# Evaluation of routing protocols of MANET in homogeneous and heterogeneous networks

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***Abstract:*** A mobile ad-hoc network (MANET) is a self-configuring infrastructure less network of mobile devices connected by wireless links. A homogeneous network is one in which all nodes have the same capabilities and resources whereas heterogeneous networks consist of different nodes with different resources [1]. In various homogenous and heterogeneous networks with technologies like WLAN, WIMAX. We analyze the performance of different routing protocols such as DYMO, AODV, and OLSR. Performance analysis is done by comparing parameters like jitter, average end to end delay and throughput.

***Keywords* - MANET, Proactive protocol, Routing protocols, Reactive protocol, WMNs.**

## I. INTRODUCTION

Ad hoc networks are those which do not depend on infrastructural support. A mobile ad-hoc network is a mobile, multi-hop wireless network which is capable of autonomous operation [2]. It includes information exchange in a network of mobile and wireless nodes without any infrastructural support. Its purpose is to set up (possibly) a short-lived network for a collection of nodes. Basic Characteristics of MANETS includes Energy constrained nodes, Bandwidth constrained, Variable capacity wireless links and Dynamic topology [2]. These networks inherit the traditional problems of wireless and mobile communications, such as bandwidth optimization, power control and transmission quality enhancement. In addition, the multi-hop nature and the lack of fixed infrastructure generates new research problems such as configuration advertising, discovery and maintenance, as well as ad-hoc addressing and self-routing. The topology is highly dynamic and frequent changes in the topology may be hard to predict [1]. The networks are based on wireless links, which will continue to have a significantly lower capacity than their wired counterparts. Physical security is limited due to the wireless transmission. The networks are affected by higher loss rates, and can present higher delays and jitter than fixed networks due to the wireless transmission.

Applications such as rescue missions in times of natural disasters, law enforcement operation, commercial and educational use and sensor networks are few examples. Ad hoc routings can be divided into two categories: on demand (or reactive) and table-driven (or proactive) protocols. In reactive protocols, a route path is established only when a node has data packets to send. On-demand protocols are Ad-hoc On-demand Distance Vector routing (AODV). Proactive routing protocols include Optimized Link State Routing Protocol (OLSR) [2].

The paper includes homogenous and heterogeneous networks, WLAN and WiMAX technologies, QualNet simulation. In this paper, section-I gives the introduction about MANET. Section-II represents types of networks homogeneous and heterogeneous. Section-III discusses the WLAN and WiMAX networks with MANET protocols. Section-IV tells about the methodology used which explains about the simulation environment, its properties, application used and designed scenarios. Performance evaluations for WMNs are presented in section-V and then we present conclusions in section-VI.

## II. TYPES OF NETWORKS

### 2.1 Homogeneous and heterogeneous networks

A homogeneous network is one in which all nodes have the same capabilities and resources. Although homogenous network are easy to model and ANALYZE, they exhibit poor scalability compared with heterogeneous networks that consist of different nodes with different resources.

A heterogeneous network is a network connecting computers and other devices with different operating systems and/or PROTOCOLS [1]. For example, local area networks (LANs) that connect Microsoft Windows and Linux based personal computers with Apple Macintosh computers are heterogeneous.

The word heterogeneous network is also used in wireless networks using different access technologies. For example, a wireless network which provides a service through a wireless LAN and is able to maintain the service when switching to a cellular network is called a wireless heterogeneous network. In this paper we are referring to the latter definition of heterogeneous networks. In case of MANETs, heterogeneous MANET comprise of mobile devices as they have different communications capability such as radio range, battery life, data transmission rate, ETC.[1]. Moreover, in real world, some of MANET networks are obviously heterogeneous like military battlefield networks and rescue operations system. Therefore, heterogeneity of nodes is another issue that needs to be considered in constructing and developing routing protocols for MANETs.

We have worked on two kinds of networks –

#### 2.1.1 WLAN

A wireless local area network (WLAN) links two or more devices using some wireless distribution method (typically spread- spectrum or OFDM radio), and usually providing a connection through an access point to the wider internet. This gives users the mobility to move around within a local coverage area and still be connected to the network. Most modern WLANs are based on IEEE 802.11 standards, marketed under the Wi-Fi brand name. Wi-Fi is a WLAN (Wireless Local Area Network) technology. It provides short-range wireless high-speed data connections between mobile data devices (such as laptops, PDAs or phones) and nearby Wi-Fi access points (special hardware connected to a wired network). The most common variant of Wi-Fi is 802.11g, which is capable of providing speeds of up to 54Mbps and is backwards compatible with 802.11b (providing up to 11Mbps).

