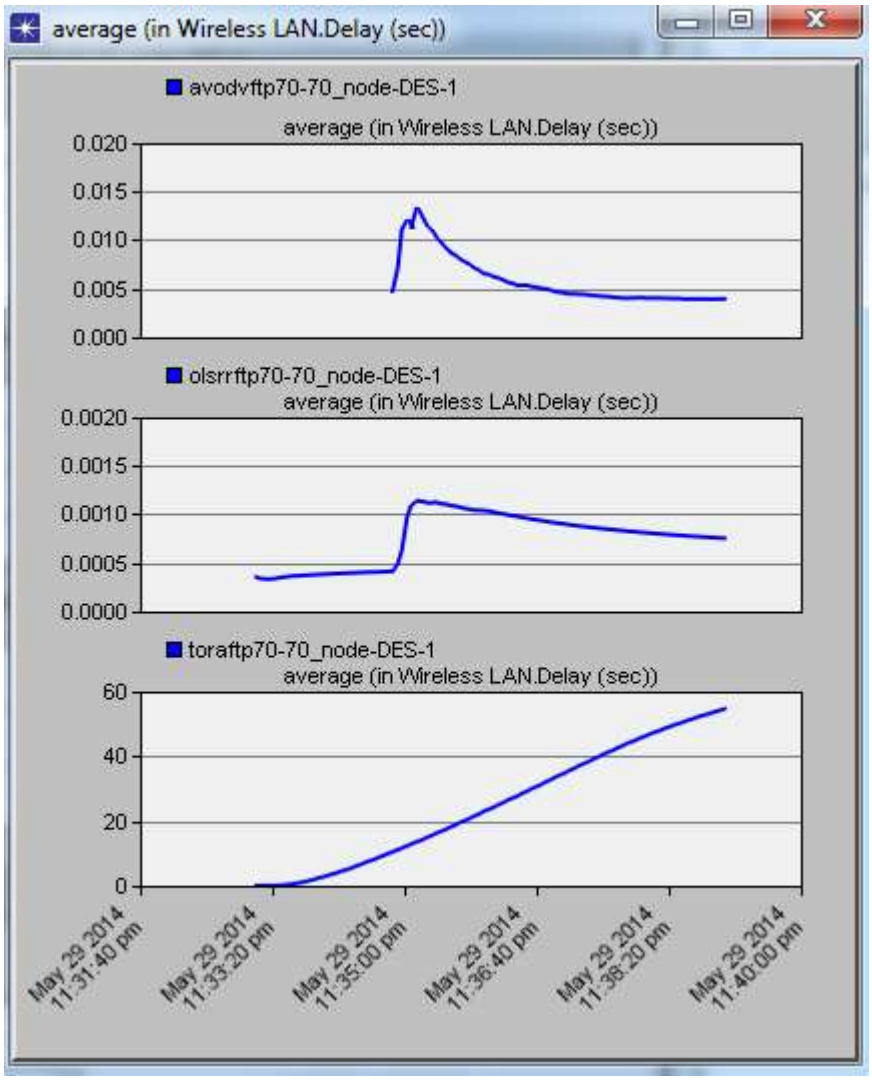

Figure 4.5 Delay with Ftp

- **Network Load-** we generate a statistical data statistics for this graph as average values of network load is plotted in the figure 4.4. In this figure the network load of AODV is zero in start of simulation and increases gradually after 3 minute of simulation time and goes it peak value after that it decreases a certain label. The network load is maximum in case of AODV and minimum in TORA. So TORA handle the FTP traffic well as compared to AODV and OLSR.

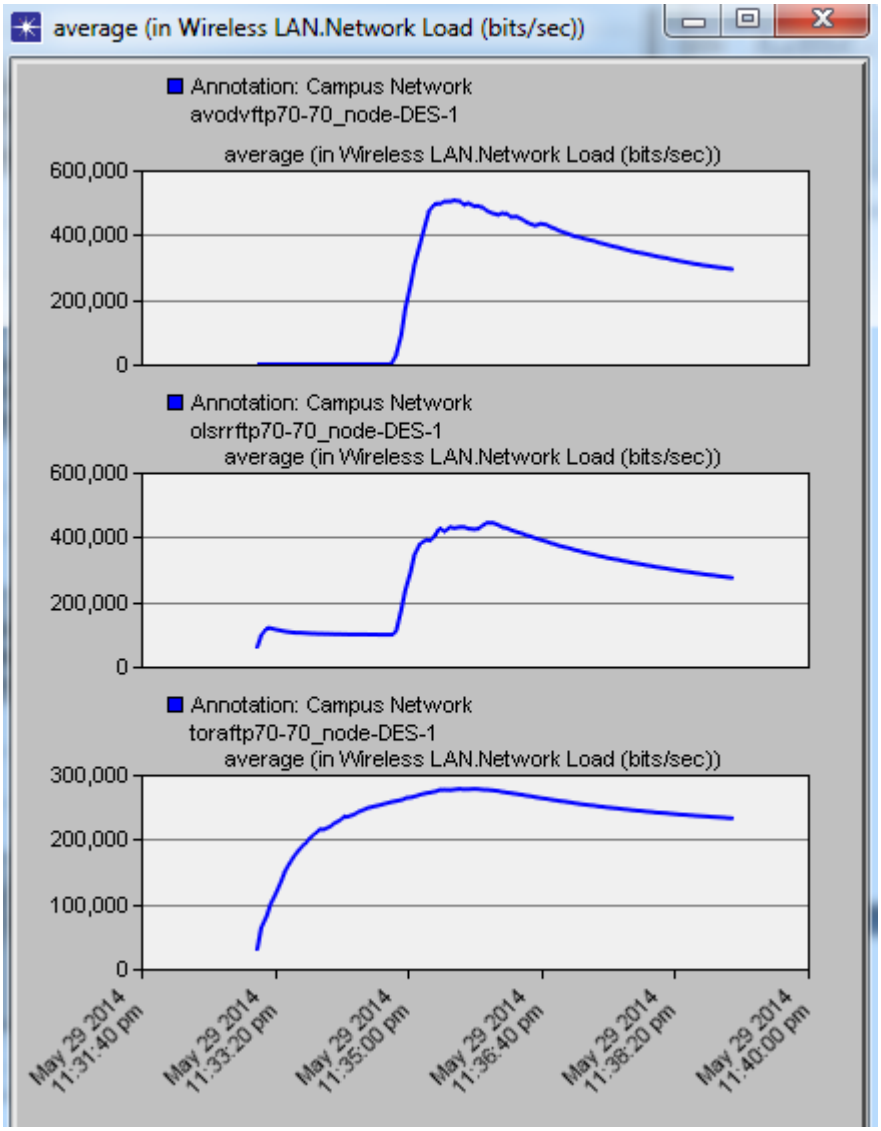

Figure 4.6 Network Load with Ftp

- **Throughput-** throughput is maximum in OLSR and minimum in TORA. AODV gives average throughput with Ftp traffic. Throughput of AODV is zero for four minute for simulation. OLSR and TORA has throughput after 2 minute of simulation.

