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Reactive and Proactive Routing Protocol Performance Investigation under Increasing Load Conditions in WMN

Sajith Kumar R
MTech Student,ECE,
Ludhiana College of Engg.
Punjab Technical University
Punjab, India

Er. Amanpreet Kaur
Assist Prof, ECE,
Ludhiana College of Engg.
Punjab Technical University
Punjab, India

Abstract— Wireless Mesh Network (WMN) has brought a revolutionary change in the field of wireless networking. One of the issues in these types of networks is resource management which includes the routing and selection of routing protocols with certain parameters. Parameters in WMNs include delay, throughput, network load, jitter etc. There are two types of routing protocols i.e. reactive protocols and proactive protocols. In Proactive routing, routes are computed automatically and independent of track arrivals. In Reactive routing, routes are discovered on demand when track must be delivered to an unknown destination. Some internet standard routing protocols are Ad hoc on Demand Distance Vector (AODV), Dynamic Source Routing (DSR), Geographic Routing Protocol (GRP), Optimized Link State Routing (OLSR), Temporary Ordered Routing Algorithm (TORA) etc. AODV and DSR are reactive protocols. OLSR and GRP are proactive routing protocols. In this thesis we have tested the AODV, OLSR, DSR, GRP and TORA in WMN under certain parameters with increasing load conditions. Different Scenarios have been implemented with different load conditions by considering different parameters. VoIP (Voice over internet protocol) traffic has been considered for analysing the different protocols. Testing of these protocols has been done in OPNET 14.5 simulator. The obtained results from OPNET have been displayed in this thesis in the form of graphs. Single protocol cannot be implemented for different conditions. To achieve best performance different protocols are suitable for different conditions. This thesis helps in validating which routing protocol will give the best performance under the assumed conditions.

Keywords— WMN, AODV, OLSR, DSR, GRP, TOR, VoIP

I. INTRODUCTION

In a wireless network each node has one Radio Frequency (RF) transmitter/receiver that has the tendency to communicate with all wireless nodes connected inside a network. RF has made the communication process very easy as compared to the wired networks. Because in wireless mesh network RF fulfils all the process of communication but in wired network it is opposite, this single interface has to be converted into multiple interfaces. Nodes should lie inside the range of transmission for the sake of successful communication. Voice over Internet Protocol is a category of hardware and software that enables people to use the Internet as the transmission medium for telephone calls by sending voice data in packets using IP.

II. ROUTING PROTOCOLS USED FOR VoIP IN WMN

Five routing protocols are considered in this paper namely AODV, DSR, GRP, OLSR and TORA. Below is brief description of each protocol.

A. The Ad-hoc on-demand Distance Vector Routing Protocol (AODV):

AODV is basically reactive protocol which supports multi routing between nodes which are playing their roles to form an Ad-hoc network. It has great advantages, for instance, for disseminating information through routes on demand basis requirement for maintenance is not necessary. One of the main qualities of AODV is that it is free from hops. The environment where AODV is activated, target sequence numbers confirm the route, to be refreshed properly. The algorithm used in AODV considers two messages, one is route request, to establish the route request message is being activated by AODV, and the other is hello message. These messages support nodes to strengthen neighbour nodes. Without the presence of hello messages, the identification of nodes is difficult.

B. Dynamic Source Routing (DSR):

Dynamic Source Routing Protocol represents source route which is implemented on demand basis. Every node should control its route cache. The node regularly updates the route cache if there is a better route, and then it can adopt new routes. In dynamic source routing process every packet has to know about the route direction, to avoid periodic route findings. DSR has the quality to find out the route and control the path for routing.MAC layer helps DSR to detect link failures.

C. GRP (Geographical Routing Protocol):

It is Gathering based routing protocol, is source initialized protocol in MANET routing protocol in which all the routing path is created by source node in Mobile Ad-hoc network. In this protocol, source node collects all the information about the route to the destination. In this procedure, source node sends a destination Query toward the destination through network. It works like AODV and DSR using RREQS (Reverse Request Query by Source).When destination Query reached to the destination, destination sends a packet called Network Information Gathering (NIG) which approach through network. When NIG packet reached at a router, router gives all the information about the network and its resources. There are many nodes called Effective Outgoing Links (EIL) where NIG packet does not reaches, routers send this information to these EILs. At last NIG reaches at source node and source node get all the information for the routing path is created by source node in Mobile Ad-hoc network.

