COMPARATIVE STUDY OF OPTIMIZED LINK STATE ROUTING PROTOCOL BASED ON IPV4 AND IPV6

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Abstract

Mobile Ad-Hoc Network (MANET) is a wireless network without infrastructure. Nodes act as a router, client and server as well and its topology is dynamic as nodes join the network whenever there is need to transmit data and leave the network when transmission gets over. Optimized Link State Routing protocol (OLSR) is a proactive MANET routing protocol used in (MANET). In this paper the performance of OLSR protocol is evaluated and compared under IPv4 and IPv6 by considering the three different routing aspects: scalability, network load and mobility. File Transfer Protocol (FTP) and Transmission Control Protocol (TCP) traffics are used over the designed network. Performance metrics delay, routing overhead, and throughput are used for the performance analysis. OPNET Modeler 14.5 is used as a simulator. The simulation results show that by increasing the number of nodes the OLSR floods the network with a high amount of routing traffic in both protocols. In IPv4, it is found that the variation in the number of nodes and the network speeds do not significantly affect the performance of OLSR in terms of end-to-end delay and throughput, while in IPv6 it has a considerable affect.

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1. Introduction

Mobile Ad-hoc Network (MANET) is a wireless system that comprises mobile nodes. Nodes in the network can be either fixed or mobile. Mobile nodes include laptop, mobile phone, MP3 player, home computer or personal digital assistance. Nodes may be located on ships, airplanes or land, irrespective of their location as they can participate in communication [1].

1.1 Routing Protocols

Routing protocols are usually engaged to determine the routes following a set of rules that enables two or more devices to communicate with each other. In an ad hoc network routes are enabled in between the nodes using multi-hop, as the propagation range of the wireless radio is limited. These protocols are categorized into three groups as Reactive, Proactive and Hybrid based on the updated time of the routing information [2].

1.1.1 Proactive Routing Protocols

A proactive routing protocol is also called a “table-driven” routing protocol. Using a proactive routing protocol, nodes in a mobile ad hoc network continuously evaluate routes to all reachable nodes and attempt to maintain consistent, up-to-date routing information. Therefore, a source node can get a routing path immediately if it needs one. In proactive routing protocols, all nodes need to maintain a consistent view of the network topology. When a network topology change occurs, respective updates must be propagated throughout the network to notify the change. Using proactive routing algorithms, mobile nodes proactively update the network state and maintain a route regardless of whether data traffic exists or not, and the overhead to maintain up-to-date network topology information is high [2].

1.1.2 Reactive Routing Protocols

Reactive routing protocols for mobile ad hoc networks are also called “on-demand” routing protocols. In a reactive routing protocol, routing paths are searched only when needed. A route discovery operation invokes a route-determination procedure. The discovery procedure terminates when either a route has been found or no route is Available after examination for all route permutations [2].

1.1.3 Hybrid Routing Protocols

Hybrid routing protocols are proposed to combine the merits of both proactive and reactive routing protocols and overcome their shortcomings. Normally, hybrid routing protocols for mobile ad hoc networks exploit hierarchical network architectures [2].

1.2 Optimized Link State Routing Protocol

OLSR is a proactive routing protocol for mobile ad hoc networks. The protocol inherits the stability of a link state algorithm and has the advantage of having routes immediately available when needed due to its proactive nature. OLSR is an optimization over the classical link state protocol, tailored for mobile ad hoc networks. OLSR minimizes the overhead from flooding of control traffic by using only selected nodes, called multi-point relays (MPRs), to retransmit control messages. This technique significantly reduces the number of retransmissions required to flood a message to all nodes in the network. Secondly, OLSR requires only partial link state to be flooded in order to provide shortest path routes [3].

OLSR is modularized into a "core" of functionality, which is always required for the protocol to operate and a set of auxiliary functions. The core specifies, in its own right, a protocol able to provide routing in a stand-alone MANET. Each auxiliary function provides additional functionality, which may be applicable in specific scenarios, e.g., in case a node is providing connectivity between the MANET and another routing domain [3].