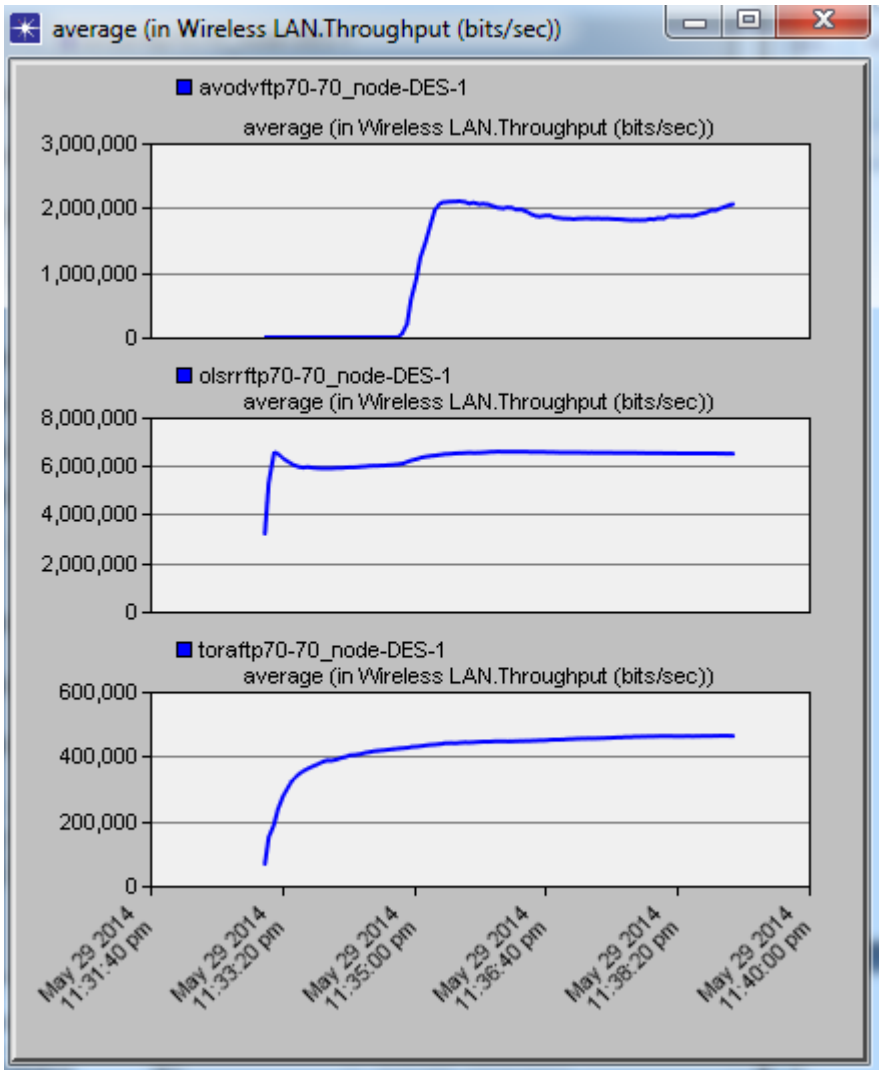

Figure 4.7 Throughput with Ftp

- **Overall analysis of Delay, Network Load and Throughput with Ftp**

The delay of OLSR is 0.00114.this is very low as compared with AODV and TORA. This is because of OLSR has select the route from it updated routing table. OLSR does not require the route request for connecting with destination that is the reason behind this low delay.

Network load is maximum in AODV and minimum in TORA. Throughput OLSR is high and low for TORA so performance of OLSR is better than other two routing protocols.

Routing Protocols/Parameter	Delay (max) Sec	Network Load (max) Bits/sec	Throughput (max) Bits/sec
AODV	0.0134	506,395.978	2,103,150.053
OLSR	0.00114	444,080.362	6,585,365.688
TORA	54.801	277,868.599	463,624.0362

Table 4.2 Average Statistical Data of Ftp

4.1.2.3 AODV, OLSR and TORA performance with HTTP

AODV, OLSR and TORA routing protocols performance have been measured with email and Ftp traffic in above section. Now in this section we measure the performance of routing protocol with Http traffic and evaluate the performance of these routing protocols.

All parameter are same as with above analysis parameter except that traffic type. In this scenario we take Http traffic with high browsing parameter. For analyzing result we generate the graph and table to check performance.

- **Delay-** Delay is high with TORA routing protocol because this is a reactive routing protocol and in this routing route is create after route discovery process.TORA has high delay value from AODV so it has worst performance than AODV. From the graph it can be seen that delay is minimum in case of OLSR and the reason behind this is same as discussed above.

  The peak values for each routing protocols are given below table 4.3.

