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Analysis Of Routing Protocols In Wmn Using Certain Parameters To Maintain Quality Of Service

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Abstract

Wireless Mesh Networks (WMNs) are bringing rapid change in the field of wireless networking. It is a trustworthy technology in applications like broadband home networking, network management and latest transportation systems. WMNs consist of mesh routers, mesh clients and gateways. It is a special kind of wireless Ad-hoc networks. Parameters in WMNs include delay, throughput, network load etc. There are two types of routing protocols i.e. reactive protocols and proactive protocols. Three routing protocols AODV, DSR and OLSR have been tested in WMNs under certain parameters which are delay, throughput and network load. The testing of these protocols will be performed in the Optimized Network Evaluation Tool (OPNET) Modeler 14.5. The obtained results from OPNET will be displayed in this paper in the form of graphs.

Keywords- Wireless Mesh Networks, Dynamic Source Routing, QoS, Mesh Routing Protocol

I. INTRODUCTION

Wireless communication has an enormous use these days and is still becoming popular from times immemorial. This is because of the latest technological demands nowadays arising from laptops, wireless devices such as wireless local area networks (LANs), etc. Because of its fast growing popularity day by day, it has led wireless communication data rates higher and it has made its prices cheaper, that is why wireless communication is growing so fast. Wireless communication can work between hosts by two different methods; one method is to allow the existing network carry data and voice, and second method is to make ad-hoc network so that hosts can communicate with each other [1]. Wireless Mesh Networks (WMNs) are one of the types of ad-hoc networks. Ad-hoc networks are also called as mobile ad-hoc networks (MANETs). Companies use wireless mesh networks for making large coverage area of wireless local area networks. WMNs are the latest technology that has lot of things in common with MANETs. Basically WMNs are consisted of wireless nodes; each node with its own packet, these nodes can communicate with each other by forwarding the packets to one another.

II. SECURITY IN WMNS

There are various challenges in WMNs on which it is necessary to overcome and hence making the WMN more and more ideal. While making an efficient network, there exist these kinds of challenges, on which it is necessary to tackle. The challenges that arise in WMNs are authentication, authorization, encryption, key management, attacks, intrusion detection and prevention, secure routing and security policies [23]. Authentication is one of the core issues in network security. When there is no interruption in our network, it is said that network is providing authentication or in other words data cannot be made stop by any third party. In WMNs thousands of nodes are being connected wirelessly with each other and as it is already said that stealing the data from a wireless network is easier than a wired network. Hence while building a WMN it is necessary to keep in minds that it must provide authentication so that users gain more confidence on a network. Authorization is the kind of permission that particular thing is accessible.

III. SECURITY MODEL FOR WMNS

In every network there are key issues i.e. availability, integrity, authenticity and confidentiality. If some actions attempt to disturb these issues, they are called intrusions. There is one system by which intrusions can be detected i.e. Intrusion Detection System (IDS). Intrusions can be prevented by using different kind of software. There is intrusion prevention system (IPS) which is a sub part of IDS that prevents the network from intrusions. In simple words to make the WMNs secure from attacks it is necessary to do intrusion detection and prevention. There is a proposed security model for WMNs that explains how the security services are put together [24]. In the intrusion prevention model, first three including authentication, integrity and data confidentiality works on Medium Access Control (MAC) layer while integrity, data confidentiality, authorization and source routing works on network layer. The right model shows that availability, intrusion detection and automated response can work on both layers i.e. network and MAC layers.