1.3 Transmission Control Protocol

Transmission Control Protocol (TCP) is a Transport Layer Protocol and originally designed for wired network in 1981. The basic responsibility of TCP is to provide reliable transfer of data between the nodes i.e. to ensure that the data is reached the destination correctly without any loss or damage. The data is transmitted in the form of continuous stream of octets. The mechanism is adopted to assign a sequence number to each octet of data and receiver responds with positive acknowledgement to ensure that the data is received correctly [4].

1.4 Random Way Point Mobility Model

The random waypoint model is by far the most widely used model in the literature. The random way point (RWP) assumes a fixed number of nodes in a fixed size rectangle. The simulation starts with the nodes uniformly distributed in the rectangle. Each node chooses a random destination and chooses a random speed distributed uniformly in the interval [v_{min}; v_{max}]. Once it arrives at the destination, it pauses for a random time uniformly distributed in [P_{min}; P_{max}], then it chooses a new speed and destination and repeats the process [5].

1.5 Internet Protocol

Internet protocol is a primary communication protocol which is used to send data packets from source to destination node in network. Data is transmitted in the form of data gram. Fragmentation is a technique which is used to send large datagram in network in it large datagram is divided into small data packets that can easily be transmitted in the network, because every network link has limited size for messages transmission in a network which known as maximum transmission unit (MTU). Datagram is used to send large amount of data. Datagram structure is defined by internet protocol and data is which is encapsulated in these datagram is sent from source to destination. Internet Protocol is connectionless protocol so there is no guarantee of delivery of data. Internet Protocol has two versions, namely, Internet Protocol Version

4 and Internet Protocol Version 6. Internet protocol version 4(IPv4) is a widely used protocol which was deployed by Internet Engineering Task Force (IETF) in early 1990. IPv4 has 32 bits address space and is able to provide 4,294,467,294 addresses [6].Some addresses are reserved for special purposes and are not available for public use. IPv4 is more prone to network attacks because no encryption and authentication is used. IPSec which is responsible for secure routing is optional in IPv4. IPv4 header format is complex and not easy to understand. IPv4 supports Quality of Service (QoS) but it relies on 8 bits type of service (TOS) field and identification of payload.IPv4 type of service (TOS) has limited functionality and payload identification is not possible when the IPv4 packet is encrypted. IPv4 address space is divided into five types of classes A, B, C, D, E, in which addresses of A,B,C are available for public use but address of class D is reserved for multicasting operations and class E address is reserved for future research and experimentation. This may lead to the problem of address exhaustion. Address exhaustion problem of IPv4 provides a base for IPv6's recent growth amongst the internet users, since IPv4 is unable to fulfill the demand of internet users. Due to address depletion problem of IPv4 mobile nodes are unable to obtain IP address from regional address registries to connect to the internet. So the need of new Internet Protocol arose, which could be fulfilled by IETF in year 1999 with the deployment of IPv6 which is also known as Internet Protocol for next generation (IPng). IPv6 has 128 bits address space and is able to provide approximately 3.4×1038 addresses.IPv6 and also it is more secure as compared to IPv4 because several encryption and authentication techniques like ESP are used. IPSec is mandatory in IPv6. IPv6 uses flow label mechanism so router easily recognize where to send information. IPv6 header size is 40 bytes and so, it is simple and small in size as compared IPv4. IPv6 supports multicasting and multi-homing, efficient routing which is not supported by IPv4 [7]. On the basis of the above discussion we conclude that internet protocol version 6 is the future internet protocol and the future internet technology depends on IPv6. Therefore, it is necessary to evaluate the performance of these routing protocols under IPv6. This can help us if immediate shifting from IPv4 environment to IPv6 environment is required.

1.6 Performance Metrics

1.6.1 End to End Delay

The packet end-to-end delay is the average time that packets take to traverse the network. This is the time from the generation of the packet by the sender up to their reception at the destination's application layer and is expressed in seconds [8].

1.6.2 Routing Overhead

It is defined as the total number of routing packets transmitted over the network, expressed in bits per second or packets per second [8].

1.6.3 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 referred to as throughput. It is expressed in bits per second or packets per second [8].

