Performance Evaluation of MANET Routing Protocols for VOIP Applications

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***Abstract*— Mobile Ad Hoc Networks (MANET) is a wireless network without any infrastructure, where each node act as router, transmitter and data sink. As various previous works have described that the performance of routing is highly dependent on the stability and availability of wireless links. With the development of the Internet services, Voice over IP (VoIP) has been participating a primary role in cutting the telephone calls costs. It can be viewed that since the demand of VoIP over wireless network is developing, utilization of VoIP over Mobile Ad-hoc Network (MANET) is required to develop as well. This paper objectives to compare the three routing protocols performance for Mobile Ad-Hoc networks (MANET's) for VOIP applications. Since routing is a serious issue in MANET, so the concentration of this paper along is the performance examine of routing protocols. We have compared three routing protocols i.e. OLSR, AODV, and TORA and it is modeled in OPNET simulator tool. The performance of these routing protocols is examined by five matrices: network load, delay, throughput, mean opinion score and jitter. All these three routing protocols are described deeply by using some performance matrices. The comparative study of protocols will be carried out and finally the conclusion will be presented as to which routing protocol is better one for MANET. The final formulation is represented at the end of this paper.**

Keywords: MANET, OLSR, AODV, TORA, VOIP, OPNET.

I. Introduction

A MANET [1,2] is a set of mobile nodes that can interact with each other without the any use of infrastructure or centralized management. Since no static infrastructure or centralized management exist, these networks are self-configured and end-to-end interaction may need routing information through various intermediary nodes. Nodes can associate to each other arbitrarily and making random configuration. Every node in MANET behaves both as a host and as a router to propagate messages for other nodes that are not inside the same radio coverage. The up to date standardized protocols are categorized into three classes: Reactive routing protocols, Proactive routing protocols, Hybrid routing protocols. Proactive routing protocols i.e. Optimized Link State Routing (OLSR) [3, 4] effort to monitor the configuration of the network for having path information between any source node and destination node existed at all time. Proactive Protocols are also known as table driven routing protocols as entire routing information is generally maintained in tables. Reactive routing protocols i.e. Ad hoc On Demand Distance Vector (AODV) [5, 6], discover the path only when there is data packet to be sent and as a result, produce low routing Overhead and control traffic. Hybrid protocols i.e. Gathering-based routing protocol (GRP) [8] could be deduced from the two previous ones, consisting the benefit of both protocols, utilizing some quality of one kind and improving it with the involvement of the another one. In this paper we measure the performance of a Reactive routing protocol AODV and TORA, Proactive routing Protocol (OLSR).

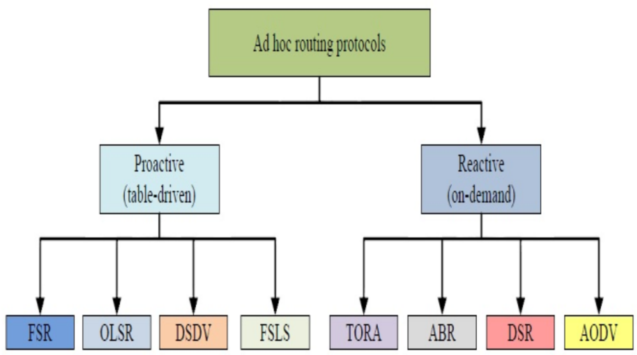

Figure 1: Classification of Routing Protocols

II. Routing Protocols in MANETs

Routing protocols in MANET [9] [10] are categorized into three classes: reactive, proactive and hybrid routing protocols. The most appropriate ones are TORA, AODV, (reactive protocol), OLSR (proactive protocol) and GRP (hybrid protocol). This section explains the main characteristics of

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three protocols OLSR (Optimized Link State Routing), AODV (Ad Hoc On-Demand Distance Vector Protocol) and TORA (Temporally Ordered Routing Algorithm) deeply examined by employing OPNET 14.5 Simulator. An ad-hoc routing protocol is a standard or convention that it enhances the scalability of wireless networks in comparison of infrastructure based wireless networks due to its decentralized nature.