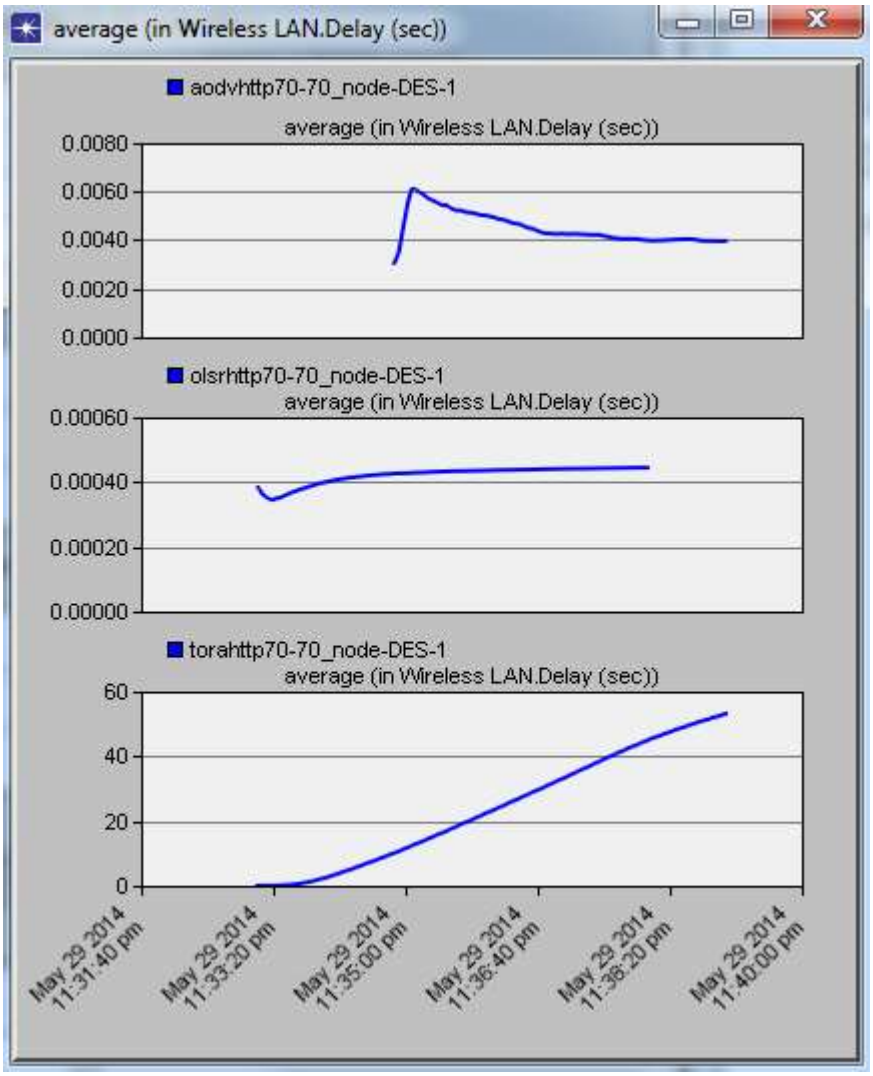

Figure 4-8: Delay with HTTP

- **Network Load –** Network load for TORA and AODV is a high as compared with OLSR in case of Http traffic. So OLSR handles the Http traffic well other than two routing protocols.

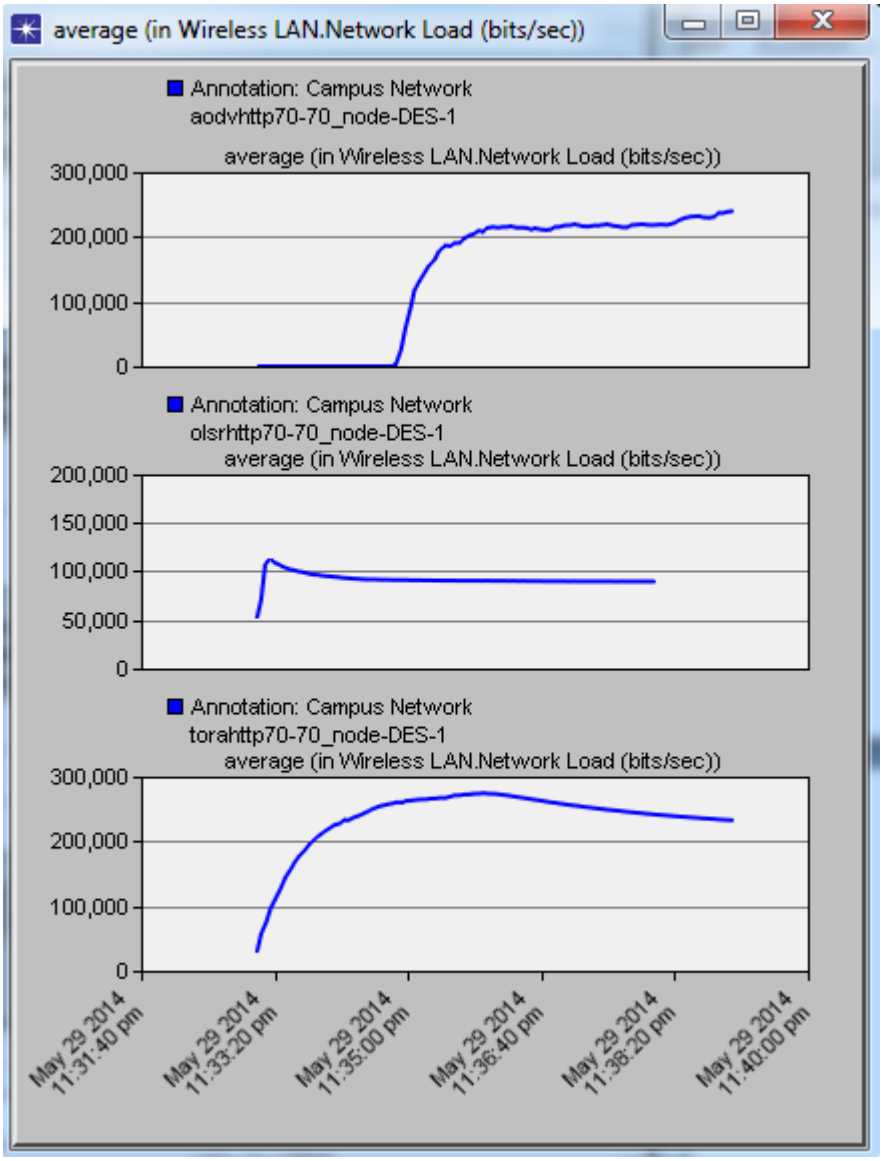

Figure 4.9 Network load with HTTP

- **Throughput**–

Throughput is high in OLSR routing among AODV and TORA. So the performance of OLSR with Http traffic is considerable high to other routing protocols.

