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Comparative Analysis of DSR, FSR and ZRP Routing Protocols in MANET

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Abstract. Mobile Ad hoc NETwork (MANET) is a collection of mobile nodes that are arbitrarily located so that the interconnections between nodes are dynamically changing. A routing protocol is used to find routes between mobile nodes to facilitate communication within the network. The main goal of such an ad hoc network routing protocol is to establish correct and efficient route between a pair of mobile nodes. Route should be discovered and maintained with a minimum of overhead and bandwidth consumption. There are number of routing protocols were proposed for adhoc networks. It is quiet difficult to compare all of the protocols. This paper presents performance evaluation of three different routing protocols i.e. Dynamic Source Routing Protocol (DSR), Fisheye State Routing (FSR) and Zone Routing Protocol (ZRP) with respect to variable pause times. Performance of DSR, FSR and ZRP is evaluated based on Average end-to-end delay, Packet delivery ratio, Throughput and Average Jitter. Based on the simulation results DSR perform well compare with other protocol except the jitter. Simulations of protocols to analyze their performance in different conditions were performed in NS 2 simulator.

Keywords: MANET, DSR, FSR, ZRP, Jitter, Throughput, Average end-to-end delay, Packet delivery ratio

1. Introduction

Mobile Ad Hoc Networks are the self-organizing and self-configuring wireless networks which do not rely on a fixed infrastructure and has the capability of rapid deployment in response to application needs. Nodes of these networks function as routers which discover and maintain routes to other nodes in the network. The Ad hoc network applications include military applications, casual conferences, meeting, virtual classrooms, emergency search-and-rescue operations, disaster relief operation, automated battlefield and operations in environments where construction of infrastructure is difficult or expensive. In MANET, due to lack of centralized entity and mobile nature of nodes, network topology changes frequently and unpredictably. Hence the routing protocols for ad hoc wireless networks have to adapt quickly to the frequent and unpredictable changes of topology [1].

There are many routing protocols available for Ad-hoc networks as AODV, CGSR, DSDV, DSR, DYMO, FSR, GSR, OLSR, STAR, TORA, WRP and ZRP etc. Most of the research study shows that DSR and AODV are performing well depend upon the environment, among the reactive protocols. In the case of proactive, FSR, TORA and OLSR protocols are performing well. The performance of different proactive, reactive and hybrid protocols have analysed by different researchers. The comparative analysis of DSR [2], [3], FSR [4] and ZRP [5] is proposed in this paper since no such analysis is available in the literature.

The organization of the paper is as follows: Section 2 presents the related work. Overview of the routing protocols is discussed in section 3. Simulation results and comparative analysis is provided in section 4. Section 5 concludes the paper.

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2. Related Work

Most recently, Ashish K. et al [6] evaluated AODV, FSR and ZRP for Scalable Networks. They performed simulations with the following two different scenarios for the performance evaluation of AODV, FSR and ZRP routing protocol.

- Network designed using random waypoint mobility model with different pause time.
- Network designed using random waypoint mobility model with variable number of nodes.

Performance of AODV, FSR and ZRP routing protocol is evaluated with respect to four performance metrics such as average end to end delay, packet delivery ratio, throughput and average jitter. AODV shows best performance when compared with FSR and ZRP in terms of packet delivery ratio and throughput. AODV delivers more than 60 percent of all CBR packets when network is presented as a function of pause time and delivers more than 80 percent of all CBR packets when network is presented as a number of nodes.

Sree Ranga Raju, et al [7] compared the performance of DSR, AODV and ZRP, especially focusing on ZRP and the impact of some of its most important attributes to the network performance. They found that the performance of ZRP was not up to the task and it performed poorly throughout all the simulation sequences.

