Performance Evalution For Routing Protocols In Mobile Adhoc Networks(Manets) By Using Network Simulator 2 (NS Version 2)

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ABSTRACT

Mobile ad-hoc network (MANET) is one of the most promising fields for research and development of wireless network [1]. As the popularity of mobile device and wireless networks significantly increased over the past years, wireless ad-hoc networks has now become one of the most vibrant and active field of communication and networks. Due to severe challenges, the special features of MANET bring this technology great opportunistic together. We have used NS2 (Network Simulator version2) Simulator from Scalable Networks to perform the simulations. The scope of this project was to test routing performance of three different routing protocols Ad-Hoc On-Demand Distance Vector (AODV), and Cluster Based Routing Protocol (CBRP).

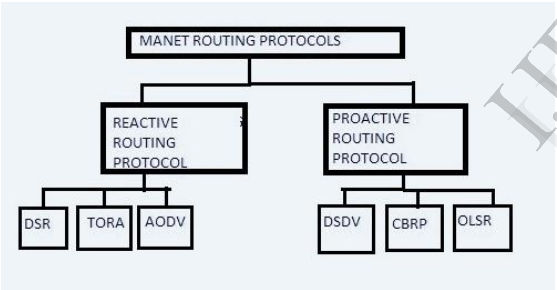

Figure1: Classification of MANET Routing protocols.

In this paper we are presenting their Overview, Characteristics, Functionality, Benefits and Limitations and makes their Comparative analysis, so to analysis their performance. The objective is to make observations about how the performance of these protocols can be improved and finally presents the results.

Keywords: MANET, Routing Protocols, Network Simulator 2, Metrics.

1. INTRODUCTION

Mobile Ad Hoc Networks (MANETs) has become one of the most prevalent areas of research in the recent years because of the challenges it pose to the related protocols. MANET is the new emerging technology which enables users to communicate without any physical infrastructure regardless of their geographical location, that's why it is sometimes referred to as a ―infrastructure less network. The proliferation of cheaper, small and more powerful devices make MANET a fastest growing network. An ad-hoc network is self-organizing and adaptive. Device in mobile ad hoc network should be able to detect the presence of other devices and perform necessary set up to facilitate communication and sharing of data and service [1]. Ad hoc networking allows the devices to maintain connections to the network as well as easily adding and removing devices to and from the network. Due to nodal mobility, the network topology may change rapidly and unpredictably over time. The network is decentralized, where network organization and message delivery must be executed by the nodes themselves. Message routing is a problem in a decentralize environment where the topology fluctuates. While the shortest path from a source to a destination based on a given cost function in a static network is usually the optimal route, this concept is difficult to extend in MANET. The set of applications for MANETs is diverse, ranging from large-scale, mobile, highly dynamic networks, to small, static networks that are constrained by power sources. Besides the legacy applications that move from traditional infrastructure environment into the ad hoc context, a great deal of new services can and will be generated for the new environment. MANET is more vulnerable than wired network due to mobile nodes, threats from compromised nodes inside the network, limited physical security, dynamic topology, scalability and lack of centralized management. Because of these vulnerabilities, MANET is more prone to malicious attacks [1].

2. APPLICATIONS OF MANETs

Ad-hoc networking can be applied anywhere where there is little or no communication infrastructure or the existing infrastructure is expensive or inconvenient to use [1]. Ad hoc networking allows the devices to maintain connections to the network as well as easily adding and removing devices to and from the network. The set of applications for MANET is diverse, ranging from large-scale, mobile, highly dynamic networks, to small, static networks that are constrained by power sources. Besides the legacy applications that move from traditional infra structured environment into the ad hoc context, a great deal of new services can and will be generated for the new environment. Typical applications include [1]

- **Military Battlefield**: Military equipment now routinely contains some sort of computer equipment. Ad- hoc networking would allow the military to take advantage of commonplace network technology to maintain an information network between the soldiers, vehicles, and military information headquarters. The basic techniques of ad hoc network came from this field.
- **Network extension:** In this application area, the networking infrastructure exists, but it has insufficient coverage. The goal of the participants of the network is *internet access*, that is, their main communication partners are outside the ad hoc network. The goal of the ad hoc network is to extend the internet connectivity beyond the reach of the access points. Most routes of the ad hoc network will connect the access points to the nodes.
- **Commercial Sector**: Ad hoc can be used in emergency/rescue operations for disaster relief efforts, e.g. in fire, flood, or earthquake. Emergency rescue operations must take place where non-existing or damaged communications infrastructure and rapid deployment of a communication network is needed. Information is relayed from one rescue team member to another over a small hand held. Other commercial scenarios include e.g. ship-to-ship ad hoc mobile communication, law enforcement, etc.

