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Influence of Variation in Node Density on Routing Protocols in MANETs

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Abstract*— Mobile ad-hoc network (MANET) is a collection of mobile nodes that have the ability to form a communication network without the help of any predefined infrastructure. The primary challenge in building a MANET is equipping each device to continuously maintain the information required to properly route traffic. Its routing protocol has to be able to cope with the new challenges that a MANET creates such as nodes mobility, security maintenance, and quality of service, limited bandwidth and limited power supply. With the increasing interest in MANETs, there has been a greater focus on the subject of improving the quality of service as per the requirement of the user according to the various conditions. The main objective of this paper is to compare the performance based on jitter present in transmission of packet in a MANET by using different types of protocols viz: Proactive, Reactive, Hybrid. This system is developed for IEEE 802.11b based Wireless network and simulated through Qualnet 5.0 with some mobile nodes. Packet size and No. of users are the two parameters in this paper which helps to find out the suitable type of protocol that can be use in a MANET.

***Keywords*— MANET, Reactive protocols, Proactive protocol, Hybrid protocols, Qualnet, Jitter, Packet Size**

I. INTRODUCTION

The wireless network [2] can be classified into two types: Fixed Network Infrastructure and Infrastructure less. In fixed network infrastructure wireless networks, the mobile node can move while communicating, the base stations are fixed and as the node goes out of the range of a base station, it gets into the range of another base station. The fig. 1, given below, depicts the fixed network infrastructure wireless network.

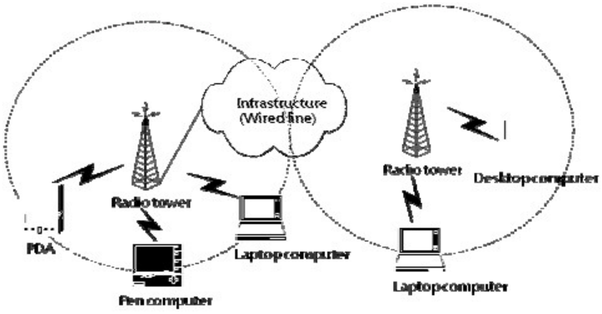

Fig1: Fixed Network Infrastructure Wireless network

The second approach of a wireless ad hoc network is that it requires no pre-established infrastructure. Wireless ad-hoc networks can be deployed in areas where a wired network infrastructure may be undesirable due to reasons such as cost or convenience.

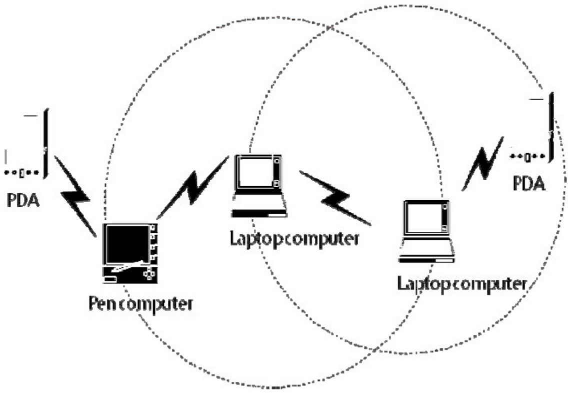

Fig2: Infrastructure less network

So there is a plethora of applications for wireless ad-hoc networks. As a matter of fact, any day-to-day application such as electronic email and file transfer can be considered to be easily deployable within an ad hoc network environment. Also, we need not emphasize the wide range of military applications possible with ad hoc networks. Not to mention, the technology was initially developed keeping in mind the military applications, such as battlefield in an unknown territory where an infrastructure network is almost impossible to have or maintain. In such situations, the ad hoc networks having self-organizing capability can be effectively used where other technologies either fail or cannot be deployed effectively [1].

