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Exploration of Recital of Ad-hoc Routing Protocols - Dynamic Source Routing (DSR) and Temporally Ordered Routing Algorithm (TORA)

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Abstract—

When a collection of wireless mobile hosts form a temporary network without the aid of any centralized administration, it is called an ad-hoc network. An ad-hoc routing protocol controls how nodes route packets in the network. Many protocols exist for routing in ad hoc mobile networks which can be either table-driven or on-demand routing. Various simulations have been done in the past to study and investigate the behaviour of ad hoc routing protocols. This research paper gives an overview of simulation results for two ad hoc routing protocols based on various parameters.

Keywords— Wireless Networks; Routing: Performance Comparison; Dynamic Source Routing (DSR), Temporally Ordered Routing Algorithm (TORA)

I. INTRODUCTION

Wireless Local Area Network is a network using which a mobile user can connect to a Local Area Network (LAN) through a wireless connection. It can be of type Infrastructure or Ad-hoc. In Infrastructure mode, there must be at least one Wireless Access Point which acts as a bridge between computers in the wireless network and the computers in the wired networks. An ad-hoc wireless network is one in which various devices send and receive messages to each other in a peer to peer manner [1]. Ad-hoc networks have various characteristics like purpose-specific, autonomous and dynamic. A packet can travel from a source to a destination either directly or through some set of intermediate packet forwarding nodes. Connectivity varies with time. At a point of time a subset of nodes may be connected and at another point of time, another set of nodes may be connected with each other. Routing determines the end-to-end path between a source node and a destination node. A routing protocol is needed because it may be necessary to traverse several nodes before a packet reaches the destination [4]. It is critical for the routing protocol to deliver packets efficiently between source and destination. A routing protocol can be table driven in which each node maintains one or more tables containing routing information to every other node in the network, demand driven in which, routes are created when required or hybrid of both table driven and demand driven. Dynamic Source Routing (DSR) is a demand driven protocol which is designed for use in multi-hop wireless ad-hoc networks [5, 6]. It makes the network completely self-organizing and self-configuring requiring no existing network infrastructure or administration. Nodes allow communication over multiple hops to exchange data packets among themselves even if they are not in direct wireless transmission range of one another. Temporally-Ordered Routing Algorithm (TORA) is a distributed routing protocol [5, 6]. Routers need to maintain information only about adjacent routers. Like a distance vector routing approach, Temporally-Ordered Routing Algorithm (TORA) maintains route on a per-destination basis [8]. Ad-hoc On-Demand Distance Vector (AODV) minimizes the number of broadcasts by creating routes on-demand [2]. Each active node periodically broadcasts a Ping message that all its neighbours receive. If a node fails to receive several Ping messages from a neighbour, a link break is detected. In this paper two protocols namely, Dynamic Source Routing (DSR) protocol and Temporally-Ordered Routing Algorithm (TORA) protocol have been implemented using network simulator OPNET. Various parameters have been investigated namely Inbound & outbound traffic through Local Area Network (LAN), traffic received & forwarded through switch, traffic sent, received & dropped through routers, comparison of delay results at every node of Local Area Network (LAN), traffic received and delay through various nodes. It has been observed that network delay increases with increase in traffic and increase in number of nodes when routing is done either of protocols. Dynamic Source Routing (DSR) performs very well when mobility in nodes is less frequent and number of nodes in the network is less. Temporally-Ordered Routing Algorithm (TORA) performs well even if the nodes are mobile. But as the number of nodes increase, its performance starts to degrade.

II. STATEMENT OF PROBLEM

The objective of this study is to investigate various parameters of Dynamic Source Routing (DSR) protocol and Temporally-Ordered Routing Algorithm (TORA) protocol. Various parameters that have been investigated using network simulator OPNET are inbound & outbound traffic through Local Area Network (LAN) using Dynamic Source

Routing (DSR), traffic received & forwarded through switch using Dynamic Source Routing (DSR), traffic sent, received & dropped through routers using Dynamic Source Routing (DSR), comparison of delay results at every node of Local Area Network (LAN) using Dynamic Source Routing (DSR), Ethernet load, traffic received & delay through various nodes using Dynamic Source Routing (DSR), traffic received & forwarded in central switch using Temporally-Ordered Routing Algorithm (TORA), traffic received & forwarded in network using Temporally-Ordered Routing Algorithm (TORA), traffic sent, received and dropped in routers using Temporally-Ordered Routing Algorithm (TORA).

III. TOOLS USED

The tool used for this study is OPNET modeler which is a tool for network modelling and simulation.

IV. NETWORK SIMULATION

Network simulation is a method of modelling the behaviour of a network to study it. Interaction between different components of a network is calculated using mathematical formulas or by capturing and playing back observations from an actual network. The behaviour of the network and the various applications and services it supports can then be observed in a test lab. Different attributes of the environment can also be modified in a controlled manner to assess how the network would behave under different conditions.

OPNET is a network simulation tool for modelling, simulating and analysing the performance of communication networks, distributed systems, computer systems and applications. It comes with different toolsets. Node model specifies interface of a network component, packet format defines protocols, process model abstracts the behaviour of a network component, and project window defines network topology and link connections and simulation window captures and displays simulation results.

Network Simulator, widely known as NS2, is an event driven simulation tool that has proved useful in studying the dynamic nature of communication networks. Simulation of wired as well as wireless network functions and protocols can be done using NS2. It contains modules for numerous network components such as routing, transport layer protocol, application, etc. To investigate network performance, researchers can simply use an easy-to-use scripting language to configure a network and observe results generated by NS2.

OMNeT is another network simulation environment. It is an open source environment which provides a component based architecture for models. Components are programmed in C++, and then assembled into larger components and models using a high-level language. Reusability of models is there. OMNeT has extensive GUI support. It is gaining importance in network simulation due to its modular nature.

In this work, I have used OPNET modeler because it offers relatively much powerful visual or graphical support for the users. It is commercial software. The graphical editor interface can be used to build network topology and entities from the application layer to the physical layer. Object-oriented programming technique is used to create the mapping from the graphical design to the implementation of the real systems. It is based on a mechanism called discrete event system which means that the system behaviour can simulate by modelling the events in the system in the order of the scenarios the user has set up. Hierarchical structure is used to organize the networks. OPNET also provides programming tools for users to define the packet format of the protocol. The programming tools are also required to accomplish the tasks of defining the state transition machine, defining network model and the process module. Three main functions of OPNET are modelling i.e. to model the network consideration, simulating i.e. perform the actual simulation to get the results and analysis to analyse various parameters and results after simulation is complete.