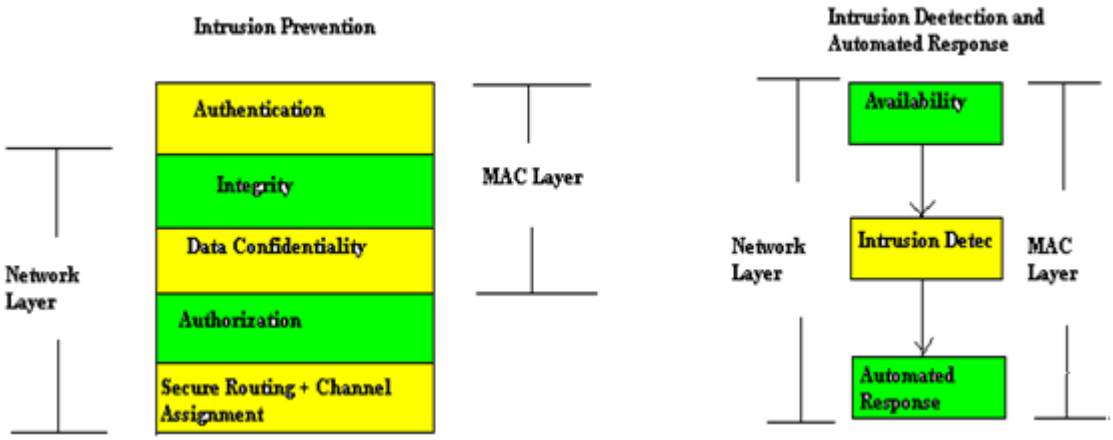

Figure 1. Security Model

IV. WIRELESS MESH NETWORK PROTOCOLS

Wireless Mesh Networks are generally considered as the type of mobile ad-hoc networks. However there are some differences between them. Firstly in wireless mesh networks almost the traffic starts from gateways and ends ups also on gateway. Secondly in wireless mesh networks, nodes are clearly separated from each other either they are in the form of stagnant nodes or mobile nodes. MANETs are linked with mobile ad-hoc networks, general MANETs routing protocols can be used in WMNs. Additionally WMNs are new technological networks which are similar to MANETs. One of the applications of WMNs is that, it provides connection to an infrastructure node. It plays vital role for providing broadband internet access. Some of the effects of routing protocols in WMNs are listed below.

1. They are responsible to strength the network.
2. They are helpful to make connection between nodes.
3. Creates synchronization between nodes.
4. Provides quality of service in terms of bandwidth utilization, delay, throughput, network load, and jitter.

As mentioned earlier general MANETs protocols can be implemented in WMNs, however the more efficient protocol which synchronizes with wireless mesh networks is mesh routing protocol (MRP). The protocol creates the continuity between routing paths and gateway destinations. It has also the ability to select the route, which is basic requirement to make better communication in WMNs. There are lots of relevant protocols in this context. Many of them have been authorized by IETF, some of them are reactive and some of them are proactive for example AODV and DSR are implemented for ad-hoc networks. Wireless mesh technology is the latest well developed technology which has vital role in the field of telecommunication as well as internet services; however there are still some challenges and problems which have been faced by trouble shooters.

V. DESIGN PARAMETERS

There are various parameters that are available in WMNs and they are also termed as performance metrics or design parameters. Every parameter has its own importance. These parameters are named and described below. These design parameters/performance metrics are used for the evaluation of routing protocols. These design parameters have a great impact on overall performance of a communication network. This paper has dealt with the first three performance metrics of a network i.e. delay, throughput and network load. These three performance metrics are evaluated with respect to routing protocols to see the performance. The descriptions of all the design parameters that are useful in WMNs are as follows.

1. Delay
2. Throughput
3. Network Load
4. Jitter
5. Packet Loss
6. Routing overhead
7. Packet Delivery Ratio

VI. SIMULATION RESULTS AND ANALYSIS

1 First Scenario

We made first scenario in which we used 15 mobile nodes from the object palette window of OPNET Modeler 14.5 and pasted all of them in the workspace window. For these 15 mobiles there had to be one server, so we took one fixed wlan_server from the object palette. These nodes were being pasted in the campus network size of 1000 x 1000 meters. Once all the mobile nodes and fixed node server have been pasted on a workspace window,

IPv4 addressing was assigned automatically to all nodes. After this we drag application config and profile config from object palette to workspace window. All the attributes of these two config(s) contain mostly the number of rows, speed in meters/seconds and pause time in seconds. So these settings must be done according to the requirement. The FTP was selected as traffic and FTP was set to High Load FTP traffic. After doing all the configurations to a network now it's time to deploy the configured profile which can be done by clicking Protocol tab in OPNET workspace window and selecting the Deploy Defined Application. Mobility Config was also dragged into workspace window, all its necessary attributes had been set and then random mobility was set to MANET as a profile. Before running simulation, individual statistics had been selected from where we can choose protocols and wireless LAN etc. The figure of this first scenario is shown as follows in which all the three protocols (AODV, DSR and OLSR) were tested against the three parameters (Delay, Throughput and Network Load).

