Simulation and Performance Analysis of Reactive Routing Protocols

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ABSTRACT
An ad-hoc network is a collection of two or more devices equipped with wireless communications and having networking capability. The devices in the network can communicate with another node that is immediately within their radio range or one that is outside their range. The intermediate node is used to relay or forward the packet from the source to the destination. An Ad-hoc Network is a self-organizing and self-configuring wireless network. It is a temporary network established without the aid of stand-alone infrastructure. The topology of an ad-hoc network changes dynamically. The topology changes due to departure or arrival of a node. The nodes in mobile ad-hoc network acts as host as well as routers that routes the packets to the destination node. The mobile ad-hoc network is established for a single session and it does not require router of a base station. In this research two Reactive Routing (On-demand) protocols have been studied and compared with each other on various performance factors. The protocols that have to be examined are Dynamic Source Routing (DSR) and Ad-hoc On Demand Distance Vector (AODV).The main part of the research is the energy consumption by these protocols to transfer the data from the source to destination. Various other factors have also been examined in this paper based on which we come to know which protocol can be used according to our requirements and produces better results.

Keywords
AODV, DSR, Mobile Ad-hoc Network

1. INTRODUCTION
Mobile ad hoc networks (MANETs) are rapidly evolving as an important area of mobile mobility. An ad-hoc network is a group of wireless mobile hosts forming a temporary network with the aid of any standalone infrastructure. MANETs have fewer infrastructures and are wireless in which there is use of number of routers which are free to move arbitrarily and can manage themselves in same manners. The topology used by MANETs is dynamic topology as they have characteristics that network topology changes very rapidly and unpredictably in which many mobile nodes moves to and from a wireless network without any fixed access point where routers and hosts move. It has to support multi-hop path for mobile nodes to communicate with each other and can have multiple hops over the links. The mobile nodes which are within the communication range of each other, then source node during data transfer can send message to the destination node directly otherwise it can send through intermediate node. Mobile ad hoc networks are self-organizing and self- configuring multi-hop wireless networks so the structure of the network changes dynamically [1]. The Node in the network not only acts as a host but also acts as a router that can route data to the other nodes in the network.

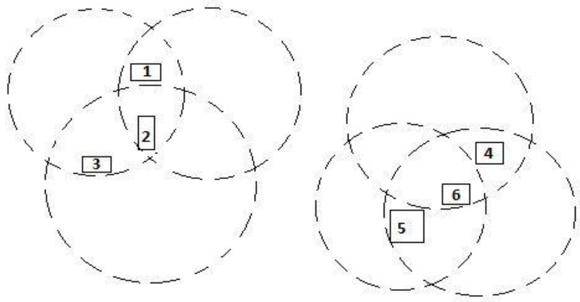

Figure 1: A Simple Mobile ad-hoc network (MANET)

The mobile platforms are free to move arbitrarily which are called as nodes which consists of a router with multiple IP-addressable hosts and multiple wireless communications devices. A node may consist of different devices or Constituted of a group of devices integrated together. The nodes consist of wireless trans-receivers which could be Omni-directional or point to point or the combination of both. The special features of MANET bring this technology great opportunity together with some challenges [2]. All the nodes or devices responsible to organize themselves dynamically the communication between the each other and to provide the necessary network functionality in the absence of fixed infrastructure routing management is needed to be done between all the nodes. One another challenging environment is the multicast in MANET is that a MANET is a self-organizing collection of wireless nodes that form a temporary wireless networks dynamic in nature by a group of mobile nodes on a wireless channel. A session for communication is achieved by single hop if the node is in transmission range of the source node or by relaying in which the data is transferred using various intermediate nodes between source and destination. However the transmission range of low power node is limited and out of range nodes are routed through immediate nodes. The advancement of mobile computing and communication devices is driving a revolutionary change in our information society. Now we can access whatever information we require from anywhere and from any part of the world. The latest technologies and using devices that supports such features of remotely connecting to a network and accessing any kind of information has made wireless networks the easiest solution for their intercommunication. The Mobile users can utilize their cellular phone to check the e-mail, browse internet and travellers with portable computers can access the internet from airports, railway stations and from other public locations where there is facility to connect to the network, tourists can use Global Positioning System (GPS) terminals installed inside the cars and now in mobiles to locate driving maps and tourist attractions. Using this technology people can exchange files and other information by connecting portable computers via wireless LANs during conferences from homes [3]. The users can also synchronize their data and transfer files between portable devices and desktops.

