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Performance Evaluation of Two Reactive and Proactive Mobile Ad Hoc Routing Protocols

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Abstract

Mobile ad hoc network (MANET) is an organization of static and wireless mobile nodes having no any central administration and fixed infrastructure. In MANET, each node can acts as routing and hosting device. Performance comparison and analysis has been conducted by using four different scenarios in NS2 (Network Simulator) for which two reactive (AODV, DSR) and two proactive (OLSR, DSDV) ad hoc routing protocols have been selected by utilizing 802.11 Mac layer. The main goal is to find out the better performing protocol by measuring three metrics Packet Delivery Ratio, Throughput and Routing Overhead. As the results show that the performance of reactive protocols is better than proactive protocols.

Keywords: *Mobile Ad hoc Network, Performance Comparison, Ad hoc Routing Protocols, ns-2.*

1. Introduction

Mobile ad hoc network (MANET) is an organization of wireless mobile and static nodes having no central administration and fixed infrastructure. In MANET, wireless and static nodes can perform as the routing and hosting device [1].Mobile ad hoc routing protocols are divided into two types of routing categories: Reactive and Proactive. Reactive routing is also recognized as on-demand routing (DSR and AODV) which are utilized on-demand routing algorithm, whereas the Proactive Routing (OLSR and DSDV) is termed as table driven routing too, in which each node remembers the complete information of its routes in its routing table [1].

1.1 Ad hoc on Demand Distance Vector

AODV, establishes route when needed, belongs to the category of reactive routing. If source node wants to send a packet to unknown destination, it starts route discovery procedure to get the path of destination [4].

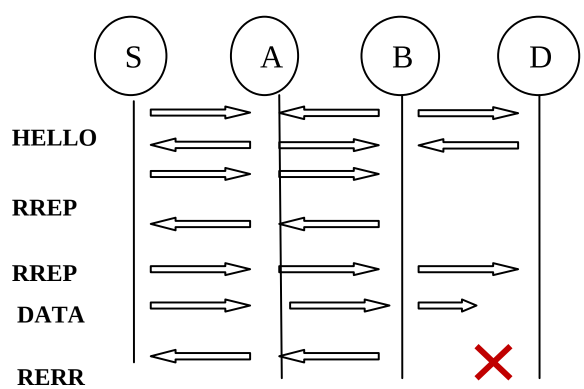

Fig 1: AODV Messaging [4]

As Figure 1 shows that every node floods Hello message for detecting and supervising link state information to find the status of neighbors node. For path creation source node, floods RREQ (Route Request) message at each intermediate node. When requested node receives RREP (Route Reply) from any node in the network, a route is established. If the source node does not receive RREP, it rebroadcasts the RREQ to the same route, or if the receiving node is the destination then it responds with RREP to the source node through the same path. Every node records the path information to its cache, which includes the list of addresses from source to destination and becomes eligible for sending data packets. Circumstances in which a source node receives two requests at a time than its force to select route with less number of hops are present. During packet distribution if the active link becomes fail than the Route Error (RERR) message is generated node-by-node fashion. Source node receives the RRER to declare the route not valid and re initiates the route discovery procedure [4, 8].

1.2 Dynamic Source Routing Protocol

DSR supports source routing procedure, which provides the strength to every packet to have full routing information. Each node has the capability of storing its route cache. The procedure of DSR is the combination of route discovery and route maintenance [9]. Route Discovery procedure starts when a source node desires to find out the path of destination node then it floods route request message through the entire network .Receiving node checks, its route cache in order to find out whether the source node address is stored or not. In case of negativity it adds address of sending node and forwards the message to the next node. Route request message floods entire network until to find the address of the destination node. At last the destination node will respond to source node by utilizing the route reply message for the purpose of valid route communication, if accidentally link failure occurs then the node sends route error message to the source node, and it also forces the source node to delete all the list of addresses for this specific path. Route Maintenance method makes enable the source node to analyze the status of destination node to determine whether it is the part of the network or not. In DSR whenever a specific node willing to send packet to target nod. It will examine its route cache to find current suitable path. If source node does not find path from its route cache then it will send route request message to every neighbor node, subsequently each node has to send route reply message to source node. Node that receives the route request message will insert address to its route cache and would forward the message to neighbor’s node, while finding the complete route record the destination node sends route reply message in unicast manner to source node for creating successful route discovery process [5].