2.1 Ad Hoc On-Demand Distance Vector Protocol (AODV) Mobile nodes in the Ad Hoc network are dynamic and they utilize multi-hop routing by utilizing Ad-Hoc On-Demand Distance Vector algorithm. AODV [11] will not hold the paths unless there is a call for path. Mobile nodes react to the any modification in network configuration and link breakage in essential times. In case of the link breakage the corresponding faulty nodes are informed with the message, and then the influenced nodes will cancel the paths utilizing the lost connection. This will help AODV to neglect the Bellman-Ford "counting to infinity" problem and then its operation is called loop-free. AODV utilizes Destination Sequence Numbers (DSN) for each path entry. DSN [12] is generated by the destination node this DSN and the corresponding path information have to be involved by the nodes while discovering the paths to destination. Paths with the highest DSN are appropriate in choosing the path to destination node. AODV utilizes the message kinds Route Request (RREQ), Route Replies (RREP) and Route Error (RERR) in discovering the path from source node to destination node by utilizing UDP (user datagram protocol) packets. The benefit of AODV is that it attempts to reduce the number of needed broadcasts. It generates the paths on basis of on-demand, as opposed to hold a whole list of paths for each destination node. Thus, the authors of AODV classify it as a pure on-demand path acquisition system.

2.2 Optimized Link State Routing (OLSR) OLSR [13] is a proactive routing protocol for MANET. It can also be carried out in any Ad Hoc network. Recently, it is also employed in Wi-MAX Mesh (Backhaul). OLSR is categorized as proactive because of its nature. Nodes in the network utilize configuration information deduced from Topology Control (TC) messages and HELLO packets to find their neighbors. Not whole nodes in the network send broadcast packets. Only Multipoint Relay (MPR) nodes send broadcast packets. Paths from the source node to the intended destination node are made before use. Every node in the network holds a routing table. This builds the routing overhead for OLSR [14] greater than any other reactive routing protocol i.e. DSR or AODV. However, the routing overhead does not increase with the number of paths in use since there is no requirement to make a new path when required. This decreases the route finding delay. In OLSR, nodes route HELLO messages to their neighbouring nodes at a pre-estimated interval. These messages are regularly sent to find the status of the links. For instance, if node X and node Y are neighbouring nodes, node X routes the HELLO message to node Y. If node Y obtains the message, the link is called asymmetric. The same keeps true for the HELLO message route by node Y to node X. If the two-way interaction is possible, the link is symmetric. These HELLO messages consists whole information about all their neighbouring nodes. This builds a node in the network to make a table with information about its multiple hop neighbouring nodes. In summation, once these symmetric links are built, a node selects a minimum number of MPR nodes that broadcast TC messages with connection status information at a pre-estimated TC interval. A TC message consist information about which MPR node in the network has chosen. TC messages also manage the evaluation of routing tables.

2.3 Temporally Ordered Routing Algorithm (TORA) TORA [15] is a reactive routing protocol. It is primarily employed in MANETs to improve scalability. TORA is an adaptive routing protocol. It is thus used in multi-hop networks. A source node and a destination node are set. TORA [16] constructs scaled paths between the source and the destination node by utilizing the Directed Acyclic Graph (DAG) made in the destination node. This algorithm does not employs "shortest path" theory, it is assumed secondary. TORA constructs optimized paths by using four messages. It begins with a Query message, then an Update message, then clear message and at last Optimizations message. This operation is performed by every node to send several parameters between the source node and destination node. The parameters involve time to break the link (t), Reflection indication bit (r),the originator id (oid), the nodes id (id) and frequency sequence (d). The first three parameters are called the reference level and last two are offset for the corresponding reference level. Links made in TORA are called "heights", and the flow is from high to low.

