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Performance Evaluation of MANET Routing Protocols Based on Internet Protocols

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Abstract: The topology of mobile ad hoc network (MANET) changes rapidly and unpredictably due to nodes mobility. This makes routing protocols very important to analyze so as to communicate efficiently between the wireless nodes. Another important issue in the MANET is the internet protocols IPv4 and IPV6. The former which have been conventionally in use for long and the latter which is seen as the future standard for network architecture is studied due to its improved protection and huge address space support. In this paper, performance of AODV, DYMO, OLSRv2 and OLSR are analyzed under the IPv4 and IPv6 standards using the Qualnet simulator. Distinct performance metrics viz. Packet delivery ratio, Throughput, Average End-to-End Delay, and Average jitter are selected for the experiment. The results are then analyzed and scrutinized to provide qualitative assessment of their performances.

Keywords: MANET, Internet protocol, performance analysis

I. INTRODUCTION

MANET is a network of mobile devices which is self configured and joined using wireless links. Conversely, MANET is a collection of wireless nodes that wish to communicate with each other, but has no predetermined topology of wireless links and no fixed infrastructure. Every mobile node acts as a host and also as a router in mobile ad hoc network. To achieve this, various reactive, proactive and hybrid routing protocols are been proposed. In reactive routing protocols e.g. Ad hoc On Demand Distance Vector (AODV), only find routes when nodes are attempting to transmit a message. It does not need frequent link and route updates therefore reduces energy consumption when there is low traffic load or high network mobility. Unlike reactive routing protocols, proactive routing protocols e.g. Optimized Link State Routing Protocol (OLSR) maintains routes no matter the traffic. This method prevents the requirement to looking for paths for every single data each message and it is more proficient when the data traffic and nodes are respectively relatively heavy and static. Hybrid routing protocol utilizes both reactive and proactive protocol mechanisms.

The two reactive protocols are described in the following section.

A. Ad-hoc on Demand Distance Vector Protocol (AODV)

AODV is capable of multicast and unicast routing. Routes are established only when they are needed, therefore it creates and keeps routes between nodes as preferred by the sending node. This makes routing overhead to be greatly reduced. The routing table of AODV consists of the sequence number and next hop data. When a path is not available for a destination in AODV, the Route-Request packet is flooded into the network. This query may obtain more than one route. The destination sequence number is used here to obtain an up to date route to the destination.

B. Dynamic MANET On-demand (DYMO)

The DYMO routing protocol also called as AODVv2 is reactive protocol which is a successor and shares many features with the AODV. But DYMO can work both as reactive as well as proactive routing protocol i.e. routes are discovered only when they are needed, or they are maintained all the time. Therefore the two operations are performed in the protocol i.e. route discovery and route maintenance. Route discovery happens when a DYMO router needs to transmit packet to a destination which it does not have a route. Route maintenance is carried out to prevent dropping packets when an active route breaks and also to prevent premature erased routes from routing table.

C. Optimized Link State Routing protocol (OLSR)

OLSR is a proactive protocol which uses the link state algorithm but as an optimized form. OLSR reduces information size send in message to reduce the retransmission number. It gives the best routes based on hops number. This is why the protocol uses the technique of multipoint relaying to competently send all of its control messages. Not like AODV, OLSR or DSDV it minimizes the control packet size by validating only a sector of relations with its surrounding nodes which is its multi-point selectors of relay where just a node’s multipoint relays retransmits its messages that are broadcast. Therefore, OLSR do not produce additional control traffic in reaction to failures of links and events of node leave/join. The protocol is predominantly appropriate in large scale and densely connected networks. In this protocol, every one of the nodes makes use of the mainly up to date information to route packets. The nodes inside the network choose a collection of nodes from their neighborhoods, which then resends its packets.

Internet Protocols (IPv4 and IPv6)

Internet protocol is a primary communication protocol which is used to send data packets from source to destination node in network. 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. 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 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. 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.

II. METHODOLOGY

1. Experimental Modeling

The routing protocols are the control parameter used in conducting this experiment. The nodes mobility is a very important factor, which is described by direction, speed, and rate of changing. The Random Waypoint Mobility Model was used because it provides a practical movement pattern of the possible mobility of people. All the nodes in this model stays motionless for their 'pause time' duration. The node then begins to move after its pause time in random direction in the network environment. It then remains static during its next pause time after it reaches its new position.

