Effect of Mobility and Different Data Traffic in Wireless Ad-hoc Network through QualNet

Shubhangi Mishra, Ashish Xavier Das, A.K.Jaisawal

Abstract- Wireless Ad Hoc Network is collection of wireless mobile hosts forming a temporary network without the aid of any established infrastructure or centralized network. An Ad-hoc network does not have any centralized arbitrator or server. Routing is process of selecting path in a network along which to send data packets. In this paper effect of different Mobility models and Data traffic are comparatively discussed on the basis of different routing protocols AODV, OLSR and ZRP. The performance of these routing protocols is analyzed by three metrics i.e. End to end delay, Jitter and Through-put. We have studied the effect, of mobility models on the performances (End to end delay, through-put and Jitter) of routing protocols AODV, OLSR, and ZRP by using in the first the CBR (Constant Bit Rate) and secondly a multiservice VBR (Variable Bit Rate) traffic. Random Waypoint Mobility model (RWP) and Group Mobility Model has been used. Simulations are performed using QualNet 6.1 version Simulator from Scalable Networks.

Keywords-MANET, AODV, OLSR, ZRP, CBR, VBR, Group Mobility, RWP (random waypoint),

I. INTRODUCTION

A Wireless ad hoc network sometimes called "Mobile Ad-hoc Network" or a "Mobile Mesh Network" is a wireless network, comprised of mobile computing devices (nodes) that use wireless transmission for communication without the aid of any established infrastructure or centralized administration such as a base station or access point. It is a self –configuring network of mobile nodes connected using wireless links forming a random topology. The nodes move freely and randomly. Each node in Wireless ad-hoc network acts both as a host and a router to forward messages for other nodes that are not within the same radio range. Ad hoc wireless networks can be deployed quickly anywhere and anytime as they eliminate the complexity of infrastructure set up. Application of wireless ad-hoc network range from military operations and emergency disaster relief, to commercial uses such as community networking. Most of these applications demand a secure and reliable communication. In Wireless Ad-hoc Network routing protocols are divided into three categories named proactive routing protocols, reactive routing protocols and hybrid routing protocols.

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There are many proactive routing protocols available for Ad-hoc networks such as DSDV, OLSR, FSR, GSR, CGSR and IARP etc. There are also a variety of reactive routing protocols such as AODV, DSR, LAR, DYMO and IERP etc. ZRP and TORA are hybrid routing protocols. The Mobility models define node movement pattern in Ad-hoc network. There are two types of mobility models named Entity or individual mobility models and Group mobility models. There are many types of Entity mobility models are available such as Random waypoint, Random direction and Random walk. There are also a variety of Group mobility models like Reference point group mobility model, Column mobility model, Nomadic community model, Pursue model and Exponential Correlated random model. A mobility model improves the coverage of wireless Ad-hoc network and also helps in security. The objective of this paper is to comparative study of AODV, OLSR and ZRP routing protocols using Group mobility model and Random waypoint mobility model and using two types of data traffic VBR and CBR.

II. ROUTING IN WIREELSS AD-HOC NETWORK

Routing is the process of selecting path in a network along which to send data packets. An Ad-hoc routing protocol is a convention or standard that controls how node decide which way to route packets between computing devices in a Wireless ad-hoc network. There are mainly three types of routing protocols: Proactive routing protocol, Reactive routing protocol and Hybrid routing protocol. In proactive routing protocol, every node maintains one or more tables representing the entire topology of the network. These tables are updated regularly in order to maintain a up-to-date routing information from each node to every other node. Proactive routing protocol is also sometimes referred as Table driven protocol. Reactive routing protocol seeks to setup route on demand. It is also called On-Demand driven protocol. If a node wants to initiate communication with a node to which it has no route, the routing protocol will try to establish such a route. And the third routing protocol is Hybrid routing protocol. This type of protocols combines the advantages of proactive and of reactive routing. The routing is initially established with some proactively prospected routes and then serves the demand from additionally activated nodes through reactive flooding. OLSR, FSR and GSR are the examples of proactive routing protocol. AODV, DYMO and DSR are the examples of reactive routing protocol. TORA, ZRP, HSLS and OOPR are the examples of hybrid routing protocol. In our work the chosen protocols are AODV, OLSR and ZRP.