V. IMPLEMENTATION OF DYNAMIC SOURCE ROUTING (DSR) PROTOCOL

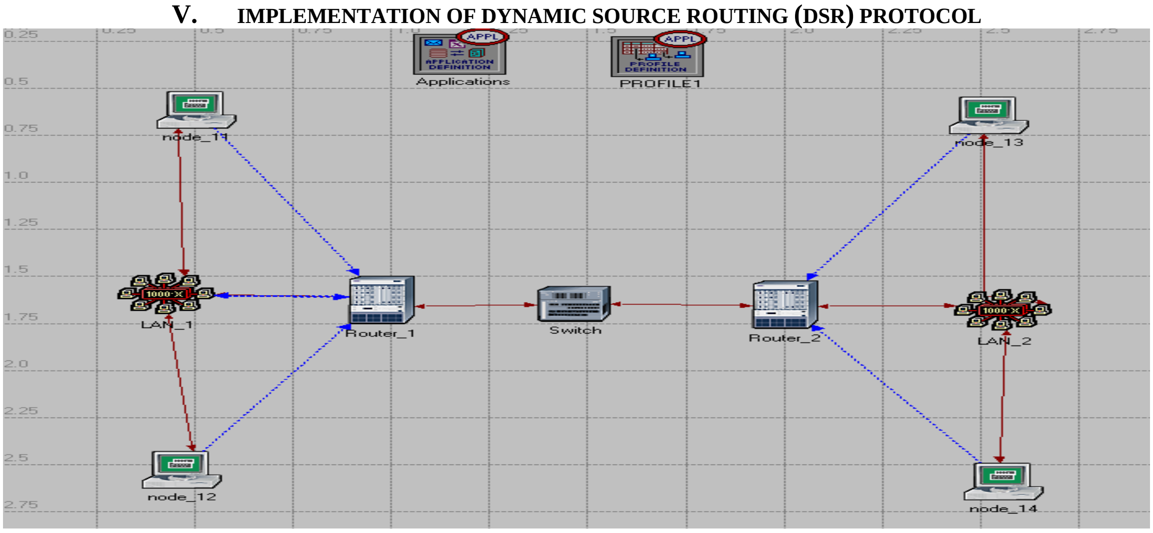

Fig. 1 Ad-hoc wireless network

The figure 5.1 shows an ad-hoc wireless network which includes two LANs (LAN_1 & LAN_2) that are connected to the switch by two routers. LAN_1 is connected to the switch through Router_1 and LAN_2 is connected through Router_2.

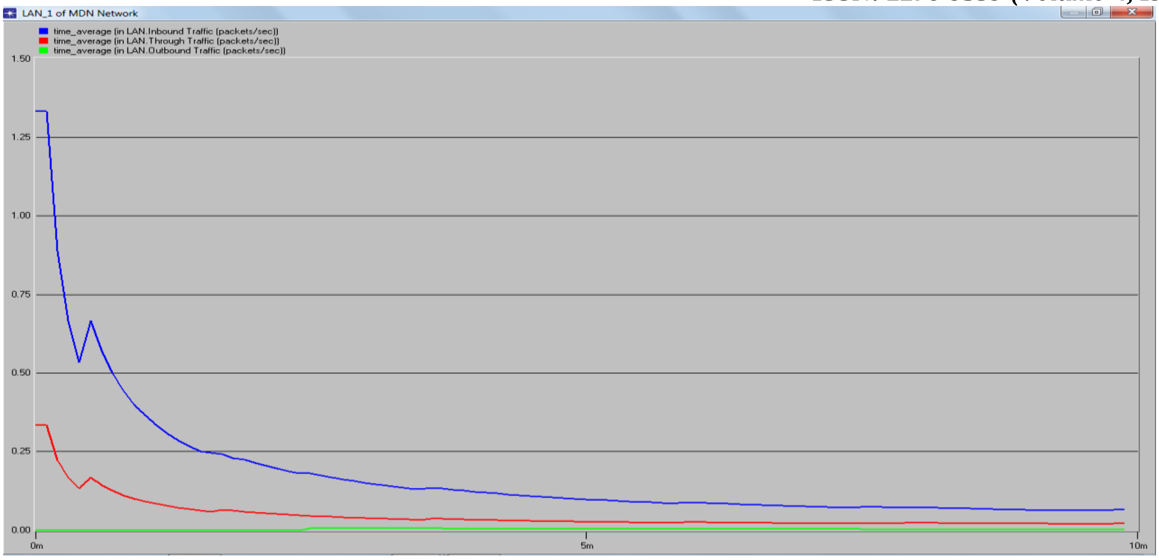

Fig. 2 Inbound, outbound and through traffic through LAN_1 using DSR

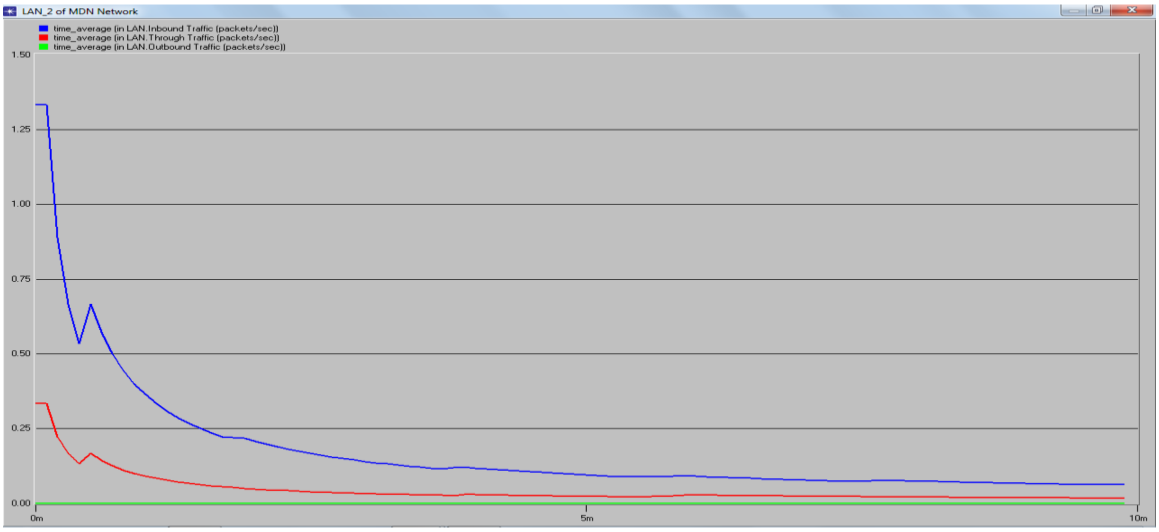

Fig 3 Inbound, outbound and through traffic through LAN_2 using DSR

Figures 5.2 and 5.3 show the inbound, outbound and through traffic through LAN_1 and LAN_2 when routing is done using Dynamic Source Routing (DSR) protocol. It is observed from figures that the inbound traffic, outbound traffic and through traffic for LAN_1 and LAN_2 using Dynamic Source Routing (DSR) protocol is comparatively equal due to the small size of the network. Inbound traffic is very high at the start of simulation process but goes on decreasing with time and then stabilizes. The Outbound traffic is almost constant throughout the simulation time. The through Traffic is high at the start of simulation process, but decreases after some time elapses. It remains constant afterwards.