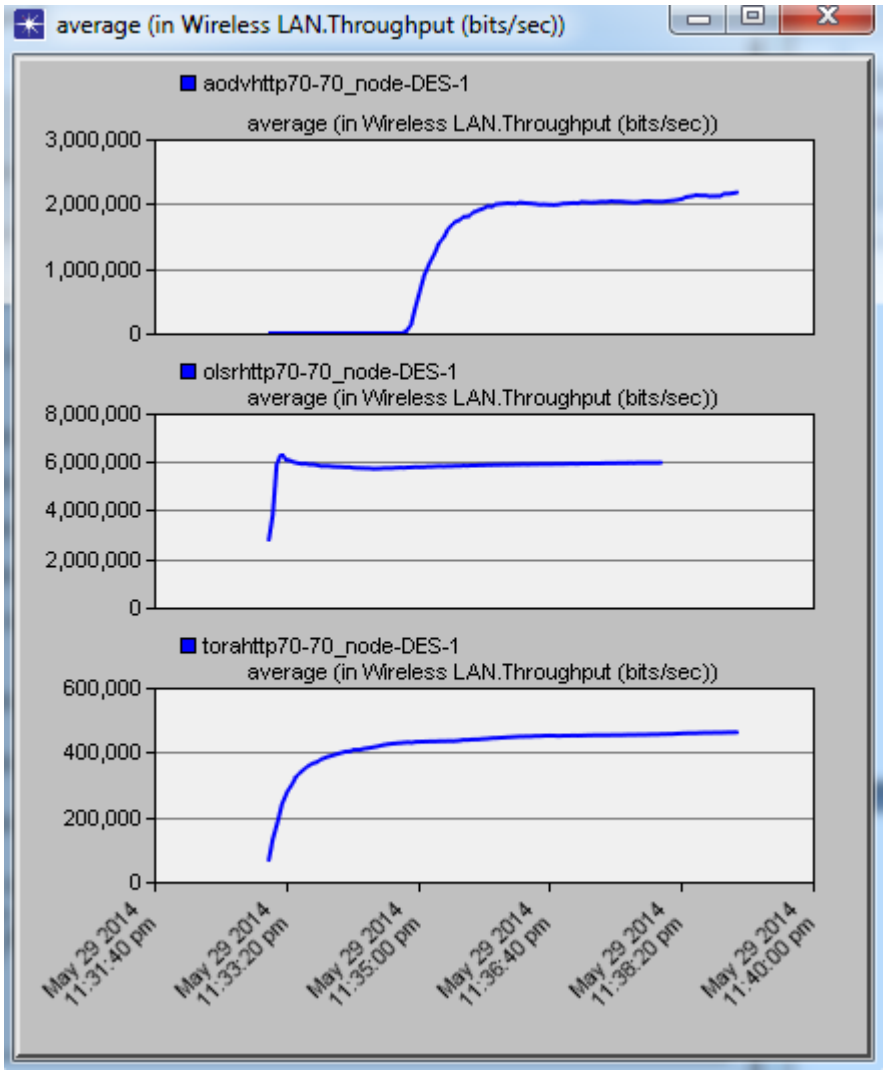

Figure 4.10 Throughput with HTTP

- **Overall Analysis of Routing Protocols with Statistical data with Http**

Below table contains average statistical data of delay, network load and throughput. After analyzing these data, the result is generated that the overall performance of OLSR routing protocol is better the other two routing protocols in HTTP traffic.

Routing Protocols/Parameter	Delay (max) Sec	Network Load (max) Bits/sec	Throughput (max) Bits/sec
AODV	0.00621	239,732.844	2,178,723.733
OLSR	0.00044	114,010.666	6,335,885.333
TORA	53.2649	274,369.444	462,071.111

Table 4.3 Average Statistical data of HTTP

4.1.2.4 AODV,OLSR and TORA performance with Voice traffic

We have analyzed different application level traffic with these routing protocols, these traffic are TCP based traffic but in this section we take voice traffic which is UDP traffic.

In this section we take statistical data from graph and analyze these data to find result for this type of traffic.

- **Delay-** the delay value is measured in second and this value is very high as compared to other traffic. The maximum delay shown in the TORA delay graph and minimum delay in AODV. So this can be said that AODV takes less time to deliver voice traffic from source to destination as compare to OLSR and TORA routing protocols. The delay in TORA measured after 2 minute of simulation and other two AODV and OLSR it comes after 4 minute.

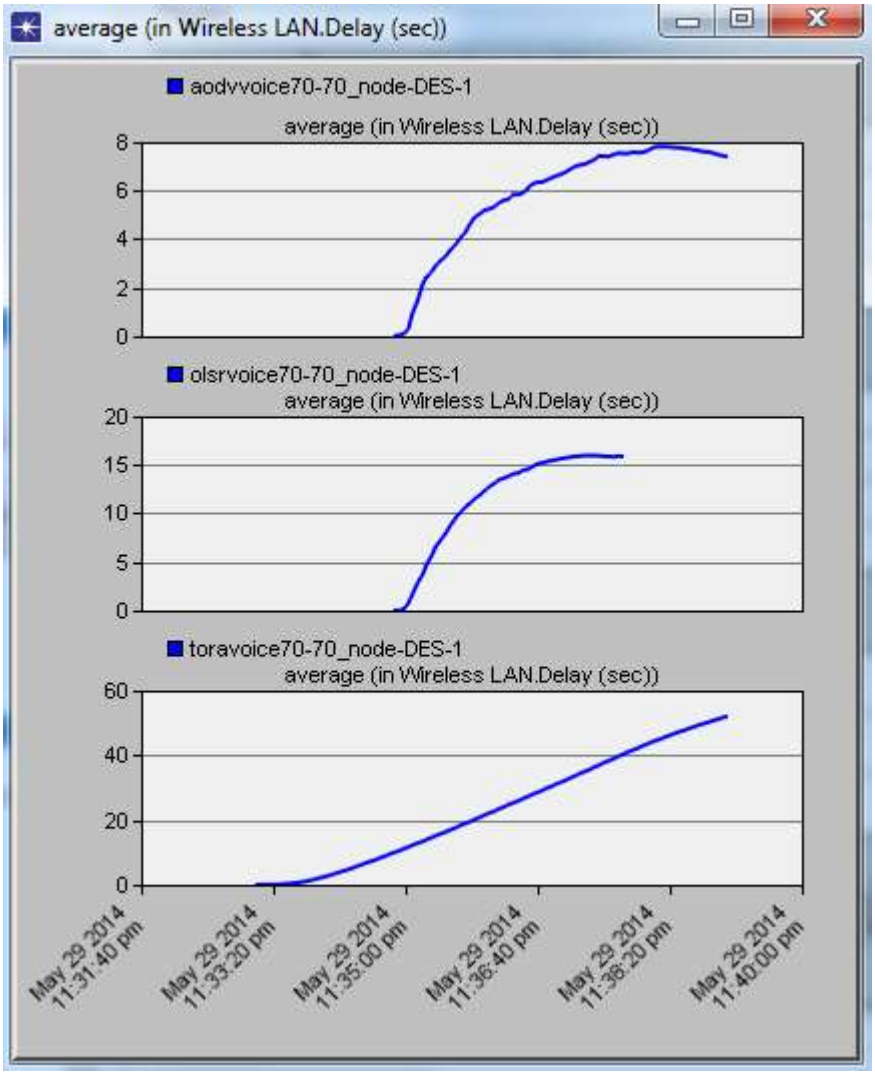

Figure 4.11 Delay with Voice

- **Network Load**- Network load ishigh with AODV and low with TORA. So TORA has high efficiency to transfer packet throughout the network and AODV has less efficiency to transfer packet from source to destination and create a high load on the network**.**