1.3 Optimized Link State Routing Protocol

OLSR, which belongs to the class of proactive routing protocols, has functionality to store routing information in permanent routing table that includes the list of addresses. OLSR provides detail information about all the possible routes. Each wireless mobile node utilizes two types of messages: Hello and TC (Topology Change). Hello message updates each node of the network about the link state information. When a node receives hello message, then it will check its routing table in order to search its own address. TC message facilitates the node to discover the status of neighbor nodes and waits for response. If it responds then the source node inserts its address in its routing table, otherwise it comes to be known that this link is fail. Broadcast of Hello massages, after a fix interval, decreases the efficiency of the network. For optimizing the broadcast, an essential approach is used which is known as Multipoint relays. OLSR provides the facility to each node to find out two-hop neighbor information, and the feature of electing distributed MPR'S by selecting an MPR that connected and exit in two neighbor's path. Selected MPR nodes obtain and forward TC and Hello messages to selected MPR nodes in order to reduce routing overhead. This main feature of OLSR makes it different from other link state routing protocols to work smoothly and properly [1]. As Figure 1.2 describes that OLSR performs routing in different ways such as, the TC message is not common among the all nodes but it varies by depending on the source node. The information which is shared between the nodes is only the link state information, On the other hand all routes of a specific node are not advertised but only those nodes are chosen for advertisement of the selection of MPR which perform the duties to communicate to other MPR in order to reduce the routing overhead of the network [3].

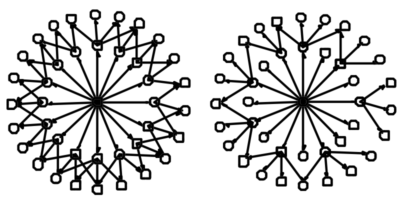

Fig 2: MRP with two neighbor's hop

B (a) Broadcast by Neighbor
B (b) Broadcast by MRP Nodes

It increases the routing overhead but keeps control on delay [3].

1.4 Destination Sequence Distance Vector

DSDV is a proactive routing protocol, which uses Bellman-Ford algorithm [4].DSDV has the capability of supporting bidirectional links. To avoid loop, this protocol uses sequence numbers which are originated by the destination node. DSDV broadcasts route advertisements at regular intervals to preserve consistency of routing information advertisement holds the advertising nodes routing entries with different fields such as destination address, next hop and hop count information of the destination and at last the known sequence number originated by that specific destination [4]. Whenever a node receives route advertisement, it will upgrade its routing table information. DSDV selects a route with lower hop count if the sequence number is equal otherwise a route with high sequence number is always preferred. Subsequently, receiving node forwards the routing information including its own route information. whenever a route failure is identified by any node, it marks it's all routing information as infinity and assigns greater sequence number as compare to routing information of different sequence number, then it floods updated information, because in such circumstances whenever any link failure occurs then odd sequence number is assigned to these routes. In the case of correct destination, even sequence number is generated for the smooth packet communication between the requested nodes to destination. When a node detects link failure it marks all routes through that link with hop count equal to infinity and assigns sequence number greater than the stored sequence number for that destination, after that broadcast updates information.it is because that nodes detecting failures always assign odd sequence numbers to these routes. Huge amount of network traffic is initiated by frequently route advertisements [4].DSDV supports two types of route packet updates: Full Dump Packets and Network Protocol Data Units [8].