III. Simulation Environment

The simulation primarily concentrates on the performance of the routing schemes to respond on the various scenarios in MANET [17]. In this paper, we measure the performance in terms delay and network load, network throughput, mos and jitter .We performed simulations on OPNET modeler. The simulation parameters are defined in table 1. Simulator is commercial network simulation environment for network simulation. It permits the users to plan and study communication networks, protocols, devices and applications with scalability and flexibility.

Table 1: NETWORK PARAMETERS

Statistic	Value
Simulator	OPNET 14.5
Routing Protocols	AODV,OLSR,TORA
802.11 data rate	11 Mbps
Node	15,30

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Scenario Size	2.5*2.5 km
Application Traffic	VOIP
Simulation Time	900 sec
Channel Type	Wireless
Performance parameter	Throughput, jitter, Delay, Network Load, MOS

IV. Results and Discussions

We performed simulations on OPNET modeler 14.5. The results indicate differences in performance between assumed routing protocols, which are the results of different mechanisms on which protocols are dependent. We performed our simulations with 30 nodes. Figures 2,3,4,5 and 6 shows the throughput, delay and network load, jitter and mos of this network with respect to total simulation time which is considered as 30 minutes for which the simulation was performed. In this simulation, the network is adjust to 15 and 30 nodes, the traffic is VOIP mode, the data transmission rate is 11 Mbps and the simulation time is 30 minutes.

4.1 Delay

The highest network delay variation for 15 and 30 nodes, a scenario is depicted in figure 2 respectively. From the graph, it is noted that AODV mean delay performance is less, approx. 9.5s, as compared to TORA and OLSR which is about 1s and 1.4s for GSM voice traffic data packet. We observe that mean packet delay increase with increasing in number of nodes. The end to end delay is maximum in AODV as compared to OLSR and TORA.

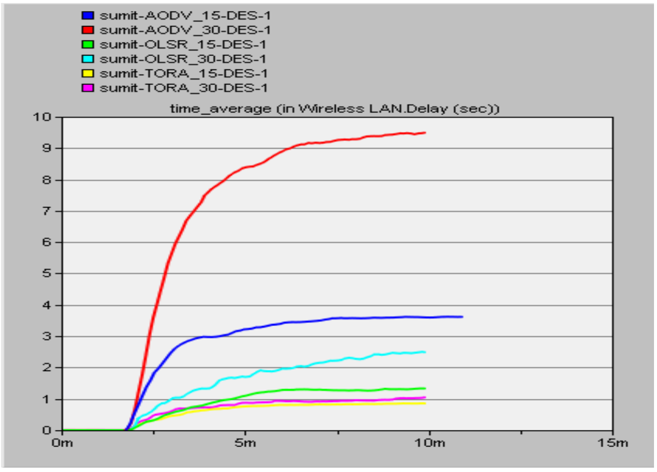

Figure 2: Delay comparison in routing protocols with 15 and 30 nodes

4.2 Network Load

The highest network load variation for 15 and 30 nodes, a scenario is depicted in fig 3 respectively. Based on wireless LAN load Networks load shows the total load bit/sec submitted to wireless LAN layer, when there is more traffic coming into the network, it is hard for the network to manage all this traffic, an effective network can easily deal with high traffic coming in, and to build the best possible network.