1.1 Ad-hoc Networking Protocols

MANET uses various routing protocols which basically face a lot of challenges because of frequently low transmission power, change in topology, and asymmetric links. The protocols that we are discussing here are the flat routing protocols in which the routing information is distributed to all connecting nodes without the use of any structure between them. The Routing protocols can be classified into two parts: 1. Table Driven 2. Source Initiated (On demand)

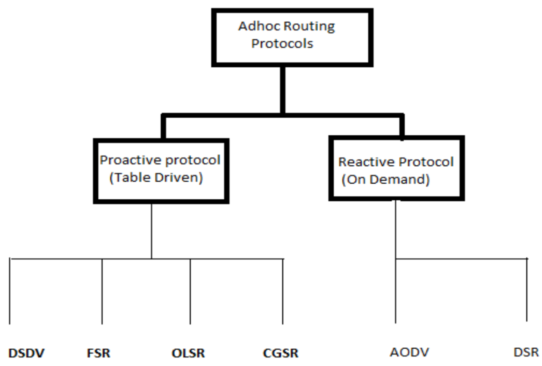

Figure2: Ad-hoc Routing Protocols

1.1.1 Proactive (Table Driven) Routing Protocols

The table driven protocols continuously keep on evaluating the routes to each node in the network so that whenever a data transfer has to be take place the route should be already known and is available quickly [4]. There is no delay in the time spend in the route discovery process. However, the shortest path can be found without any time delay but these protocols are not suitable where there is a lot of traffic i.e. dense ad hoc environment. Various efforts have been made to improve these protocols and to use in ad hoc environment. It maintains the unicast routes between all pair of nodes. It does not consider whether all routes are actually used or not. In link state table driven protocols, every node maintains the view of the topology used by the network and captures the cost of each link and broadcast it to all the other nodes in the network by broadcasting it. In distance vector proactive protocols, each node maintains a routing table that stores the cost of every node in the network, next node to reach the destination and the total no of nodes to reach the destination and this routing information table is send to all neighbors in the network. Proactive routing protocols maintain one or more routing tables for nodes in the network [5]. The routing table is updated periodically or in response to change in the topology of the network. In these types of protocols the source node does not need route-discovery procedures to find a route to a destination node. Proactive protocols continuously evaluates the routes within the network so that when we are required to forward the packet route is already known and immediately ready for use. There is no time delay takes place. Various Table Driven protocols are: DSDV, Fish eye state routing (FSR), Optimized link state routing (OLSR), Cluster gateway switch routing (CGSR) etc.

1.1.2 Reactive (On-Demand) Routing Protocol

These protocols are also called as on demand routing protocols and are more efficient than proactive routing and most of the work is now being done on these protocols to make it better and better. In these protocols a route between a source and destination is formed whenever that route is needed whereas in proactive protocols we were maintaining all routes and sharing it with the other nodes periodically which waste network bandwidth as well as time. The time delay in these types of protocols is more because whenever communication has to occur the route has to be discovered first. Reactive protocols have no network information at nodes if there is no communication. These protocols do not maintain or constantly update their route tables with the latest route topology. If a node wants to send a packet to another node then this protocols searches for the route and establishes the connection in order to transmit and receive the packet [6]. The main approach of routing is to search a route between a source and destination whenever that route is needed. Discovery of route on demand avoids the cost of maintaining routes and controls the traffic of the network. The various on demand protocols are: Dynamic source routing (DSR), ad-hoc on demand distance vector (AODV).