D. Optimized Link State Routing (OLSR):

OLSR is a point-to-point proactive protocol that employs an efficient link state packet forwarding mechanism called multipoint relaying. It optimizes the pure link state routing protocol. Optimizations are done in two ways: by reducing the size of the control packets and by reducing the number of links used for forwarding the link state packets. Here each node maintains the topology information about network by periodically exchanging link-state messages among the other nodes. OLSR is based on the following three mechanisms: neighbour sensing, efficient flooding and computation of an optimal route using the shortest-path algorithm. Neighbour sensing is the detection of changes in the neighbourhood of node. Each node determines an optimal route to every known destination using this topology information and stores this information in a routing table. The shortest path algorithm is then applied for computing the optimal path. Routes to every destination are immediately available when data transmission begins and remain valid for a specific period of time till the information is expired.

E. Temporally Ordered Routing Algorithm (TORA):

TORA is an adaptive on demand routing protocol for multi hop networks. TORA is source initiated specially proposed routing protocol for highly dynamic mobile, multi-hop wireless networks. TORA is based on link reversal algorithms. TORA establish the routes quickly and minimize the communication overhead by localizing algorithm reaction to topological changes when possible. Instead of using the concept of shortest path for computing routes which take huge amount of bandwidth TORA algorithm maintains the "direction of the next destination" to forward the packets. Thus the source node maintains one or two "downstream paths" to the destination node through multiple intermediate neighbouring nodes. The three steps involved in TORA are: a) route creation, b) route maintenance and c) route erasure. TORA uses the concept of "directed acyclic graphs" (DAG) to establish downstream paths to destination.

III. METHODOLOGY

Simulation environment used is OPNET. It stands for Optimized Network Evaluation Tool. It is a very sophisticated tool and gives very user friendly Graphical User Interface (GUI). It is used especially for network simulations which includes the research and development of the networks. OPNET is among the leading simulators these days. Most of the other networking tools do not have so much vast library like OPNET. In this tool we can have a deep understanding of routing protocols, network devices and network scenarios in a very efficient manner. The good thing about OPNET is that it has the ability to simulate each and every happening of a system. There are various useful tools inside OPNET such as the tools made for programming our own packet formats in the routing protocols. In OPNET we can easily make a network model of any type by introducing the nodes in that network model and having a connection of these nodes with each other and with a network model as well.

Fifteen Scenarios has been taken , In first five Scenario 20 WMN nodes , in 2nd five Scenarios 40 WMN nodes and in third five Scenarios 80 WMN nodes have been taken. Here we have taken five protocols AODV, DSR, OLSR, GRP and TORA . For 20 WMN nodes , 40 WMN nodes and 80 WMN nodes each protocol is implemented.

Below is screenshot of one of fifteen scenarios.