3. Overview of MANET Routing Protocols

3.1 Dynamic Source Routing

The Dynamic Source Routing protocol is composed of two main mechanisms to allow the discovery and maintenance of source routes in the ad hoc networks. Route Discovery: Is the mechanism by which a source node to send a packet to a destination node, obtains a source route to the destination. Route discovery is used only when the source node attempts to send a packet to a destination and does not already know a route to that destination. Route Maintenance: Is the mechanism by which a node to send a packet to a destination is able to detect, while using a source route to the destination, if the network topology has changed. If this is the case then it must no longer use this route to the destination because a link along the route broken. Route maintenance for this route is used only when the source node is actually sending packets to the destination. A source puts the entire routing path in the data packet, and the packet is sent through the intermediate nodes specified in the path, If the source does not have a routing path to the destination, then it performs a route discovery by flooding the network with a route request (RREQ) packet. Any node that has a path to the destination in question can reply to the RREQ packet by sending a route reply (RREP) packet. The reply is sent using the route recorded in the RREQ packet.

The responsibility for assessing the status of a route falls to each node in the route. Each must insure that packets successfully cross the link to the next node. If it doesn't receive an acknowledgement, it reports the error back to the source, and leaves it to the source to establish a new route. While this process could use up a lot of bandwidth, DSR gives each node a route cache for them to use aggressively to reduce the number of control messages sent. If it has a cache entry for any destination request received, it uses the cached copy rather than forward the request. In addition, it promiscuously listens to other control messages for additional routing data to add to the cache.

3.2 Fisheye State Routing

Fisheye State Routing (FSR) [4] protocol is a proactive (table driven) ad hoc routing protocol and its mechanisms are based on the Link State Routing protocol used in wired networks. FSR is an implicit hierarchical routing protocol. It reduces the routing update overhead in large networks by using a fisheye technique. Fisheye has the ability to see objects the better when they are nearer to its focal point that means each node maintains accurate information about near nodes and not so accurate about far-away nodes. The scope of fisheye is defined as the set of nodes that can be reached within a given number of hops. The number of levels and the radius of each scope will depend on the size of the network. Entries corresponding to nodes within the smaller scope are propagated to the neighbors with the highest frequency and the exchanges in smaller scopes are more frequent than in larger. That makes the topology information about near nodes more precise than the information about far away nodes. FSR minimized the consumed bandwidth as the link state update packets that are exchanged only among neighboring nodes and it manages to reduce the message size of the topology information due to removal of topology information concerned far-away nodes. Even if a node doesn't have accurate information about far away nodes, the packets will be routed correctly because the route information becomes more and more accurate as the packet gets closer to the destination. This means that FSR scales well to large mobile ad hoc networks as the overhead is controlled and supports high rates of mobility.

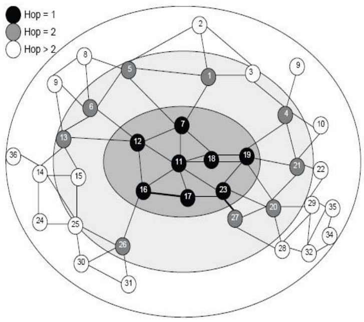

Fig. 2: Fisheye Scope

Fig. 2 illustrates how the fisheye technique is applied to a MANET. When the size of a network increases, sending update messages may potentially consume the bandwidth. FSR uses the fisheye technique to reduce the size of the update message without affecting routing. In the figure, three fisheye scopes are defined with respect to the focal point, node 11.

3.3 Zone Routing Protocol

Zone Routing Protocol or ZRP was the first hybrid routing protocol with both a proactive and a reactive routing component. ZRP was first introduced by Haas in 1997. ZRP is 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-neighborhood (e. g. k=3). In ZRP, the distance and a node, all nodes within hop distance from node belong to the routing zone of node. ZRP is formed by two sub-protocols, 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, 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. Most of the existing proactive routing algorithms can be used as the IARP for ZRP. 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 the 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 packet 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.

Consider the network in Fig. 3 The node S has a packet to send to node X. The zone radius is r=*2*. The node uses the routing table provided by IARP to check whether the destination is within its zone. Since it is not found, a route request is issued using IERP. The request is broadcast to the peripheral nodes (gray in the picture). Each of these searches their routing table for the destination.