1.2 Difference between Pro-active and Reactive Routing Protocols

Table 1: Difference between Table driven and on demand protocols

Pro-active Routing Protocols	**Reactive Routing Protocols**
In Pro-active routing protocols, routing information is exchanged periodically	In Reactive Protocols there are no periodic information exchange until there is change in the topology
Pro-active protocols attempts to maintain up-to-date routing information from each node to every other node present in the network	In on demand routing protocols a route is built only when required i.e. the route is built only when nodes want to communicate for information exchange
In table driven protocols, the first packet latency is less as compared to on-demand protocols	In on demand protocols, the first packet latency is more as compared to table- driven protocols because a route need to be built first and then communication takes place
A table driven protocols maintains a routing table which contains available routes to every other node in ad-hoc network	In on demand routing protocols the routing table may or may not contain a route to all the other nodes in the network

2. REACTIVE PROTOCOLS

2.1 Ad-hoc On Demand Distance Vector

The Ad hoc On Demand Distance Vector (AODV) routing algorithm is a routing protocol designed for ad hoc mobile wireless networks. AODV is capable of both unicasting and multicasting routing. AODV is an on demand algorithm which means that it creates routes between nodes only when the source node has to transfer the data to other node. These routes are maintained as long as they are required by the sources. AODV also forms trees which are used to connect members of a multicast group. The tree consists of the members of the group and the nodes that are required to connect the members. There is use of sequence numbers in AODV so that freshness of routes can be maintained. In AODV the route is built using a route request / route reply query cycle. Whenever a node requires a route to a destination for which it does not have a route already, it broadcasts a route request (RREQ) packet across the network. The Nodes that receives this packet updates the information for the source node and sets backwards pointers to the source node in the routing tables. RREP is not only consists of broadcast ID, current sequence number, and IP address of source node but also it maintains the most recent sequence number for the destination

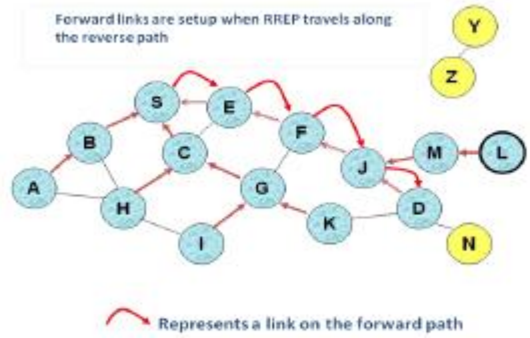

Figure 3: Route setup in AODV

The node that receives the RREQ may send a route reply (RREP) if it is either the destination or if it has a route to the destination with corresponding sequence number greater than or equal to that of RREQ currently existing. It unicasts a RREP back to the source node else it rebroadcasts the RREQ. The Nodes keeps track of the RREQ's source IP address and if they receive a RREQ which they had processed already, they discard it and will not forward that RREQ. As a result of this RREP propagates back to the source and nodes set up forward pointers to the destination node. On receiving the RREP by the source node it begins to forward data packets to the destination. When the source receives a RREP containing a greater sequence number it updates its routing information for that destination and start using better route [7]. AODV only maintains the routes as long as the route remains active.

2.2 Dynamic Source Routing

The Dynamic Source Routing protocol (DSR) is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks. The DSR allows the network to be a self-configuring cum self-organizing without the need for any standalone network infrastructure. DSR is being implemented by different groups, and deployed on several tests. Dynamic Source Routing can operate with nodes using Mobile IP and DSR have seamlessly migrated between cellular data services and WLAN, and DSR mobile ad hoc networks. The DSR protocol uses the two main mechanisms of "Route Discovery" and "Route Maintenance" which works together to allow nodes to discover and maintain routes to destinations in the ad hoc network. The DSR protocol allows more than one routes to any destination and allows each sender to select and control the routes used during routing the packets. The main advantage of DSR protocol is that it easily guarantees loop-free routing. It also has support for use in networks having unidirectional links and very rapid recovery when there is change in routes in the network [8]. The figure below shows a route discovery phenomenon in DSR where source node S and Destination node is D:

