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Performance Evaluation and Networks Analysis of Multimedia Traffic over MANETs Using OPNET

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Abstract- Advances in wireless technology and portable computing along with the demands for greater user mobility have provided a major thrust on the development of an emerging class of rapidly deployable architectures referred to as ad-doc networks. An ad hoc network is a collection of mobile nodes forming a temporary network without the aid of any centralized administration or standard support services. With the growth of the Internet services, multimedia has been playing a key role in cutting the costs of telephone calls. It can be seen that since demand of voice over wireless network is growing, use of voice over Mobile Ad-hoc Network (MANET) is expected to grow as well. This paper aims to compare performance of three routing protocols for Mobile Ad-Hoc networks (MANET's). Since routing is a critical issue in MANET, so the focus of this paper along is the performance analysis of routing protocols. We compared three routing protocols i.e. AODV, OLSR and TORA and it's simulated in OPNET modeller tool. The performance of these routing protocols is analyzed by four matrices: delay, network load and throughput and jitter. The comparison analysis will be carrying out about these protocols and in this paper discusses the performance evaluation and comparison of three MANET routing protocols in different simulation scenarios drawing valuable conclusions and future improvements.

Keywords— MANET, AODV, OLSR, TORA, OPNET, MULTIMEDIA

I. INTRODUCTION

A MANET [1,2] is a collection of mobile nodes that can communicate with each other without the use of predefined infrastructure or centralized administration.Since no fixed infrastructure or centralized administration is available, these networks are self-organized and end-to-end communication may require routing information via several intermediate nodes. Nodes can connect each other randomly and forming arbitrary topologies. Each node in MANET acts both as a host and as a router to forward messages for other nodes that are not within the same radio range. The up to date standardized protocols are classified into three categories: Proactive routing protocols, Reactive routing protocols, Hybrid routing protocols. Proactive protocols, such as Optimized Link State Routing (OLSR) [3, 4] attempt to monitor the topology of the network in order to have route information between any source and destination available at all time. Proactive Routing Protocols are also called table driven routing protocols as all the routing information is usually kept in tables. Reactive routing protocols such as Ad hoc On Demand Distance Vector (AODV) [5, 6], find the route only when there is data to be transmitted and as a result, generate low control traffic and routing overhead. Hybrid protocols such as Gathering-based routing protocol (GRP) [8] could be derived from the two previous ones, containing the advantages of both the protocols, using some quality of one type and enhancing it with the participation of the other one. In this paper we evaluate the performance of a Proactive Routing Protocol (OLSR), a Reactive routing protocol AODV and TORA.

This paper is organized as follows: Section 2 presents overview of Routing protocols in MANETs. Section 3 describes the Simulation Environment studied. Section 4 analyzes results and discussion. Section 5 concludes this paper.

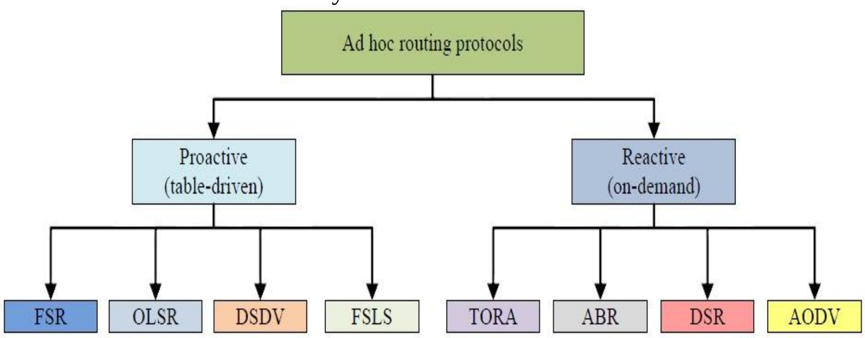

Figure 1: Classification of Routing Protocols

II. ROUTING PROTOCOLS IN MANETS

Routing protocols in MANET [9] [10] are divided into three categories: proactive, reactive and hybrid routing protocols. The most popular ones are AODV, TORA (reactive), OLSR (proactive) and GRP (hybrid).

This section describes the main features of three protocols AODV (Ad Hoc On-Demand Distance Vector Protocol), OLSR (Optimized Link State Routing) and TORA (Temporally Ordered Routing Algorithm) deeply studied using OPNET 14.5. An ad-hoc routing protocol is a convention, or standard, that it improves the scalability of wireless networks compared to infrastructure based wireless networks because of its decentralized nature.