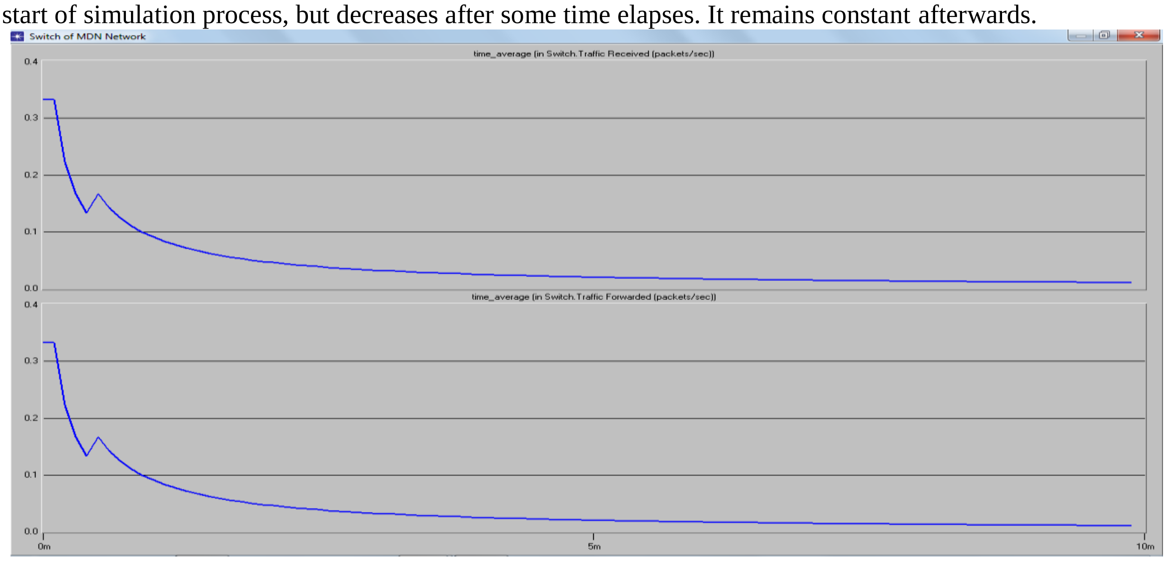

Fig. 4 Traffic received & forwarded through switch of network using DSR

As shown in figure 5.4, the traffic received and forwarded through switch of ad-hoc network are comparatively equal. It indicates that the switch is forwarding all the data packets received to the destination.

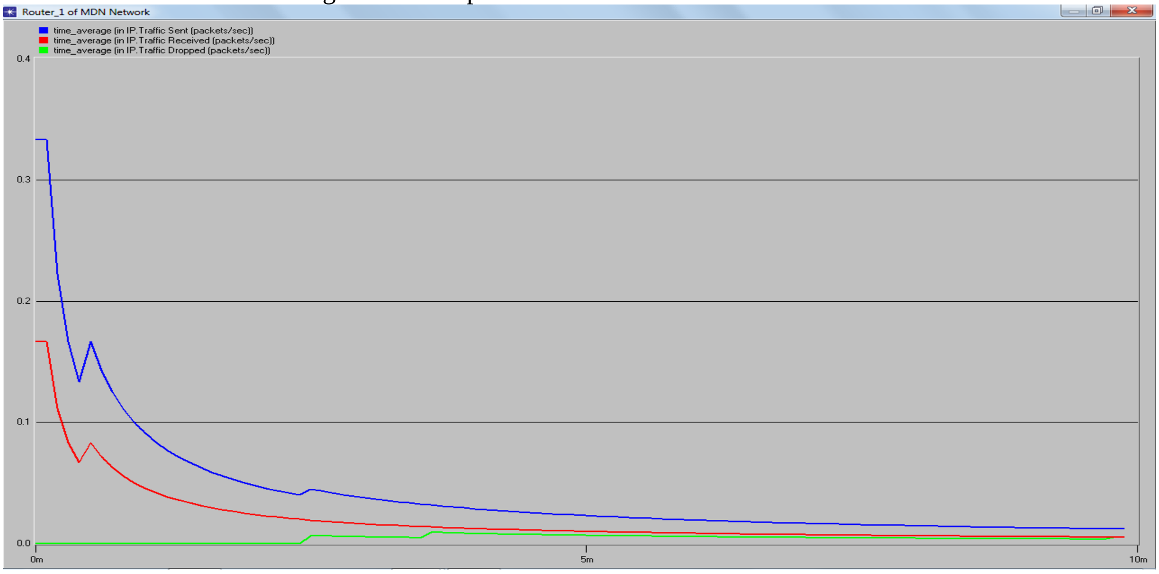

Fig. 5 Traffic sent, received and dropped through Router_1 using DSR

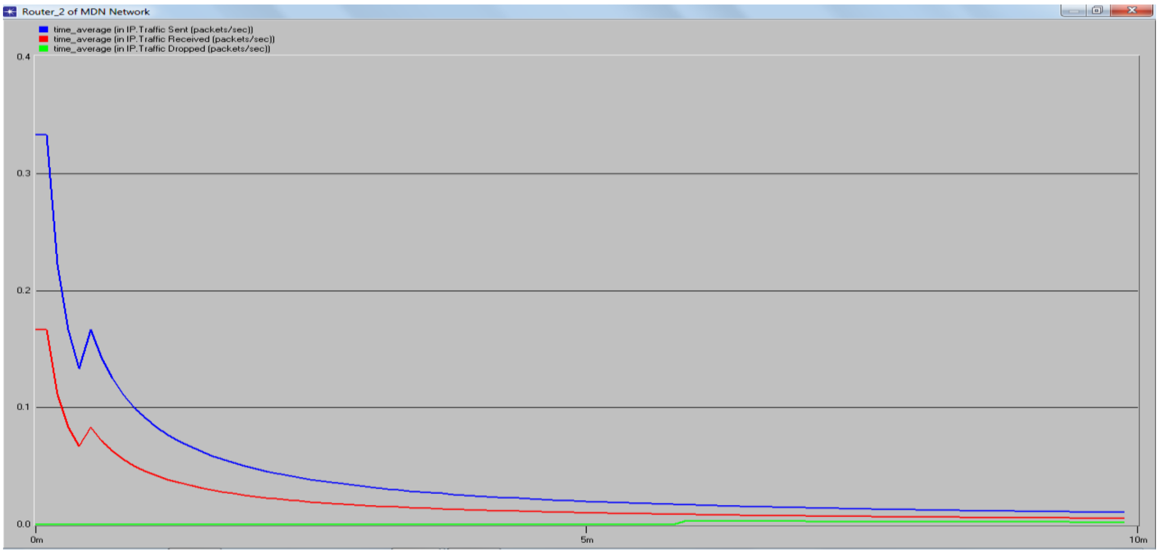

Fig. 6 Traffic sent, received and dropped through Router_2 using DSR

It is observed from figure 5.5 and 5.6 that in Router_1 and Router_2 traffic sent is higher than traffic received. Traffic dropped in both routers remains constant throughout the simulation process. Very less drop is seen in this case.