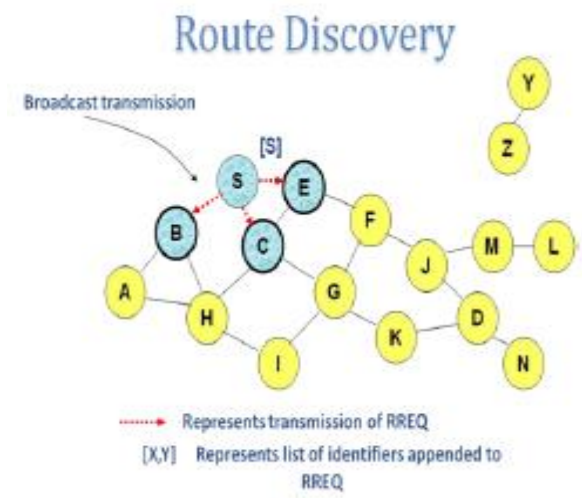

Figure 4: Route Discovery in DSR

After the rout discovery process the RREP is send back by the destination node to the source node containing the path using which the data transfer would take place. The following figure shows the RREP process where destination node D sends the path back to source S .

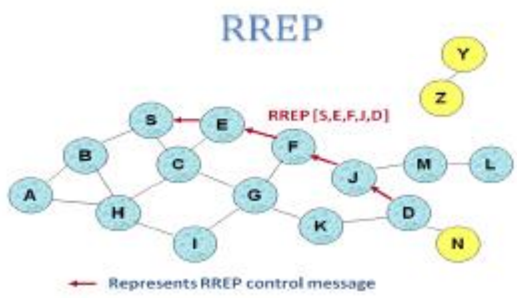

Figure 5: RREP in DSR

The Route is chosen based on the number of hop counts. The path with lesser hop counts is chosen, if two paths are having same number of hop counts than a random path is selected.

3. SIMULATION TOOLS AND METRICS

3.1 Simulation Tool

The simulation tool used for analysis is NS- 2. NS supports for simulation over wired and wireless networks such as TCP, routing, and multicast protocols. NS2 is object oriented simulator and its code is written in C++ and the frontend to be used is OTcl interpreter. The most of the simulation scripts are developed in Tool Command Language (Tcl) [9]. So as to develop components for ns2 both the Tcl and C++ have to be used essentially.

3.2 Performance Metrics

The Performance of AODV and DSR reactive routing protocols will be evaluated on the basis of the following two factors:-

3.2.1 Packet Delivery Fraction

The ratio of the number of data packets from CBR sources successfully delivered to the receiver. The formula for calculating it is:

Packet delivery fraction = (Received packets/Sent packets)*100.

3.2.2 Average End to end delay of data packets

Average end to end delay is the average time from the beginning of a packet transmission at a source node until packet delivery to a destination. This includes delays which are caused by buffering of data packets which incurs during discovery of routes. The Delay occurs due to queuing that occurs at the interface queue. It also includes retransmission delays, propagation times. To calculate delay the sending (S) time (t) and receiving(R) time (T) and then we have to average it. The size of the packet to calculate Packet Delivery Fraction and Average End to End Delay is to be taken of large size but should be kept constant throughout [10]. Using this information the graph is to be plotted between average end to end delivery and the pause time by varying the number of nodes.

3.2.3 Energy Consumption

Energy consumption is a major issue in mobile ad-hoc networks. A critical issue during routing is to conserve as much power as we can so as to achieve high throughput.

3.2.4 Throughput

The throughput of the above stated protocols has to be measured. Throughput is the measure of the total packets successfully delivered to the destination.

4. RESULTS

1. The Following figure shows that the packet delivery fraction of AODV is better than the DSR. With the analysis results it is now proved that AODV can be used where the data is to be transferred at constant bit rate as the AODV successfully able to transfer more packets generated by CBR sources to the destination.

Figure 6: Packet Delivery Fraction

2. The Graph below shows that the end to end delay in the case of DSR is more and is much less in the AODV. As both these protocols are on demand protocols so before starting the communication a path has to be built so that delay in forming a path is the end to end delay and AODV has lower end to end delay than DSR.