2. Related Work

In [5] simulation based **p**erformance, comparison and analysis of proactive and reactive protocols like DSDV, AODV and DSR are elaborated by different scenarios by measuring three metrics i.e. Mobility Rates, Movement Speed. The performance of AODV and DSR is better than DSDV in the circumstances when the transmission power is enhanced. Routing load of AODV is increased as the transmission power gets enhanced. In [6] the simulation executed in real environment generating, the effects and robustness of ad hoc routing protocols by utilizing two mobility models such as constrained mobility model and the free space model. Protocols like DSDV and DSR are simulated by three most important metrics Packet Delivery Ratio, Routing Overhead and Packet Delivery Latency versus number of nodes .The results show that highly overloaded network does not produce the required result as less overloaded network does. In [8] two ad hoc routing protocols such as DSDV and DSR are simulated by using their algorithms and analyzed their functionalities by using the four performance metrics such as Deliberation, end to end delay. At last the results show that different ad hoc routing protocols support various environments including their advantages and limitations.

3. Simulation Parameters

The standard common parameters in all four scenarios are Packet Delivery Ratio, Routing Overhead, and Throughput verses variable number of mobile and static nodes.

3.1.1. Packet delivery ratio: is considered as ratio between the numbers of packets sent by the sender and received by the receiver.

PDR = Packet Send / Packet Receive.

3.1.2. Routing Overhead: is based on the number of nodes as including the hop-wise transmission of packet which is considered as single transmission.

Routing Overhead = No of RTR.

3.1.3. Throughput: is the amount of data that is successfully received at the receiving node by sending node through the network.

Throughput =Packet Receive /Packet send.

Random Way Point selected as mobility model because the numbers of nodes are distributed randomly.

4. Simulation Design and Methodology

Simulation has been done with pause time 0.0ms, which is considered as by default value, whereas each simulation takes 100ms time to complete. The numbers of nodes are 100,120,200,250 with different numbers of static and mobile nodes. Simulated network areas are 500m×500m, 700m×700m, 800m×800m, 1000m×1000m.Traffic type between the nodes is CBR (Constant Bit Rate) with packet size of 512-bytes and packet-sending rate is 4 packets per second. CBR has selected in this simulation, because it provides fair performance comparison between two reactive and proactive ad hoc routing protocols. Variable bit rate makes the traffic load unpredictable that not provide the best simulation result and the Mac has been applied is 802.11 Mac which consider as a layer.

5. Experimental Results

Experimental results of proactive and reactive mobile ad hoc routing protocols which are obtained via Perl Script [8].

5.1. Packet Delivery Ratio

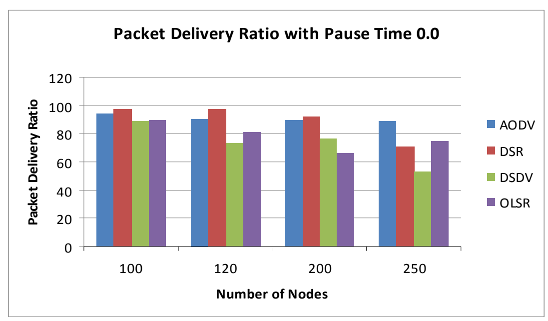

Fig 3: Packet Delivery Ratio VS No of nodes (Pause time 0.0)

Figure 3 shows that the performance of AODV is consistent as the number of nodes are increased (100, 120, 200& 250) it is because it supports high level of mobility with limited usage of Hello messages. DSR has better performance when the number of nodes are in the range of 200, if the number of nodes are increased to 250, then the performance of DSR would be affected because high level of mobility affects the performance of DSR. Performance of DSDV is not much better when numbers of nodes are increased, because it does not support mobility and drops the data delivery packets for which there is no valid route. If the number of nodes including mobile nodes decrease than the routing status becomes relatively stable. OLSR is best with less amount of static and mobile nodes (100 and 120 nodes), because less amount of packets are dropped, which will not cause the delay during the route discovery process. In scenario with 200 nodes, with the combination of static nodes, the throughput decreases due to dropping of more packets.

