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 - homogenous 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

A. 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[2]. 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 kind of networks-

i. 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
Provided wireless high-speed data connections between mobile
users. It is a part of a wireless local area network (Wi-Fi)
technology. The most common variant of Wi-Fi is 802.11g, which
is capable of providing speeds of up to 54 Mbps and is backwards
compatible with 802.11b (providing up to 11 Mbps).

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.

WiMAX

WiMAX stands for Worldwide Interoperability for Microwave
Access and 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, with
the 2011 update providing up to 1 Gbit/for fixed stations. It is a part of a
“fourth generation,” or 4G, of wireless -communication technology. WiMAX far surpasses the 30-metre (100-foot)
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

The most common variant of Wi-Fi is 802.11g, which
is capable of providing speeds of up to 54 Mbps and is backwards
compatible with 802.11b (providing up to 11 Mbps).

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.

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, with
the 2011 update providing up to 1 Gbit/for fixed stations. It is a part of a
“fourth generation,” or 4G, of wireless -communication technology. WiMAX far surpasses the 30-metre (100-foot)
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

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 2.3 MHz 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 ANALYSED

A. 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
neighbouring nodes, and two separate counters: a node
sequence number and a broadcast-id. The (source-address,
broadcast-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.

B. 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. [4]

C. 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 pro-active 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.

Scenario Designed:

A. Parameters analyzed:
   i. 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...

V. RESULTS

Fig.1 Homogeneous network with WLAN with 20 nodes

Fig.2 Simulation of homogeneous network

Fig.3 Heterogeneous network model with WLAN and WIMAX with 20 nodes

Fig.4 Simulation of heterogeneous network
at which second packet was received \( rx = \) time at which second packet was received

ii. 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

iii. 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.

B. SIMULATION RESULTS:

a. Homogenous network: WLAN


IV. TABLE

TABLE I. HOMOGENEOUS NETWORK: WLAN

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.

REFERENCES


<table>
<thead>
<tr>
<th>Routing Protocols</th>
<th>Average Jitter (sec)</th>
<th>Average End-to-End Delay (sec)</th>
<th>Throughput (bits/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AODV</td>
<td>0.000170796</td>
<td>0.0107505</td>
<td>4095</td>
</tr>
<tr>
<td>OLSR</td>
<td>0.000591453</td>
<td>0.0120653</td>
<td>337</td>
</tr>
<tr>
<td>DYMO</td>
<td>0.000302472</td>
<td>0.0142854</td>
<td>4281</td>
</tr>
</tbody>
</table>

TABLE I. HOMOGENEOUS NETWORK: WLAN

<table>
<thead>
<tr>
<th>Routing Protocols</th>
<th>Average Jitter (sec)</th>
<th>Average End-to-End Delay (sec)</th>
<th>Throughput (bits/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AODV</td>
<td>0.00744544</td>
<td>0.0267272</td>
<td>4091</td>
</tr>
<tr>
<td>OLSR</td>
<td>0.0125089</td>
<td>0.0300971</td>
<td>4075</td>
</tr>
<tr>
<td>DYMO</td>
<td>0.00216176</td>
<td>0.0223569</td>
<td>4010</td>
</tr>
</tbody>
</table>

TABLE II. HOMOGENEOUS NETWORK: WiMAX

<table>
<thead>
<tr>
<th>Routing Protocols</th>
<th>Average Jitter (sec)</th>
<th>Average End-to-End Delay (sec)</th>
<th>Throughput (bits/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AODV</td>
<td>0.004236</td>
<td>0.0270247</td>
<td>4148</td>
</tr>
<tr>
<td>DYMO</td>
<td>0.058429</td>
<td>0.212841</td>
<td>4387</td>
</tr>
<tr>
<td>OLSR</td>
<td>0.0034281</td>
<td>0.0260356</td>
<td>4146</td>
</tr>
</tbody>
</table>

TABLE III. HETEROGENEOUS NETWORK

CONCLUSION
International Journal of Engineering Research & Technology

- Fast, Easy, Transparent Publication
- More than 50000 Satisfied Authors
- Free Hard Copies of Certificates & Paper

Publication of Paper: Immediately after Online Peer Review

Why publish in IJERT?
- Broad Scope: high standards
- Fully Open Access: high visibility, high impact
- High quality: rigorous online peer review
- International readership
- Retain copyright of your article
- No Space constraints (any no. of pages)

Submit your Article

www.ijert.org