Transmission Rate of non-cooperative routing in Ad hoc Network

[1]K.Vanisree and [2]V.S.K.Reddy

[1]*Asso.Professor,Department of ECE*
Krishna muthy institute of engineering and technology, Hyderabad, Andhra Pradesh, India
e-mail : vaishnav_56@yahoo.co.in
[2]*Principal, Malla Reddy College of Engineering &Technology, Hyderabad, Andhra Pradesh, India*
e-mail: vskreddy2003@gmail.com

Abstract **- This paper analyzes routing in lossy networks under the assumption of non-cooperative aspect of existing routing protocols. We study the three existing non-cooperative routing protocols namely AODV, DSDV, and DSR under different topologies and under different communication traffic pattern to analyze its performance under each of the scenario and traffic. We also analyze them based on various number communications i.e. number of flows. We try to find among the non-cooperative protocols which one performs better under given scenario and traffic.**

KeyWords **- Non-cooperative transmission, energy efficiency, routing protocol, Packet delivery ratio, end-to-end delay Packet drop, energy consumption, flow., tranismission rate**

I. INTRODUCTION

A mobile ad hoc network (MANET), sometimes called a mobile mesh network, is a self-configuring 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. Such networks may operate by themselves or may be connected to the larger Internet. The primary challenge in building a MANET is equipping each device to continuously maintain the information required to properly route traffic and have enough energy to keep it alive.

From the energy point of view, nodes spend most of their energy in transmitting data, but in many applications these nodes are small and have limited energy supply such as in wireless sensor networks. Much work has been done in this area to reduce the total required transmit power going from a source node to a destination node by choosing a transmission scheme that requires the minimum amount of transmit power.

In large scale networks, the control decision are often has to be taken at the each end user or node in accordance with the requirement and performance metrics. Such networks are called as non-cooperative networks. Non-cooperative routing has been under study for a long time under the concept of traffic and telecommunications networks.

In this paper, the performance of three existing non-cooperative protocols are studied, namely AODV, DSDV and DSR under different topologies and traffic scenarios to see which of them performs better in a given scenario. The paper gives detailed about the scenarios and traffic pattern taken for the comparison study and also gives the results in detail for better understanding of these three protocols.

The paper is organized as follows. Section-II discusses the related work done in this field and gives a brief but yet an elaborate description of three non-cooperative protocols under study. In section-III, the system model is given and in the next section (IV), we give the performance metrics taken up for this study. In section V the simulation results and discussions are given. In section-VI the conclusion is presented followed by the future work in section VII.

II. RELATED WORK

There has been quite a few no. of studies done based on these three protocols. In paper [1] a study on AODV protocol of two flavours namely AODV-UU and AODV-UCSB under different load and packet sizes. In paper [6] the on-demand routing protocols namely AODV and DSR have been compared under varying load, mobility, network size and connectivity. In that paper, it is shown that under high pause time DSR performs better and under high mobility AODV performs better. It is also shown that the overhead routing is higher in case of AODV compared to DSR. In paper [7], the authors have studied the three protocols under grid environment and concluded that AODV is the better one in the given scenario of mobility pattern model with varying degree of pause time. In the following chapters a brief yet elaborate description about the non-cooperative protocols taken up for the study purpose is given.

A. Ad hoc On-demand Distance Vector (AODV):

The routing protocol is an on-demand routing protocol designed for mobile ad hoc networks. AODV is capable of both unicast and multicast routing. It is an

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on demand algorithm, means that it builds routes between nodes only as desired by source nodes. It maintains these routes as long as they are needed by the sources. Additionally, AODV forms trees which connect multicast group members. The trees are composed of the group members and the nodes needed to connect the members. AODV uses sequence numbers to ensure the freshness of routes. It is loop-free, self-starting, and scales to large numbers of mobile nodes. It is used to pass messages from one computer or node to another one to which it cannot directly communicate. It does this by passing the message along its neighbors to reach the receiver. This route is formed by discovering the routes through which data can be passed. It also makes sure there is no loop in the identified route and it also tries to find the shortest path route between the source and the receiver. It can also handle changes in nodes link, route links and can create new routes if it finds an error in the existing route.

AODV builds routes using a route request / route reply query cycle. When a source node desires a route to a destination for which it does not already have a route, it broadcasts a route request (RREQ) packet across the network. Nodes receiving this packet update their information for the source node and set up backwards pointers to the source node in the route tables. In addition to the source node's IP address, current sequence number, and broadcast ID, the RREQ also contains the most recent sequence number for the destination of which the source node is aware. A node receiving 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 contained in the RREQ. If this is the case, it unicasts a RREP back to the source. Otherwise, it rebroadcasts the RREQ. Nodes keep track of the RREQ's source IP address and broadcast ID. If they receive a RREQ which they have already processed, they discard the RREQ and do not forward it.