2. Software Platforms

Software used in this paper is OPNET modeler 14.5. OPNET is a network and application management software designed and distributed by OPNET Technologies Inc. Among other things OPNET Technologies Inc, model communication devices, technologies, protocols, and architectures, and provide simulation of their performance in a dynamic virtual network environment [9].

3. Design and Implementation

3.1 Simulation Model

Components used for designing of the network are MANET – Station (mobile), wireless Server – Station (fixed), application configuration which decides the type of application running in the network, profile configuration for configuring the type of profile on the network. Mobility configuration will decide the mobility model of every node which is selected as random waypoint for this simulation. Attributes of workstation will set the OLSR protocol used for the simulation. Simulation parameters used in this work are listed in table 1.

Table 1: Simulation Parameters

Parameters	Value
Area	1000x1000 m^2
Network Size (no. of nodes)	5,20, 50
Data Rate	11 Mbps
Mobility Model	Random way point
Pause Time	300 Seconds
File Size	1000 and 50000 bytes
Traffic Type	FTP
Mobility Speed	10 and 28 (m/s)
Simulation Time	3,600 Seconds
Addressing Mode	IPv4-IPv6

3.2 Wireless parameters

Default wireless network parameters were used for the simulation except the data rate that was increased to 11Mbps. The default TCP and FTP parameters were used over the network designed network.

3.3 OLSR Parameters

The defaults parameters of OLSR are used over the network designed are documented in table 2.

Table 2: OLSR Parameters

Parameters	Value
Willingness	default
Hello interval (seconds)	2.0
TC interval (seconds)	5.0
Neighbor hold time (seconds)	6.0
Topology hold time (seconds)	15.0
Duplicate message hold time (seconds)	30.0
Address mode	IPv4

3.4 Mobility Configuration

RWP is used as mobility model. The mobility and wireless network parameters were identical for all nodes in each scenario. All nodes were configured to move randomly within the defined wireless domain. The speed of each mobile node was defined by a constant 10 m/s for low mobility or 28 m/s for high mobility. The pause time is set to the constant 300.

4. Results and Discussions

4.1 Impact of Scalability on OLSR Protocol Performance

4.1.1 Delay

Figure 1 and 2 shows the delay obtained of 5, 20 and 50 nodes for IPv4 and IPv6 respectively. It observed that the OLSR delay increases dramatically as the number of nodes increases in IPv6 while being lower and constant in IPv4.

4.1.2 Routing Overhead

Figure 3 and 4 shows the routing traffic sent in bits/sec of 5, 20 and 50 nodes for IPv4 and IPv6 respectively. OLSR protocol sends a higher amount of routing traffic into the network in IPv4 and lower traffic in IPv6.

4.1.3 Throughput

Figure 5 and 6 shows the throughput in bits/sec of 5, 20 and 50 nodes for IPv4 and IPv6 respectively. OLSR has a high and consistent amount of throughput in IPv4 because of low delay while it has low and degraded throughput in IPv6 because of high delay introduced by increasing the number of nodes.