There is currently a new standard in the works called 802.11n (offering twice the speeds of 802.11b) and there are already retail networking devices that support its draft specifications. Wi-Fi is much faster than any data technologies operating through the cellular network like GPRS, EDGE and even UMTS and HSDPA. The range covered by a Wi-Fi access point is from 30 to 100 meters indoors while outdoors a single access point can cover about 650 meters.

### 2.1.2 WIMAX

WiMAX stands for Worldwide Interoperability for Microwave Access and it is based on IEEE 802.16 standards WiMAX (Worldwide Interoperability for Microwave Access) is a wireless communications standard designed to provide 30 to 40 megabit-per-second data rates,[1] with the 2011 update providing up to 1 Gbit/s for fixed stations. It is a part of a "fourth generation," or 4G, of wireless-communication technology. WiMAX far surpasses the 30-metre (100foot) wireless range of a conventional Wi-Fi local area network (LAN), offering a metropolitan area network with a signal radius of about 50 km (30 miles).

In this technological world, we have so many technologies that help us in every aspect of our daily life such as transportation, communication etc. WiMAX Technology works same as Wi-Fi does but it is more improved and efficient then Wi-Fi and it can route data to Wi-Fi that is Wi-Fi devices can take advantage of WiMAX connection. WiMAX technology provides higher speed connection up to 70 Mbps over the area of 30 miles. There is no need for line of sight connection between subscriber terminals and the base station in WiMAX technology and it can support hundreds if not thousands of subscribers from a single base station. It is also specified in 802.16 standards that it will supports low latency applications such as voice, video, and Internet access at the same time The WiMAX network is just like a cell phone. When a user send data from a subscriber device to a base station then that base station broadcast the wireless signal into channel which is called uplink and base station transmit the same or another user is called downlink. The base station of WiMAX has higher broadcasting power, antennas and enhanced additional algorithms. WiMAX technology providers build a network with the help of towers that enable communication access over many miles. The broadband service of WiMAX technology is available in coverage areas. The coverage areas of WiMAX technology separated in series of over lied areas called channel. When a user sends data from one location to another the wireless connection is transferred from one cell to another cell. When signal transmit form user to WiMAX base station or base to user (WiMAX receiver) the wireless channel faces many attenuation such as fraction, reflection, refraction, wall obstruction etc. These all attenuation may cause of distorted, and split toward multi path.

The target of WiMAX receiver is to rebuild the transmitted data perfectly to make possible reliable data transmission. The orthogonal frequency division multiplexed access (OFDMA) in WiMAX technology, is a great technique used to professionally take advantage from the frequency bands. The transmission frequencies of WiMAX technology from 2.3MHz to 3.5 GHz make it low price wireless network. Each spectral profile of WiMAX technology may need different hardware infrastructure. Each spectrum contains its bandwidth profile which resolved channel bandwidth. The bandwidth signal is separately in OFDMA (Orthogonal Frequency Division Multiplexed Access) which is used to carry data called sub carrier.

## III. ROUTING PROTOCOLS ANALYZED

### 3.1 AODV (Ad-hoc on demand Distance Vector Protocol)

It is a reactive protocol. Each node in the network maintains a routing table with the routing information entries to its neighboring nodes, and two separate counters: a node sequence number and a broadcast-id. The (source-address, broad cast-id) pair is used to identify the RREQ uniquely. As RREQ travels from node to node, it automatically sets up the reverse path from all these nodes back to the source. Each node that receives this packet records the address of the node from which it was received.

If an intermediate node has a route entry for the desired destination in its routing table, it compares the destination sequence number in its routing table with that in the RREQ. If the destination sequence number in its routing table is less than that in the RREQ, it rebroadcasts the RREQ to its neighbors. Otherwise, it unicasts a route reply packet to its neighbor from which it was received the RREQ if the same request was not processed previously. Once the RREP is generated, it travels back to the source, based on the reverse path that it has set in it until travelled to this node [2]. For monitoring links, hello messages are used which are broadcast by nodes periodically. No hello messages mean link failure**.**

### 3.2 OLSR (Optimized Link State Protocol)

OLSR is a proactive routing protocol that is an optimized version of a pure link state protocol by applying Multipoint Relays (MPR) concept. The idea of MPR is to reduce flooding of broadcast packets by shrinking the number of nodes that retransmit the packets. OLSR does not scale well because the routing information are propagate to all the nodes in the network. In case of large network or mobile nodes, more updates are required to keep the information up to date, thus producing a large amount of control overhead [3].