As the RREP propagates back to the source, nodes set up forward pointers to the destination. Once the source node receives the RREP, it may begin to forward data packets to the destination. If the source later receives a RREP containing a greater sequence number or contains the same sequence number with a smaller hop count, it may update its routing information for that destination and begin using the better route.

As long as the route remains active, it will continue to be maintained. A route is considered active as long as there are data packets periodically traveling from the source to the destination along that path. Once the source stops sending data packets, the links will time out and eventually be deleted from the intermediate node routing tables. If a link break occurs while the route is active, the node upstream of the break propagates a route error (RERR) message to the source node to inform it of the now unreachable destination(s). After receiving the RERR, if the source node still desires the route, it can reinitiate route discovery.

The following figure illustrates the reverse path and forward path formation that takes place during RREQ and RREP phases.

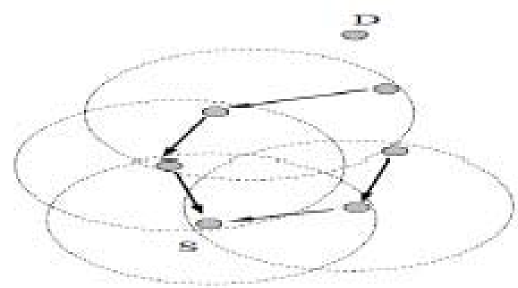

FIG 1: Reverse path information using RREQ

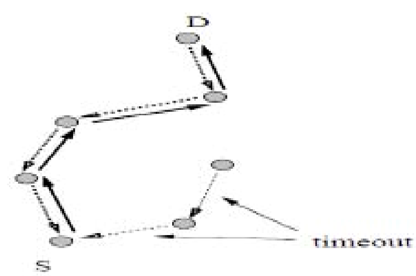

FIG 2 : Forward path information during RREP.

B. Dynamic Source Routing protocol (DSR)

Dynamic Source Routing (DSR) is a routing protocol for wireless mesh networks. It is similar to AODV in that it forms a route on-demand when a transmitting computer requests one. However, it uses source routing instead of relying on the routing table at each intermediate device. It is a simple on demand routing protocol designed for use in multi-hop wireless ad hoc networks. DSR allows the network to be completely self-organizing and self-configuring, without the need for any existing network infrastructure or administration. The main difference between AODV and DSR is that while in the former, the route to the destination is maintained at each node; in the latter it is the source which maintains the route to the destination. It is a reactive protocol.

Determining source routes requires accumulating the address of each device between the source and destination during route discovery. The accumulated path information is cached by nodes processing the route discovery packets. The learned paths are used to route packets. To accomplish source routing, the routed packets contain the address of each device the packet will traverse. This may result in high overhead for long paths or large addresses, like IPv6. To avoid using source routing, DSR optionally defines a flow id option that allows packets to be forwarded on a hop-by-hop basis.

This protocol is truly based on source routing whereby all the routing information is maintained (continually updated) at mobile nodes. It has only two major phases, which are Route Discovery and Route Maintenance. Route Reply would only be generated if the message has reached the intended destination node (route record which is initially contained in Route Request would be inserted into the Route Reply).

To return the Route Reply, the destination node must have a route to the source node. If the route is in the Destination Node's route cache, the route would be used. Otherwise, the node will reverse the route based on the route record in the Route Reply message header (this requires that all links are symmetric). In the event of fatal transmission, the Route Maintenance Phase is initiated whereby the Route Error packets are generated at a node. The erroneous hop will be removed from the node's route cache; all routes containing the hop are truncated at that point. Again, the Route Discovery Phase is initiated to determine the most viable route.

DSR protocol consists of two mechanism that allow it discover and maintain a route at the source.

1. Route Discovery: The mechanism by which a node **S** wishing to send a packet to a destination node **D** obtains a source route to **D**. Route Discovery is used only when **S** attempts to send a packet to **D** and does not already know a route to **D**.

When a source node wants to send a packet to a destination node, it first checks its route cache to see whether it has a route to the destination. If not, it will start building one by sending out the route request packet which is broadcast. All the forwarding nodes, will add their id in the source route tree and broadcast the packet. When the receiver gets the route request packet either using existing route the source or the one read from the route request packet will be used to forward the route reply message back to the sender.