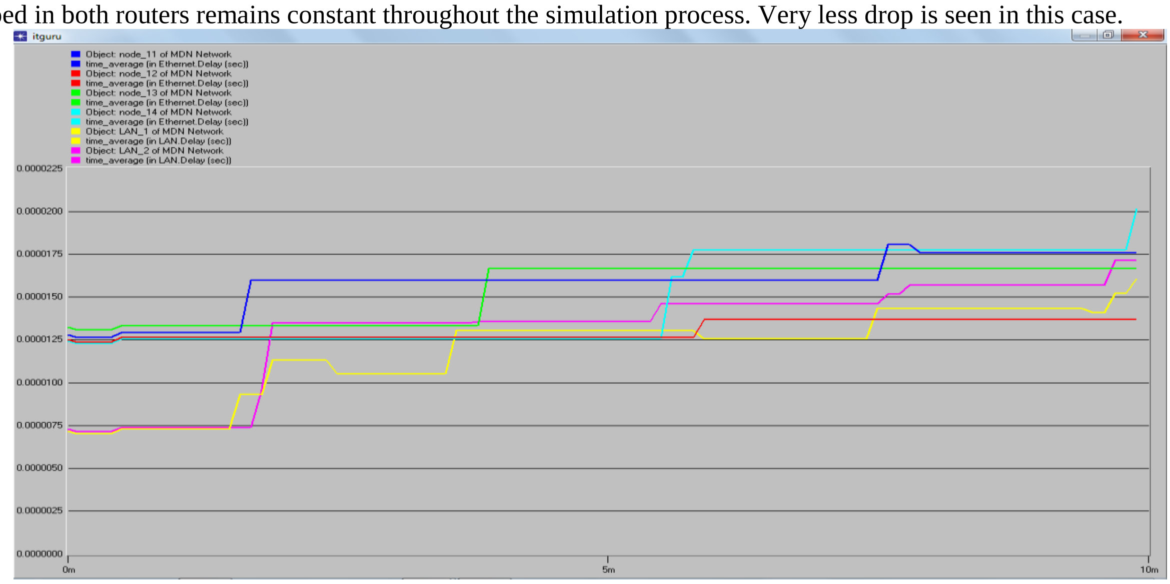

Fig. 7 Comparison of Delay results at every node and LAN using DSR

Figure 5.7 shows that at the start of simulation process, both LAN_1 and LAN_2 offer less delay than all nodes. Up to 1m it is almost same but after this simulation time, delays of node11, LAN_1, LAN_2 abruptly increases and the remains constant up to 5m simulation time. At the end of simulation time, the delay of node_14 is very high followed by node_11, LAN_2, node_13, LAN_1, node_12.