3. ROUTINGPROTOCOLS

"Routing is the process of information exchange from one host to the other host in a network." Routing is the mechanism of forwarding packet towards its destination using most efficient path [2]. Efficiency of the path is measured in various metrics like, Number of hops, traffic, security, etc. In Ad-hoc network each host node acts as specialized router itself [2]. It is the act of moving information from a source to a destination in an inter network. At least one intermediate node within the internetwork is encountered during the transfer of information [3].

4. CLASSIFICATION OF ROUTING PROTOCOLS

Classification of routing protocols in mobile ad hoc network can be done in many ways, but most of these are done depending on routing strategy and network structure [3] [4] [5]. The routing protocols can be categorized as flat routing, hierarchical routing and geographic position assisted routing while depending on the network structure [6].

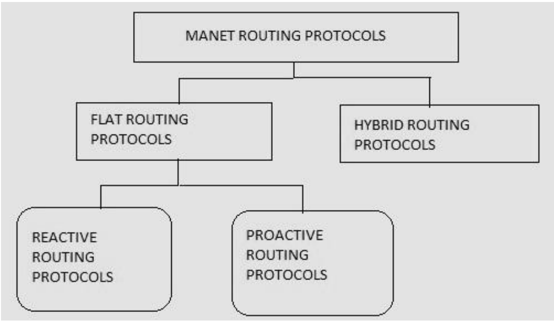

Figure2: Classification of Routing Protocols in Mobile Ad-hoc Networks

4.1 FLAT ROUTING PROTOCOLS

Flat routing protocols are divided mainly into two classes [4]; the first one is proactive routing (table driven) protocols and other is reactive (on-demand) routing protocols. One thing is general for both protocol classes is that every node participating in routing play an equal role. They have further been classified after their design principles; proactive routing is mostly based on LS (link-state) while on-demand routing is based on DV (distance-vector).

4.1.1 PROACTIVE ROUTING PROTOCOLS

These types of protocols are also called as "Table driven routing protocols" [7]. This Maintains fresh lists of destinations and their routes by periodically distributing routing tables throughout the network. The main disadvantages of such algorithms are:

- Respective amount of data for maintenance.
- Slow reaction on restructuring and failures.

4.1.2 REACTIVE ROUTING PROTOCOLS

These types of protocols are also called as "On-demand routing protocols" [7]. This finds a route on demand by flooding the network with Route Request packets. The main disadvantages of such algorithms are:

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- High latency time in route finding.
- Excessive flooding can lead to network clogging.

5. Ad-Hoc On-demand Distance Vector Routing (AODV)

The Ad Hoc On-Demand Distance Vector routing protocol (AODV) is an improvement of the Destination-Sequenced Distance Vector routing protocol (DSDV). DSDV has its efficiency in creating smaller ad-hoc networks. Since it requires periodic advertisement and global dissemination of connectivity information for correct operation, it leads to frequent system-wide broadcasts [8]. Therefore the size of DSDV ad-hoc networks is strongly limited. When using DSDV, every mobile node also needs to maintain a complete list of routes for each destination within the mobile network. The advantage of AODV is that it tries to minimize the number of required broadcasts. It creates the routes on a on-demand basis, as opposed to maintain a complete list of routes for each destination. Therefore, the authors of AODV classify it as a **pure on-demand route acquisitionsystem.**

5.1 PATH DISCOVERY PROCESS

AODV routing protocol uses a broadcast route discovery mechanism and it depends on dynamically established route [8]. AODV builds routes by using a route request (RREQ)/ route reply (RREP) query cycle. When a source node requires a destination route for which it does not have a route already, it broadcasts RREQ packet across the network [9], [10]. The nodes receiving this packet update the information for the source node and sets up backward pointer information for the source node in the routing table.