2. Simulation Scenario

Performance of AODV, DYMO, OLSR are compared in a terrain consisting of 50. 5 data traffic applications of Constant Bit Rate (CBR) are used between random sources to destinations. These nodes are positioned on an environment of 1000m x 1000m. The modeling and analysis of the scenarios was carried out using Qualnet software. Table 1.0 shows the basic parameters for the scenario. The node placement in the scenario is shown in Figure 1.2 below. Load, mobility and speed traffic are kept constant throughout the experiment.

Table 1.0 Scenario Parameters

Parameter	*Value*
Network type:	Ad hoc wireless
Number of nodes	50
Terrain:	1000 by1000
Simulation time:	200 sec
Traffic application:	CBR
Number of CBR:	5
Item to send:	0
Packet size:	512B
Interval:	0.1 sec
CBR start-end:	5 – 0 sec
Network Protocol:	IPv4 and IPv6
MAC Protocol:	**IEEE 802.11**
Mobility Model:	RandomWaypoint
Speed (Min-Max):	(0-3) m/s
Pause time:	20 sec
Physical Layer Model:	PHY 802.11b
Data Rate:	11Mbps
Transmission Power:	25dBm
Noise Factor:	10.0
Receive Sensitivity:	83.0
Number of channels:	1
Wireless Channel Frequency:	2.4 GHz
Routing Protocols:	AODV,DYMO, OLSRv2,OLSR
Environment:	Urban
Shadowing Model:	Constant

3. Node Placement

A number of 50 nodes are selected for the analysis as shown below:

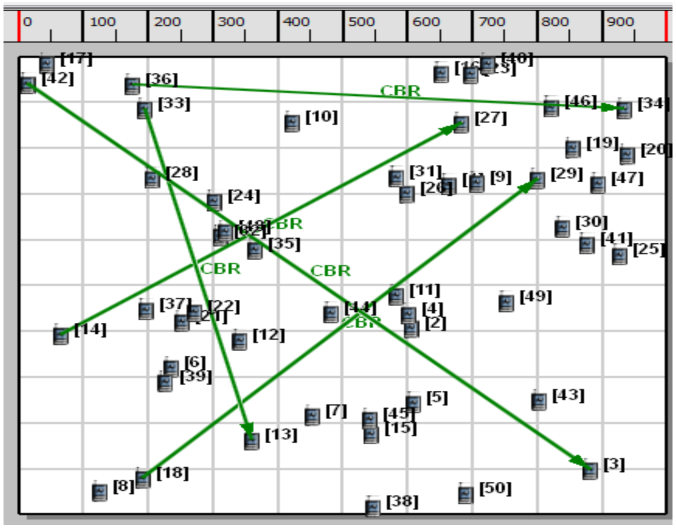
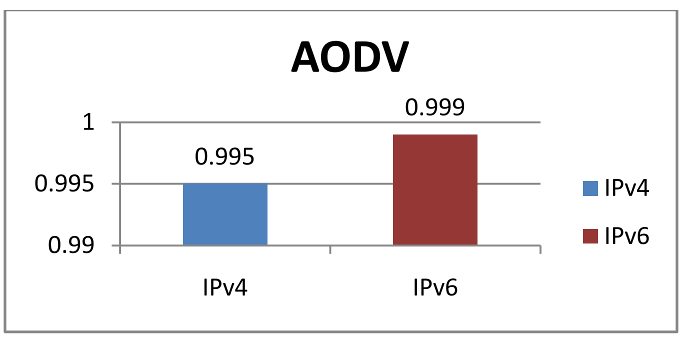


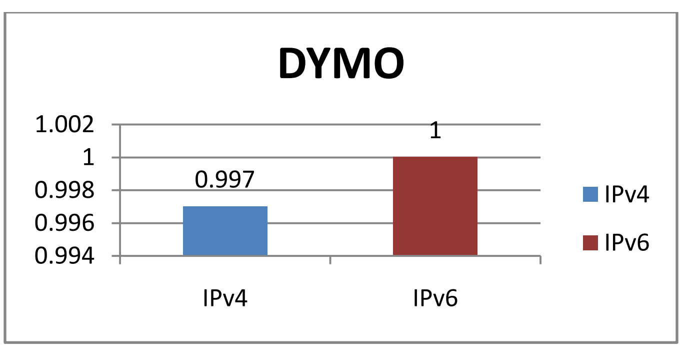
Figure 1: simulation environment with 50 nodes