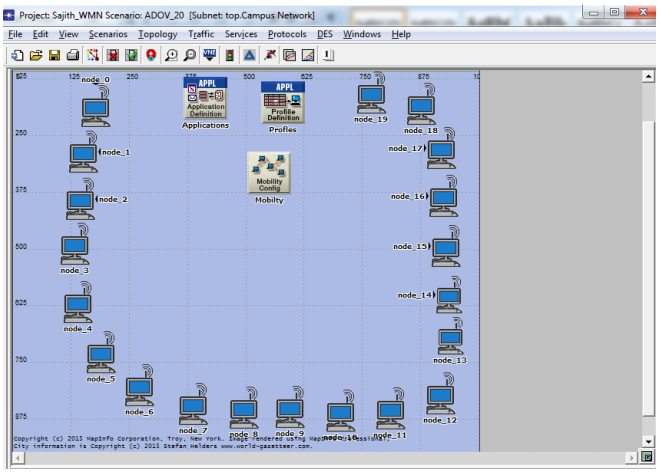

Fig: 1Scenario with 20 WMN nodes with AODV protocol Implemented

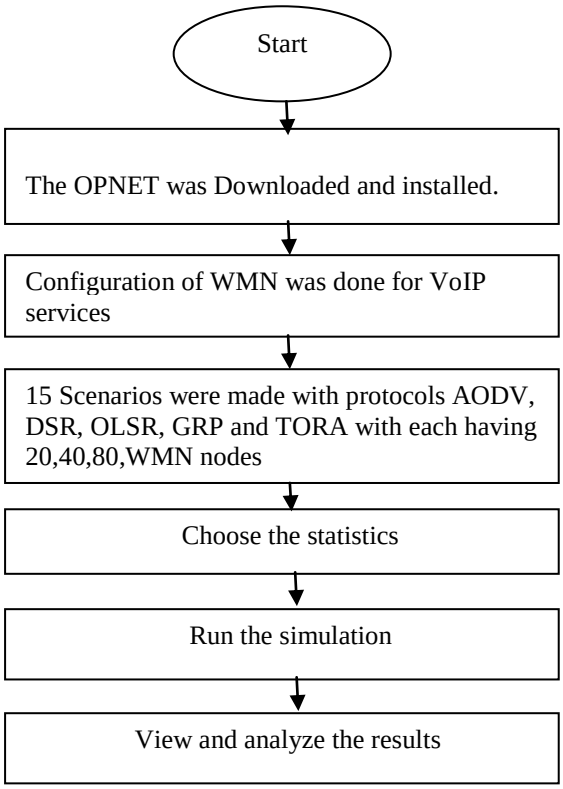

Fig:2 Flow Chart for simulation

***A. Simulation*:**

After making all three scenarios in OPNET Modeler 14.5, we run the simulation and compared the results of these three scenarios. Simulation was performed for 4 minutes and graphs were taken and saved in bitmap image. These graphs were found very helpful for statistical analysis as they are showing reasonable variations in the graphs. Results in the form of graphs were taken from every possibility so that the results can become more defined and satisfactory.

Table 1 Simulation parameter and performance metrics

Maximum Simulation Time	4 min
Environment Size	1000 m*1000m
No. of Nodes	20, 40, 80
Routing Protocols	AODV, DSR, GRP, OLSR, TORA
Data rate	11 Mbps
Speed	10 m/s
Traffic type	VoIP

B. Performance Metrics:

While comparing five protocols we focus on four performance measures Jitter, Delay, Network load, Throughput.

1. Jitter: It is the variation in the time between packets arriving, caused by network congestion, timing drift, or route changes. The deviation can be in terms of amplitude, phase timing, or the width of the signal pulse.
2. Delay: It is the time taken by a packet from the movement it is transmitted on the network by source node to reach the destination node.
3. Network load: It is the amount of traffic being carried by the network. It is the total data traffic (in bits/sec) received by the entire WLAN from higher layers that is accepted and queued for transmission.
4. Throughput: It is the number of packets received by all the destinations over the duration of simulation.

***C. Performance Analysis*:**

These figures are taken for performance comparison between all protocols. However these figures are another view of our simulation results. These figures include all protocols in one scenario and for one parameter. The figures for all three nodes scenario with all protocols for jitter, delay, network load and throughput separately are as under.