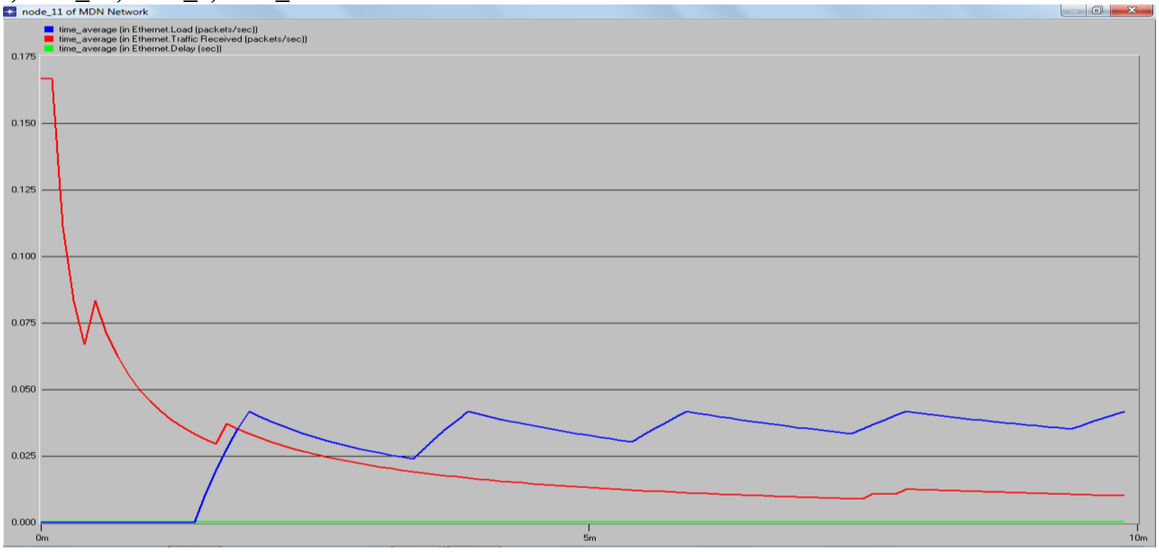

Fig. 8 Ethernet load, traffic received and delay through node_11 using DSR

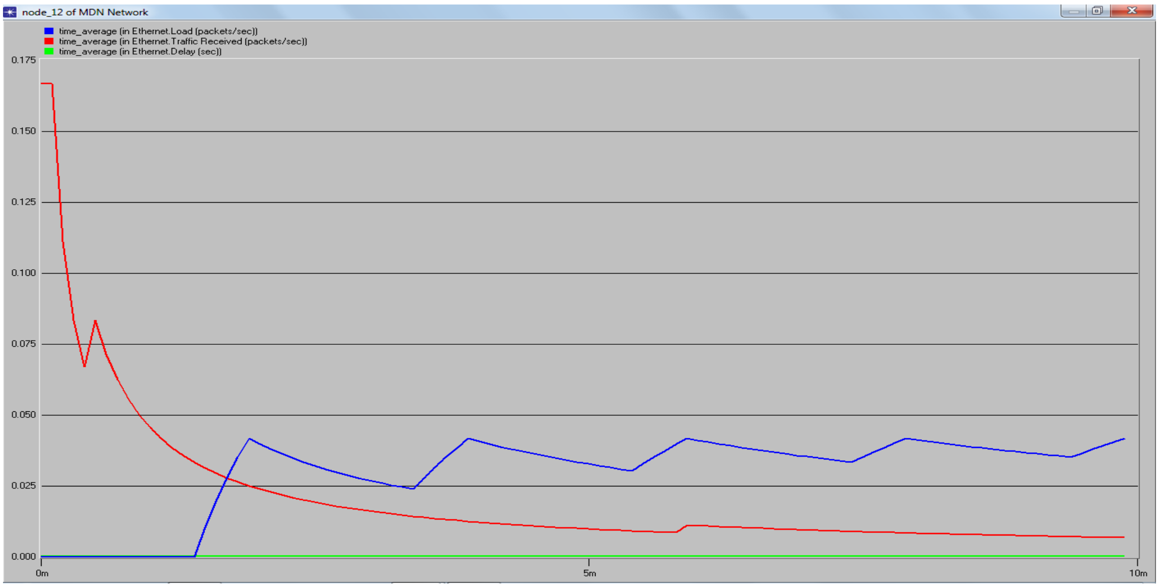

Fig. 9 Ethernet load, traffic received and delay through node_12 using DSR

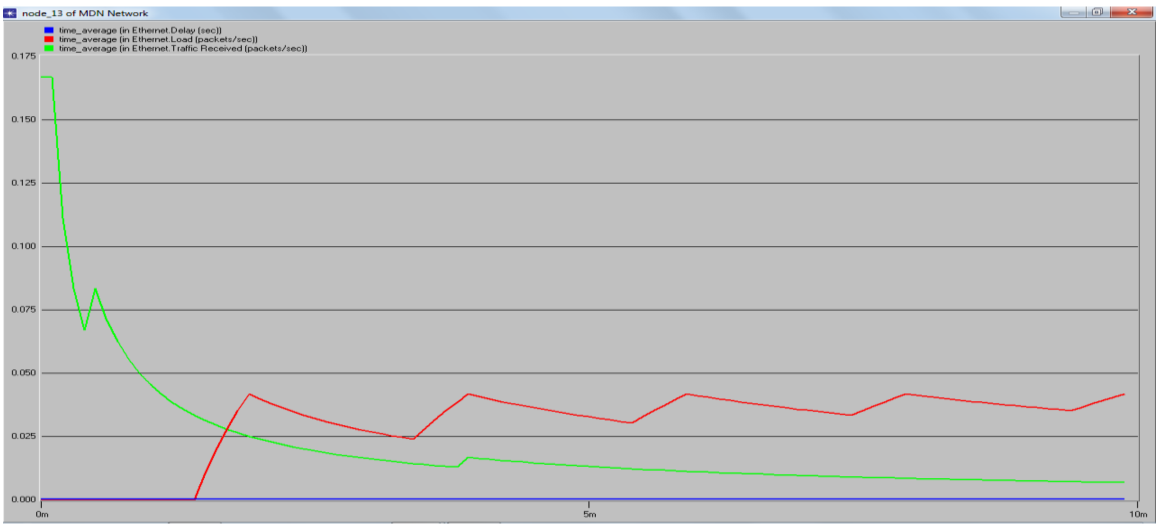

Fig. 10 Ethernet load, traffic received and delay through node_13 using DSR

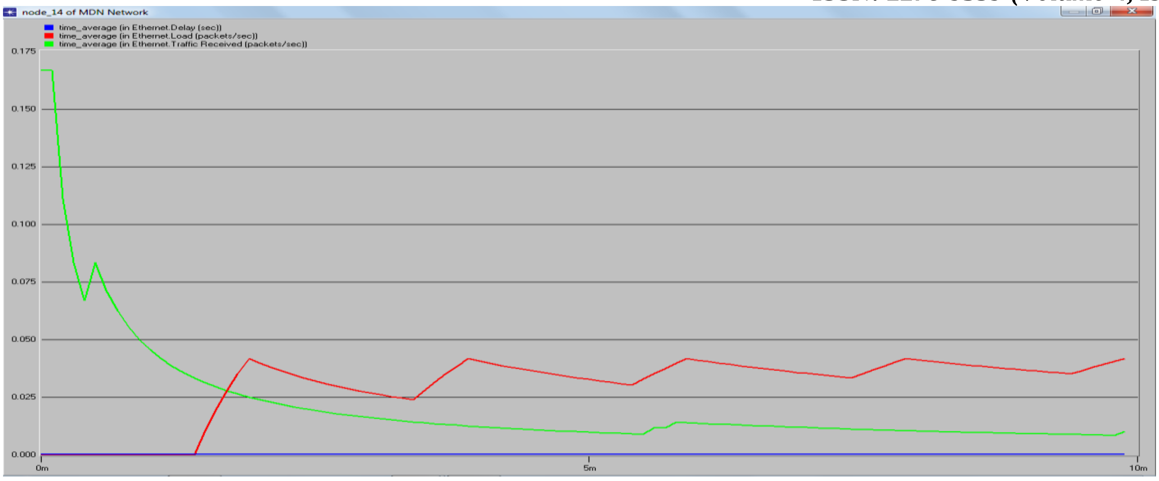

Fig. 11 Ethernet load, traffic received and delay through node_14 using DSR

It is concluded from the figures 5.8 to 5.11 that Ethernet delay at various nodes is negligible during whole simulation process. Ethernet traffic received is very high at the start of simulation but it decreases abruptly and at the end of simulation time. It is less than the Ethernet load.

VI. IMPLEMENTATION OF TEMPORALLY-ORDERED ROUTING ALGORITHM (TORA)

Figure 6.1 shows an ad-hoc wireless network in which four networks are used which are connected the central switch with the help of routers. NETWORK_1and NETWORK _2 are connected to switch by ROUTER_1 and ROUTER_2 respectively. Similarly NETWORK_3 and NETWORK_4 are connected to switch by ROUTER_3 and ROUTER_4 respectively.

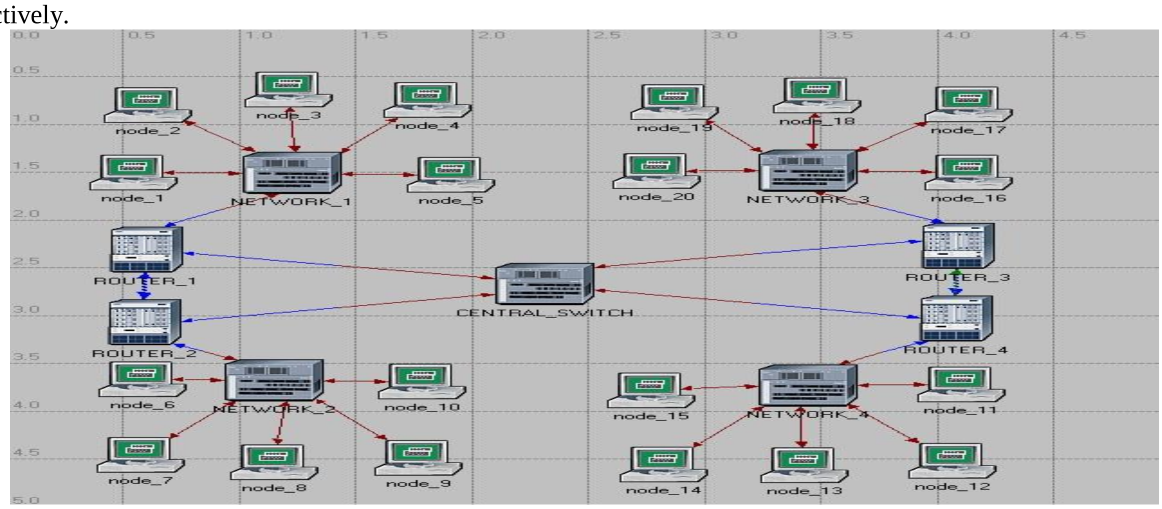

Fig. 12 Ad-hoc wireless network

NETWORK_1 is connected to five nodes (node_1, node_2, node_3, node_4 and node_5). NETWORK_2 contains five nodes (node_6, node_7, node_8, node_9 and node_10). NETWORK _3 has five nodes (node_16, node_17, node_18, node_19 and node_20). NETWORK _4 is connected to five nodes (node_11, node_12, node_13, node_14 and node_15).