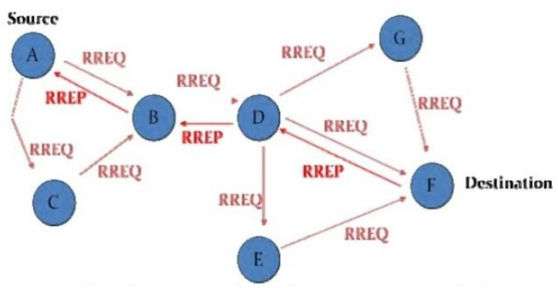

Figure3: Route Discovery Process of AODV Routing Protocol [11]

RREQ contains source node Internet Protocol (IP) address, destination's IP address, Broadcast ID [9], [10], [12]. The source node broadcasts RREQ packets to its neighbour's for initiating path discovery. After receiving RREQ, it sends RREP packet back to the destination, otherwise it again broadcasts RREQ packet further to its neighbour's. It automatically sets up the reverse path from all nodes back from source to destination. As RREP is propagated back to the source, nodes sets up forward pointer to the destination [10]. For desired destination, a single route table entry (i.e. address of destination, next hop along the path, the number of hops to the destination) is maintained by a node. A node chooses fresh node out of two different routes. If both routesare discovered at the same time, then the route with fewer hops is preferred. The nodes generate and forward route error messages to their neighbour's that have been using routes that include the broken link. After receiving the route error messages, route discovery is initiated by a node to replace the failed paths [9], [13].

6. Cluster-Based Routing Protocol (CBRP)

The cluster-based routing protocol (further on referred to as CBRP) was introduced by Jiang et al in 1999.CBRP is a routing protocol designed for use in mobile ad hoc networks. The protocol divides the nodes of the ad hoc network into a number of overlapping or disjoint two-hop-diameter clusters in a distributed manner. A clusterhead is elected for each cluster to maintain cluster membership information. Intercluster routes are discovered dynamically using the cluster membership information kept at each clusterhead. By clustering nodes into groups, the protocol efficiently minimizes the flooding traffic during route discovery and speeds up this process as well. Furthermore, the protocol takes into consideration the existence of unidirectional links and uses these links for both Intercluster and Intercluster routing. The two major new features that have been added to the protocol are route shortening and local repair. Both features make use of the two-hop-topology information maintained by each node through the broadcasting of Hello messages. The routeshortening mechanism dynamically shortens the source route of the data packet being forwarded and informs the source about the better route. Local route repair patches a broken source route automatically and avoids route rediscovery by the source. There are several major difficulties for designing a routing protocol for a MANET. Firstly and most importantly, a MANET has a dynamically changing topology due to the movement of mobile nodes, which favors routing protocols that dynamically discover routes over conventional distance-vector routing protocols. Secondly, the fact that a MANET lacks any structure makes IP sub netting inefficient. However, routing protocols that are flat (i.e., have no hierarchy) might suffer from excessive overhead when scaled up. Third, links in mobile networks could be asymmetric at times. If a routing protocol relies only on bidirectional links, the size and connectivity of the network may be severely limited; in other words, a protocol that makes use of unidirectional links can significantly reduce network partitions and improve routing performance [14].

CBRP has the following features:

- Fully distributed operation.
- Less flooding traffic during the dynamic route discovery process.
- Explicit exploitation of unidirectional links that would otherwise be unused.
- Broken routes could be repaired locally without rediscovery.
- Suboptimal routes could be shortened as they are used.

In these protocols, clusters are introduced to minimize updating overhead during topology change. However, the overhead for maintaining up-to-date information about the whole network's cluster membership and Intercluster routing information at each and every node to route a packet is considerable. As network topology changes from time to time due to node movement, the effort to maintain such up-to- date information is expensive and rarely justified as such global cluster membership information is obsolete long before it is used. In comparison, simpler and smaller clusters are used; however, the use of theseclusters is mainly for the task of channel assignment

6.1 ROUTE DISCOVERY

Route discovery is done by using source routing. In the CBRP only cluster headsare flooded with route request package (RREQ). Gateway nodes receive theRREQs as well, but without broadcasting them. They forward them to the nextclusterhead [15]. This strategy reduces the network traffic.Initially, node S broadcasts a RREQ with unique ID containing the destination'saddress, the neighbouringclusterhead(s)—including the gateway nodes

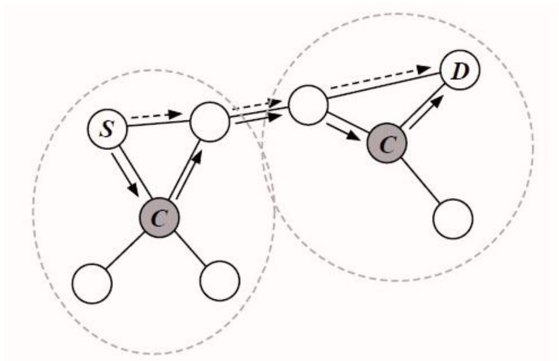

Figure4:Theloose source route (non-dashed arrows) and the strict source route(dashed arrows) from S to D.