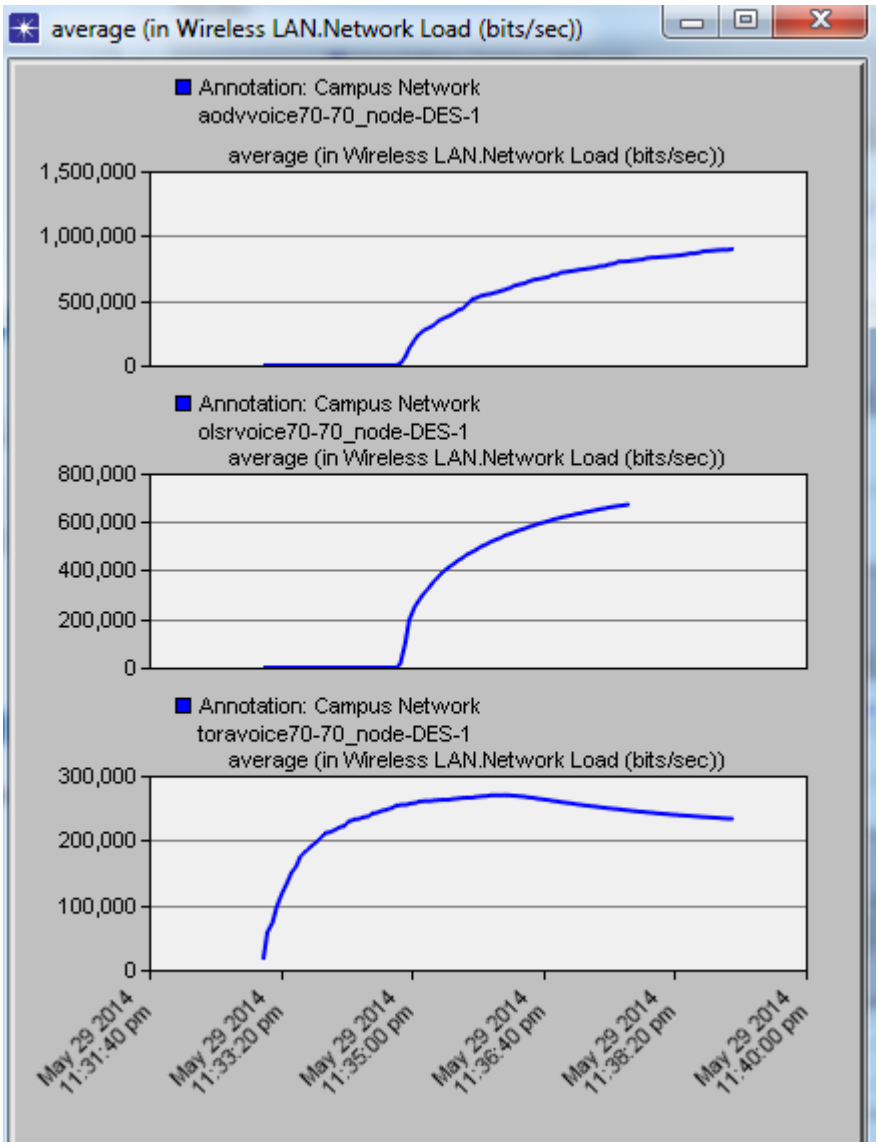

Figure 4.12 Network Load with Voice

- **Throughput-** The below average throughput graph shows that AODV has high throughput so it has better performance with voice traffic and TORA has less throughput so it is not suitable for voice traffic for this scenario. The exact peak value id given in table4.4.

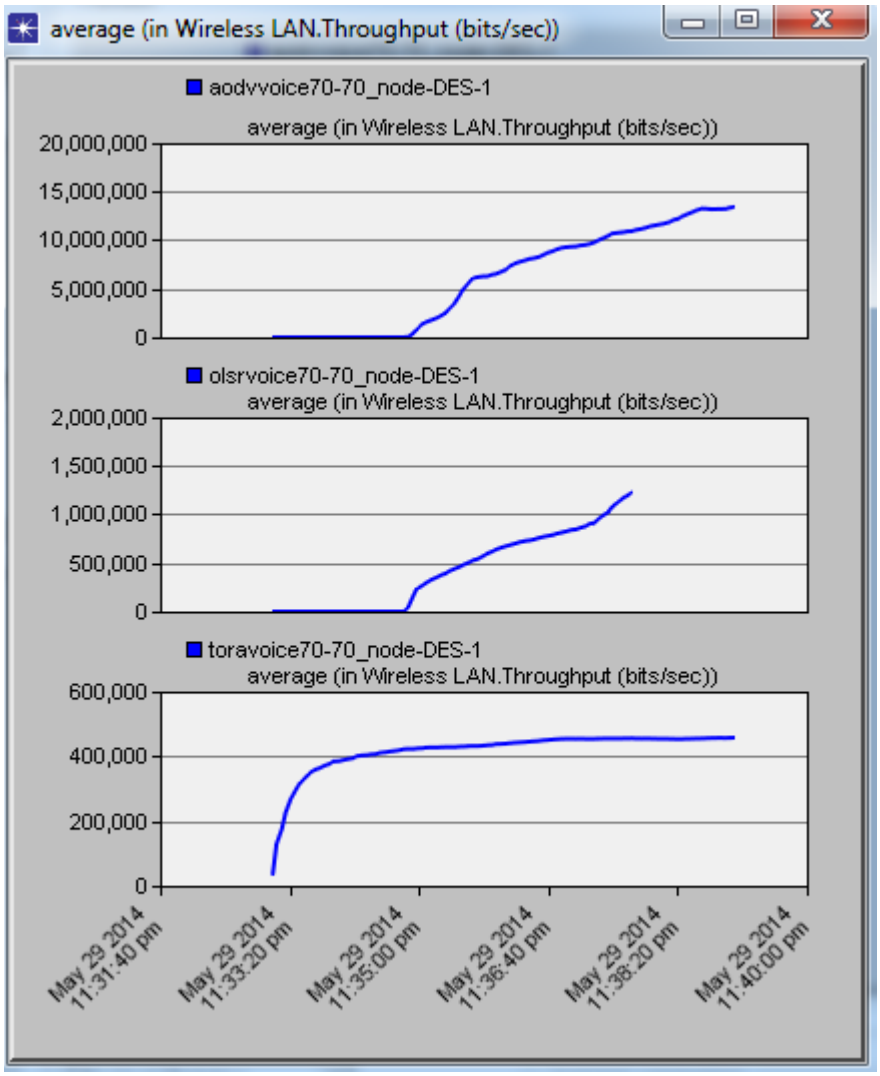

Figure 4.13 Throughput with Voice

- **Overall analysis of Routing Protocol with Voice**

We generate table4.4 from analyzing data given in the above graph. In this table the values are average peak values of delay, network load and throughput with several MANET routing protocols. From this table we can see that highest delay in TORA routing protocol and lowest delay value is 7.813 sec for AODV. Network load high value 897,175.200 bits/sec for AODV and lowest for TORA, is 269,865.811 bits/sec. Throughput is maximum for AODV and its average max value is 13,416,417.777 bits/sec. throughput is minimum for TORA and its value is 457,645.777 bits/sec.

Routing Protocols/Parameter	Delay (max) Sec	Network Load (max) Bits/sec	Throughput (max) Bits/sec
AODV	7.813	897,175.200	13,416,417.777
OLSR	15.972	671,405.128	1,226,454.814
TORA	52.064	269,865.811	457,645.777

Table 4.4 Average peak values for Delay, network load and throughput with voice traffic

4.2 Analysis of Memory usage

In this section we evaluate the different routing protocol performance with respect to memory utilization for different traffics

4.2.1 Memory usage with E-mail

These graphs are generated at time of simulation. Allthe graphs show the memory usage of routing protocols with email traffic.

Figure 4.14 is the graph of AODV routing protocol memory utilization with email traffic.