2.1 Ad Hoc On-Demand Distance Vector Protocol (AODV)

Mobile nodes in the Ad Hoc network are dynamic and they use multi-hop routing by using Ad-Hoc On-Demand Distance Vector algorithm. AODV [11] will not maintain the routes unless there is a request for route. Mobile nodes respond to the any change in network topology and link failures in necessary times. In case of the link failures the respective defective nodes are notified with the message, and then the affected nodes will revoke the routes using the lost link. This will help AODV to avoid the Bellman-Ford "counting to infinity" problem and then its operation is known as loop-free. AODV uses Destination Sequence Numbers (DSN) for every route entry. DSN [12] is created by the destination this DSN and the respective route information have to be included by the nodes while finding the routes to destination nodes. Routes with the greatest DSN are preferred in selecting the route to destination. AODV uses the message types Route Request (RREQ), Route Replies (RREP) and Route Error (RERR) in finding the route from source to destination by using UDP (user datagram protocol) packets. The advantage of AODV is that it tries to minimize the number of required broadcasts. It creates the routes on an on-demand basis, as opposed to maintain a complete list of routes for each destination. Therefore, the authors of AODV classify it as a pure on-demand route acquisition system.

2.2 Optimized Link State Routing (OLSR)

OLSR [13] is a proactive IP routing protocol for mobile ad hoc networks. It can also be implemented in any Ad Hoc network. Lately, it is also used in Wi-MAX Mesh (Backhaul). OLSR is classified as proactive due to its nature. Nodes in the network use topology information derived from HELLO packets and Topology Control (TC) messages to discover their neighbors. Not all nodes in the network route broadcast packets. Only Multipoint Relay (MPR) nodes route broadcast packets. Routes from the source to the intended destination are built before use. Each node in the network keeps a routing table. This makes the routing overhead for OLSR [14] higher than any other reactive routing protocol such as AODV or DSR. However, the routing overhead does not increase with the number of routes in use since there is no need to build a new route when needed. This reduces the route discovery delay. In OLSR, nodes send HELLO messages to their neighbors at a predetermined interval. These messages are periodically sent to determine the status of the links.

2.3 Temporally Ordered Routing Algorithm (TORA)

TORA [15] is a routing algorithm. It is mainly used in MANETs to enhance scalability. TORA is an adaptive routing protocol. It is therefore used in multi-hop networks. A destination node and a source node are set. TORA [16] establishes scaled routes between the source and the destination using the Directed Acyclic Graph (DAG) built in the destination node. This algorithm does not use 'shortest path' theory, it is considered secondary. TORA builds optimized routes using four messages. Its starts with a Query message followed by an Update message then clear message and finally Optimizations message. This operation is performed by each node to send various parameters between the source and destination node. The parameters include time to break the link (t), the originator id (oid), Reflection indication bit (r), frequency sequence (d) and the nodes id (i). The first three parameters are called the reference level and last two are offset for the respective reference level. Links built in TORA are referred to as 'heights', and the flow is from high to low.

III. RELATED WORK

Extensive research work has been done on the performance evaluation of routing protocols using OPNET network simulator. Different methods and simulation environments give different results for MANET routing protocols performance. We need to look in a broader view for the effects of these routing protocols which are not considered in a specific environment. Md. Golam Kaosar et. al[15] the research investigates the maximize the performance of MANET during voice transmission we choose some parameters and methodological approaches e.g. Method of media access, selection of audio codec, selection of routing protocol etc in efficient and optimum way. Abdellah Jamali el. al [16] this paper is about routing protocols in an ad hoc network used in multimedia and real time application and also review the QoS. Choice of routing protocols depends upon network size. The multimedia applications can be supported in ad hoc network with different size. Ravi Shankar Ramakrishnan et. al [17] in this paper the integration of all types of traffic onto a single IP network has several advantages as well as disadvantages. While reducing cost and increasing mobility and functionality, VoIP may lead to reliability concerns, degraded voice quality, incompatibility, and end-user complaints due to changing network characteristics. Zhan Huawai et. al [18] in this paper the characteristic of the ad hoc network were introduced and was explained how does it differs from the original fixed wired network and the focus on two well algorithms AODV and OLSR are analyzed and compared. Phillippa Biggs [19] this paper describes summary overview of how VoIP technology works Drivers and Obstacles to VoIP deployment alongside other background material relevant to the debate on the future of voice and prepared under ITU new Initiatives Programme, Eric Thibodeau el at. [20] this results of this paper show that node mobility and node density have a limited influence on the performance of the protocol. However, the route length and the network load seem to be the critical factors deteriorating the performance of the routing protocol. This paper concludes that MAC layer misbehaviour (802.11) is responsible of a majority of false route loss detections. We finally suggest solutions in order to reduce MAC layer misbehaviour and to improve future MANET routing protocols for mobility support of VoIP.