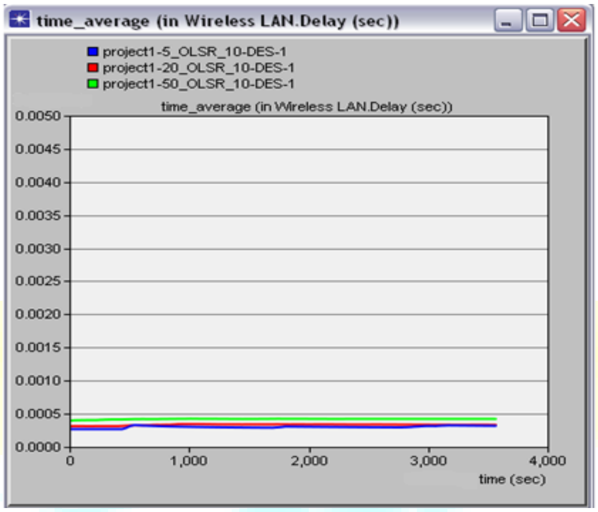

Figure 1. IPv4 Delay graph

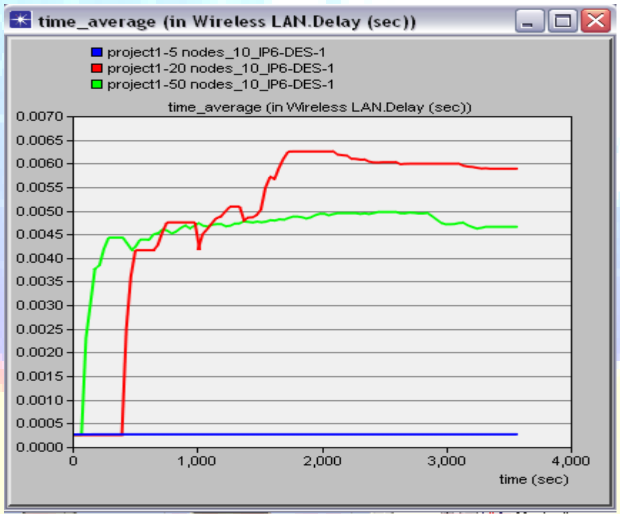

Figure 2. IPv6 Delay graph

4.2 Impact of Traffic Load on OLSR Protocol Performance

4.2.1 Delay

Figure 7 and 8 shows the delay of low and high load traffics for IPv4 and IPv6 respectively. OLSR protocol shows in both the low and high load traffics same and consistent behavior in IPv4 while it increases in IPv6 when increasing the network traffic.

4.2.2 Throughput

Figure 9 and 10 shows the throughput of low and high load traffics for IPv4 and IPv6 respectively. OLSR has a high amount of throughput in both scenarios for IPv4. In IPv6 scenarios the throughput is affected and degraded by delay increasing in high load.