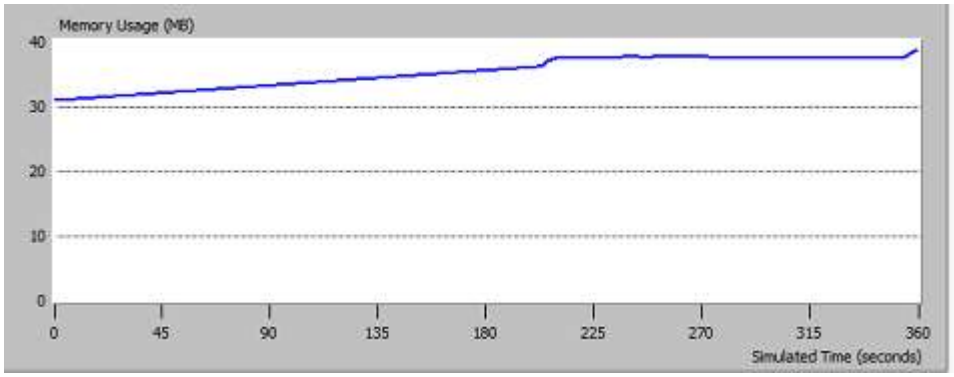

Figure 4.14 Memory usage with AODV (e-mail)

- This figure4.15 is the graph for OLSR routing simulation memory usage for email traffic.

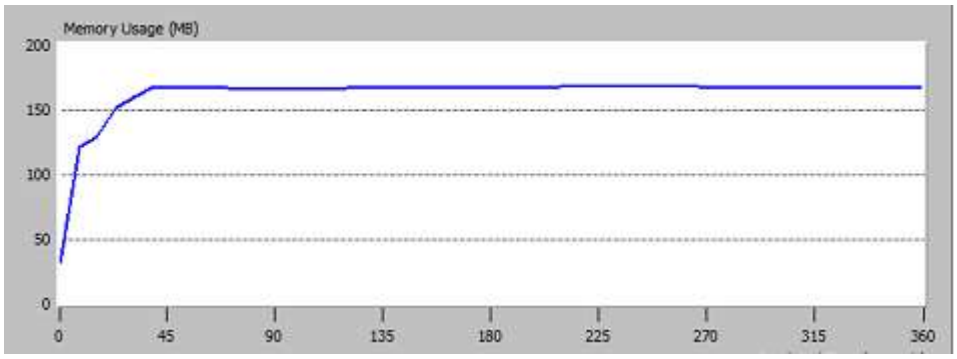

Figure 4.15 Memory usage with OLSR (email)

- Figure 4.16 is the memory utilization graph for TORA routing protocol with email application.

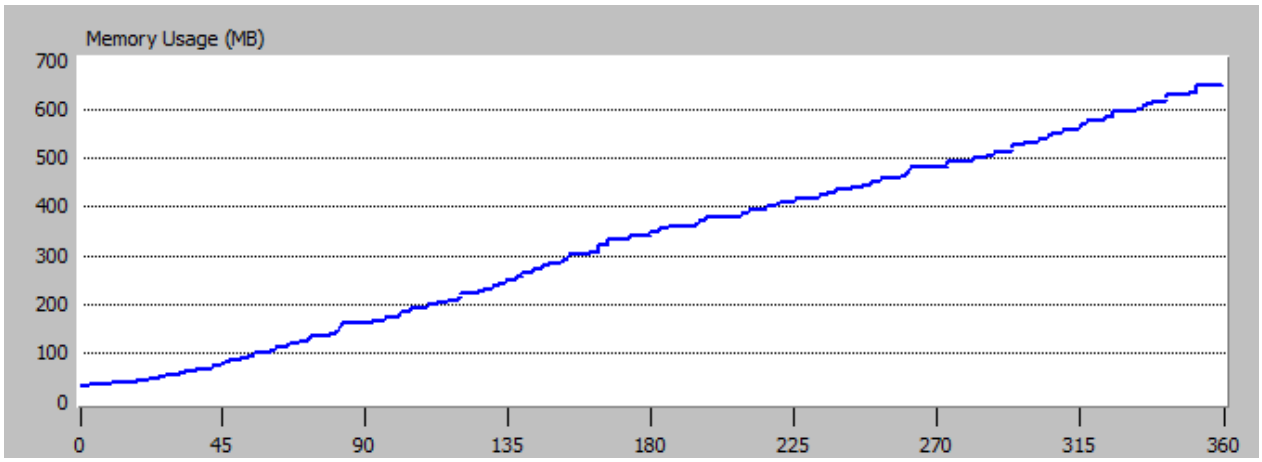

Figure 4.16 Memory usage with TORA (email)

- **Result for e-mail**
  Memory usage is high for TORA routing protocol at the time of simulation with e-mail traffic, when we use the scenario of 70 mobile nodes. For different scenario it can be increase or decrease so at the time of modeling the scenario user should give attention for memory requirement to simulate a big network.

4.2.2 Memory usage with FTP and HTTP

In this section we take FTP and HTTP both together because there is difference in memory usage by routing protocol for these types of traffic.

- Figure 4.17 is the memory usage graph which is same for AODV with HTTP and FTP traffic.

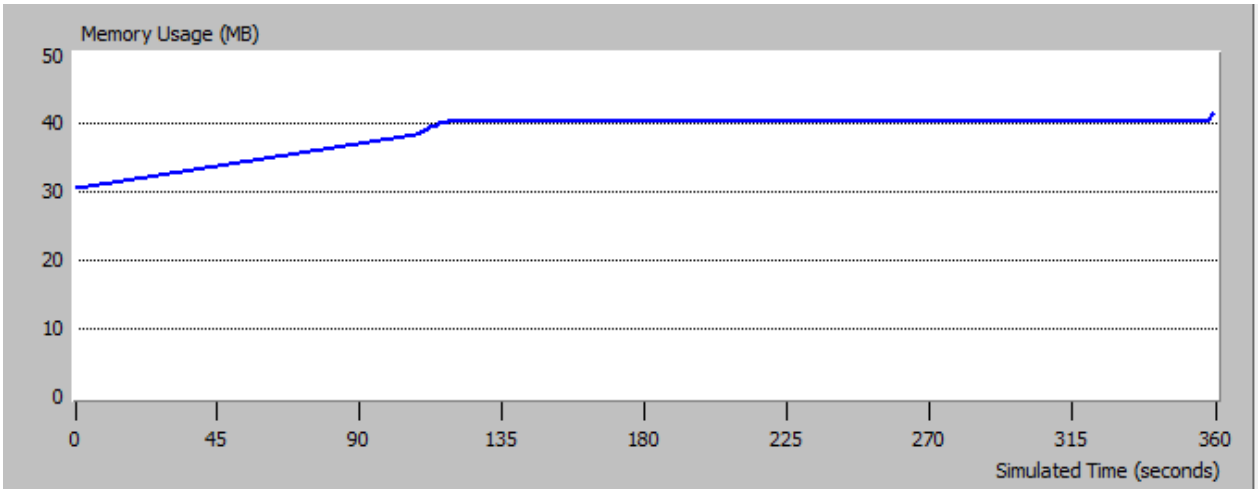

Figure 4.17 Memory usage with AODV (HTTP & FTP)

- Figure 4.18 is the memory usage graph for OLSR with HTTP and FTP traffic. This graph is same for HTTP and FTP with OLSR.