IV. SIMULATION ENVIRONMENT

The simulation mainly focuses on the performance of the routing strategies to react on the different scenarios in MANET [17]. Because the three protocols (AODV, OLSR and TORA) cover different routing strategies mentioned above, we will discuss these routing strategies based on the simulation results of the three protocols. In this paper, we evaluate the performance in terms of network throughput, delay and network load, jitter and mos.We carried out simulations on Opnet simulator [18] [19].

The simulation parameters are summarized in table 1. Modeler is commercial network simulation environment for network modelling and simulation. It allows the users to design and study communication networks, devices, protocols, and applications with flexibility and scalability.

Table 1: Network Parameters

Statistic	Value
Simulator	OPNET 14.5
Routing Protocols	AODV,OLSR and TORA
802.11 data rate	11 Mbps
Node	15,30
Scenario Size	2.5*2.5 km
Application Traffic	VOIP
Simulation Time	900 second
Channel Type	Wireless/GSM Voice channel
Network Interface Type	Phy/WirelessPhy
Performance Parameter	Throughput, Delay, Network Load and Jitter

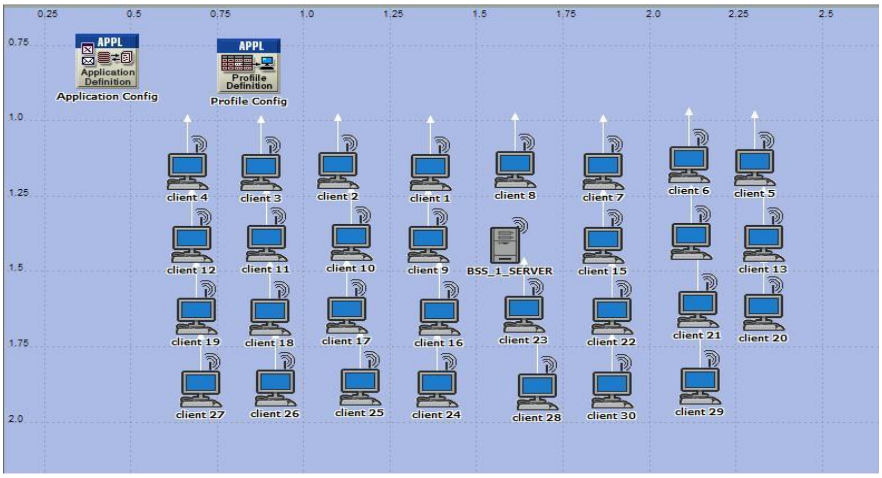

Figure 2: Network Topology Used

Figure 2. Shows a sample network created with 15 and 30 Nodes, application configuration and profile configuration and VOIP traffic for the network in which GSM voices channel has been chosen as an application. Simulation environment consists of 30 wireless mobile nodes which are placed uniformly and forming a Mobile Ad-hoc Network, moving about over a 2.5 X 2.5 km area for 900 seconds of simulated time. Nodes move according to GSM voice channel. In communication model, traffic sources are VOIP (Voice over Internet Protocol).Figure 2 depicts a network with 30 fixed nodes whose behaviour has to be analyzed nodes in the network with respect to time to determine the effecting features of each protocol. We evaluate five parameters in our study on overall network performance.

V. RESULT ANALYSIS AND DISCUSSION

We carried out simulations on Opnet simulator 14.5. The results show differences in performance between considered routing protocols, which are the consequence of various mechanisms on which protocols are based. We carried out our simulations with 30 nodes. Figures 3 to 11 depicts the throughput, delay and network load and jitter of this network with respect to total simulation time which is taken as 30 minutes for which the simulation was run. In this simulation, the network is set to 15 and 30 nodes, the traffic is VOIP mode, the data transmission rate is 11 Mbps and the simulation time is 30 minutes.