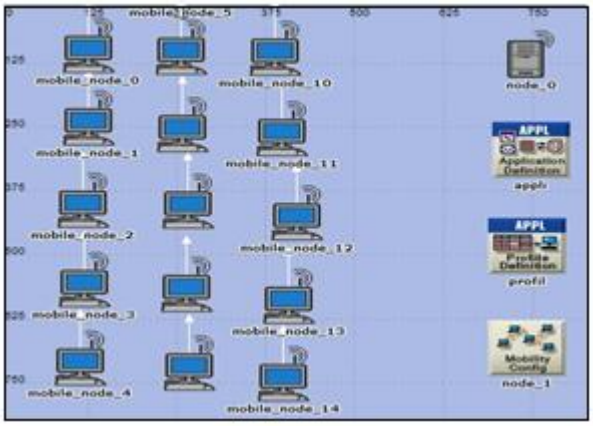

Figure 2. Paper Simulation Scenario with 15 nodes

2 Second Scenario

Similarly we made our second scenario in which have increased the number of mobile nodes from 15 to 30.All the settings in this scenario remained same like it had in the first scenario, only the number of nodes was increased. In this scenario also, the protocols are tested against the three parameters. The figure of our second scenario in simulation environment is shown as follows.

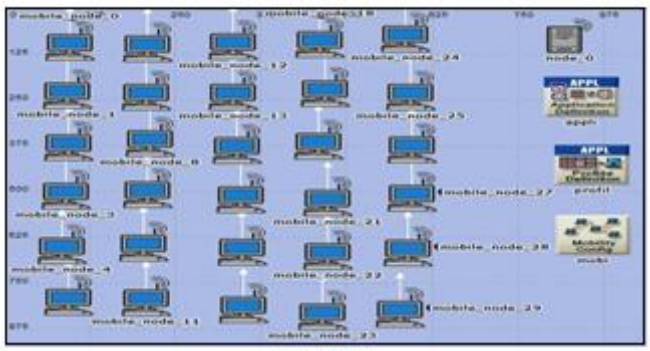

Figure 3. Paper Simulation Scenario with 30 nodes

3 Simulation Results

After making all three scenarios in OPNET Modeler 14.5, we run the simulation and compared the results of these three scenarios. Initially simulation time was set to 50 minutes and graphs were taken, but for statistical calculation we found those graphs very difficult as the graphs are showing very little variations in it. That is why we then performed the simulation for 3 minutes (180 seconds) 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. Hence we preferred those graphs that were obtained during 3 minutes simulation. The DES execution manager window for both the simulation periods clearly shows that simulation has been performed for 50 minutes and 30 minutes also.

3.1.1 When Nodes=15, AODV Performance

This figure was taken when we were working in our scenario 1 when we have 15 mobile nodes and 1 fixed node server. The protocol run in this case was Ad-hoc On-Demand Vector (AODV) against all three parameters. In this figure delay, throughput and network load are being shown when AODV protocol is used in MANETs. The graphs are showing in time average form. The upper small window is showing the delay when AODV protocol was used, the x-axis denotes time which is in minutes and y-axis is also in time but in seconds. According to the upper figure the average peak value of delay is almost 0.027 seconds, and it gradually drops and attains a constant value of approximately 0.001 seconds, after 3 minutes the value of delay is almost 0.001 seconds. Similarly the middle graph is for network load when protocol was AODV and nodes were 15. The x-axis of this graph denotes time which is in minutes and y-axis denotes data rate which is in bits/seconds. According to this graph the peak value of network load is 500,000 bits/sec and it gradually drops as time progresses and reaches to almost 80,000 bits/sec after 3 minutes. The third graph is for

throughput when AODV protocol was used and numbers of nodes were 15. The x-axis denotes time which is in minutes and y-axis denotes data rate which is in bits/seconds. According to this graph the peak value of throughput is almost 510,000 bits/sec and after this it gradually decreases and reaches to almost 100,000 bits/sec at time 3 minutes.

