Jitter based Comparison of Proactive, Reactive and Hybrid Routing Protocols in Mobile Ad-hoc Network

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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. Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently. Each must forward traffic unrelated to its own use, and therefore be a router. 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. These challenges set new demands on MANET routing protocols. 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 such as cell size, weather, traffic, mobility of users etc. 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. Packet size and No. of users are the two parameters in this paper which helps to find out the suitable type of traffic that can be use in a MANET.

Keywords: Mobile ad-hoc network, Reactive protocols, Proactive protocol, Hybrid protocols, Qualnet, Jitter

I. INTRODUCTION

Wireless telecommunications is the transfer of information between two or more points that are not physically connected. Distances can be short, such as a few meters for television remote control, or as far as thousands or even millions of kilometers for deep-space radio communications. It encompasses various types of fixed, mobile, and portable two-way radios, cellular telephones, personal digital assistants (PDAs), and wireless networking. Wireless networking is an emerging technology that allows users to access information and services electronically, regardless of their geographic position.

The use of wireless communication between mobile users has become increasingly popular due to recent performance advancements in computer and wireless technology. This has led to lower prices and higher data rates, which are the two main reasons why mobile computing is expected to see increasingly widespread use and applications. There are two distinct approaches for enabling wireless communications between mobile hosts. The first approach is to use a fixed network infrastructure that provides wireless access points. In this network, a mobile host communicates with the network through an access point within its communication radius. When it goes out of range of one access point, it connects with a new access point within its range and starts communicating through it. An example of this type of network is the cellular network infrastructure. A major problem of this approach is handoff, which tries to handle the situation when a connection should be smoothly handed over from one access point to another access point without noticeable delay or packet loss. Another issue is that networks based on a fixed infrastructure are limited to places where there exist such network infra-structures [1].

The second approach of a wireless ad hoc network is that it requires no pre-established infrastructure. Laptops and personal digital assistants (PDAs) that communicate directly with each other are examples of nodes in an ad hoc network. Nodes in the ad-hoc network are often mobile, but can also consist of stationary nodes. Each of the nodes has a wireless interface and communicates with others over either radio or infrared channels.

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. 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 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 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. 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 neighborhood. This sequence number ensures that the most recent route is selected for execution of the route discovery. AODV 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 neighbor, 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.

B. Optimized Link State Routing Protocol (OLSR)

The Optimized Link State Routing Protocol (OLSR) [24] 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 neighbour 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 neighbours 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.

C. Zone Routing Protocol (ZRP)

Zone Routing Protocol [25] 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

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 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 high 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. 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
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

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 DISCUSSIONS

In this section, the performance of AODV, OLSR and ZRP are analyzed 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 high.

Five models are considered for the comparison on the basis of jitter.

Fig 1 shows model 1 which shows the variation of jitter for 25 nodes network for high mobility. The performance of AODV is poor as the jitter is very high, OLSR has very low values of jitter which shoes that it has got good behavior, ZRP has got moderate values of jitter for increasing packet size depicting that its performance is better than AODV.

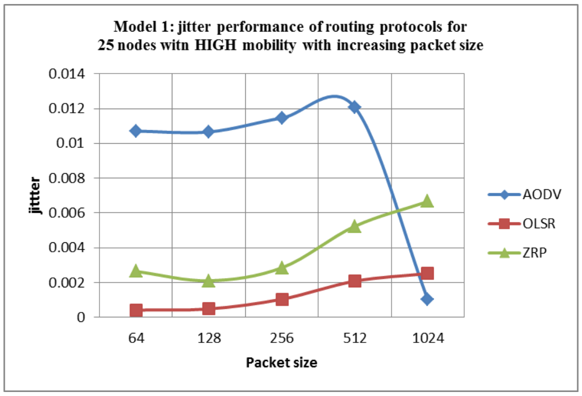

Fig 1: Jitter Analysis for AODV, OLSR, ZRP in Model 1

Model 2 responses as is shown in Fig 2, which is a network of 35 nodes. This model shows that AODV has a high jitter value than all other protocols and OLSR has minimum value whereas the value for jitter for ZRP is varying sinusoidal.