II. ROUTING PROTOCOLS

Routing protocols[13] are challenging to design as performance degrades with the growth of number of nodes in the environment and a large ad hoc network is difficult to manage The routing protocols used in this paper is unicast protocols. The routing protocols in MANETs are classified into reactive and proactive and hybrid protocols [2]. A routing protocol determines the path of a packet from the source to the destination. To forward a packet, the network protocol needs to know the next node in the path as well as the outgoing interface on which to send the packet. A routing protocol [27] computes such routing information. In general, routing protocols can be divided into two categories: proactive routing protocols and on-demand routing protocols. A proactive routing protocol discovers the network topology and computes the routing information regardless of whether the network protocol has a packet which needs that information. An on-demand or reactive routing protocol tries to discover a path to a destination only when the network protocol receives a packet addressed to that destination. The reactive protocols are Ad-hoc on Demand Distance Vector (AODV), Dynamic Source Routing(DSR), Dynamic MANET On-demand (DYMO) routing protocol, Link Quality Source Routing (LQSR), Location Aided Routing(LAR). The proactive protocols are Bellman-Ford, Fisheye, Optimized Link State Routing (OLSR) and Source Tree Adaptive Routing (STAR). The hybrid protocol is ZRP protocol. The general routing requirements of any routing protocol is scalability, reliability, throughput, load balancing, and congestion control. Performance comparison among some set of routing protocols are already reported by the researchers in papers and many more. These performance comparisons are carried out for ad hoc networks.

A. Zone Routing Protocol (ZRP)

Zone Routing Protocol [26] or ZRP was the first hybrid routing protocol with both a proactive and a reactive routing component. ZRP was proposed to reduce the control overhead of proactive routing protocols and decrease the latency caused by route discovery in reactive routing protocols. ZRP defines a zone around each node consisting of the node's k-neighborhood (that is, all nodes within k hops of the node). A proactive routing protocol, Intra-zone Routing Protocol (IARP), is used inside routing zones, and a reactive routing protocol, Inter-zone Routing Protocol (IERP), is used between routing zones. A route to a destination within the local zone can be established from the source's proactively cached routing table by IARP. Therefore, if the source and destination of a packet are in the same zone, the packet can be delivered immediately. Most of the existing proactive routing algorithms can be used as the IARP for ZRP

B. Ad Hoc On Demand Distance Vector (AODV)

AODV [14] discover the nodes on-demand basis and are maintained as long as they are required. It maintains a sequence number, which it increases each time it finds a change in the topology of its neighbourhood. This sequence number ensures that the most recent route is selected for execution of the route discovery. AODV [19] is able to provide unicast, multicast and broadcast communication ability. Combination of the three makes it an advantage protocol. AODV is capable of operating on both wired and wireless media, although it has been designed specifically for wireless domain. Route tables used by AODV store the destination and next hop IP addresses as well as the destination sequence number. AODV also provide quick deletion of invalid routes breakage. If a node fails to receive three consecutive HELLO messages from a neighbour, it is concluded that link is broken for the specific node and a RERR message is broadcasted to any upstream node. In fact a more conservative routing table and sequence number driven approach is utilized in AODV. This reduces the routing overhead, but introduces some initial latency due to the on-demand route setup.

C. Optimized Link State Routing Protocol (OLSR)

The Optimized Link State Routing Protocol (OLSR) [17] is an IP routing protocol optimized for mobile ad-hoc networks, which can also be used on other wireless ad-hoc networks. OLSR is a proactive link-state routing protocol, which uses hello and topology control (TC) messages to discover and then disseminate link state information throughout the mobile ad-hoc network. Individual nodes use this topology information to compute next hop destinations for all nodes in the network using shortest hop forwarding paths. In wireless ad-hoc networks, there is different notion of a link, packets can and do go out the same interface; hence, a different approach is needed in order to optimize the flooding process. Using Hello messages the OLSR protocol at each node discovers 2-hop neighbor information and performs a distributed election of a set of multipoint relays (MPRs). Nodes select MPRs such that there exist a path to each of its 2-hop neighbors via a node selected as an MPR. These MPR nodes then source and forward TC messages that contain the MPR selectors. This functioning of MPRs makes OLSR unique from other link state routing protocols in a few different ways: The forwarding path for TC messages is not shared among all nodes but varies depending on the source, only a subset of nodes source link state information, not all links of a node are advertised but only those that represent MPR selections. Since link-state routing requires the topology database to be synchronized across the network, OSPF and IS-IS perform topology flooding using a reliable algorithm. Such an algorithm is very difficult to design for ad-hoc wireless networks, so OLSR doesn't bother with reliability; it simply floods topology data often enough to make sure that the database does not remain unsynchronized for extended periods of time.