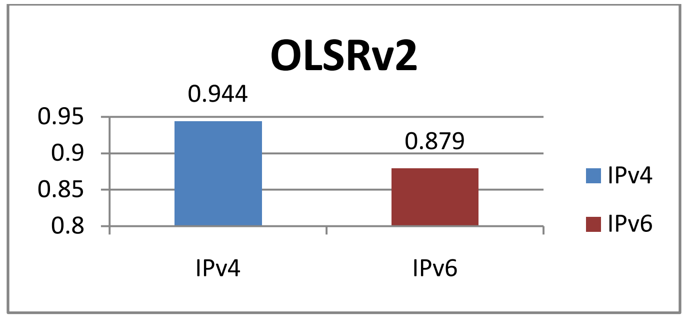
III. RESULTS AND ANALYSIS

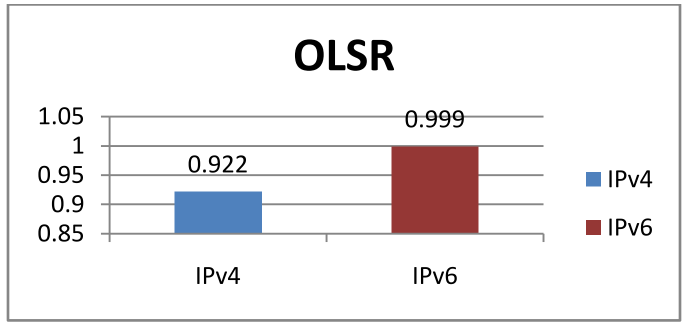
1. Packet Delivery Ratio Analysis

Figure below shows Packet Delivery Ratio of AODV, DYMO, OLSRv2 & OLSR in IPv4 and IPv6. It is seen that DYMO performs best in IPv6. Also all protocols show a better performance in IPv6 compared to the corresponding IPv4 except for OLSRv2 which shows better performance in IPv4.



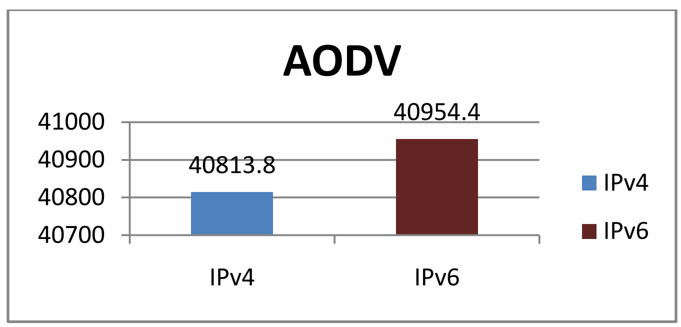


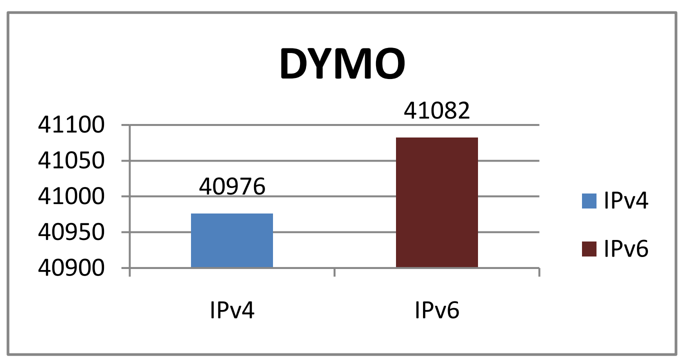




2. Throughput Analysis

Throughput is the average rate of packets that reaches the destination successfully**.** The figures below show throughput of AODV, DYMO, OLSRv2 & OLSR in both IPv4 and IPv6. It is noticed that DYMO performs best in both IPv4 and IPv6. Also all IPv6 are better except for OLSRv2 where IPv4 is better.