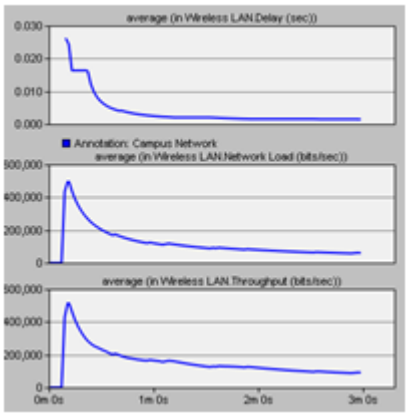

Figure 4. Showing Graphs of all parameters when nodes=15 (AODV)

3.1.2 When Nodes=15, DSR Performance

This figure was taken when the numbers of nodes were 15 and the protocol was Dynamic Source Routing (DSR) in MANETs. This below figure is also showing the delay, network load and throughput of DSR protocol. The upper small figure is showing delay, in which x-axis denotes time which is in minutes and the y-axis also denotes time which is in seconds. The middle figure is for network load in which x-axis denotes time which is in minutes and the y-axis denotes data rate which is in bits/seconds. The third figure is for throughput in which x-axis denotes time which is in minutes and the y-axis denotes data rate which is in bits/sec. The peak value of delay in DSR is approx 0.030 seconds and after 3 minutes it reaches to almost 0.010 seconds. The peak value of network load in DSR is almost attaining a value of 400,000 bits/sec and then gradually decreases and reaches to approx 50,000 bits/sec at 3 minutes time. The behavior of throughput in DSR protocol is showing that after 3 minutes the value of throughput is approximately equal to 50,000 bits/sec when the numbers of nodes are 15.

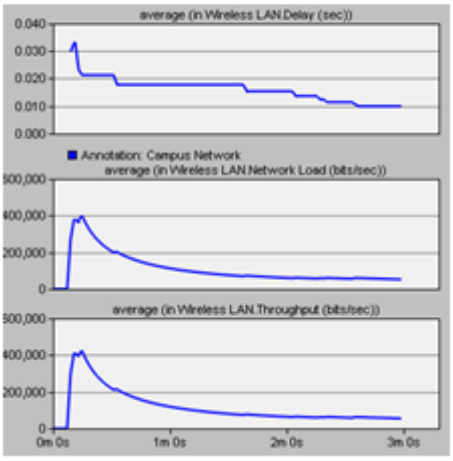

Figure 5. Showing Graphs of all parameters when nodes=15 (DSR)

3.1.3 *When Nodes=15, OLSR Performance*

Like above two criteria the figure for OLSR is also collected and saved when there are 15 mobile nodes in a scenario. The x-axis denotes time in minutes and y-axis denotes time in seconds for the upper window in this below figure. While the second middle figure has x-axis in minutes and y-axis in bits/sec because y-axis shows data rate. In the third small window the x-axis denotes time in minutes and y-axis denotes data rate in bits/sec. The average delay of OLSR after 3 minutes is approximately 0.0009 seconds which is very low as compared to first two routing protocols. The network load in OLSR is approximately 50,000 bits/sec after 3 minutes and its peak value 450,000 bits/sec. The peak value of throughput of OLSR in 15 nodes scenario is almost equal to 580,000 bits/sec.