III. SIMULATION ENVIRONMENTS

The overall goal of this simulation study is to evaluate and analyze the performance of three existing routing protocols; they are: AODV, OLSR and ZRP over Mobile Ad-hoc Networks (MANETs) environment. The simulations have been performed using Qualnet version 5.0, software that provides scalable simulations of Wireless Networks. The parameters are summarized in Table 1.

TABLE 1: SUMMARY OF SIMULATION ENVIRONMENTS

Parameters	Values
Number of nodes	Chosen from different models
Network Size	1500m x 1500m
Node Placement	Random
Path loss Model	Free Space Propagation Model
Propagation Environment	Metropolitan
Shadowing Model	Constant (4 db)
Transmission rate at PHY	2 Mbits/s
Physical layer protocol	PHY802.11b
Data link layer protocol	MAC802.11
Queue size at router	15KB
Queuing policy at router	First-in-First-out
Traffic Flow	Constant Bit Rate (CBR)
Duration of Experiment	120 sec.
Data Transmission Start	10 sec.
Data Transmission Stop	90 sec.
Unicast Routing Protocols	AODV,OLSR, ZRP
Mobility	Low/ Random

The simulation model over different networks in which network varies from 25 nodes (clients) to 80 nodes (clients) over a terrain of 1500m x 1500m area. Transmission of data packets is done by user defined by node no. 13 and destined to user at node no. 3.We used low mobility models for all the three cases. There are five simulation models used to perform this task:

Model 1: In this model, the network used is very small of size 25 nodes.

Model 2: This network the size has been increased from 25 to 35 nodes.

Model 3: Size of network is increased to 50 in this simulation model or we can say that no. of user in an area got increased from 35 to 50.

Model 4: The no. of users, in this network is increased to 65 users and now there is an increase in congestion.

Model 5: Now, the network is of 80 nodes, such that the users got closed and network becomes more compact and crowded.

The senders and receivers are same in each model among network members are placed at same place initially but as the simulation starts, the nodes starts moving and the location of source and destination node changes and also of other nodes which are in the network. The packet size without header is changing from 64, 128, 256, 512, 1024 bytes. The whole experiments are carried out on the three main protocols of reactive type which are AODV, OLSR and ZRP. To evaluate the performance of Routing Protocols, we studied jitter as the main parameter which describes the behavior of different Routing protocols.

Jitter: Jitter is the undesired deviation from true periodicity of an assumed periodic signal in electronics and telecommunications, often in relation to a reference clock source. Jitter may be observed in characteristics such as the frequency of successive pulses, the signal amplitude, or phase of periodic signals. Jitter is a significant, and usually undesired, factor in the design of almost all communications links.

IV. RESULTS AND DISCUSSION

In this section, the performance of AODV, OLSR and ZRP are analysed and demonstrated based on the results obtained from the simulation A number of experiments are performed to explore the performance of these protocols with respect to jitter. Simulations are performed by varying Packet size and keeping mobility low. Five models are considered for the comparison on the basis of jitter. Fig 3 shows model 1 which shows the variation of jitter for 25 nodes network for low mobility. The performance of OLSR is poor as the jitter is very high, AODV has very low values of jitter which shoes that it has got good behavior, ZRP has got very low values of jitter for increasing packet size depicting that its performance is better than AODV.