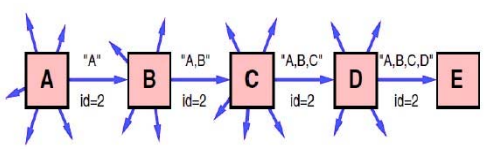

FIG 3. Route discovery phase

2. Route Maintenance: The mechanism by which node **S** is able to detect, while using a source route to **D**, if the network topology has changed such that it can no longer use its route to **D** because a link along the route no longer works. When Route Maintenance indicates a source route is broken, **S** can attempt to use any other route it happens to know to **D**, or can invoke Route Discovery again to find a new route. Route Maintenance is used only when **S** is actually sending packets to **D**.

When originating or forwarding a packet using a source route, each node transmitting the packet is responsible for confirming that the packet has been received by the next hop along the source route; the packet is retransmitted (up to a maximum number of attempts) until this confirmation of receipt is received. This is achieved by overhearing the packet being transmitted by the forwarded node. If it fails to over hear the packet, then it sends a route error message to the original sender telling where it failed to forward the packet.

C. Destination Sequenced Distance Vector (DSDV)

Destination Sequenced Distance Vector (DSDV), also known as Distributed Bellman-Ford or RIP (Routing Information Protocol) is a proactive protocol, where each node maintains a table in which route every other nodes are maintained. It is a table driven protocol.

In this protocol each node maintains a view of the network topology with a cost for each link. Each node periodically broadcasts link costs to its outgoing links to all other nodes such as flooding. The table is periodically sent to all its neighbors to maintain topology.

The routing table consists of following entries.

- all available destinations
- the next node to reach to destination
- the number of hops to reach the destination.

Some of the problems that may arise in this protocol are

- All routing decisions are taken in a completely distributed fashion.
- Each node uses its local information for routing messages. However, the local information may be old and invalid.
- Local information may not be updated promptly.

This gives rise to loops. A message may loop around a cycle for a long time

III. SYSTEM MODEL

A. Methodology

The framework and skeleton overview for the performance evaluation of the chosen protocols is given. The techniques used are modeling the network,

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simulating the network and measuring the performance of the protocols.

Performance is the key criteria in all aspect of activity to measure the effectiveness of the system. We need to know the techniques to evaluate the performance of the given system and to know the best performer for the given price. The three techniques used are modeling, simulation and measurement.

Simulation is the simplest and best form compared to analytical modeling as it requires fewer assumptions and can have more details. Computer based simulation tool is best suitable as it is cost effective and consumes less time, also at the same time can deliver at a better speed and accuracy.

There are number of network simulator tool available for the project like OPNET, Glomosim, Qualnet and network simulator (NS-2) etc. Here we have chosen NS-2 as the computer network simulator.

B. Advantages of NS-2

NS2 is an open-source simulation tool that runs on Linux. It is a discreet event simulator targeted at networking research and provides substantial support for simulation of routing, multicast protocols and IP protocols, such as UDP, TCP, RTP and SRM over wired and wireless (local and satellite) networks. It has many advantages that make it a useful tool, such as support for multiple protocols and the capability of graphically detailing network traffic. Additionally, NS2 supports several algorithms in routing and queuing. LAN routing and broadcasts are part of routing algorithms. Queuing algorithms include fair queuing, deficit round-robin and FIFO.

C. Simulation Model

The nodes initial placement and movement pattern are given in a scenario file which the NS-2 accepts as one of the input parameters. The communication between randomly chosen source and destination nodes is also given as in a traffic file, which the NS-2 accepts as its second input parameters.

TABLE 1. THE BASIC ARCHITECTURE OF NS-2 SIMULATION MODEL

Channel	Channel/WirelessChannel
Propagation	Propagation/TwoRayGround
Network interface	Phy/WirelessPhy
MAC	Mac/802_11
Interface queue	Queue/DropTail/PriQueue
Link layer	LL
Antenna	Antenna/OmniAntenna
Interface queue length	500
No. of nodes	25,50,75,100
Protocols	AODV, DSDV, DSR
Simulation area size	1000 x 100 M
Simulation duration	100 secs
Type of communication	UDP/CBR
Packet size	200 bytes
Packet interval	4 pkts per second
# of communication	5

The output generated by the NS-2 simulator consists of a trace file, named *.tr, where each layer agent like UDP, AODV record their activities like sending a packet, receiving a packet etc.

The second output generated by NS-2 is a animation file, named *.nam, which when animated using NAM animator tool, will show what happens during the entire simulation period.