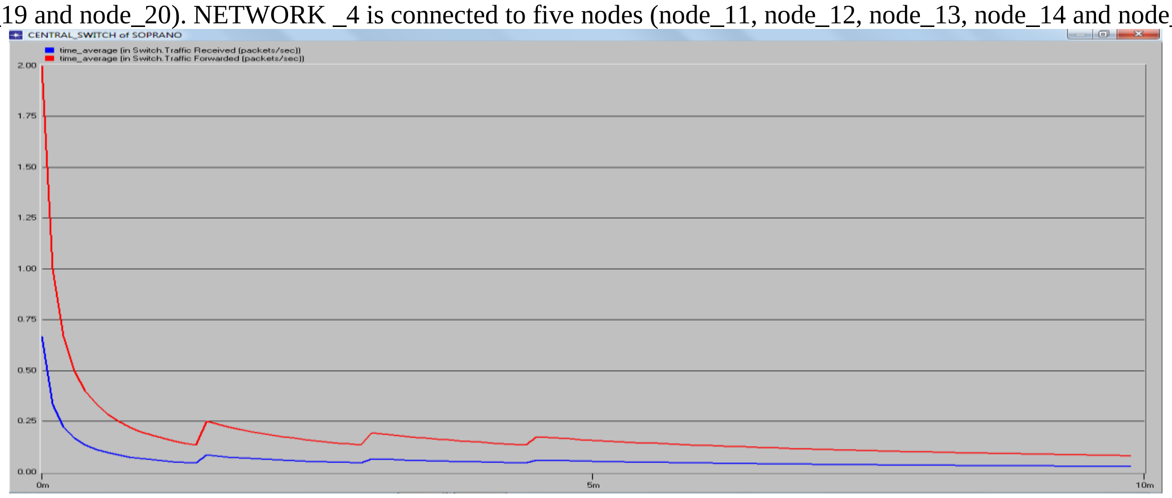

Fig. 13 Traffic received and Forwarded in central switch using TORA

Figure 6.2 depicts that when routing is done using Temporally-Ordered Routing Algorithm (TORA) protocol, traffic received in central switch at the start of simulation time is less than the traffic forwarded. Both start decreasing after some simulation time and sometimes both hike for very short time then again start decreasing till the end of simulation process.