### 3.3 DYMO (Dynamic MANET On-Demand Routing)

The DYMO routing protocol is successor to the popular Ad-Hoc On-Demand Distance Vector AODV protocol and shares many of its benefits. It is, however, slightly easier to implement and designed with future enhancements in mind. DYMO can work as both a proactive and as a reactive routing protocol, i.e. routes can be discovered just when they are needed. DYMO belongs to the category of MANET routing protocols called on-demand or reactive routing protocols. An on-demand protocol only tries to discover a route to a destination, when it is actually needed by an application. To evaluate a protocol specification, especially a protocol draft, it is important that several implementations are made available by independent sources. In addition, when several implementations are available they can be tested for interoperability. If two implementations are found not to be interoperable, it can be because the specification is unclear and parts of it can be interpreted wrongly. Eventually, for an Internet-Draft to be promoted to an RFC at least two independent implementations must exist and be interoperable.

## IV. METHODOLOGY

The network simulator used is Qualnet version 5.0. Qualnet is a commercial version of GlomoSim used by Scalable Network Technologies. Qualnet provides an environment for designing protocols, creating and animating scenarios and analyzing their performance [7]. The scenario for performance analysis was designed according to following specifications:

- Terrain: 1500 X 1500 square meter
- Wireless subnet used: 1
- Number of nodes: 9/20
- Application: CBR
- Number of maximum buffer packets: 512

- Simulation Time: 100 sec.

#### 4.1.1 Scenarios Designed

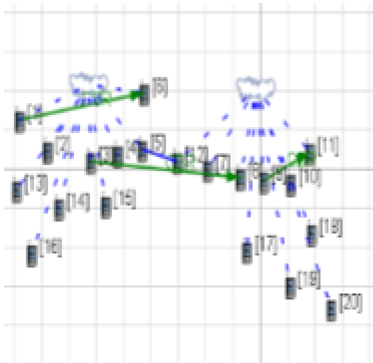


Figure 1: Homogenous network with WLAN (20 nodes)

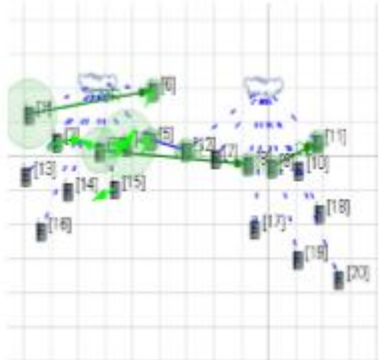


Figure 2: Simulation of homogeneous network

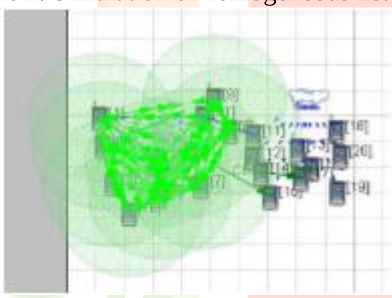


Figure 3: Heterogeneous network with WLAN and WiMAX (20 nodes)

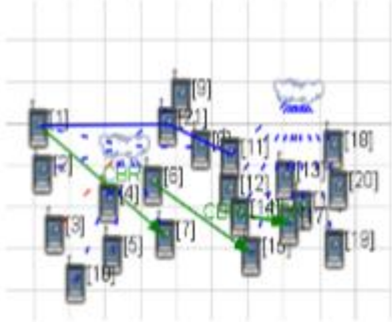


Figure 4: Simulation of Heterogeneous network

## V. RESULTS

### 5.1 AVERAGE JITTER

It is referred as Packet Delay Variation (PDV).It is basically difference in packet transfer delays for successive packets.