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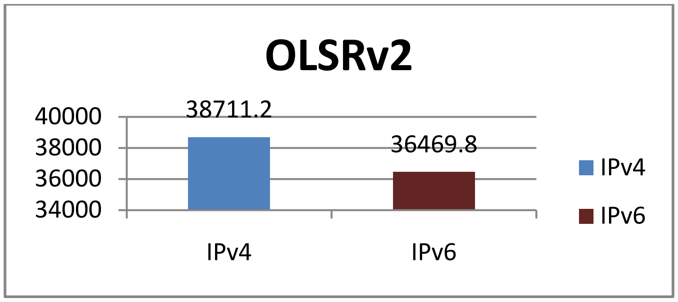
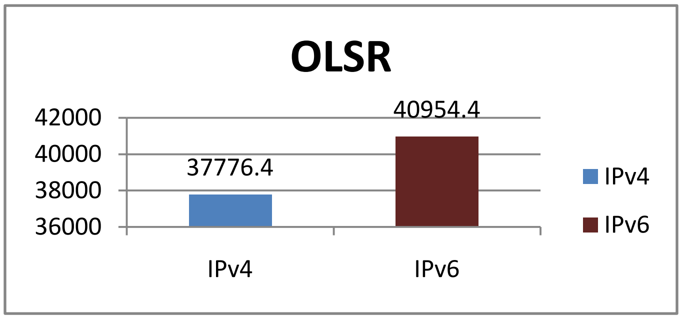
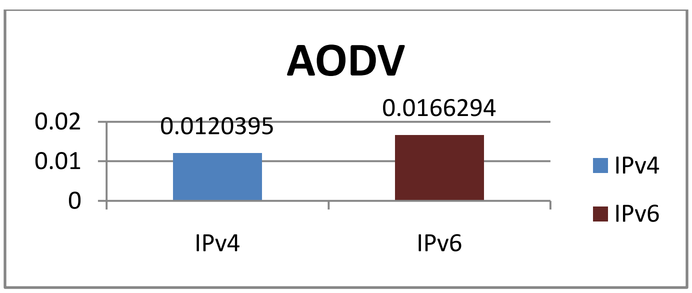
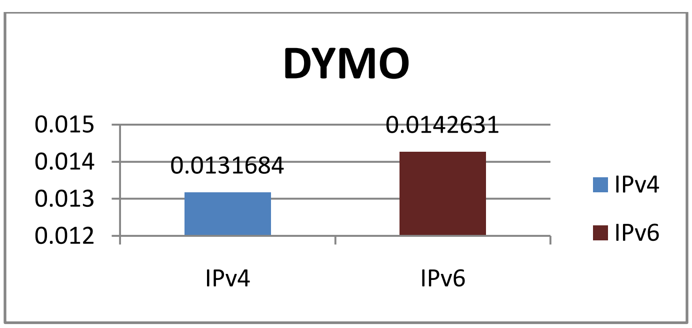


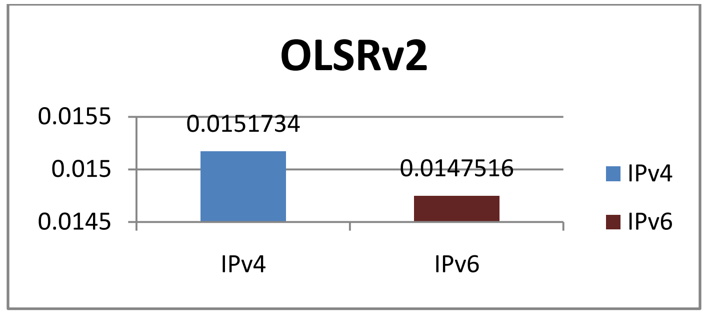


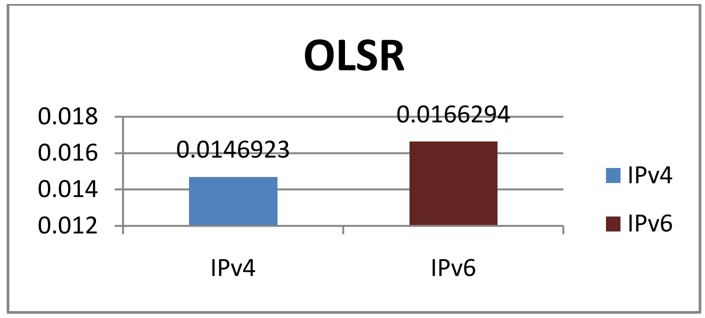
3. Average end-to-end Delay Analysis

Average end-to-end delay = TotalTime duration evolved by the packets to reach destination / Totalnumber of received packets. The figures below shows the average end-to-end delays in both IPv4 and IPv6. It can be observed that all IPv6 have higher average end-to-end delay, except for OLSR where the IPv4 is higher.