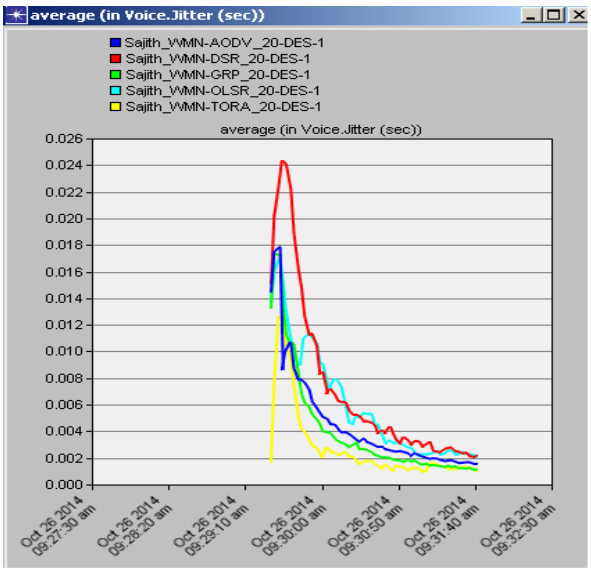

Fig:3 Showing Jitter value for 20 nodes

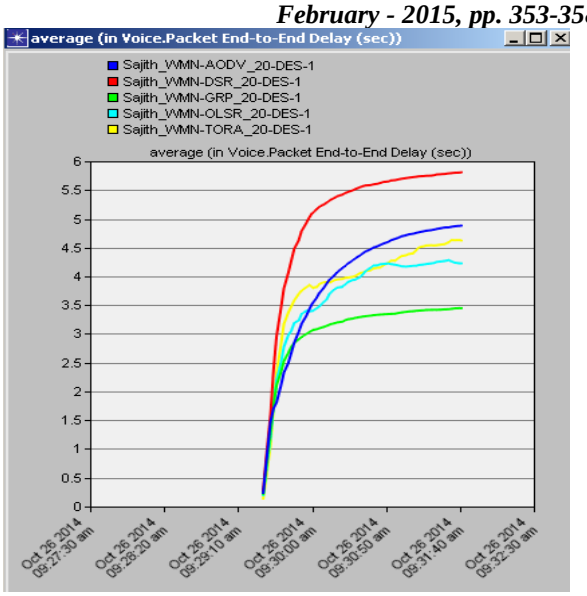

Fig:4 Showing Delay for 20 nodes

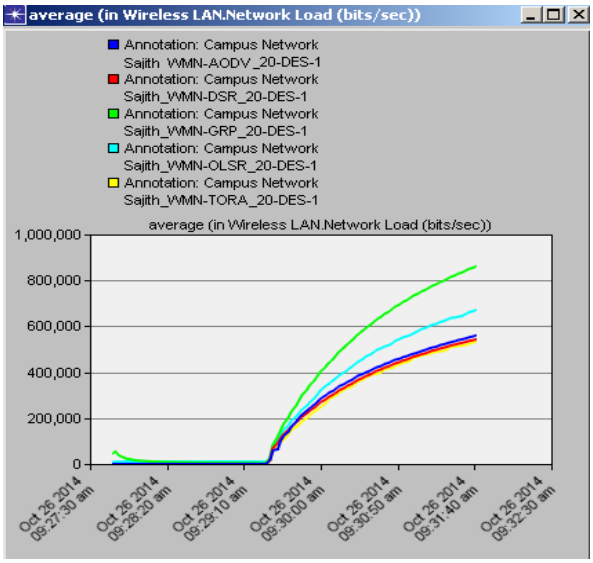

Fig:5 Showing Network Load for 20 nodes

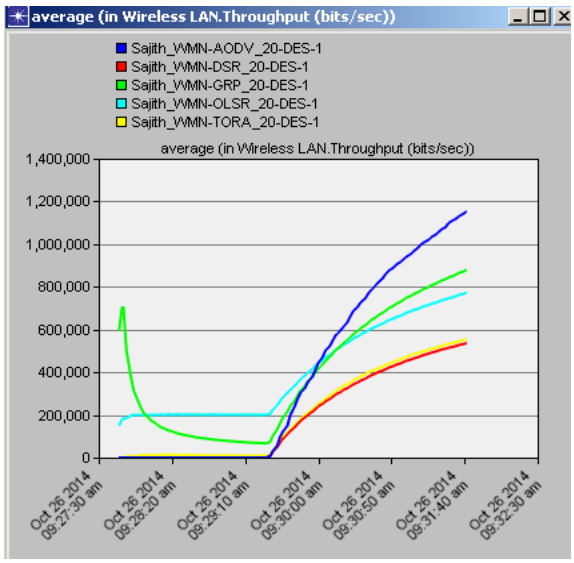

Fig:6 Showing Throughput for 20 nodes

D. Performance analysis for 20 nodes:

From the above figures it can be concluded that value of jitter (Time variation of receiving of packet) in case of TORA is much better than other protocols. Protocol GRP is very close to TORA in case of this parameter. In case of Delay GRP performs better followed by OLSR. In Case of Network load TORA, DSR and AODV are having almost similar performance, GRP has worse performance. AODV has better throughput followed by GRP. DSR has least throughput.