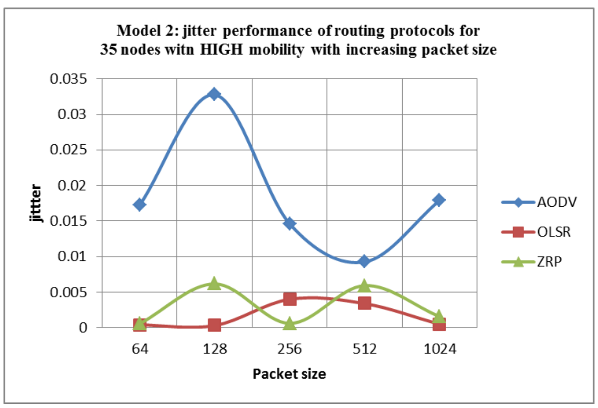

Fig 2: Jitter Analysis for AODV, OLSR, ZRP in Model 2

Fig 3 shows the jitter analysis of Model 3. This network has 50 nodes with high mobility and shows that the jitter is higher when protocol used is AODV and remaining protocols have the nearly same jitter.
Fig 4 is used to represent the jitter analysis of Model 4 which is a network of 65 nodes of high mobility and the jitter observed for Model 4 defines that OLSR and ZRP have minimum jitter again and AODV has maximum value.

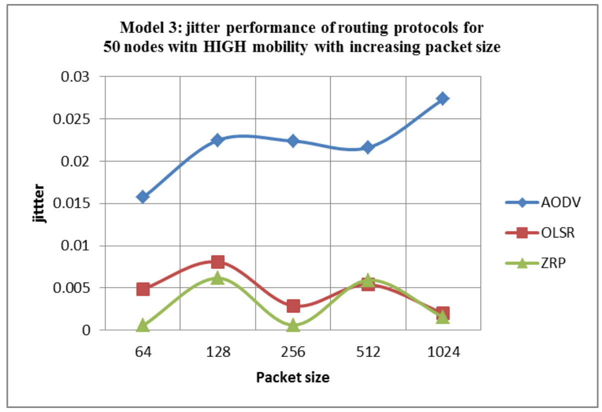

Fig 3: Jitter Analysis for AODV, OLSR, ZRP in Model 3

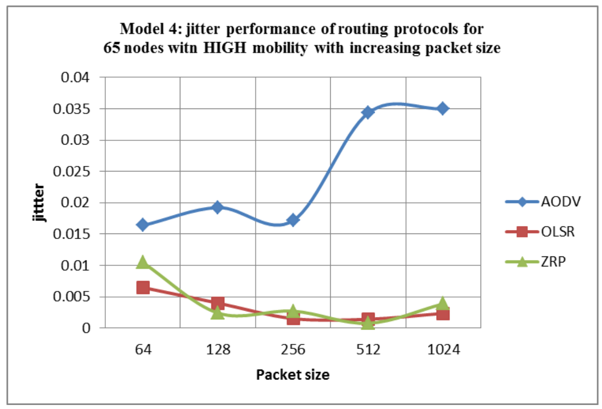

Fig 4: Jitter Analysis for AODV, OLSR, ZRP in Model 4

In Fig 5, effect of packet size is shown for a network of 80 nodes, which has very high value of jitter for ZRP, moderate value for AODV and again low value for OLSR

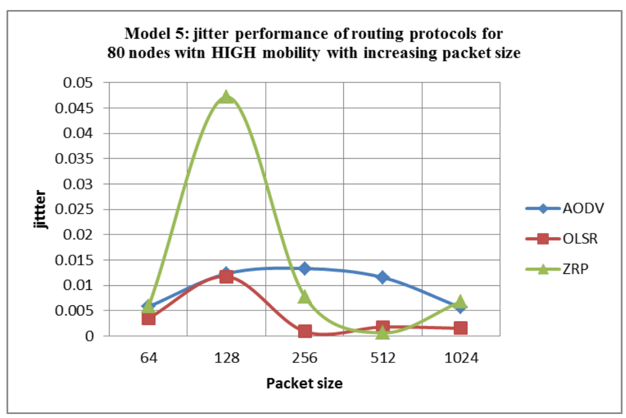

Fig 5: Jitter Analysis for AODV, OLSR, ZRP in Model 5

Fig 1 to fig 5 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 highly mobile nodes.

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 but as the number of nodes increase to 80 its performance deteriorates considerably, so ZRP can be used for small networks. 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.

REFERENCES

[1] Mahender Kumar Mishra, "A Trustful Routing Protocol for Adhoc Network", Global Journal of Computer Science and Technology, Volume 11 Issue 8 Version 1.0, May 2011

[2] Yan zuang, Jjijun luo, Honglin hu, "Wireless Networking: Architecture, Protocols And Standards", Auerbach publications,Taylor & Francis group,LLc,2007.