If the RREQ reaches the destination node D it contains the loose source route[S,C1,C2, . . . ,Ck,D] (figure 3). D sends a route reply message (RREP) back to Susing the reversed loose source route [D,Ck, . . . ,C1, S]. Every time a clusterheadreceives this RREP it computes a strict source route, which then consists only ofnodes that form the shortest path within each cluster.

6.2ROUTING and ROUTE IMPROVEMENT

Due to node movement, (dis-)appearance of nodes or failures, the CBRP includestwo mechanisms to improve a route: The first is Local Repair and thesecond is Route Shortening [15].

Local Repair

If a connection between two nodes fails, the CBRP is able to repair the route.Therefore one of the following nodes of the route has to be in the two-hoptopology database of the node that discovered the broken link (figure5). If thenode is unable to repair the route, the route has to be recalculated.

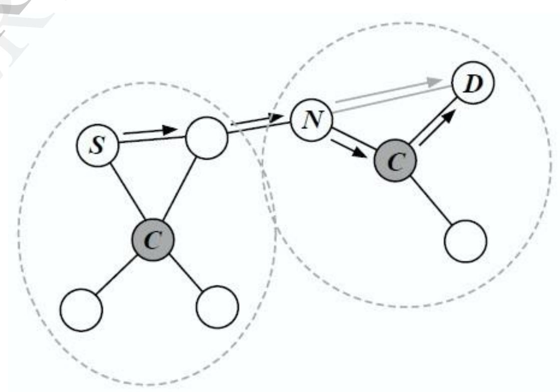

Figure5:The broken route between N and D (gray arrow) was repaired by using the clusterhead.

Route Shortening

Sometimes a node may discover a connection between itself and another succeedingnode of the route that is not its direct successor or a connection betweentwo following nodes, respectively [15]. This can be done by examining the informationstored in the two-hop topology database. If so, it shortens the route byexcluding the redundant node(s) from the route (figure 6).

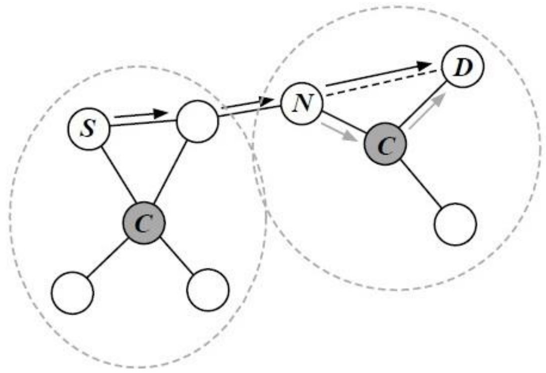

Figure6: Node N discovered a new connection between itself and D (dashed line)and shortened the route.

7. SIMULATION ENVIRONMENT

Network Simulators

According to dictionary, Simulation can be defined as ―reproduction of essential features of something as an aid to study or training. In simulation, we can construct a mathematical model to reproduce the characteristics of a phenomenon, system, or processoften using a computer in order to information or solve problems. Nowadays, there aremany network simulators that can simulate the MANET [15]. In this section we will introducethe most commonly used simulators. We will compare their advantages anddisadvantages and choose one to as platform to implement reactive/proactive protocoland conduct simulations in this project.

PERFORMANCE METRICS

We use the following metrics to evaluate the network performance. Note that these metrics differ from those used by others. Because our main concern is energy efficiency, energy level is given a higher weight than connectivity.

- **Packet delivery ratio:** The data packet delivery ratio is the ratio of the number of packets generated at the sources to the number of packets received by the destinations.

  PDR= No.Of received packets/No.Of sent packets

- **Average End-to-end delay:** This metric includes not only the delays of data propagation and transfer, but also all possible delays caused by buffering, queuing, and retransmittingdatapackets.

  AED= ∑ (Received time – sent time)/Total data packets received

- **General Throughput:** To calculate the average throughput of the Application traffic between source node and destination node.

  General Throughput = Total Received Bytes / Elapsed Time

  Once destination node receives a packet, print out the real-time throughput.

- **Bandwidth:** Bandwidth describes the maximum transfer rate of a network. It measures how much data can be sent over a specific connection in a given amount of time.

PARAMETER VALUES

PARAMETER	VALUE
Number of Nodes	40& 50
Environment Size	800x800
Traffic Size	CBR (constant Bit Rate)
Packet Size	1500 bytes
Maximum Speed	20m/s
Queue Length	5000
Simulator	Ns-2.34
Mobility Pattern	Random Waypoint
MAC Layer	IEEE 802.11
Simulation Time	10 sec
Bandwidth	11 Mbps
Routing Protocols	AODV & CBRP

8. RESULTS and DISCUSSIONS

In this paper we analyzed that the performance of the routing protocols between CBRP and AODV based on the performance metrics general throughput, The simulation result shows the AODV routing protocol producing the effective results than CBRP.Our simulation results graphs also have shown the performance of the various routing protocols.