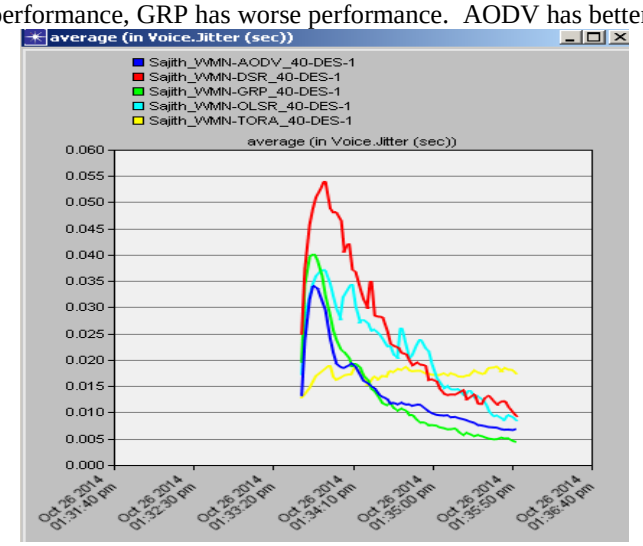

Fig:7 Showing Jitter value for 40 nodes

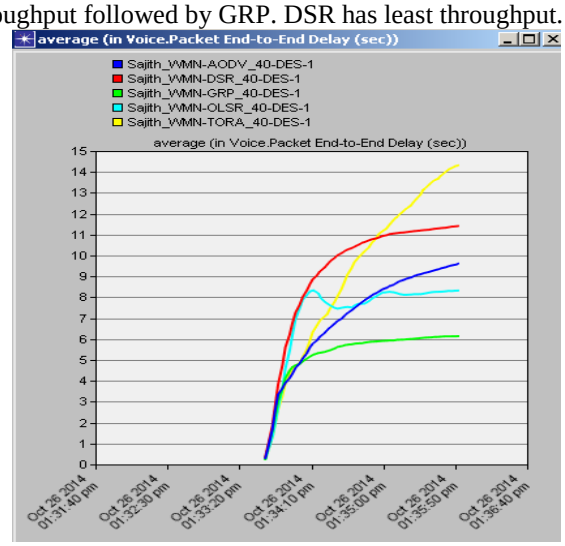

Fig:8 Showing Delay for 40 nodes

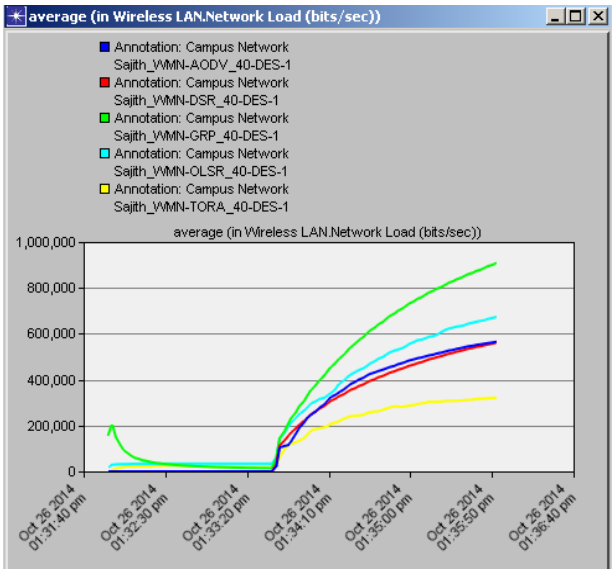

Fig:9 Showing Network Load for 40 nodes

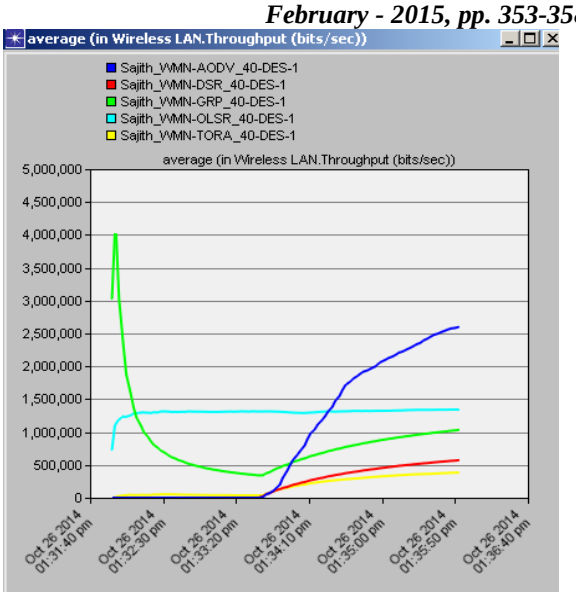

Fig:10 Showing Throughput for 40 nodes

E. Performance analysis for 40 nodes:

In this scenario GRP has better value for jitter and delay, followed by AODV. In case of network load TORA is the best performer and GRP is least performer. In case of throughput AODV is best performer and TORA is least one.