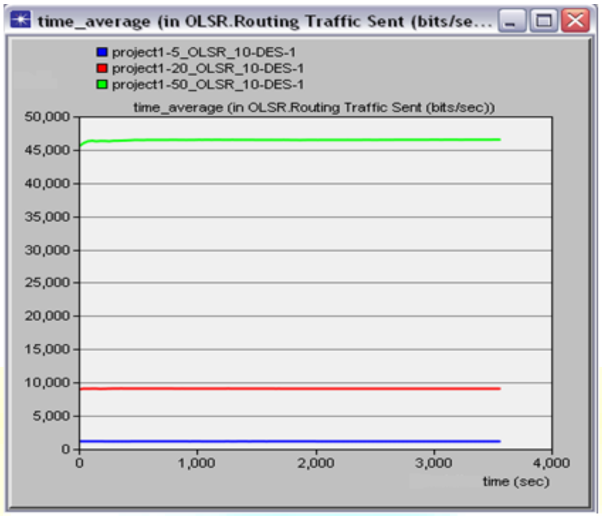

Figure 3. IPv4 Routing overhead graph

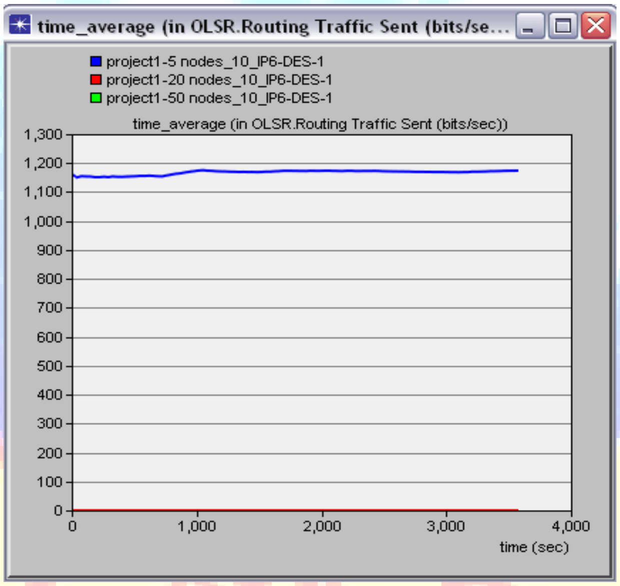

Figure 4. IPv6 Routing overhead graph

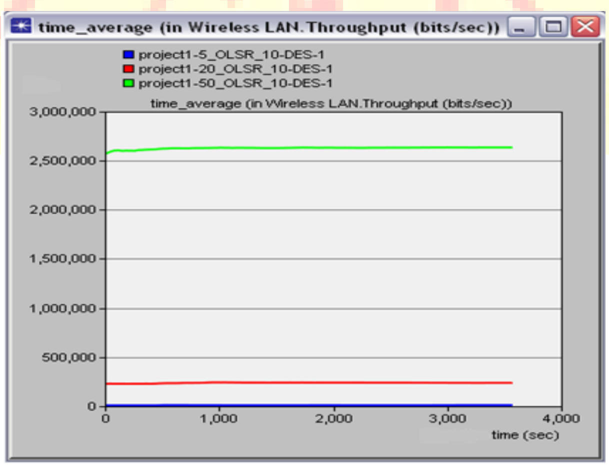

Figure 5. IPv4 Throughput graph

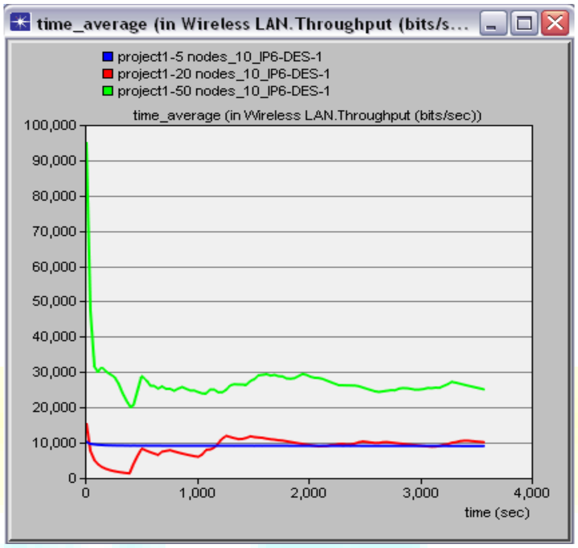

Figure 6. IPv6 Throughput graph

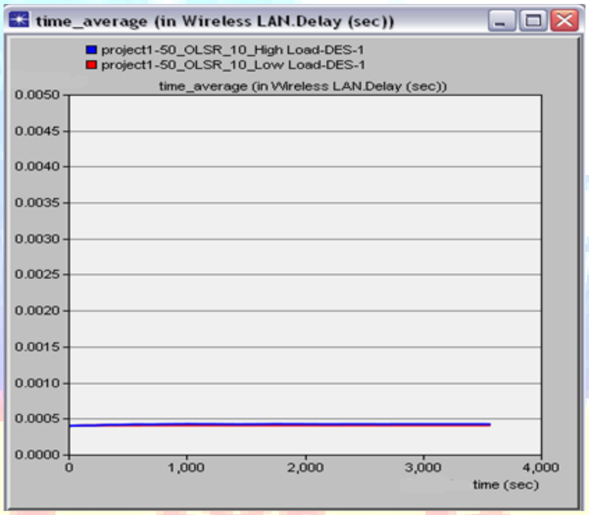

Figure 7. IPv4 Delay graph for high and low network loads

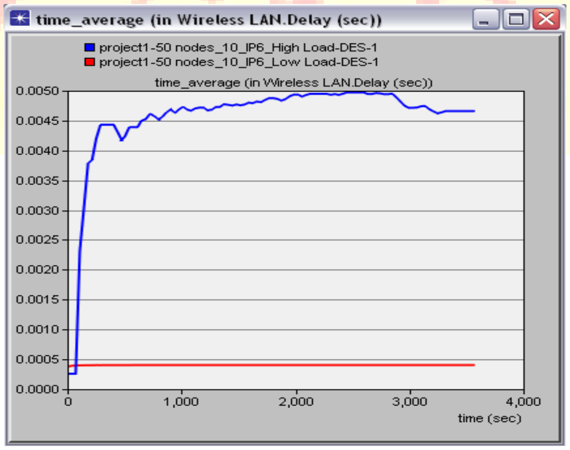