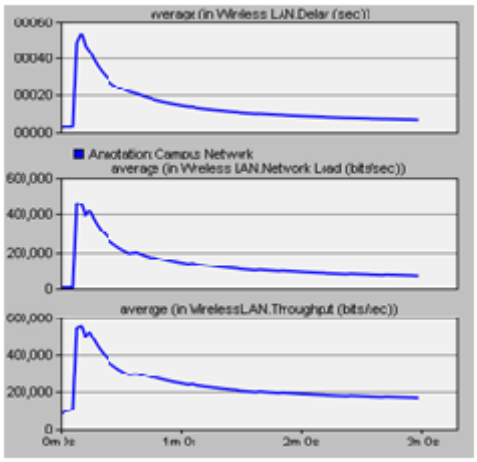

Figure 6. Showing Graphs of all parameters when nodes=15 (OLSR)

3.2.1 When Nodes=30, AODV Performance

When we have increased the number of nodes from 15 to 30, the protocols are checked individually on all parameters. First of all we have chosen AODV to see its performance on delay, throughput and network load. On increasing the number of nodes it made a slight difference on the graph of AODV delay, the delay's peak value is starting from almost 0.048 seconds and reaches to almost 0.001 seconds after 3 minutes time. Similarly the load on network is also showing a different behavior than the one that was in 15 nodes. The peak value of network load is 790,000 bits/sec. Throughput of DSR in this scenario has also increased as the number of nodes was also increased. ADOV protocol gives throughput almost equal to 250,000 bits/sec when number of nodes is 30. This is shown in figure below.

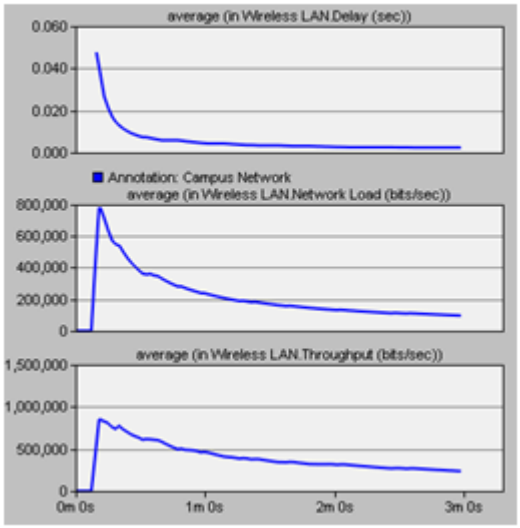

Figure 7. Showing Graphs of all parameters when nodes=30 (AODV)

3.2.2 When Nodes=30, DSR Performance

When we have number of mobile nodes equal to 30, we checked the behavior of DSR protocol when run on MANETs. The design of this figure is also the same like the previous figures. If we have a deep look on this figure we can observe easily that while increasing the numbers of nodes, definitely the delay of all protocols increase but their delays vary in numeric values. Like in this figure the delay in 30 nodes scenario is almost equal to 0.02 sec exactly after 3 minutes. And if we see the delay in 15 nodes scenario it was 0.010 sec. Because number of nodes is increased the delay has also increased because when data has to pass more nodes while reaching to its destination node, definitely the delay will be introduced in it. And in the middle figure the network load is also increased and reaches up to 125,000 bits/sec in 3 minutes, the figure is as below.

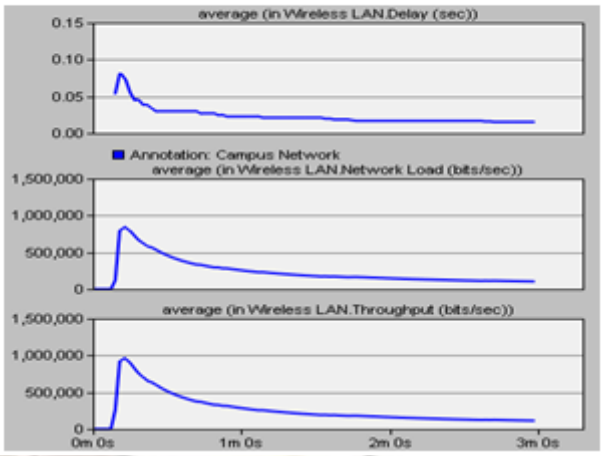

Figure 8. Showing Graphs of all Parameters when nodes=30 (DSR)