5.1 Throughput

The ratio of the total amount of data that reaches a receiver from a sender to the time it takes for the receiver to get the last packet is called throughput. Its units of measurement is bits/sec or packet per second. A high throughput network is generally desirable. We have made a comparative performance evaluation of protocols i.e. AODV, OLSR and TORA and obtained the throughput for 15 and 30 clients' nodes from scenario as shown in fig.3 and fig. 4 given below:

Change in number of nodes:

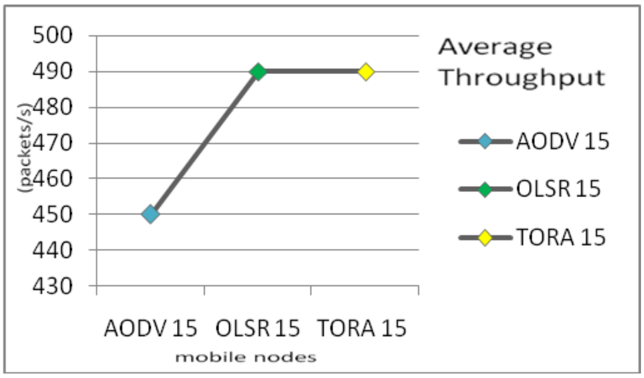

Figure 3 Measurements of throughput with 15 nodes

Fig.3 in the graph number of nodes is taken on X –axis and number of packets in bits/sec are taken on Y-axis. From the measurements of throughput on 15 nodes, it is observed that OLSR and TORA give same performance but better as compared to AODV for GSM voice traffic data.

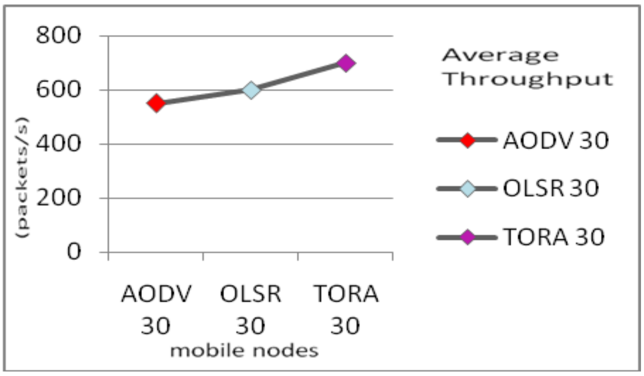

Figure.4 Measurements of throughput with 30 nodes

Fig.4 in the graph number of nodes is taken on X –axis and number of packets in bits/sec are taken on Y-axis. From the measurements of throughput on 30 nodes, it is observed that for voice traffic data TORA increases throughput continuously than OLSR and AODV, but OLSR throughput increases uniformly better as compared to AODV performance for GSM voice traffic data.

So, from the above discussion, we can say that Throughput of TORA performance changes sharply with simulation time and change in mobile nodes and becomes nearly 700 kbps at the end of simulation when mobile nodes increase from 15 to 30. But reliable and stable throughput performance is visible in case of OLSR as throughput initially 600 kbps drops to 490kbps only at the end of simulation if number of nodes falls from 30 to 15 whereas in case of TORA, it falls from 700 kbps to 490 kbps. So, behavior of proactive OLSR in smaller networks with nodes falling shows that the proactive protocols can handle mobility better than reactive protocols. AODV tends to performs poorly in both scenarios.

5.2 Delay: Fig. 5 and Fig 6 in the graph number of nodes 15 and 30 is taken on X –axis and measurement of delay in seconds are taken on Y-axis. From the measurements of delay on 15 nodes, it is observed that AODV give maximum delay as compared to OLSR and TORA for GSM voice traffic data. The maximum network delay variation for 15 and 30 nodes a scenario is shown in respectively figure5.5. Calculate average packet end-to-end delay of each transmitted packet during the simulation time period in 30 nodes and 15 nodes of MANET network. From the graph, it is observed that AODV average delay performance is less, nearly 9.5s, than that of OLSR and TORA which is nearly 1.4s and 1s for GSM voice traffic data. We see that average packet delay increases with increase in number of nodes. The end to end delay in OLSR and TORA is lower side and is maximum in AODV.