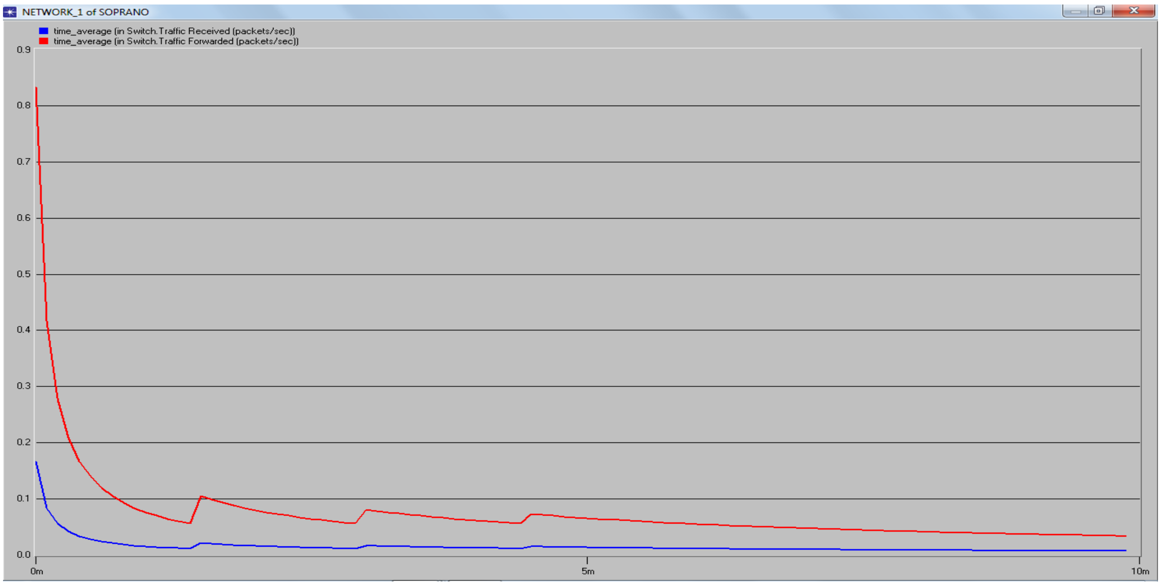

Fig. 14 Traffic received and Forwarded in NETWORK_1 using TORA

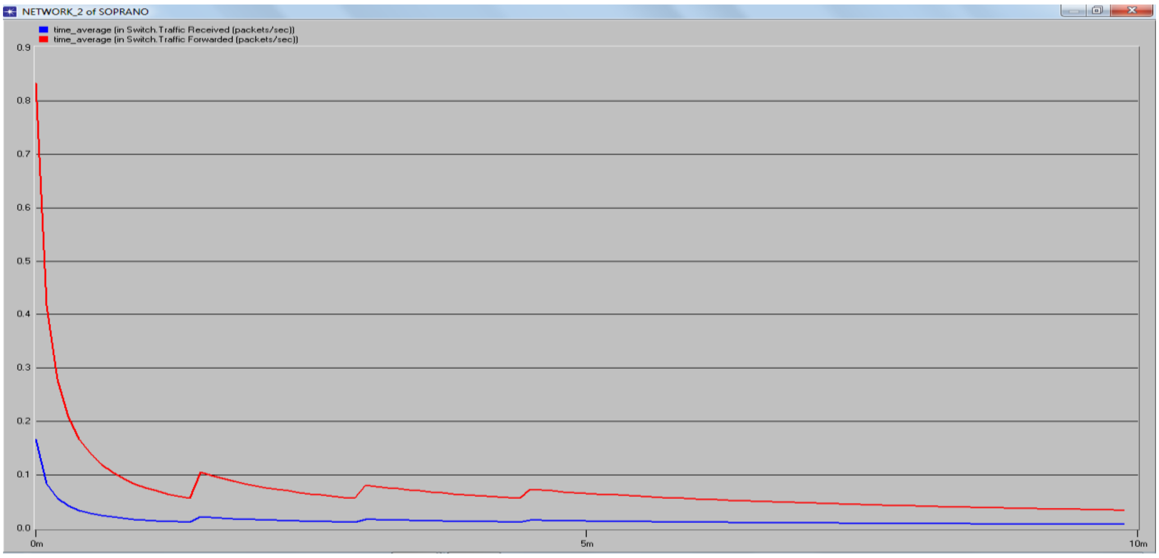

Fig. 15 Traffic received and Forwarded in NETWORK_2 using TORA

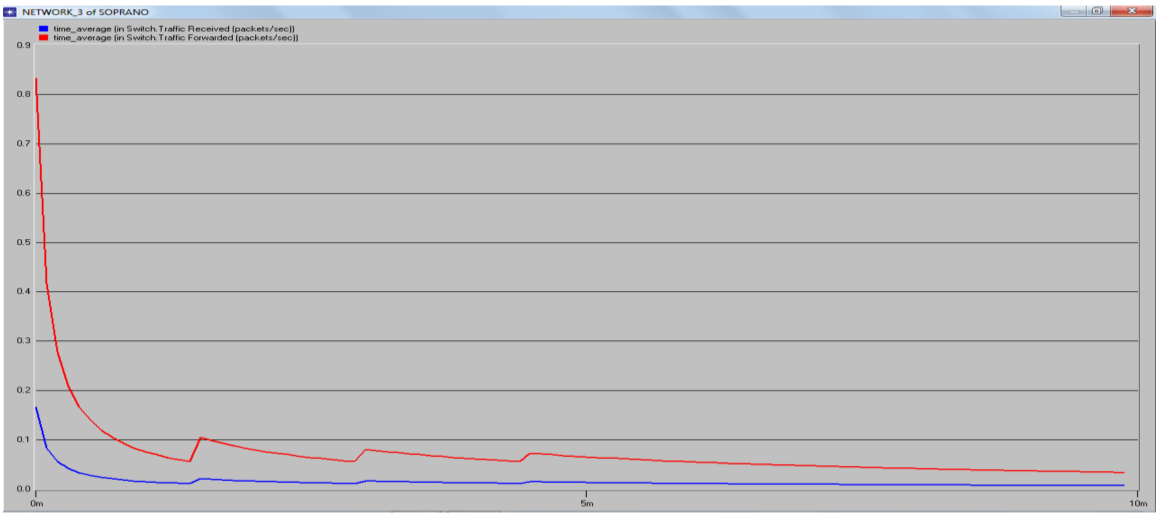

Fig. 16 Traffic received and Forwarded in NETWORK_3 using TORA

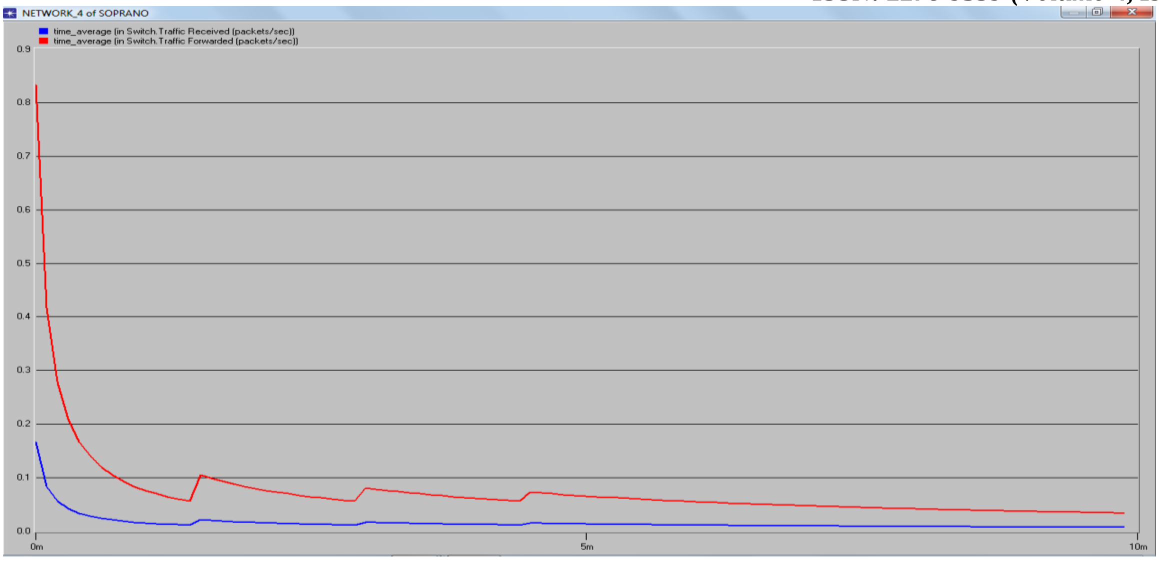

Fig. 17 Traffic received and Forwarded in NETWORK_4 using TORA

It is observed from figures (6.3 to 6.6) that traffic received in NETWORK_1, NETWORK_2, NETWORK_3, and NETWORK_4 at zero simulation time is less than the traffic forwarded. Both start decreasing after zero simulation time and sometimes both hike for a very short time then again start decreasing and become constant till the last simulation time.