Figure 8. IPv6 Delay graph for high and low network loads

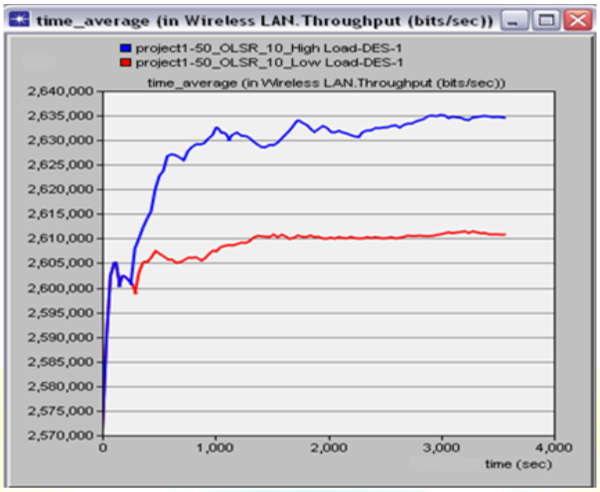

Figure 9. IPv4 Throughput graph for high and low network loads.

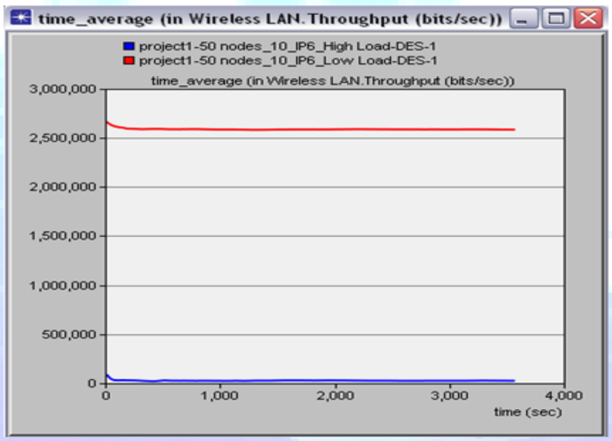

Figure 10. IPv6 Throughput graph for high and low network loads.

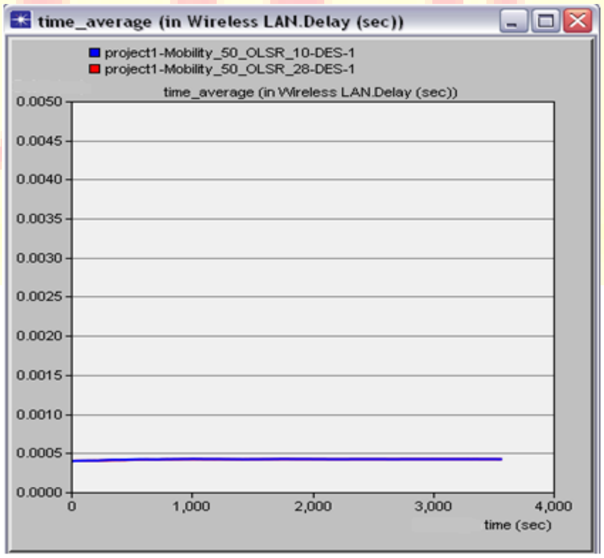

Figure 11. IPv4 Delay graph for speeds 10 m/s and 28 m/s.

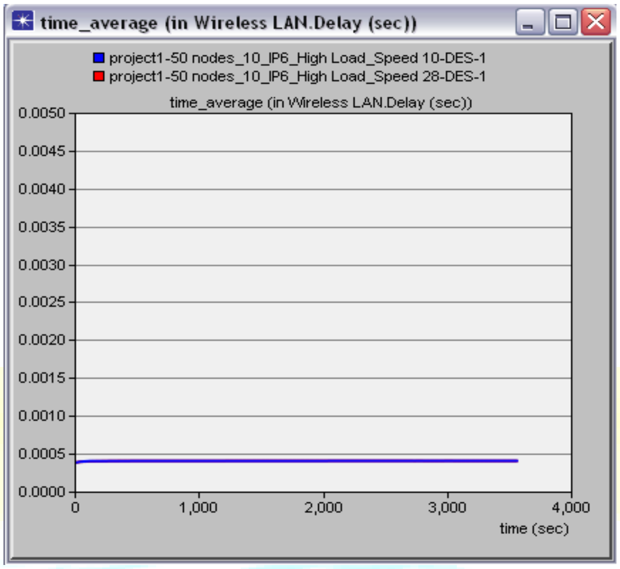

Figure 12. . IPv6 Delay graph for speeds 10 m/s and 28 m/s.