A. Ad-hoc On Demand Distance Vector

Ad-hoc on demand distance vector [1] is a demand-driven or reactive routing protocol. "AODV" technology was given by Perkins & Royer. AODV is an on-demand routing protocol with small delay. It is an improvement of DSDV protocol. In AODV routes are only established when needed to reduce traffic overhead. AODV supports unicast, multicast and broadcast without any further protocol. The count- to- infinity and loop problem is solved with sequence numbers and the registration of the costs. In AODV every hop has the constant cost of one. Link breakages can locally be repaired very quickly.

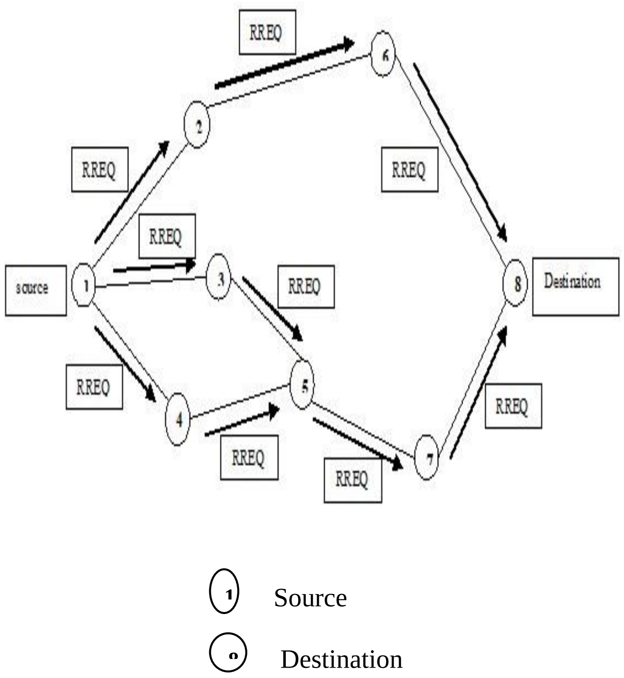

Figure 1: AODV route establishment

In above figure when a node wishes to transmit traffic to a host to which it has no route, it will generate a route request (RREQ) message that will be flooded in a limited way to other nodes. This cause control traffic overhead to be dynamic and it will result in an initial delay when initiating such communication. A route is considered found when the RREQ message reaches either the destination itself or an intermediate node with a valid route entry for the destination. For as long as route exists between two endpoints, AODV remains passive. When the route become invalid or lost, AODV will again issue a request. An important feature of AODV is the maintenance of timer based states in each node regarding utilization of individual routing table entries.

B. Optimized Link State Routing Protocol

OLSR [5] is proactive or table-driven routing protocol. In Ad-hoc network it is an optimization of pure link state algorithm. The routes are always immediately available when needed due to its proactive nature. In a pure link state protocol, all the links with neighbour nodes are declared and are flooded in the entire network. The key feature of this protocol is the use of "multipoint relays" (MPR). Each node selects a set of its neighbour nodes as MPR. Only nodes, selected as such MPRs are responsible for generating and forwarding topology information, intended for the diffusion into the entire network.