3.2.3 When Nodes=30, OLSR Performance

The figure of 30 nodes scenario with OLSR protocol is also showing that on increasing the number of nodes the delay generating by OLSR is also increasing but when we compared the delay of this figure with 15 nodes OLSR it is observable that the delay has the same value equal to 0.009 seconds after 3 minutes and the graph of delay also looks like same as in 15 nodes scenario. The peak value of network load in this scenario for OLSR protocol is approx 750,000 bits/sec and after 3 minutes the value is 150,000 bits/sec. Similarly we can measure and observe the value of throughput and can see the changing behavior of this graph.

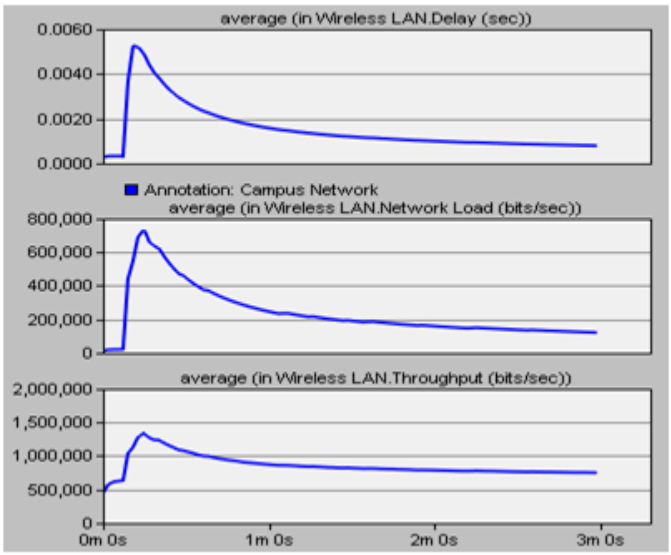

Figure 9. Showing Graphs of all Parameters with nodes=30 (OLSR)

VII. PERFORMANCE COMPARISON

These figures are specially taken for the sake of comparison and for making the statistical calculation more easy and precise. 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 delay, network load and throughput separately are as under.

1 All Protocols, 15 Nodes

These figures are showing delay, network load and throughput respectively in 15 nodes scenario with all three routing protocols AOD, DSR and OLSR. The color scheme above the graphs are clearly showing, which graph belongs to which protocol.