*Jitter = (rx1-tx1)-(rx2-tx2), where,*

tx1= time at which first packet was transmitted
tx2= time at which first packet was transmitted
rx1= time at which second packet was received
rx2= time at which second packet was received

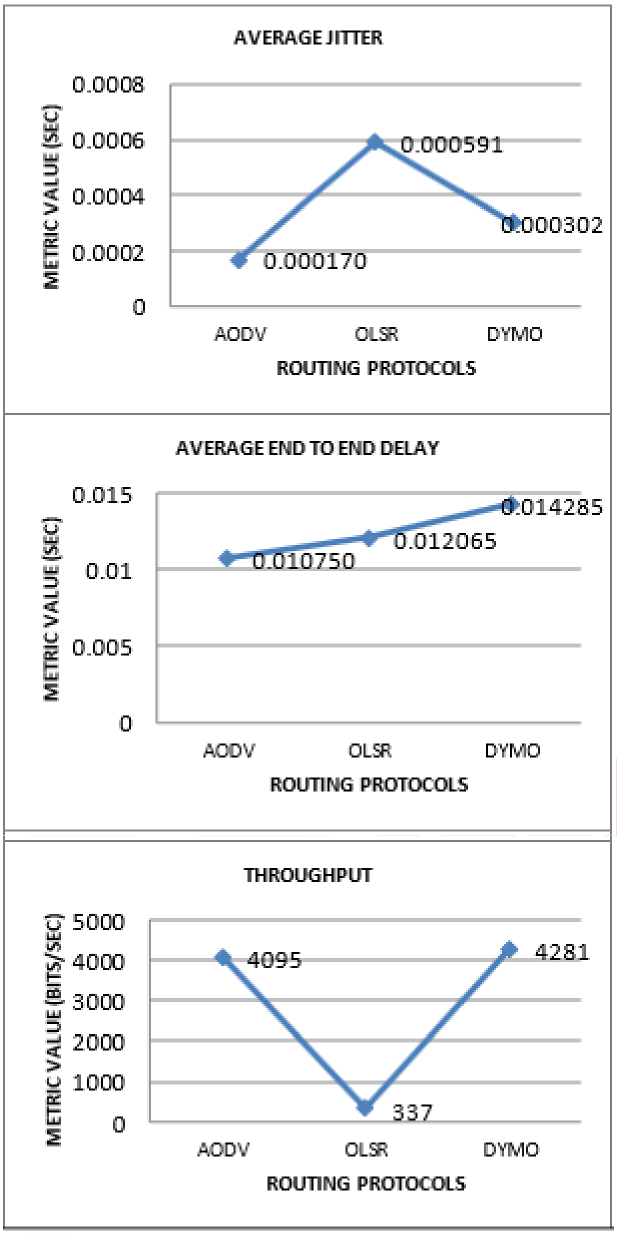
### 5.2 THROUGHPUT

It is the average rate of successful message delivery over medium. It is expressed in bits per second.

*Throughput= successful packets delivered/ total packets sent.*

### 5.3 AVERAGE END-TO-END DELAY

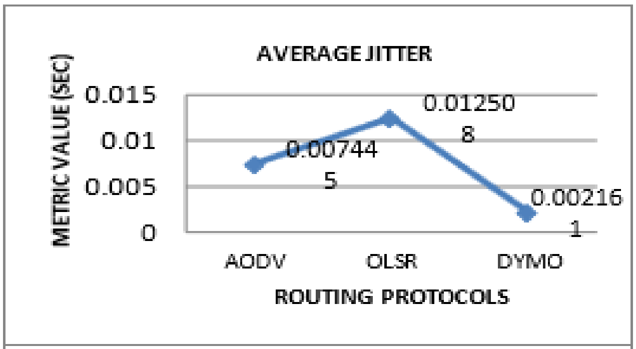
It is the time taken for a packet to be transmitted across a network from source to destination. This delay comprises of transmission, propagation, and processing delays.