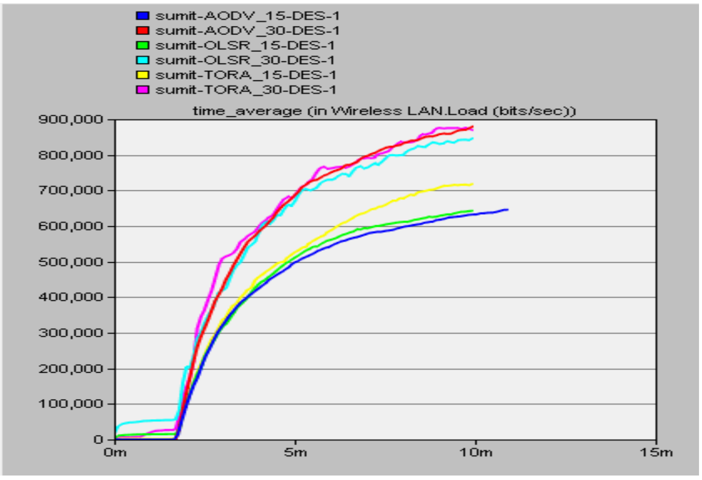

Figure 3: Network Load comparison in routing protocols with 15 and 30 nodes

fig 4 indicates that, for various number of nodes, loads are changing compared to each other for 30 nodes starting network load for AODV network is high, but reduces quickly with 15 nodes. On the other side, for any load, TORA and OLSR are indicating a considerable good performance which is 900 kbps and 700 kbps for both 30 and 15 nodes of MANET network respectively.

4.3 Throughput

The ratio of the total amount of data that arrives a receiver from a sender to the time it takes for the receiver to obtain the last packet is known as throughput. It is evaluated in packets per second or bits/sec. A high network throughput is required. We are comparing these protocols i.e. AODV, TORA and OLSR and receive the throughput for both 15 and 30 client nodes from the scenario which is given below. Figure 4 it is clear that throughput of TORA increases quickly with simulation time and mobility becomes approx. 700 kbps at the end of simulation. On the other side there is reduction in throughput from initial 500 kbps to 550 kbps at the end of simulation in situation of AODV. With the reduction in the number of nodes of the network such that from 30 to 15 nodes, in case of OLSR, initially throughput is 600 kbps to 490 kbps in comparison of AODV and TORA at the end of simulation. This is because of the proactive nature An OLSR protocol in smaller networks with nodes breakage indicates that the proactive protocols can manage mobility better as compared to reactive protocols

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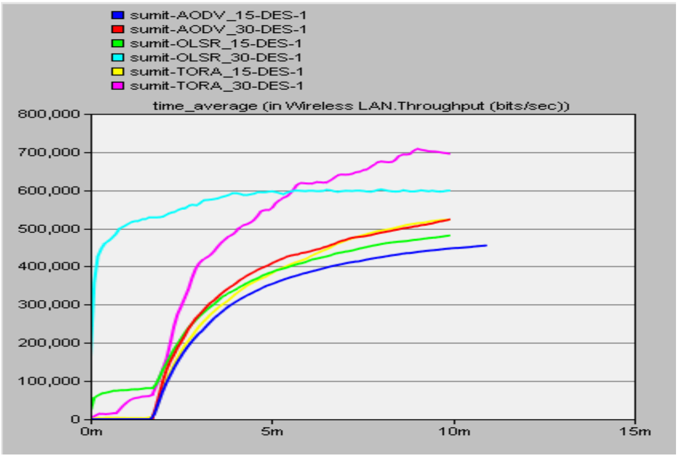

Figure 4: Throughput comparison in routing protocols with 15 and 30 nodes

4.4 Jitter

Jitter explains the degree of variability in packet arrivals, which depends on timing drift, network congestion (bursts of data traffic) or paths changes. Jitter is the delay variance from point-to-point. The fig 5 shows a detail graphical explanation of Jitter delay for 15 nodes and 30 nodes. In starting, each protocol (TORA, AODV and OLSR) indicate irregular jitter curves. After few minutes of simulation time the variation of voice packet jitter is quite steady for various protocols, i.e. the jitter of all protocols indicate steady curves preserving small variations.