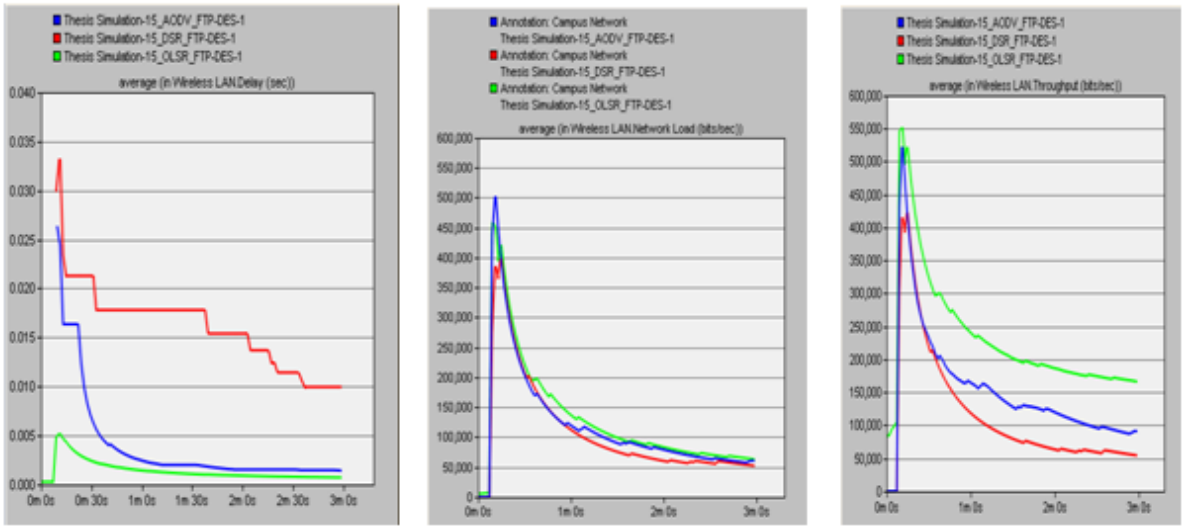

Figure 10. 10 Showing Delay, Network load and Throughput (15 nodes)

2 All Protocols, 30 Nodes

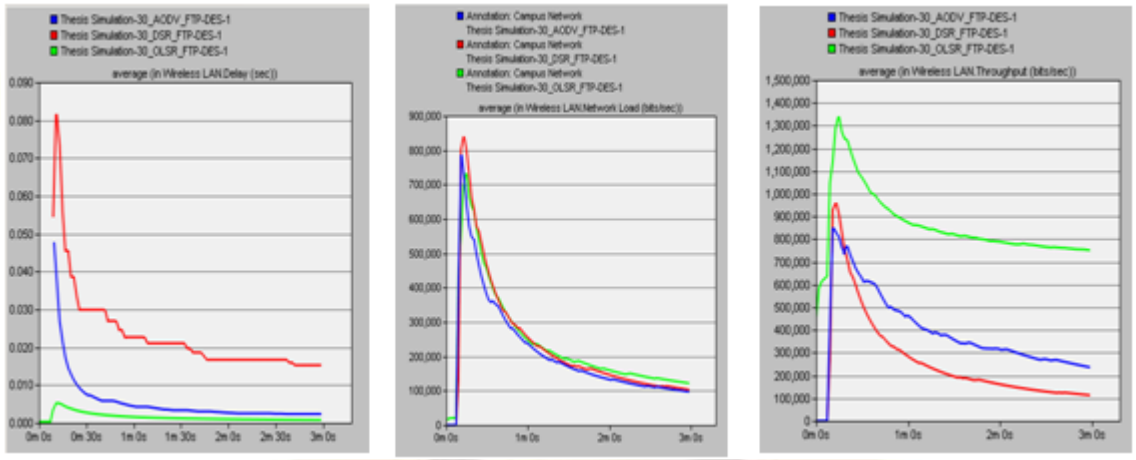

Figure 11. Showing Delay, Network load and Throughput (30 nodes)

VIII. CONCLUSION

The analytical study of this paper demonstrates that WMN technology proved to be a revolutionary and modern technology which has remarkable impacts in the field of Telecommunications and Internet Systems. 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. There are some suggestions regarding analytical study, routing protocols should not be centralized. These should be distributed in nature. Routing protocols used in ad-hoc networks should develop loop free routes; due to loop free environment bandwidth consumption becomes low. 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 paper. Thus to achieve good results and efficiency

in communication according to scenarios and parameters, selection of suitable category of protocol is very important. The simulation study of this paper reveals that, Optimized Link State Routing (OLSR) protocol works better than Ad-hoc on-demand Vector (AODV) and Dynamic Source Routing (DSR) protocols regarding end to end delay and throughput in all three scenarios (15, 30 and 60 nodes), while regarding network load it was observed that OLSR had better result in 60 nodes scenario only, in 15 and 30 nodes scenario OLSR network load was high. Traffic is distributed to all nodes in each scenario in equal amount. From our simulation we can conclude that DSR is a very slow routing protocol as it has taken lot of time while simulating each scenario (15, 30 and 60), OLSR does not take so much time. Finally we conclude that OLSR gives better results in terms of delay and throughput due to its proactive behavior. OLSR has the quality to reduce size of information that is why it gives less delay, controls flood within a network therefore throughput is better than other protocols. So we can easily recommend that in these kinds of networks and parameters that we have created in this paper, OLSR is a good option to use as compared to AODV and DSR.

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