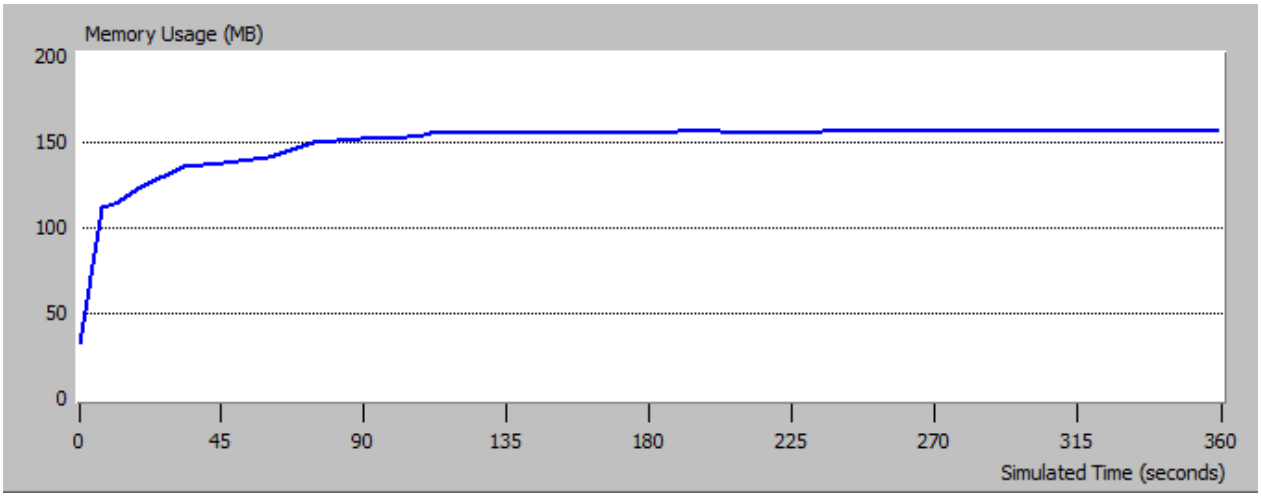

Figure 4.18 Memory usage with OLSR (HTTP & FTP)

- Figure 4.19 shows the memory used by simulator when running http and ftp traffic. There are a short of difference between HTTP and FTP memory usage.

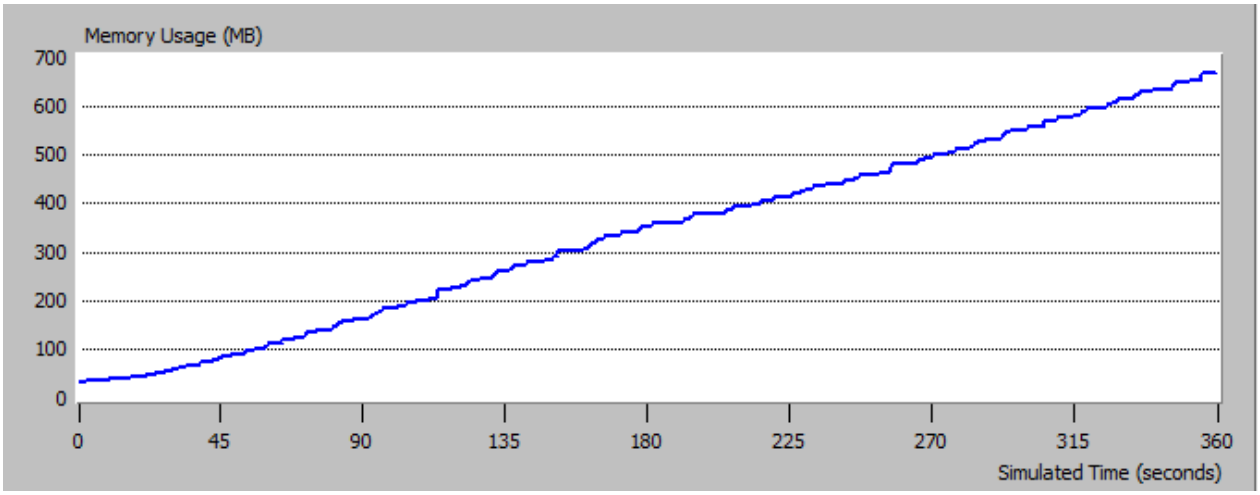

Figure 4.19 Memory usage with TORA (HTTP & FTP)

- **Result**- maximum memory utilization in TORA near about 650 MB. It is very high as compared with AODV.

4.2.3Memory usage with Voice

In this section we analyze and provide the result to use which routing protocol for voice traffic with reference to memory utilization.

- Figure 4.20 is the memory utilization graph of AODV over voice traffic. By this graph one can see and analyze that memory utilization by AODV is highest as compared with above traffic. It is near about 900 MB requires for simulate the voice over AODV.

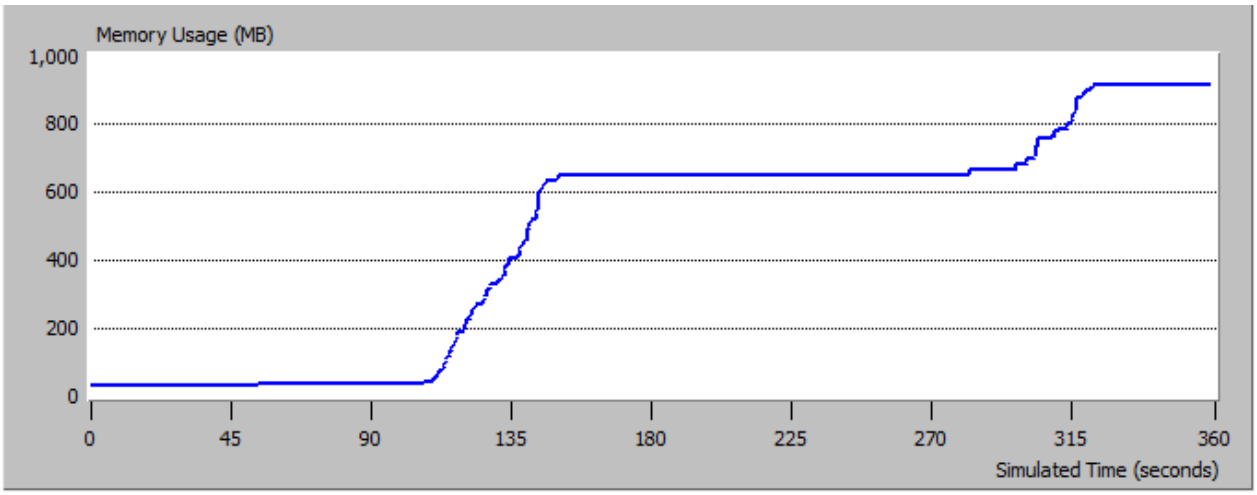

Figure 4.20 Memory usage with AODV (Voice)

- Figure 4.21 is the memory usage graph for OLSR with respect to voice. In this graph we can see that memory usage of OLSR is near about same for all simulation.