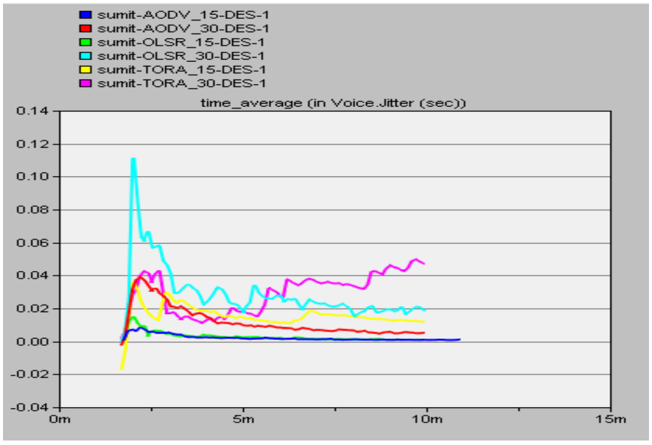

Figure 5: Jitter comparison in routing protocols with 15 and 30 nodes

To be more particular; at first of simulation OLSR got maximum jitter in comparison of TORA and AODV. TORA keeps little jitter of approx. 0.05 (sec) and TORA have higher jitter in comparison of AODV and OLSR.

4.5 MOS (Mean Opinion Score)

In voice interaction, quality generally prescribes whether the experience is a good or bad one. Besides the qualitative explanation we hear i.e. 'quite good' or 'very bad', there is a mathematical way of showing voice quality. It is known as Mean Opinion Score (MOS). MOS offers a mathematical indication of the detected quality of the media obtained after being transmitted. And finally compressed by utilizing codec's. MOS is showed in one number, from 1 to 5, 5 being the best and 1 the worst. The mean opinion value is considered for various network size initially we are taken 15 and 30 nodes and in fig.6 compared three routing protocols and noted that AODV has the good voice quality for 15 nodes and 30 nodes.

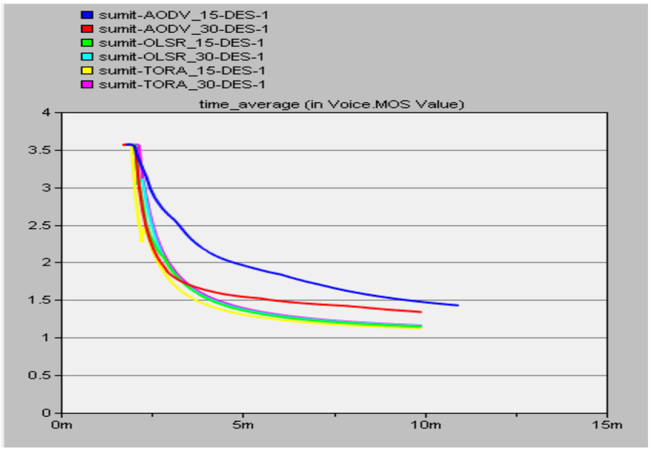

Figure 6: MOS comparison in routing protocols with 15 and 30 nodes

Conclusion

In this paper, we talked about the three routing protocols (AODV, OLSR and TORA) depend on OPNET simulator. Our aim was to examine the performance of these three routing protocols in MANET on the above specified parameters. We examined for various proactive and reactive ad-hoc routing protocols with various mobile nodes transmitting GSM voice traffic data. At last, it is found that the total performance of OLSR is better selection for small and large networks. The performance of TORA performs well with small and large sized network in comparison of AODV. Simulation result also described TORA reactive routing protocol is best suitable for MANET protocol in high population of nodes, while AODV has very poor QoS in high population of node networks with GSM voice traffic data. At last, we reach to the point that the routing protocols performance changes with network. It is the choice of suitable routing protocols (taking into consideration the kind of network) that finally affect the efficiency of that network in wonderful way. So proactive routing protocol OLSR performs better in terms of throughput, jitters and obtains the same low delay as OLSR. In future, we will concentrate on how to obtain acceptable and stable performance in dynamic ad hoc networks by making virtual bone networks employing local broadcasting method in OLSR.

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