Figure7: Average End to End Delay

3. The Graph below shows the total energy consumption of AODV and DSR protocols. The results show that DSR consumes more energy than AODV. So where there are more constraints based on energy AODV can be used. The energy is the main issue in a wireless so AODV uses less energy than DSR and hence widely preferred.

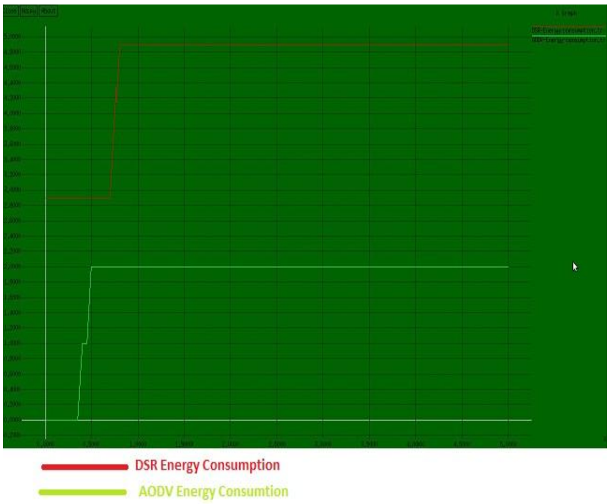

Figure 8: Energy Consumption

4. The following graph shows the average throughput of AODV and DSR. Based on the results the AODV has more throughput than DSR. Throughput is the measure of ratio of the total packet successfully delivered to the total packet sent. So the results show that the AODV suffer less packet losses and has shown higher throughput than DSR but in smaller networks where the mobility is less DSR also has equivalent throughput to AODV.

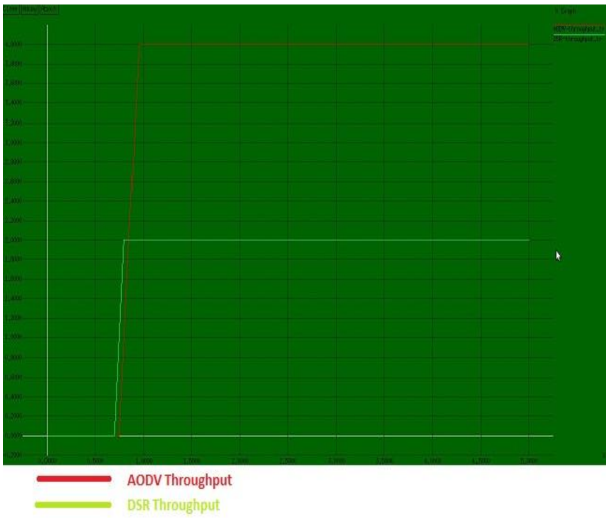

Figure 9: Average Throughput

5. CONCLUSION & FUTURE SCOPE

The comparison analysis of the AODV and DSR on demand routing protocols had produced the outcome that AODV performs better than DSR. With the larger number of nodes the efficiency of the DSR becomes less but AODV performs better than DSR in these conditions. AODV has better Packet delivery fraction than DSR so therefore AODV is better for data transfer at CBR. The end to end delay is also less in AODV makes it better than DSR. The energy is still a big issue in these protocols. The analysis has shown that AODV is more energy efficient than DSR and its energy efficiency can be improved further using techniques like load balancing. The throughput of AODV is also better than DSR but DSR still performs better where there is less mobility. The changes in applications occur time to time with the development of new technologies. The applications can be enhanced by adding some new features. Some of the features that can be included in order to this work are:

1. The packet size could be increased so that the packet has to be segmented before sending and defragmented at the receiver and then the performance of the AODV and DSR should be measured.

2. The application can also be enhanced by increasing the number of nodes and then measuring the throughput and packet delivery fraction.

3. Advancements in physical and link layer technologies are required to enable MANETs to transfer larger volumes of traffic, and to enable low latency services over longer distances.

4. Developing a distributed and bandwidth- efficient security architecture that can interoperate with the emerging infrastructure is also a necessary utilization of this technology.

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