5.2. Routing Overhead

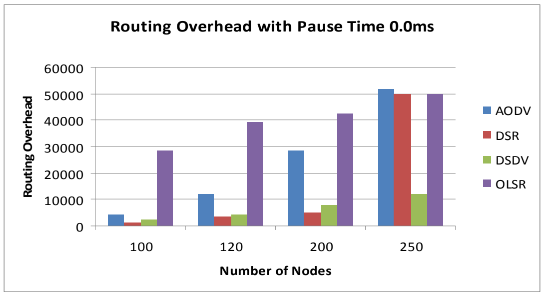

Fig 4: Routing Overhead VS No of Nodes (Pause Time 0.0)

Figure 4 shows that as the numbers of nodes are 100, 120, 200 and 250, the routing overhead of OLSR is very high when the number of nodes increase this is why because of its nature of proactive protocol and HELLO and TC messages are broadcasted after a fix interval of time for route discovery. OLSR works well in dense network. Routing overhead of AODV consistently increases as the number of nodes below 200 due to low mobility, but when the numbers of nodes are 250 then the mobility go also increases as AODV uses Hello massages and which cause routes breakage resulting. Performance of DSDV is better and consistent as compare to other ad hoc routing protocols as the number of nodes are below 200 and with little mobility, but as the number of nodes are 250 then the routing overhead of DSDV is increased a little bit as DSDV requires periodically flooding routing updates , DSR has the feature of maintaining the multiple routes of the same destination as it saves this information in its cache which reduces the routing overhead, but when the mobility increases as the number of nodes are increased. The performance of DSR is affected by high number of nodes.

5.3. Throughput

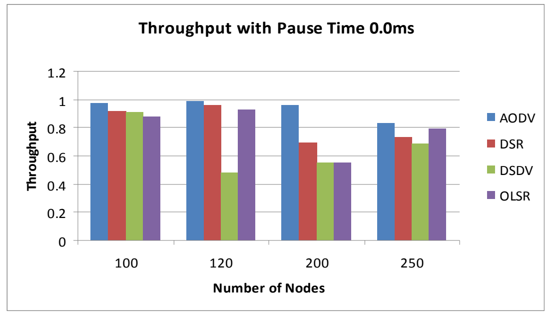

Fig 5: Throughput VS No of Nodes (Pause Time 0.0ms)

Figure 5 shows that the performance of AODV is much better and consistent when the numbers of nodes are increased. It will increase the throughput because it supports large number mobility and there is less amount of packet loss. Throughput remains consistent due to increase in the delay. DSDV performs well when the numbers of nodes are 100 because it supports less number of nodes and limited amount of mobility. When the numbers of nodes are increased to 120 and 200, mobility level also increases which causes delay, then the performance of DSDV affected by dropping large amount of packets. According to fourth scenario when the numbers of nodes are 250, it performs less as compare to 100 nodes due the problem of increasing the overhead. In DSR when number of nodes are 100, 120 the throughput is better because it is efficient in less than 200 nodes because of less amount of mobility. On the other hand, numbers of nodes are above than 200 the throughput decreases due to fast movement of mobile nodes which results as a cause of packet loss and delay but when number of nodes are 250 then it performs well because of more static nodes and less amount of mobile nodes. Performance of OLSR is best with less amount of static and mobile nodes (as 100 and 120 nodes), because less amount of packets are dropped, which will not cause the delay during the route discovery process. In scenario with 200 nodes with the combination of static nodes, the throughput decreases due to dropping of more packets.

6. Conclusion

AODV performs well and remains consistent in Packet Delivery Ratio and Throughput as it supports high level of mobility as well as large number of nodes. It produces latency for route selection having less chance of packet loss, but Routing Overhead increases when numbers of nodes are increased as it uses Hello massages. **DSR** also performs well as Packet Delivery Ratio and Throughput remains stable. Routing overhead of DSR increases when mobility increases, which causes latency that degrades its performance. **DSDV** done well in Packet Delivery Ratio, with limited amount of nodes, whenever the number of nodes is increased packets are going to drop. Due to high level of mobility with large number of mobile and static nodes, the routing overhead would increase and throughput would decrease. **OLSR** is consistent with Packet Delivery Ratio and throughput, but it uses Hello and TC messages that increases the outing overhead. In four scenarios the bandwidth is limited for packet transmission in the network that makes the proactive routing protocols less efficient as compare to reactive ad hoc routing protocols.

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