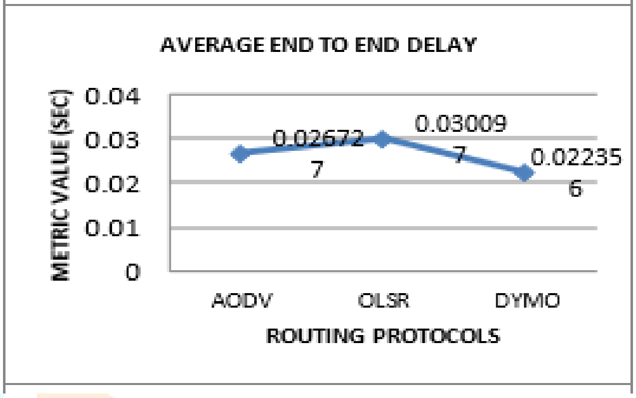


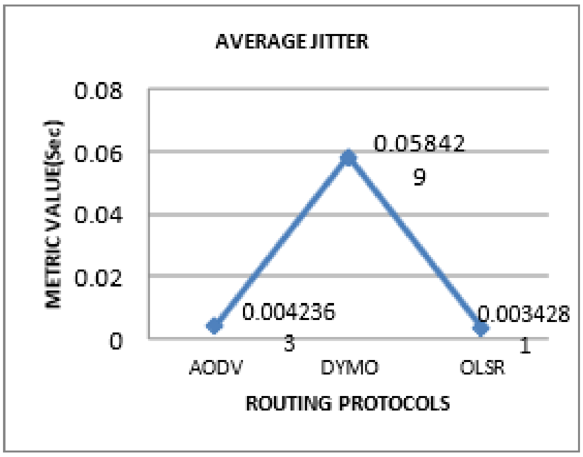

5.1.2 WiMAX only network

Table 1: WLAN output

| Routing Protocols | Average Jitter (sec) | Average end to end delay(sec) | Throughput (bits/sec) |
|---|---|---|---|
| AODV | 0.000171 | 0.010751 | 4095 |
| OLSR | 0.000591 | 0.012065 | 4337 |
| DYMO | 0.000302 | 0.014285 | 4281 |



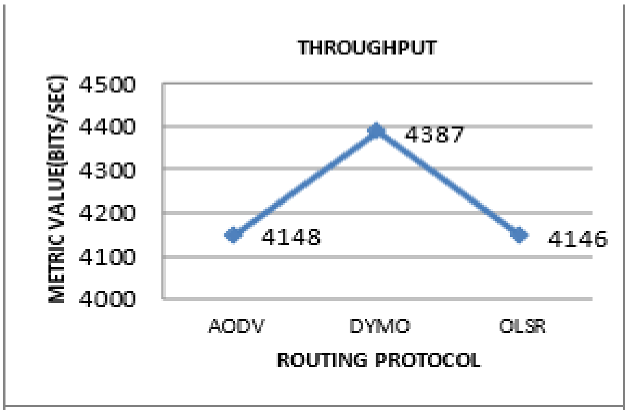



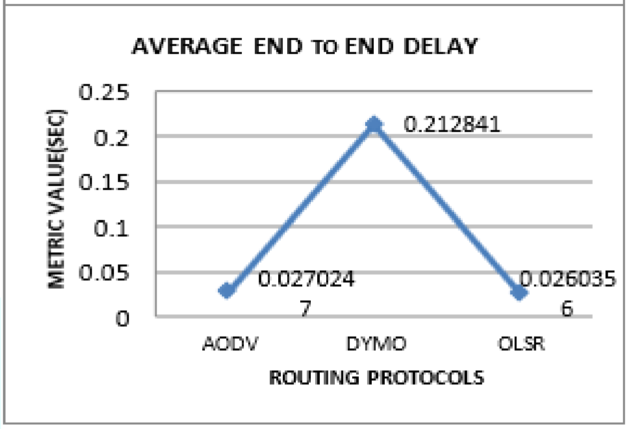




5.1.3 Heterogeneous Network

Table 2: WiMAX output

| Routing Protocols | Average Jitter (sec) | Average end to end delay(sec) | Throughput (bits/sec) |
|---|---|---|---|
| | | | |
| AODV | 0.00744544 | 0.0267272 | 4091 |
| OLSR | 0.0125089 | 0.0300971 | 4075 |
| DYMO | 0.00216176 | 0.0223569 | 4010 |




| Routing Protocols | Average Jitter (sec) | Average end to end delay(sec) | Throughput (bits/sec) |
|---|---|---|---|
| AODV | 0.0042363 | 0.0270247 | 4148 |
| OLSR | 0.058429 | 0.212841 | 4387 |
| DYMO | 0.0034281 | 0.0260356 | 4467 |

## VI. CONCLUSION

We are concluding that for the Homogeneous as well as heterogeneous networks out of DYMO, AODV and OLSR, DYMO which is a reactive protocol provides the most efficient routing strategy since it gives the maximum throughput. Although DYMO encounters significant delay and jitter in both homogeneous and heterogeneous networks but that can be nullified by its enhanced throughput. However out of OLSR, which is a proactive protocol and AODV, a reactive protocol AODV shows better throughput. On the top of that AODV shows the least jitter and end to end delay but in nutshell DYMO leads the race and OLSR is the least efficient among all three network types.

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