[3] Ian F. Akyildiz, Xudong Wang, Weilin Wang, "Wireless networks: A Survey" 1st January 2005.

[4] Anastasios, D. Khalil, K. "IEEE 802.11sWireless Networks" Dept. of Communication Systems, Lund University, Sweden.

[5] Omar Villavicencio-Calderon. "Wireless networks: performance analysis and enhancements." university of Puerto Rico mayag uez campus, 2008.

[6] Kravets and Zhong (2003), "On demand power management for ad-hoc networks", in: IEEE Annual Conference on Computer Communications (INFOCOM).

[7] Carlo Alberto Boano and Md. Sakhawat Hossen. "VoIP over Wireless Networks: Implications and Challenges," May 1, 2008.

[8] Andrew Brzezinski, Gil Zussman, "Enabling Distributed Throughput Maximization in Wireless Mesh Networks" , IEEE GLOBECOM 2007

[9] Alexandros V., and Anastasios A. E., "Evaluation of Multicasting Algorithms in Manets", Proceedings of World Academy of Science, Engineering and Technology, vol. 5, April, 2005.

[10] Zhijun W., Yong L., and Lu W., "Multicast in Mobile ad hoc Networks", CCTA, 2007, pp. 151-164.

[11] Zeldi S., Farhat A., Aisha H., "Performance analysis of multicast tree protocols", Proceedings of the ICT4M International Conference, Kuala Lumpur, 2006.

[12] D. Lundberg ,"Ad Hoc Protocol Evaluation and Experiences of real world Ad Hoc networking", Uppsala University Department of Information Technology, technical report 2004-026, June, 2004.

[13] R. Bagrodia, M. Gerla, J. Hsu, W. Su, and S.-J. Lee, "A performance comparison study of ad hoc wireless multicast protocols", Proc. of the 19th Annual Joint Conf. of the IEEE Computer and Communications Societies, March, 2000, pp. 565 –574.

[14] C.E. Perkins and E.M Royer, "Ad Hoc On-Demand Distance Vector Routing", Proc 2nd IEEE Workshop Mobile Comp. Sys and Apps., New Orlean LA, Feb 1999, pp. 90-100.

[15] Multi-Linked AODV Routing Protocol for Wireless Mesh Networks, IEEE GLOBECOM 2007.

[16] Study of Distance Vector Routing Protocols for Mobile Ad Hoc Networks IEEE International Conference on Pervasive Computing and Communications (PerCom'03).

[17] OLSR Mesh Networks for Broadband Access: Enhancements, Implementation and Deployment.

[18] Wikipedia, *"The free encyclopedia-, Mobile ad-hoc Network",* http://en.wikipedia.org/wiki/Mobile_ad-hoc_ network, *Oct*-2004.

[19] Charles E.Perkins and Elizabeth M. Royer, "*Ad hoc on demand distance vector (AODV) routing (Internet-Draft)*", Aug-1998.

[20] Pallavi Khatri, Monika Rajput, Alankar Shastri and Keshav Solanki, " Perfomance study of Adhoc Reactive routing protocols", Journal of Computer Science 6 (10): 1130-1134, 2010

[21] Yogesh chauhan, Sharad Sharma, Vijay Kumar, "Performance evaluation of Wireless Mesh Network under varied traffic", GIMT, IETET-oct.2010.

[22] Johnson, D.B., D.A. Maltz and J. Broch, 1999. DSR: The Dynamic Source Routing Protocol for Multihop Wireless Ad Hoc Networks. In: In Ad Hoc Networking, Perkins, C.E. (Ed.). Addison-Wesley, USA, pp: 139-172.

[23] Rolf ehrenreich thorup advisor: lars kristensen, "implementing and evaluating the dymo routing protocol" department of computer science, university of Aarhus, Denmark-February, 2007.

[24] Ankur Gupta, yogesh Chauhan, Sharad Sharma, shikha bhardwaj "Performance evaluation of Mobile Adhoc Network under varied traffic", NCEC, Abhipur-Nov.2010

[25] M. Abolhasan, B. Hagelstein, J. C.-P. Wang "Real-world performance of current proactive multi-hop mesh protocols", IEEE APCC, Shanghai, China, 8-10th October 2009.

[26] Nicklas Beijar "Zone Routing Protocol (ZRP)", Networking Laboratory, Helsinki University of Technology, Finland