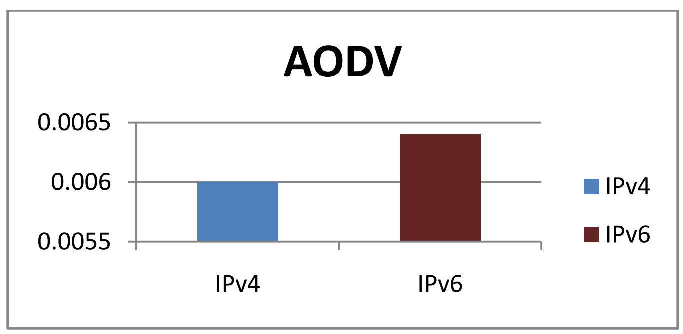


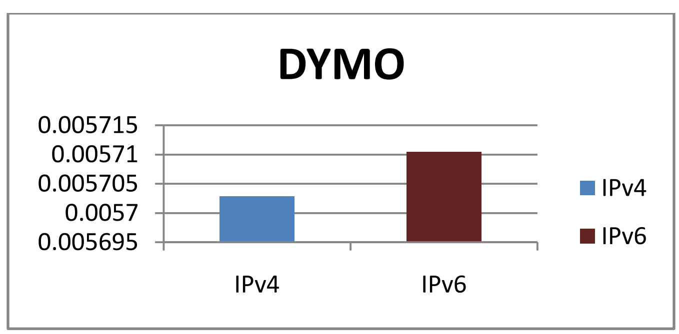


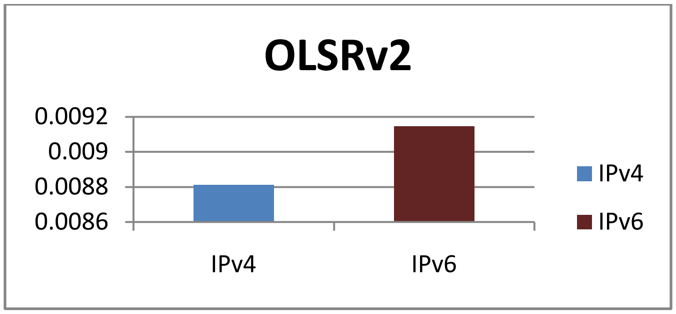


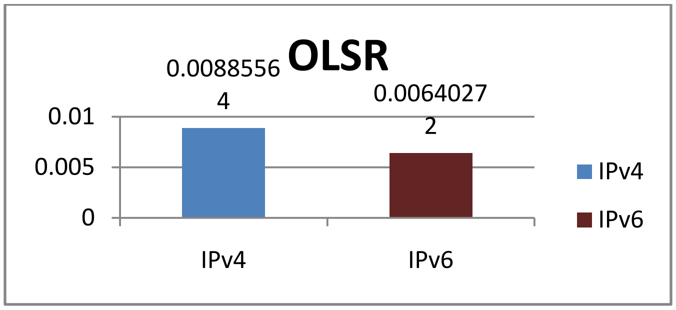
4. Average Jitter Analysis

Calculated as time when 1st packet is received at the destination minus time when first data packet is transferred from the source. This incorporates all the delays as a result of buffering when performing latency of discovery, queuing at the interface queue, resending delays in the MAC, transfer and propagation times**.** Figures below represents average jitter of AODV, DYMO, OLSRv2 & OLSR in both IPv4 and IPv6. It can be observed that all protocols shows higher average end-to-end delay under the IPv6 environment, except for OLSR where it is higher under IPv4.









IV. CONCLUSION

The above graphical results indicate the following:

- All protocols except OLSRv2 have higher Packet delivery ratio and Throughput under IPv6 than IPv4
- DYMO have the best performance in terms of delivery ratio and Throughput in both IPv4 and IPv6
- All protocols except OLSRv2 have higher End-to-end delay under the IPv6 than IPv4 environment
- All protocols except OLSR have higher Average Jitter under IPv6 than IPv4

Therefore it can be concluded that Routing under the IPv6 shows better performance in terms of packet delivery ratio and throughput than in the IPv4 with exception of OLSRv2 protocol which performs better in IPv4.

But the high throughput and packet delivery ratio in the IPv6 environment also comes with a price of higher delay and jitter (except in OLSR).

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