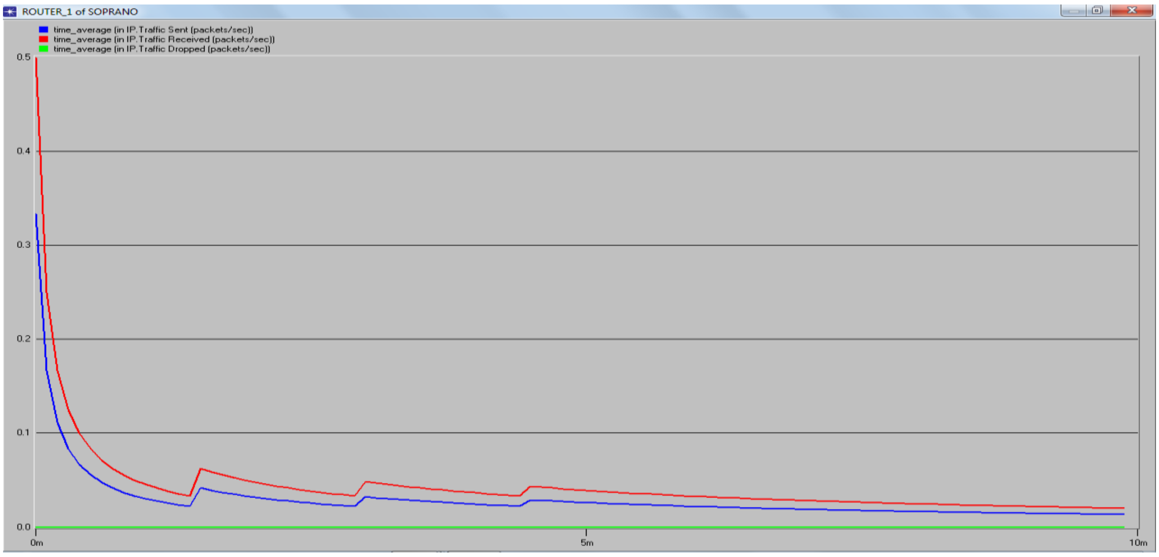

Fig. 18 Traffic sent, Received and Dropped in ROUTER_1 using TORA

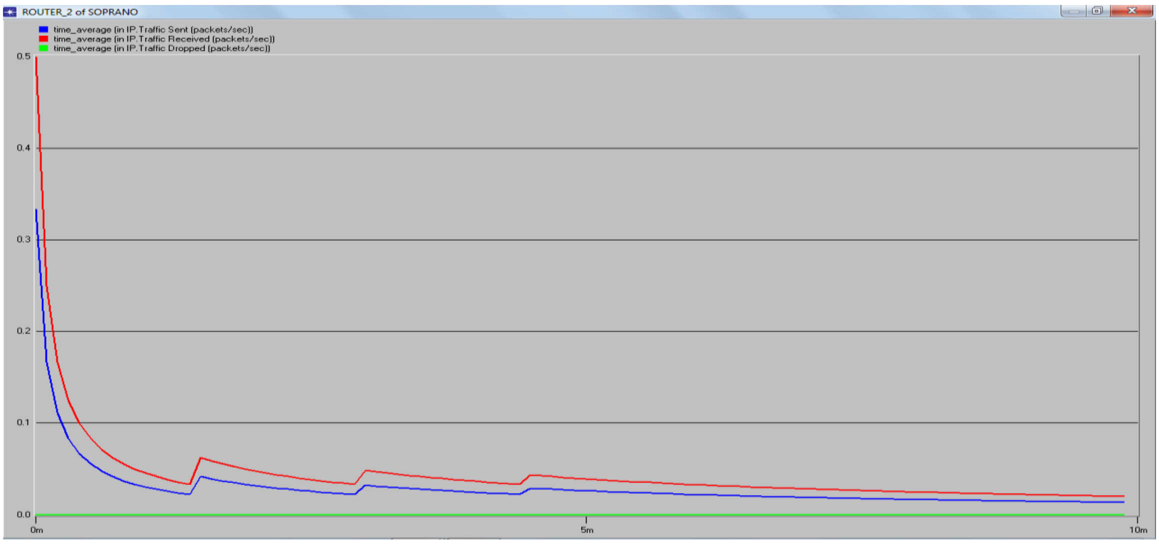

Fig. 19 Traffic sent, Received and Dropped in ROUTER_2 using TORA

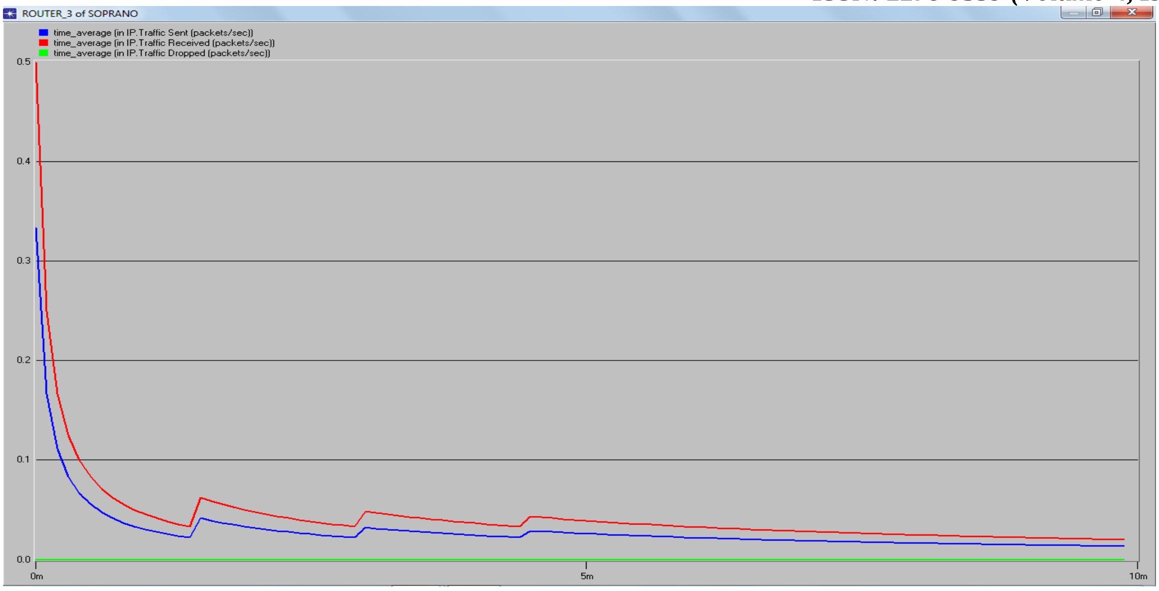

Fig. 20 Traffic sent, Received and Dropped in ROUTER_3 using TORA

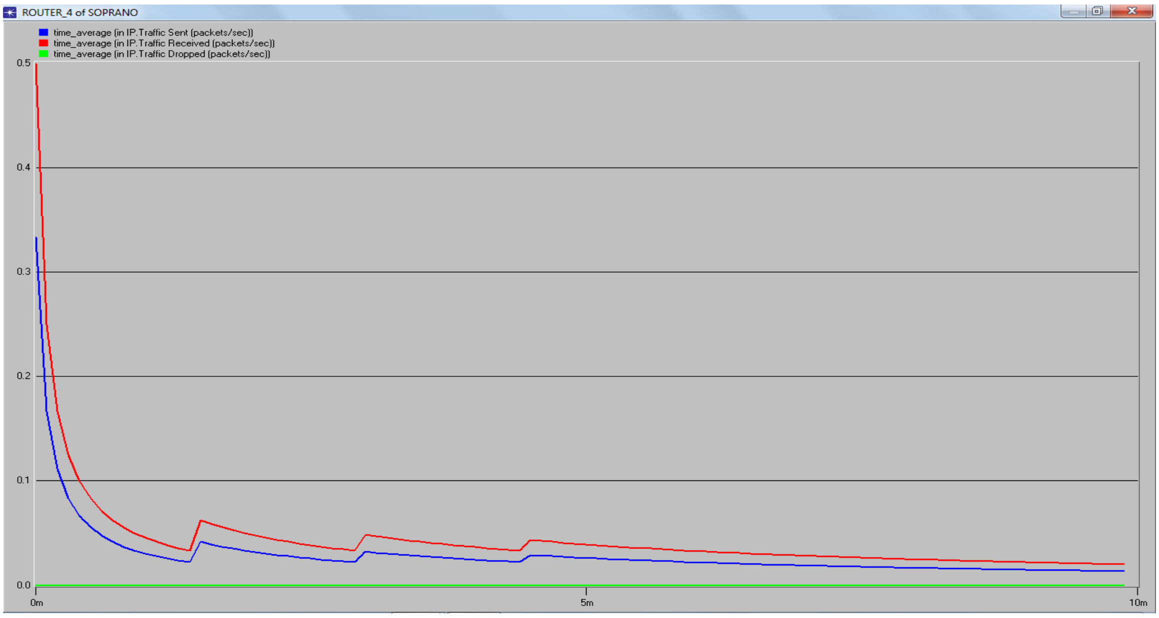

Fig. 21 Traffic sent, Received and Dropped in ROUTER_4 using TORA

As shown in figures (6.7- 6.11), the traffic sent in all routers is very high as compared to received traffic at zero simulation time. The dropped traffic is negligible throughout the simulation process. The received traffic lies in between the sent and dropped traffic during all the time of simulation.

VII. CONCLUSION

This paper gives an overview of implementation results of two ad hoc routing protocols based on various parameters. Simulated and analysed Dynamic Source Routing (DSR) and Temporally-Ordered Routing Algorithm (TORA) for various parameters like Inbound & outbound traffic through Local Area Network (LAN), traffic received & forwarded through switch, traffic sent, received & dropped through routers, comparison of delay results at every node of Local Area Network (LAN), traffic received and delay through various nodes. Based on simulation results it is concluded that as the traffic increases in the network, it increases the delay when routing is done using either of protocols. Increase in number of nodes also results in increase in delay. Dynamic Source Routing (DSR) performs very well when there is less mobility in nodes and number of nodes in the network is less. Temporally-Ordered Routing Algorithm (TORA) performs well even if the nodes are mobile. But as the number of nodes increase, its performance starts degrading.

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