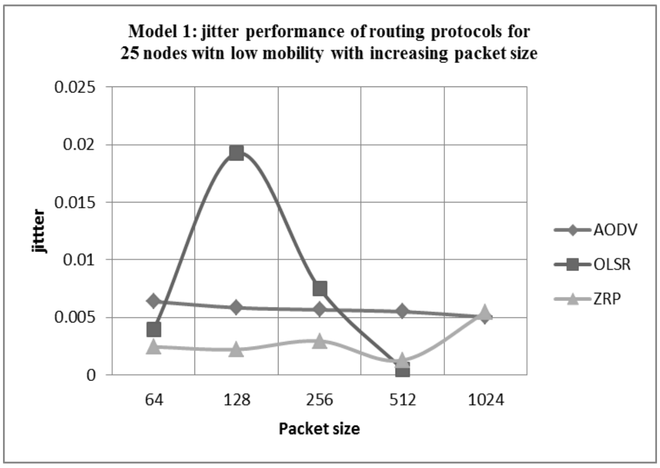

Fig 3: Jitter Analysis for AODV, OLSR, ZRP in Model 1

Model 2 responses as is shown in Fig 4, which is a network of 35 nodes. This model shows that AODV has a high jitter value than all other protocols and OLSR and ZRP have very low value of jitter depicting good performance.

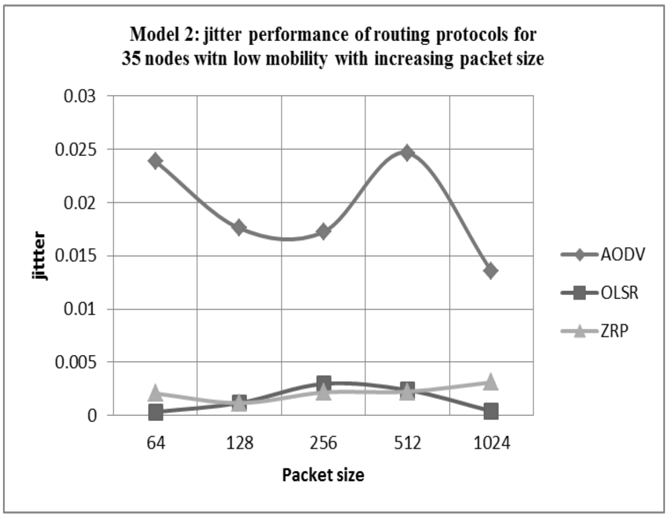

Fig 4: Jitter Analysis for AODV, OLSR, ZRP in Model 2

Fig 5 shows the jitter analysis of Model 3. This network has 50 nodes with low mobility and shows that the jitter is higher when protocol used is AODV and remaining protocols have the nearly same jitter. ZRP and OLSR have high value for jitter for lower packet size and as the packet size is increased the jitter decreases.

Fig 6 is used to represent the jitter analysis of Model 4 which is a network of 65 nodes of low mobility and the jitter observed for Model 4 defines that AODV has very poor performance and OLSR have minimum jitter. ZRP has high jitter for low packet size and as the packet size is increased the jitter decreases and becomes comparable to OLSR.