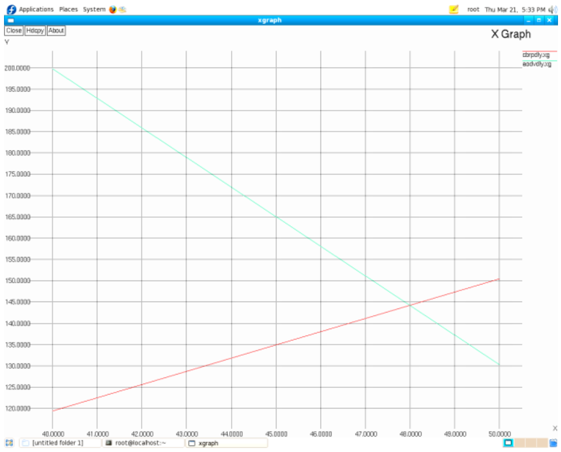

Fig 8.1: Comparison of DELAY in AODV and CBRP

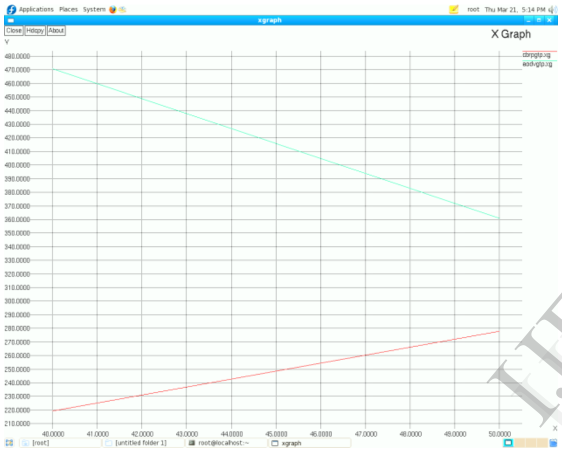

Fig 8.2: Comparison of THROUGHPUT in AODV and CBRP

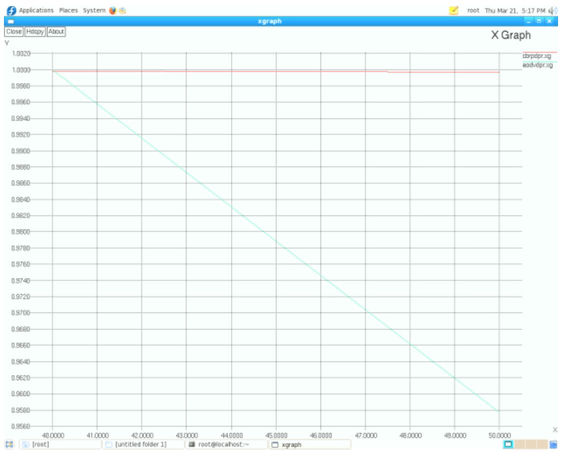

Fig 8.3: Comparison of PACKET DELIVERY RATIO in AODV and CBRP

As per our simulation results we observed AODV routing protocol produces the effective results for maximum number of nodes. For general throughput the protocol which produces the best is AODV.

Some of the graphs are shown above is used to analyze the performance of various routing protocols AODV, CBRP

9. CONCLUSION

We have compared two routing protocols namely, AODV and CBRP from Reactive and Proactive Routing Protocols. The simulationof these protocols has been carried out using NS-2 Simulator.

Three different simulation network parameters are performed to calculate the performance of these routing protocols.So, we can conclude that if the MANET has to be setup for a small amount of time thenAODV should be prefer due to low initial packet loss and CBRP should not be prefer tosetup a MANET for a small amount of time because initially there is packet loss is veryhigh. If we have to use the MANET for a longer duration then both the protocols can beused, because after sometimes both the protocols have same ratio of packet delivering.

The two protocols Ad hoc On-Demand Distance Vector Routing (AODV) and Cluster Based Routing Protocol (CBRP) have been compared using simulation, it would be interesting tonote the behavior of these protocols on a real life test bed.
In this work other network parameters such as Throughput, Delay and Packet Delivery Ratio. Whereas the bandwidth kept constant in the threedifferent simulation scenarios. It would be interesting to observe the behavior of thesetwo protocols by varying these network parameters.

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