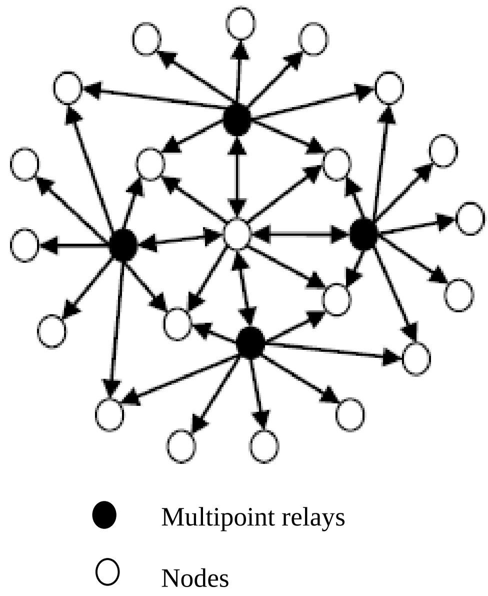

Figure 2: OLSR Multipoint Relays

The MPR node can be selected in the neighbour of source node. Each node in the network keeps a list of MPR nodes. This MPR selector is obtained from HELLO packets sending between in neighbour nodes. These routes are built before any source node intends to send a message to a specified destination. The Topology Control (TC) message is broadcast throughout the network to exchange the topological information. Each node maintains the routing table in which routes for all available destinations nodes are kept. Control traffic in OLSR is exchanged through two different type of messages HELLO and TC messages. Hello messages are exchanged periodically among neighbour nodes, in order to detect links to neighbours, to detect the identity of neighbours and to signal MPR selection. TC messages are periodically flooded to the entire network in order to signal link state information to all nodes. A dense network is best working environment for OLSR protocol, where the most communication is concentrated between a large numbers of nodes. Multipoint Relays

C. Zone Routing Protocol

Zone routing protocol [6] was the first hybrid routing protocol with both a proactive and a reactive component. It was first introduced by Haas in 1997. ZRP was proposed to reduce the control overhead of proactive routing protocols and decrease the latency caused by routing discover in reactive routing protocols. ZRP defines a zone around each node consisting of its k neighbourhood. That is in ZRP all nodes within k-hop distance from node belong to the routing Zone of node. ZRP is formed by two sub protocols, a proactive routing protocol i.e. Intra-zone routing (IARP), is used inside routing zones, and a reactive routing protocol i.e. Inter-zone routing protocol(IERP), is used between routing zones, respectively. A route to a destination within the local zone can be established from the proactively cached routing table of the source by IARP. Therefore if the source and destination is in the same zone the packet can be delivered immediately.

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For routes beyond the local zone, route discovery happens reactively. The source node sends a route requests to its border nodes, containing its own address, the destination address and a unique sequence number. Border nodes are nodes which are exactly the maximum number of hops to defined local zone away from the source. The border nodes check their local zone for the destination. If the requested node is not a member of this local zone, the node adds its own address to the route request packet and forwards the packets to its border nodes. If the destination is a member of the local zone of the node, it sends a route reply on the reverse path back to the source. The source node uses the path saved in the route reply packet to send data packets to the destination.

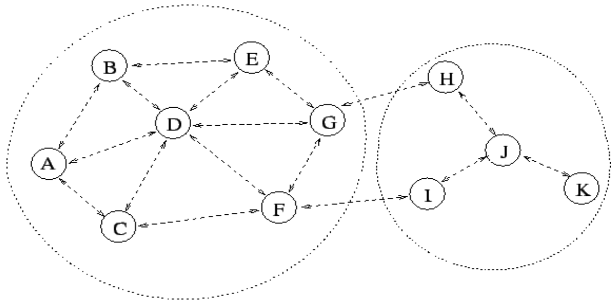

Figure 3: Routing zone of node A and node J with zone radius r = 2

III. SIMULATION ENVIRONMENT

A. Mobility Model

The mobility model defines node movement pattern in Wireless Ad-hoc network. These models can have a great effect upon the result of simulation and thus the evaluation of these protocols. There are two types of mobility models: Entity or Individual mobility model and Group mobility model. Random waypoint and Group Mobility model are used in our work.

i. RWP (Random Waypoint) Mobility Model

It is very simple model based on pause time between changing direction or speed. In this model each node is assigned an initial location, a destination and a speed. A mobile node begins by staying in one location for a certain period of time (i.e. pause). Once this time expires, the mobile node chooses a random destination in simulation area and a speed that is uniformly distributed between max. Speed and min. Speed. The mobile node then travel toward the newly chosen destination at the selected speed. Upon arrival, the mobile node pauses for a specified period of time starting the process again.