IV -PERFORMANCE ANALYSIS

The performance metrics taken into account are

1. Packet delivery ratio %
2. end-to-end delay
3. Packet drop %
4. energy consumption
5. throughput

A. Packet delivery ratio %

The packet delivery ratio (PDR) is defined as the ratio between no. of packets received by the receiver to the no. of packets sent by the corresponding sender.

B. End-to-end delay – average

The average end-to-end delay is defined as the time taken by the packet to reach the receiver from the sender. The packet sent by the source will get delayed due to no. of reasons like being buffered at intermediate nodes, delays caused at MAC layer due to channel availability etc. The average delay is calculated by summing all the individual packet delays and dividing them by the total no. of packets received.

C. Packet Drop %

The Packet drop ratio is defined as the ratio between no. of packets dropped by the nodes to the total no. of packets generated by the respective senders.

D. Energy Consumption

Every mobile node will consume energy for sending a packet, receiving a packet. This study concentrates on the total energy consumed by the mobile node during the simulation period.

V- RESULTS

Fig 4 shows the energy expended overall by each protocol. As AODV and DSR go for constructing routes on-demand they will experience more energy loss compared to DSDV where table is constructed once and updated as and when there is change in the neighborhood topology. As the no. of nodes are increased, all three protocols spend more or less same amount of energy as shown for 100 nodes in the graph.

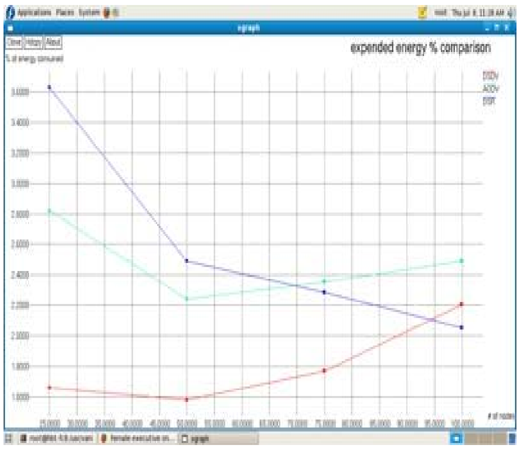

FIG 4. Energy comparison (Nodes Vs. Energy)

Fig 5 shows end-to-end delay for various no. of mobile nodes. As can be seen from the graph, when the no. of nodes is less it takes more time to reach the destination, whereas if the network has enough no. of nodes, the average end-to-end delay has come down.

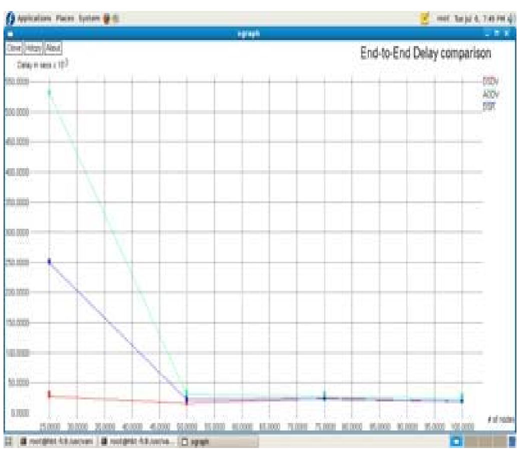

FIG 5. END –TO-END DELAY COMPARISON (Nodes Vs. Delay)

Fig 6 shows the drop % of three protocols. As AODV and DSR are of on-demand routing protocols, they tend to maintain the routes in a valid state always compared to DSDV which is table driven protocol (i.e proactive protocol). So it drops more packets compared to other two, as some of its table entries may not be correct.

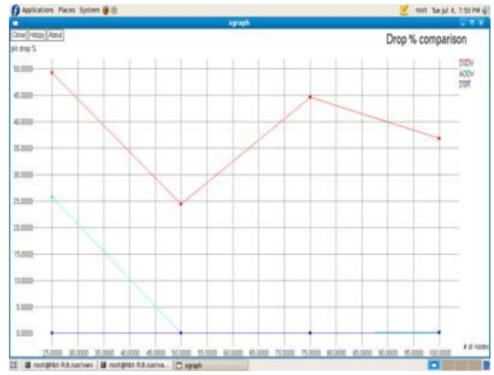

FIG 6. Drop % Comparison (Nodes Vs. Drop)z

Fig 7 shows the packet delivery ratio % of the protocols under study. As expected the DSDV performs poor because of table driven routing architecture compared to other two protocols.