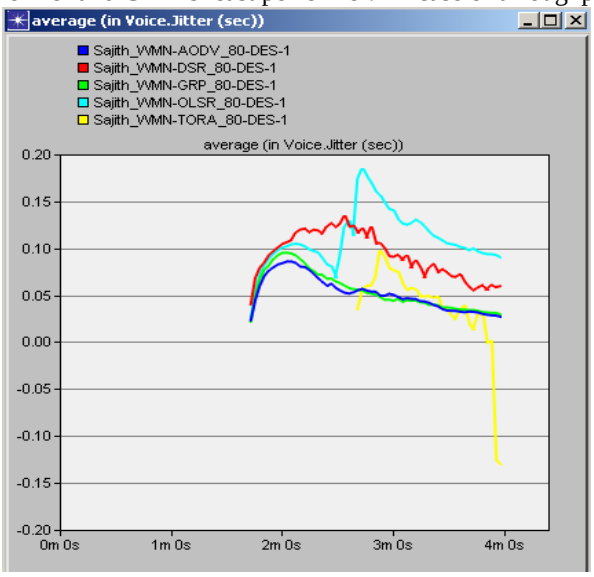

Fig:11 Showing Jitter value for 80 nodes

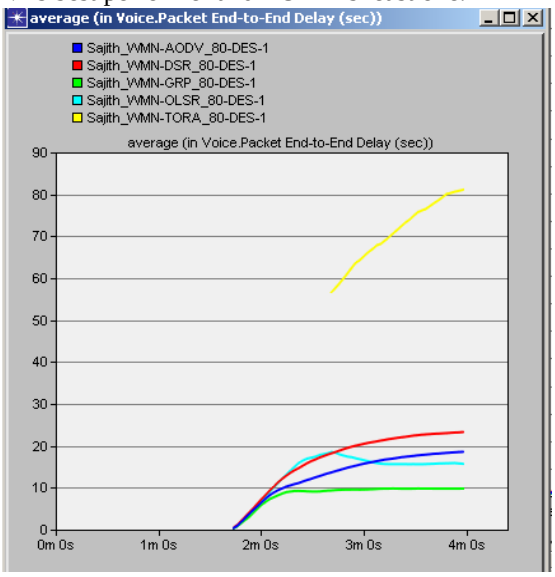

Fig:12 Showing Delay for 80 nodes

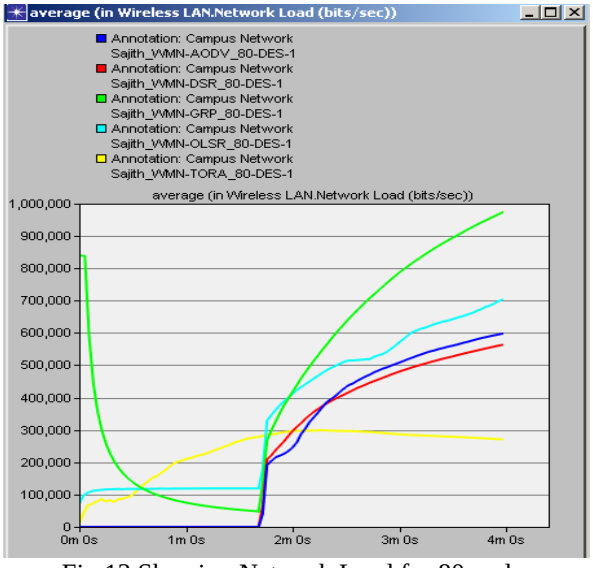

Fig:13 Showing Network Load for 80 nodes

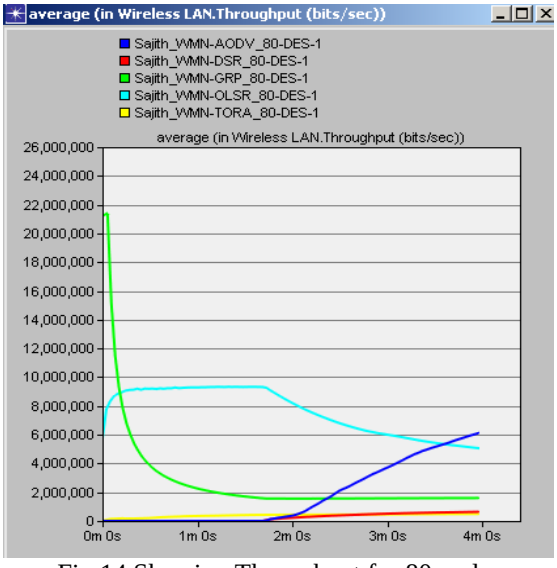

Fig:14 Showing Throughput for 80 nodes

F. Performance analysis for 80 nodes:

TORA shows sharp decrease in value of Jitter followed by GRP. OLSR has worst response to jitter. GRP has the least delay followed by OLSR. TORA has an exponential increase in delay. In case of network load TORA is the best performer while GRP producing highest network load. In case of throughput AODV is the best performer followed by OLSR and GRP.

III. CONCLUSIONS

The Routing protocols play vital role to increase the credibility of WMNs. The selection of appropriate routing protocol with respect to network improves the efficiency and reliability of network. From the above study it can be concluded that routing protocols should not be centralized. These should be distributive in nature. Routing protocols should have capability to maintain QoS in terms of different parameters such as delay, load, jitter and throughput etc. Mainly there are two categories of protocols used in WMNs or MANETs i.e. reactive and proactive. Both types of protocols have different utilization in MANETs; both categories have advantages and disadvantages discussed in this thesis. Thus to achieve good results and efficiency in communication according to scenarios and parameters, selection of suitable category of protocol is very important.

In case of Jitter TORA perform better in all scenarios followed by GRP. AODV overall can be considered after these above mentioned two protocols. In Case of delay GRP consistently performed better than all the protocols and is followed by DSR. Overall GRP has comparatively better performance in all scenarios except network load. In case of network Load TORA has performed better and is followed by DSR. AODV, TORA and DSR are reactive protocols. OLSR is proactive protocol and GRP is hybrid.

Traffic taken was VoIP and distributed equally in all nodes. Some routing protocols perform well in larger network while some perform well in smaller network. Moreover it cannot be said that particular protocol should not be used because every routing protocol has its own attributes on which it performs well. In this case overall GRP is performing better leaving the case of network load. So it can easily be recommended that in these kinds of networks and parameters that have been created in this thesis, GRP is a good option to use as compared to other protocols where network load is not dominating.

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