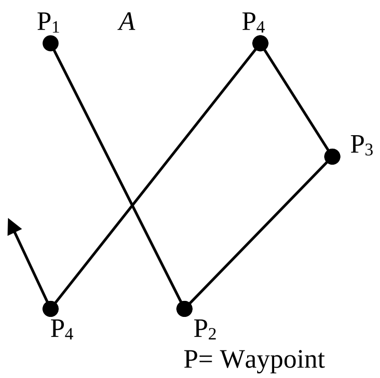

Figure 4: Random Waypoint mobility model

ii. Group Mobility Model

In group mobility model nodes move independent of one another. The Group mobility model represents the random motion of a group of mobile nodes as well as the random motion of each individual mobile node within the group. Group movements are based upon the path travelled by a logical centre for the group. It is used to calculate group motion via a group motion vector GM. The motion of the group centre completely characterizes the movement of this corresponding group of mobile nodes. Including their direction and speed. Individual mobile nodes randomly move about their own predefined reference points whose movements depend on the group movement. As the individual reference point move from time τ to $\tau+1$, their locations are updated according to the group's logical centre. Once the updated reference group points, $RP(\tau+1)$ are calculated, they are combined with a random vector, *RM*, to represent the random motion of each mobile node about its individual reference point. The length of *RM* is uniform distributed within a specified radius centred at $RP(\tau+1)$ and its direction is uniformly distributed between *0* and *Pi*.

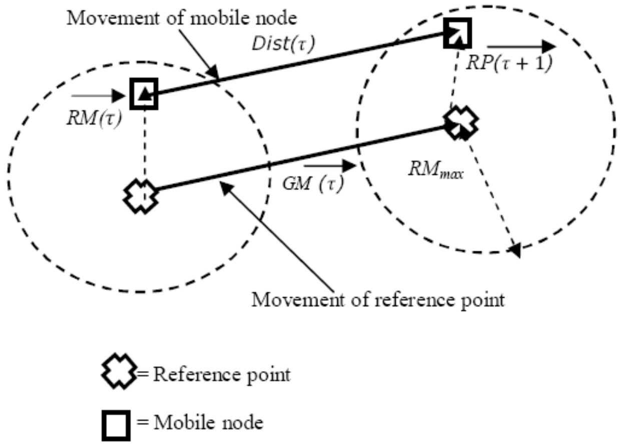

Figure 5: Group mobility model

B. Data Traffic Model

A traffic generation model is a stochastic model of the traffic flows or the data sources in a communication network. We have used two different data traffic VBR and CBR.

i. Constant Bit Rate

Constant bit rate is the form of a technique which is used for the purpose of measuring the rate at which the encoding of the data takes place. It is not an ON/OFF traffic.

ii. Variable Bit Rate

VBR is an ON/OFF traffic with exponential distribution. It generates Traffic during ON period. VBR files vary the amount of output data per time segment. VBR allows a higher bit rate (and therefore requires more storage space) to be allocated to the more.

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C. Simulation Setup

We have performed simulations on QualNet 6.1 simulator and performance of AODV, OLSR & ZRP routing protocols are evaluated. For our scenario, we have taken 500m X 500m dimension of space to perform the simulations and nodes are placed randomly on the space. The IEEE 802.11 [9] is used as the Medium Access Control layer protocol for wireless Local Area Networks. The number of nodes is taken as 20 and simulations are performed for 0.25 sec. pause time. In the scenario UDP (User Datagram Protocol) connection is used, Traffic source CBR (Constant Bit Rate) and VBR (Variable Bit Rate) are used. RWP (random waypoint) and GPM (Group Mobility) used as a mobility model. Minimum speed of nodes is taken as 1 m/s and maximum speed of nodes is taken as 5 m/s. We have performed the simulation for 100 seconds. The simulation parameters are summarized in table 1.