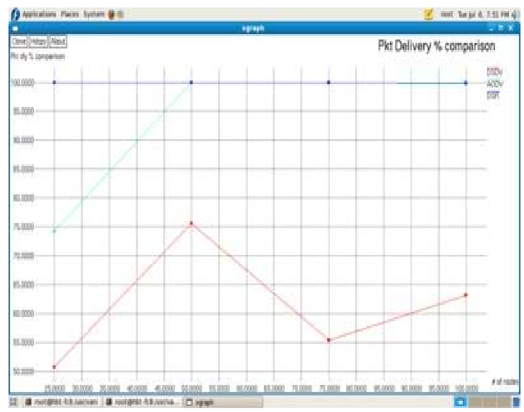

FIG 7. Packet Delivery % Comparison Nodes Vs. pkt. Delivery)

Fig 8 shows The Throughput ie information received when the no of flows is high the information received is maximum in both AODV and DSR because DSDV is table driven routing architecture

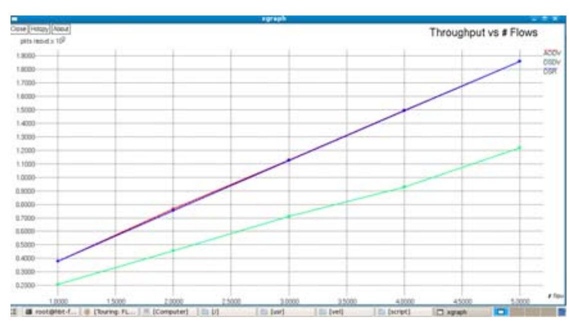

Fig 8. Throughtput Flows (hroughtput Vs Flows)

Fig 9 shows end-to-end delay for various no. of flows. As can be seen from the graph, when the no. of flows is more AODV performance better then other protocols.

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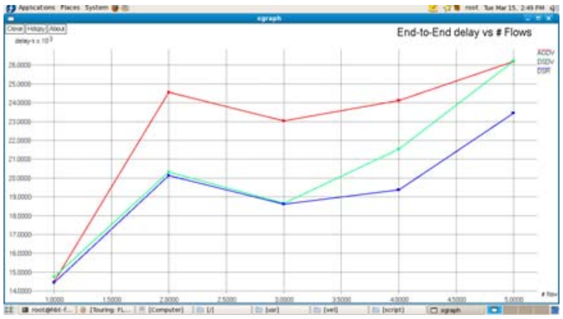
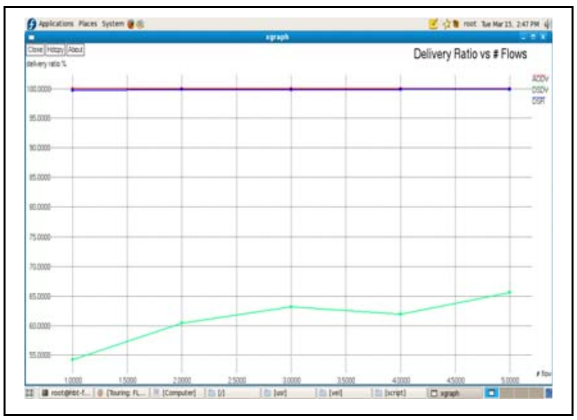


Fig 9 . End-to-End delay ,Flows
(End-to-End delay Vs Flows)

Fig 10 shows delivery ration % vs flows . When the number of communications is more the DSDV performs poor because of table driven routing architecture compared to other two protocols.



Fg 10.Delivery Ratio flows
(Delivery Ratio Vs flows)

VI. CONCLUSION

In this paper, the three non-cooperative protocols namely DSR, DSDV and AODV have been investigated. While DSDV falls in the category of proactive protocol, the other two falls under the category of reactive protocols. As proved by theoretical calculations, AODV and DSR performance are more or less on equal levels compared to DSDV. Both AODV and DSR almost deliver all the packets while the DSDV failed sometimes. The Throughput is maximum and almost same in ADOV and DSR.

VII. FUTURE WORK

For the future work, it is proposed to convert any one of the non-cooperative routing protocols into a co-operative routing agent either based on nodes link cost or on the transmission power of individual nodes. Further scope is to introduce cooperativeness among the participating nodes in order to lessen the burden on one particular forwarding node. This may lead to better throughput, end-to-end delay and in-directly lead to lengthen the lifetime of the network. In order to achieve the last stated criteria, we plan to introduce a weigh factor for each node that will include both the link cost in terms of distance to be covered and success rate of transmission and the residual energy of the participating node. We also propose to go in for reliability aspect as well as diversity in the network for better lifetime of the network.

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