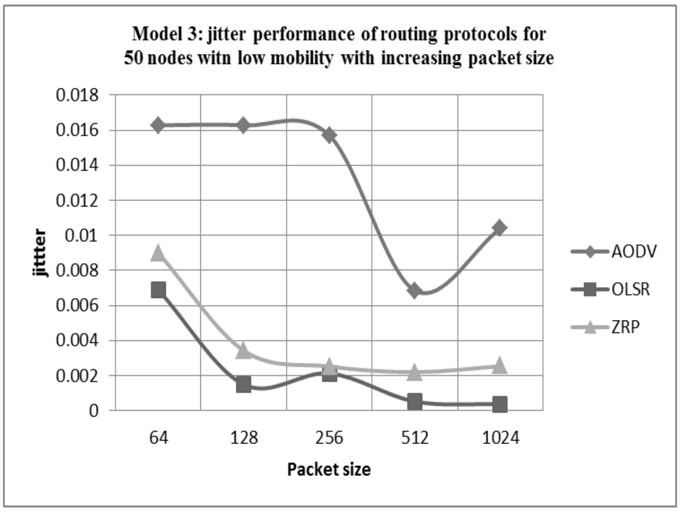

Fig 5: Jitter Analysis for AODV, OLSR, ZRP in Model 3

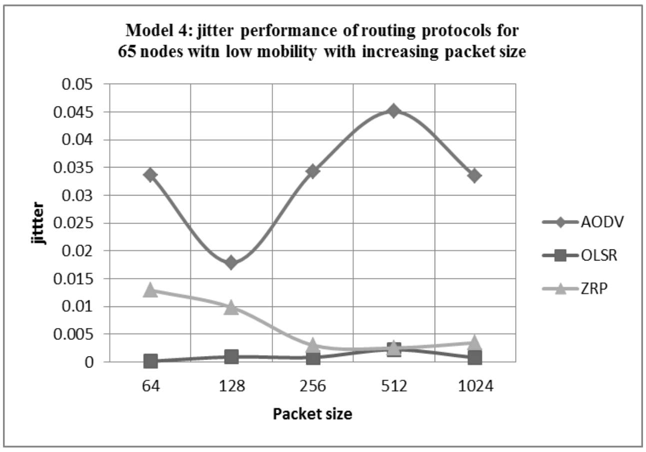

Fig 6: Jitter Analysis for AODV, OLSR, ZRP in Model 4

In Fig 7, effect of packet size is shown for a network of 80 nodes, which has very high value of jitter for AODV for lower packet size and lowest value of jitter for high packet size. For OLSR and ZRP the jitter is almost the same.

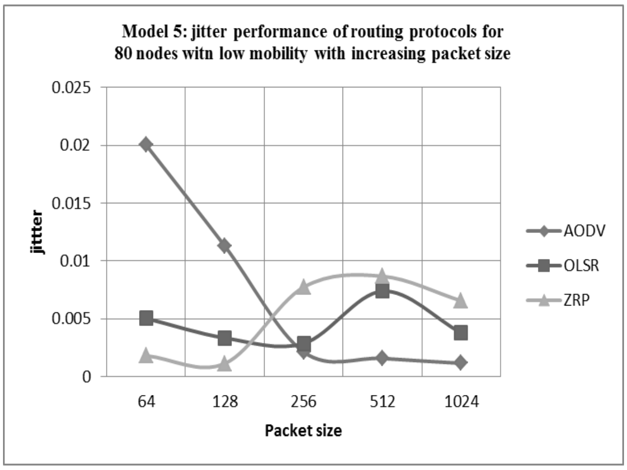

Fig 7: Jitter Analysis for AODV, OLSR, ZRP in Model 5

Fig 2 to fig 7 shows the effect of packet size on jitter for various models of 25 nodes, 35 nodes, 50 nodes, 65 nodes and 80 nodes respectively for mobile nodes having low mobility.

V. CONCLUSION

In this paper, analysis and investigations are carried out on the acquired simulation results of three prominent routing protocols, AODV, OLSR and ZRP. All the simulations are performed over Mobile Adhoc networks. The three protocols are the representative of proactive, reactive and hybrid type of Routing Protocols respectively. From the investigation, it can be easily determined that the performance of OLSR which is a proactive protocol is best when we compare on the basis of jitter. AODV has the poorest performance amongst the three protocols examined. ZRP which is a hybrid protocol has moderate performance So it is concluded that OLSR (On- Demand Routing Protocol) shows the comparatively high performance than all other type of protocols. So when aim is to minimize the jitter, On Demand Routing protocols can be used. This work can be further extended to improve this system by implementing another parameters like end to end delay, packet delivery ratio, security issues etc. such that the overhead of selecting routing protocol can be minimized.

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