Table 1. Simulation parameters

Simulation Parameter	**Values**
Dimension	500×500
No. of nodes	20
No. of connection	4
Node placement strategy	Random
Mobility model	Random waypoint, Group mobility model
Traffic source	CBR, VBR
Packet size	512 Bytes
Pause Time	0.25 sec
Simulation time	100sec
Channel frequency	2.4GHz
Data Rate	2Mbps
Path Loss Model	Two Ray Model
Physical layer radio type	IEEE802.11b
MAC Protocol	IEEE802.11
Antenna model	Omni-directional

IV. RESULTS AND DISCUSSIONS

The QualNet 6.1 network simulator has been used to analyze the parametric performance of AODV, OLSR & ZRP through different data traffic CBR and VBR, and mobility model Random waypoint and Group mobility.

Received Throughput: It is the ratio of successfully transmitted data per second. The throughput is analyzed with varying CBR and VBR data traffic. According to our simulation results better performance is shown by AODV at high mobility using CBR data traffic compared to other protocols. It shows that OLSR performance is also nearer to AODV protocol. By using VBR data traffic OLSR performs better than AODV and ZRP protocols. It shows that OLSR performs well in both data traffics. Thus OLSR outperforms in both cases and performance of ZRP is least in both cases.

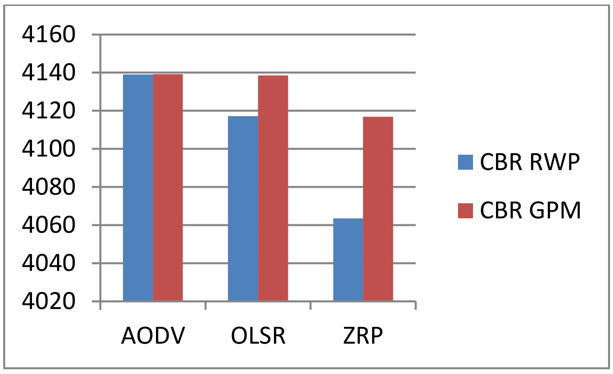

Figure 6: Received Throughput with CBR

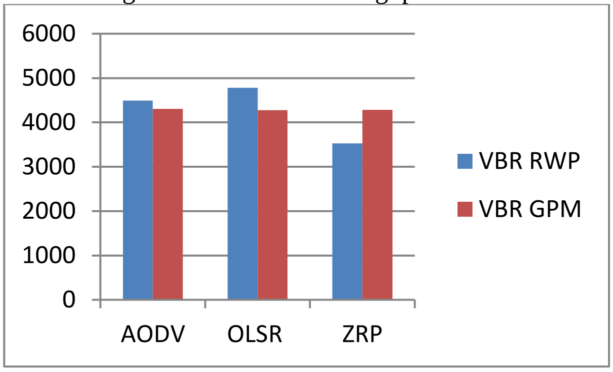

Figure 7: Received Throughput with VBR

Average End-to-End Delay: The delay of the packet is the time it takes the packet to achieve the destination after it leaves the source. In this analysis it is observed as expected the delays are more for AODV in comparison to OLSR. In CBR and VBR data traffics OLSR performs better than AODV and ZRP routing protocols. The end-to-end delay of OLSR is less because it has reduced routing overhead and queuing delay While OLSR shows least delay in both data traffics (CBR and VBR) thus it is better among three.