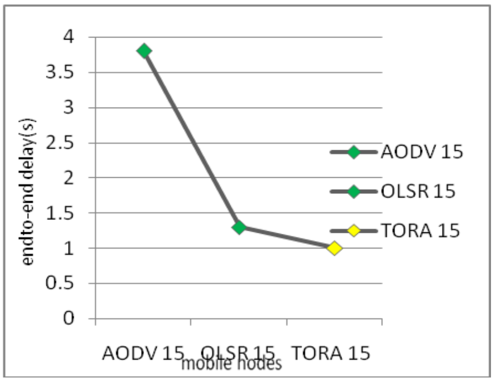

Figure.5 Measurements of delay(s) with 15 nodes

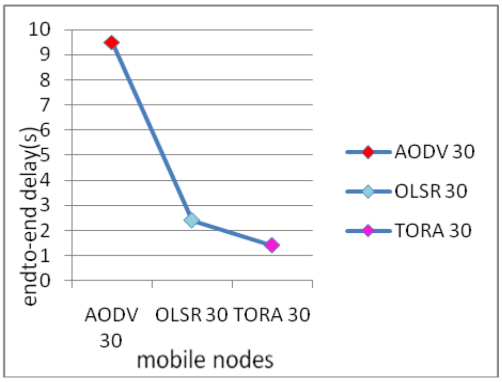

Figure.6 Measurements of delay(s) with 30 nodes

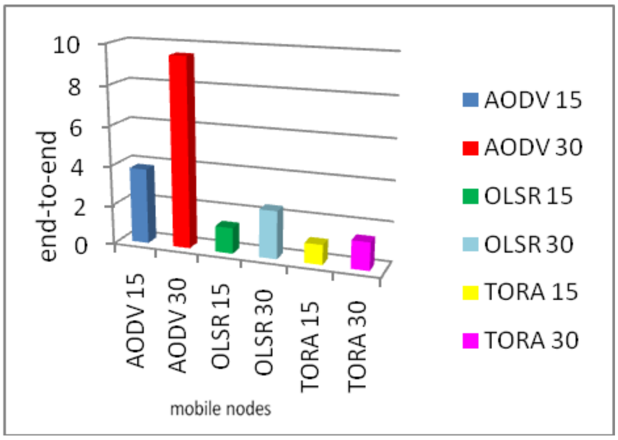

Figure.7: Delay comparison in routing protocols with 15 and 30 nodes

5.3 Network Load

The maximum network load variation for 15 and 30 nodes a scenario is shown in respectively figure 8. Based on wireless LAN load Networks load represents the total load bit/sec submitted to wireless LAN layer, when there is more traffic coming into the network, it is difficult for the network to handle all this traffic, An efficient network can easily cope with large traffic coming in, and to make the best possible network.

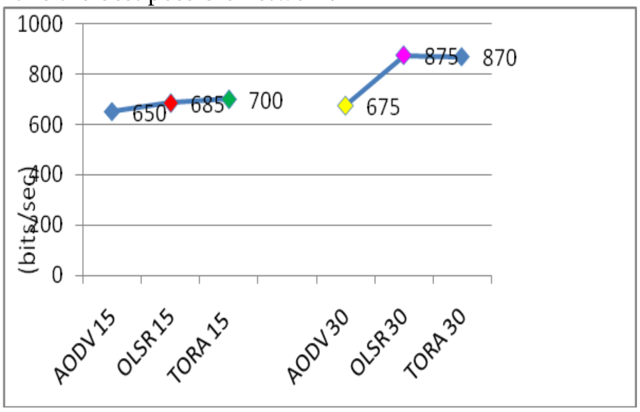

Figure .8 Measurements of Network Load with 15 and 30 nodes

Fig 8 in the graph number of nodes is taken on X –axis and number of packets in bits/sec are taken on Y-axis. From the measurements of Network Load on 15 and 30 nodes, it is observed that for voice traffic data TORA increases network load continuously than OLSR and AODV, but OLSR network load increases uniformly better as compared to AODV performance for GSM voice traffic data.

5.4 Jitter: Jitter describes the degree of variability in packet arrivals, which can be caused by network congestion (bursts of data traffic), timing drift or because of route changes. Jitter is the delay variance from point-to-point or Tx. to Rx. [18].