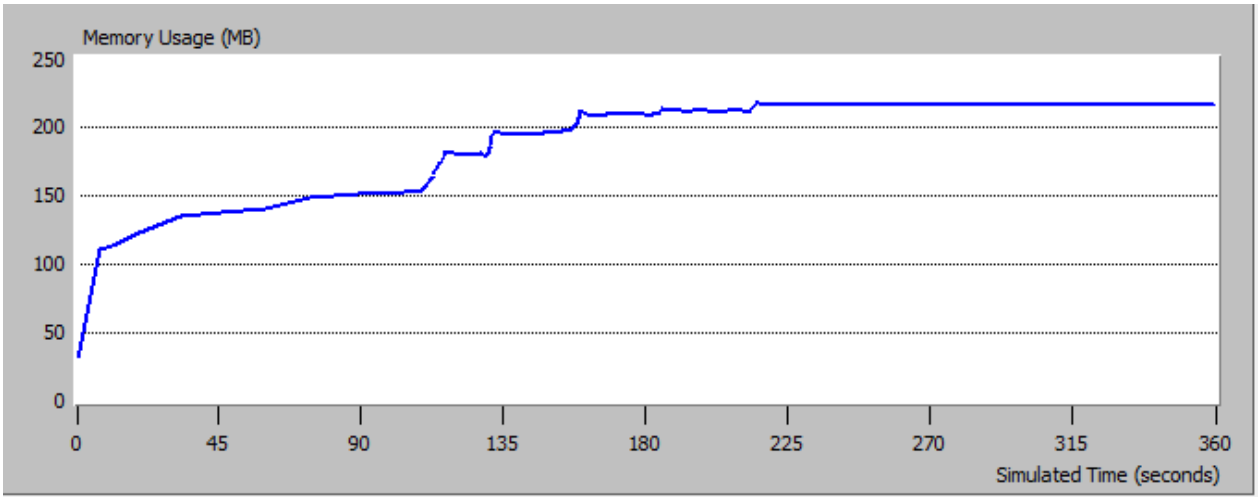

Figure 4.21 Memory usage with OLSR (Voice)

- Figure 4.22 in this graph we can see memory usage increase gradually at the end of simulation time.
  The graph of memory usage is defined by two major axis. In this X-axis represents time of simulation and Y-axis represent the memory usage in MB.TORA memory utilization is constant for all cases of traffic.

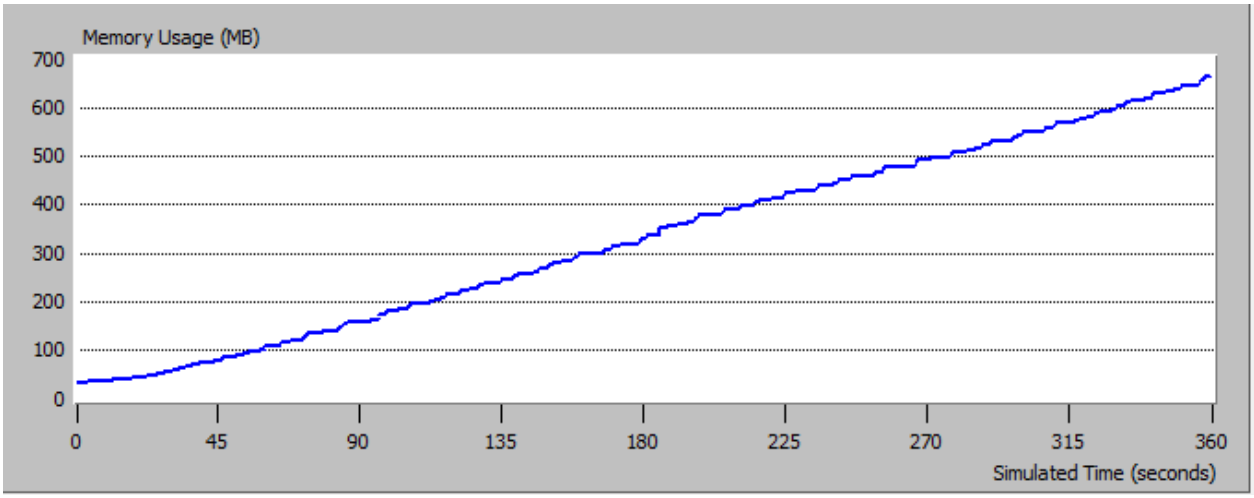

Figure 4.22 Memory usage with TORA (Voice)

- **Result –** memory utilization in this case highest for AODV and lowest for OLSR.

Chapter 5: Conclusion and Future work

In this chapter we provide the conclusion of our research work. This thesis report consists of two type of analysis. In this thesis we have analyzed the routing protocol performance with different application traffics. Application traffics are used in this research e-mail, Http, Ftp and Voice. Our secondary work of this thesis is to analyze the memory usage of these routing protocols with different applications and check the performance of routing protocol. In this thesis we have used two kind of mobile ad hoc routing protocols, Reactive routing protocols and Proactive routing protocols. We use two reactive routing protocols AODV and TORA, and one proactive routing protocol OLSR. Each routing protocol has its own advantage and disadvantage for particular scenario. For increasing the reliability of network, a most appropriate routing protocol should be used. For example loop free routing protocol should be used for improving the network performance.

In this thesis we have used three different performance parameter, they are throughput, delay and network load.

The selection of routing protocol for Mobile ad hoc network is a serious issue. If routing protocols will be reliable and efficient then transmission of data over network will be easy and accurate. Transmission failure rate can be decrease by using such type of routing protocols. In this research we get two types of results. First result is the graphical representation these performance parameters. That is average graph values. Second result is the statistical data of these graphical results.

There are a large no of graph in this thesis that are used to analyze the behavior of routing protocols by using different traffic and on the basis of memory usage. The analysis and result chapter gives the conclusion that OLSR routing protocol performed well in E-mail, Http and Ftp traffic with comparison to AODV and TORA. This conclusion is done on the basis of delay and throughput.

AODV outperforms the two protocols OLSR and TORA in Voice traffic in terms of Delay and throughput. In terms of network load AODV performs well with email because it deploys low traffic on the network. OLSR performs well with HTTP traffic. TORA performs well with voice traffic.

On the basis of memory usage AODV performs well because memory usage is very low as compare with OLSR and TORA with E-mail, HTTP, and FTP.
Memory usage of TORA is very high in comparison with AODV and OLSR with all traffic accept Voice. Here the conclusion about Voice traffic, memory usage high with AODV and low with OLSR so OLSR has high performance with voice traffic and AODV require high memory space for simulating voice traffic over network.

There is lot of work related to this thesis such as evaluate the routing protocols with different mobility models. The work of future is to evaluate the performance of different hybrid routing protocol with different application level traffics.

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