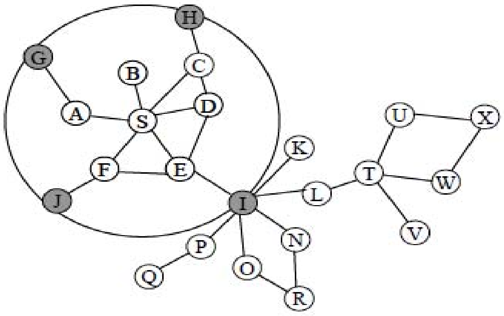

Fig. 3: Routing node of S

4. Simulation Results and Analysis

4.1 Average End-to-End Delay

End-to-end delay indicates how long it a packet takes to travel from the CBR source to the application layer of the destination. [8]. This includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC, propagation and transfer times. The average delay from the source to the destination's application layer is shown in figure 4. According to our simulation results, best performance is shown by FSR having lowest end to end delay. With the increase in pause time average end to end delay is constant from pause time up to 60 sec, then decreases for DSR, initially FSR increases then decreases and ZRP increases up to 40 sec, decreases up to 60 sec and constant from pause time 60s to 100s**.**

4.2 Packet Delivery Ratio

Packet delivery ratio is the fraction of packets sent by the application that are received by the receivers and is calculated by dividing the number of packets received by the destination through the number of packets originated by the application layer of the source. For better performance of a routing protocol, it should be better [9]. The packet delivery ratio is shown in figure 5, DSR perform much better than FSR and ZRP of all CBR packets.

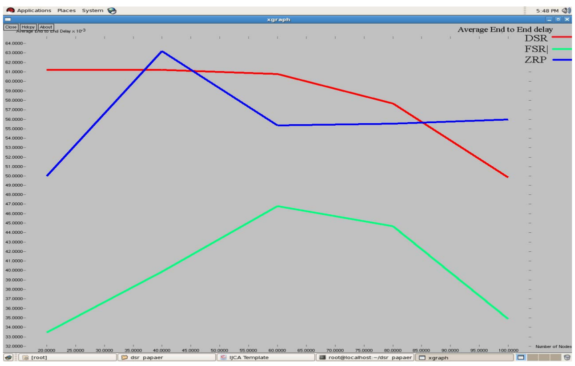

Fig. 4: Average End to End Delay

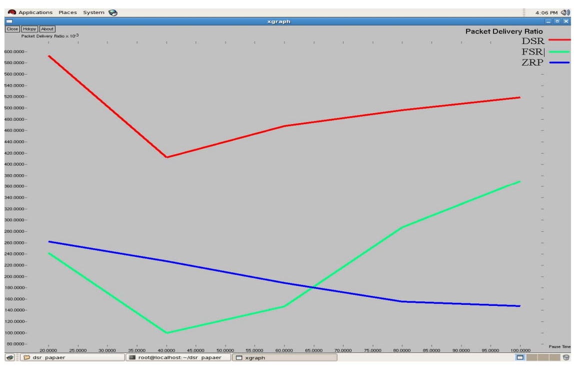

Fig. 5: Packet Delivery Ratio

4.3 Throughput

The throughput is defined as the total amount of data a receiver receives from the sender divided by the time it takes for the receiver to get the last packet. The throughput is measured in bits per second (bit/s or bps) [10]. The throughput is shown in figure 6. According to our simulation results, best performance is shown by DSR as it delivers data packets at higher rate in comparison to FSR and ZRP.