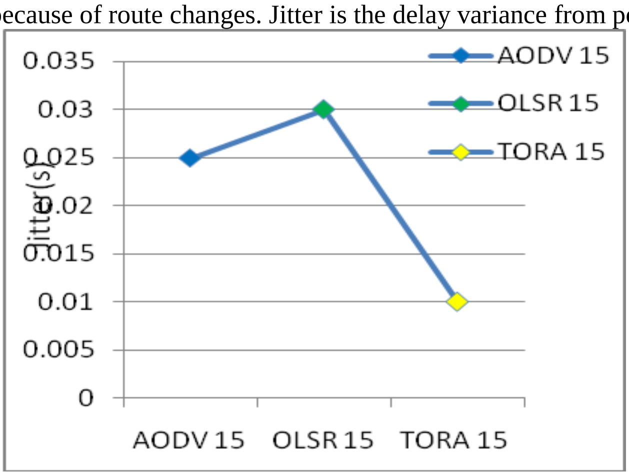

Figure 9 Measurements of Jitter(s) with 15 nodes

Fig. 9 in the graph number of nodes is taken on X –axis and number of jitter in sec are taken on Y-axis. From the measurements of Jitter on 15 nodes, it is observed that OLSR give better performance but better as compared to AODV for GSM voice traffic data.

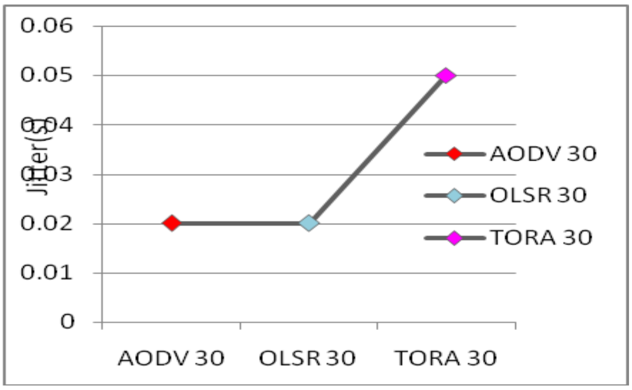

Figure 10 Measurements of Jitter(s) with 30 nodes

Fig 10 in the graph number of nodes is taken on X –axis and number of Jitter in sec are taken on Y-axis. From the measurements of jitter on 30 nodes, it is observed that for delay variation traffic data TORA increases jitter continuously than OLSR and AODV, but OLSR jitter same as compared to AODV performance for GSM voice traffic data.

The figure 11 shows a detail graphical description of Jitter delay for 15 nodes and 30 nodes. Initially every protocol (AODV, TORA and OLSR) show irregular jitter curves. After few minutes simulation time the variation of voice packet jitter is quite steady for different protocols, i.e. the jitter of all protocols show steady curves maintaining small variations. To be more specific; in the beginning of simulation OLSR got higher jitter compared to AODV and TORA. TORA maintains little jitter of about 0.05 (sec) and TORA have maximum jitter compared to AODV and OLSR.

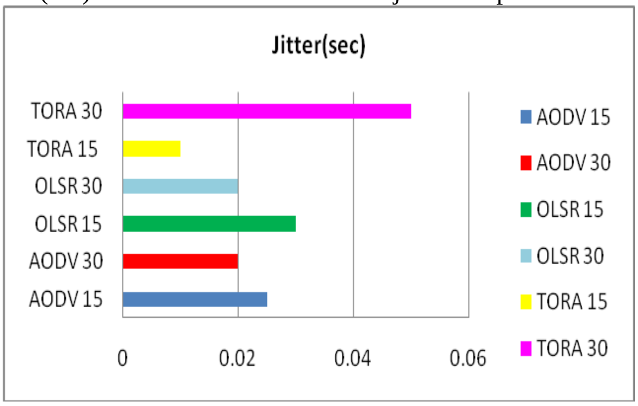

Figure11 Measurements of Jitter(s) with 30 nodes

V. CONCLUSIONS

In this paper, we discussed the three routing protocols (AODV, OLSR and TORA) based on OPNET simulations. Our motive was to check the performance of these three routing protocols in MANET on the above mentioned parameters. We analysed for different reactive and proactive ad-hoc routing protocols with different mobile nodes transmitting GSM voice traffic data. Finally it is concluded that the overall performance of OLSR is better choice for small and large networks. The performance of TORA does scale well with large and small sized network as compared to AODV. Simulation result also showed TORA reactive routing protocol is the finest suited for MANET protocol in dense population of nodes, whereas AODV has very poor QoS in high populated node networks with GSM voice traffic data. At the end we came to the point that the performance of routing protocols vary with network. It is the selection of accurate routing protocols (taking into consideration the type of network) that ultimately influence the efficiency of that network in magnificent way.

So proactive protocol OLSR outperforms in terms of throughput jitters and gets the same low delay as OLSR. In future, we will focus on how to get stable and acceptable performance in dynamic ad hoc networks by constructing virtual bone networks using local broadcasting strategy in OLSR.

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