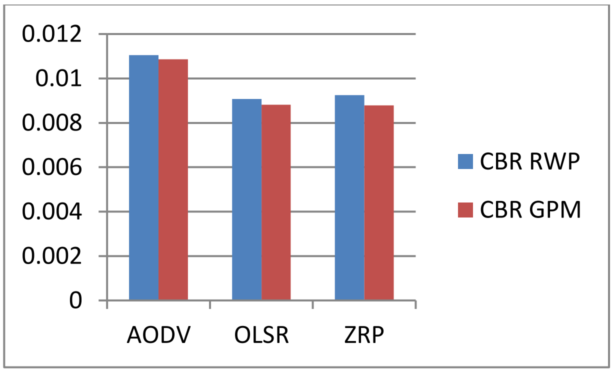

Fig.8 Average End to End delay with CBR

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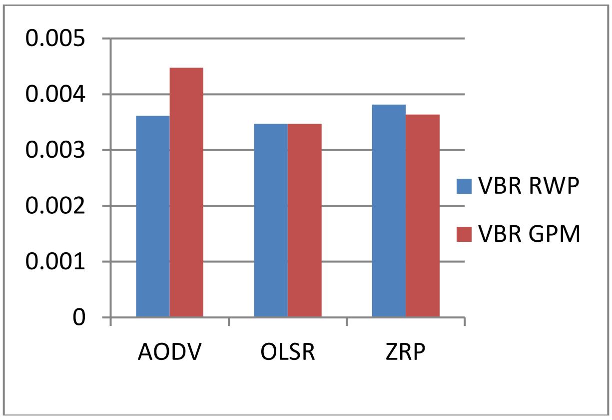

Fig.9 Average End to End delay with VBR

Average Jitter: Jitter is the variation in the time between packets arriving, caused by network congestion, timing drift, or route changes. Jitter should be small for a routing protocol to perform better. AODV performs better in CBR data traffic, but the performance of OLSR is also nearer to AODV. While with CBR data traffic OLSR gives best performance. Thus OLSR outperforms AODV & ZRP. ZRP shows worst performance for higher no. of nodes.

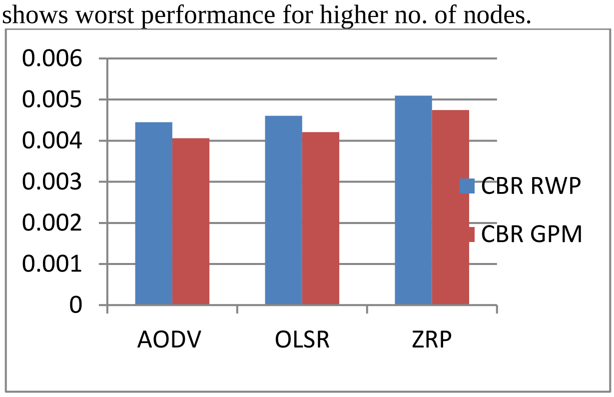

Figure 10: Average Jitter with CBR

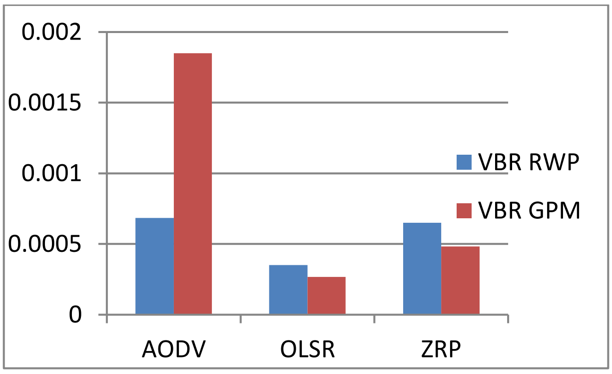

Figure 11: Average Jitter with VBR

V. CONCLUSION

It is observed in the analysis that OLSR outperforms AODV & ZRP in general for all the scenarios. OLSR is suitable for both data traffics. Performance of ZRP is worst in all cases. AODV performances are nearby OLSR. But OLSR performs in both data traffics and mobility model. It has the least end-to-end delay and jitter. OLSR has the highest received throughput compared to AODV and ZRP. The simulation study has been conducted using network simulator QualNet 6.1 for the performance comparison of AODV, OLSR and ZRP protocols in different data traffic and mobility model environment. Hence we can conclude that OLSR is best when compared to all other routing protocols.

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