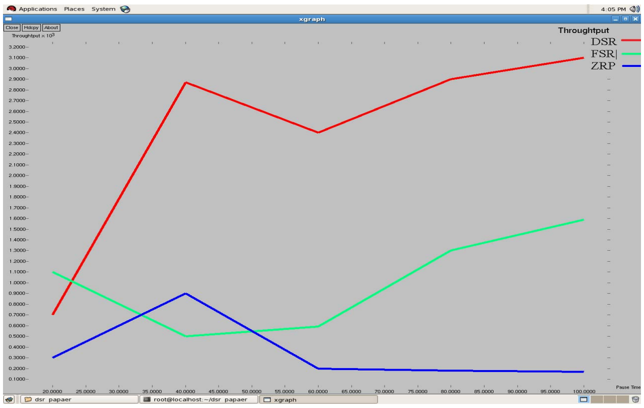

Fig. 6: Throughput

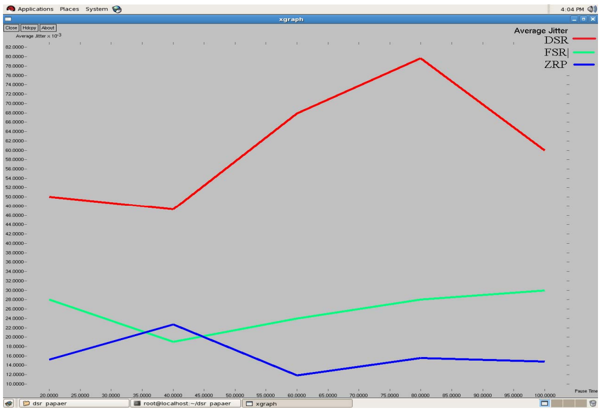

Fig. 7: Average Jitter

4.4 Average Jitter

Jitter is the variation in the time between packets arriving, caused by network congestion, timing drift, or route changes. It should be less for a routing protocol to perform better. The average jitter is shown in figure 7. In DSR, there is more chance for jitter as source node initiate route discovery mechanism by broadcasting a route request packet to its neighbors. According to our simulation results, ZRP has less average jittering than DSR and FSR routing protocols.

5. Conclusions

In this paper, a performance comparison of DSR, FSR and ZRP routing protocols for mobile Ad-hoc networks is presented as a function of pause time. Performance of these routing protocol is evaluated with respect to four performance metrics such as average end to end delay, packet delivery ratio, throughput and average jitter. According to our simulation results, DSR shows best performance than FSR and ZRP in terms of packet delivery ratio and throughput as a function of pause time. FSR show lowest end-to-end delay and ZRP has less average jittering than DSR and FSR. DSR performed the worst in case of average jitter and ZRP performed the worst in case of throughput. In future, number of nodes, more sources, additional metrics such as average hop count, routing overhead may be used.

6. References

[1] Elizabeth, Royer, Chai-Keong, Toh: “A Review of Current Routing Protocols for Ad Hoc Mobile Wireless Networks,” IEEE Personal Communications, April 1999.

[2] D. Johnson, D. Maltz and Yih-Chun Hu. “The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks,”http://www.ietf.org/internet-drafts/draftietfmanet- DSR-09.txt, IETF Internet draft, Apr. 2003.

[3] David B. Johnson and David A. Maltz. “Dynamic source routing for ad hoc wireless networks”. In Mobile Computing, edited by Tomasz Imielinski and Hank Korth, chapter 5, pages 153–181. Kluwer Academic Publishers, 1996.

[4] Guangyu Pei; Gerla, M.; Tsu-Wei Chen; “Fisheye state routing: a routing scheme for ad hoc wireless networks,”IEEE International Conference on Communications, 2000.

[5] Zone Routing Protocol by Nicklas Beijar, Networking laboratory, Helsinki University Of technology, Finland. Licentiate course on Telecommunications Technology, 2002

[6] Ashish K. Maurya, Dinesh Singh , “ Simulation based Performance Comparison of AODV, FSR and ZRP Routing Protocols in MANET”, International Journal of Computer Applications (0975 – 8887) Volume 12– No.2, November 2010

[7] Sree Ranga Raju, Kiran Runkana, Jitendranath Mungara, ” ZRP versus AODV and DSR: A comprehensive study on ZRP performance”, International Journal of Computer Applications (0975 – 8887) Volume 1– No12, 2010

[8] David Oliver Jorg, “Performance Comparison of MANET Routing Protocols In Different Network Sizes”, Computer Science Project, Institute of Computer Science and Applied Mathematics, Computer Networks and

Distributed Systems (RVS), University of Berne, Switzerland, 2003.

[9] Jorjeta G.Jetcheva and David B. Johson, “A Performance Comparison of On-Demand Multicast Routing Protocols for Ad Hoc Networks,” school of computer science, computer science department, Pittsburgh, December 15, 200.

[10] U. T. Nguyen and X. Xiong, “Rate-adaptive Multicast in Mobile Ad-hoc Networks,” IEEE International Conference on Ad hocand Mobile Computing, Networking and Communications 2005 (WiMob 2005), Monreal, Canada, August 2005