4.3 Impact of Node Mobility on OLSR Protocol Performance

4.3.1 Delay

Figure 11 and 12 shows the delay of low and high mobility for IPv4 and IPv6 respectively. OLSR protocol presents low delay while varying the nodes speeds in both IPv4 and IPv6 protocols.

4.3.2 Throughput

Figure 13 and 14 shows the throughput of low and high mobility for IPv4 and IPv6 respectively. OLSR protocol significantly presents high amount of throughput at both scenarios for IPv4 and IPv6.

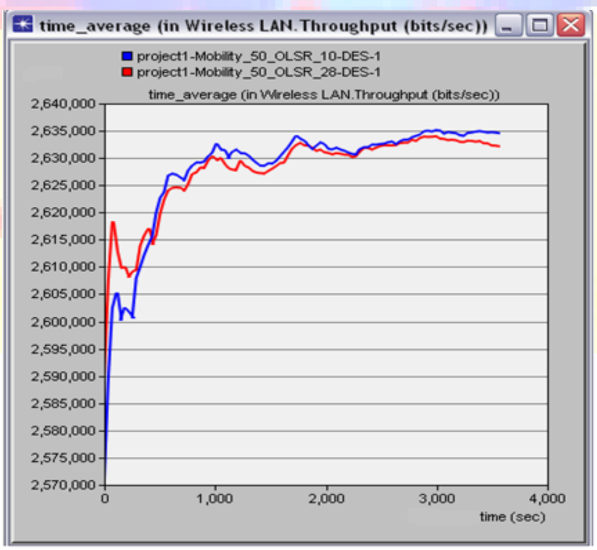

Figure 13. IPv4 Throughput for speeds 10 m/s and 28 m/s.

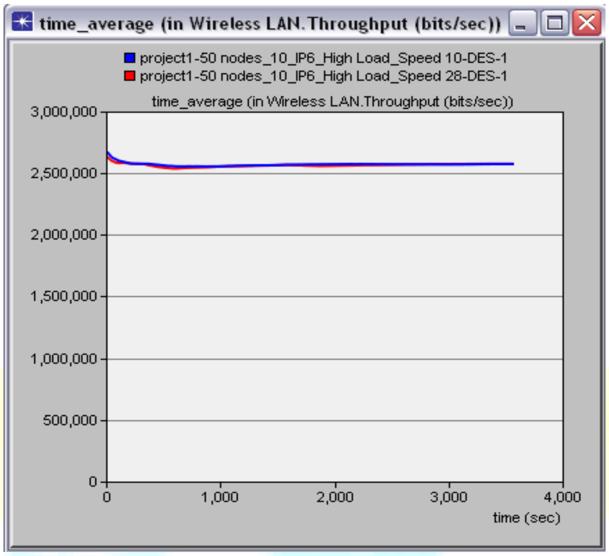

Figure 14. IPv4 Throughput for speeds 10 m/s and 28 m/s.

5. Conclusion

In this paper the performance analysis of routing protocol OLSR is performed and compared using IPv4 and IPv6 focusing on scalability, network load and mobility. The performance metrics delay, routing overhead and throughput were used to analyze and compare the protocol performance. The network is designed using the FTP and TCP as application layer and transport layer protocols.

Based on simulation results and focusing on scalability, Based on the simulation results OLSR protocol showed a low delay, high traffic load and high amount of throughput when using IPv4 and a high delay, high traffic load and low throughput when using IPv6.

In case of traffic load OLSR protocol performance noticed similar and high in terms of both throughput and delay. Thus is a high throughput and lower delay when using IPv4 while noticed high delay and degradable throughput when using IPv6. In case of mobility OLSR protocol performance in both IPv4 and IPv6 is not affected even at a higher nodes speed.

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