National conference on Machine Intelligence Research and Advancement (NCMIRA, 12), INDIA.

Working of DSR And AODV in Congested Networks

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Abstract

Ad hoc networks are characterized by multi-hop wireless connectivity, frequently changing network topology and the need for efficient dynamic routing protocols. The wireless mobile nodes in this network communicate with each other without centralized control or established infrastructure. Since the wireless links are highly error prone and can go down frequently due to mobility of nodes, therefore, routing in MANET is a critical task due to highly dynamic environment. In recent years, several routing protocols have been proposed for mobile ad hoc networks and prominent among them are DSR (Dynamic Source Routing) and AODV (Ad hoc On Demand Distance Vector). In this paper, a comparison of the performance of these two on-demand routing protocols has been done by presenting their functionality. NS2 has been used as simulator and various scenarios have been generated to study the effect of UDP connection.

Keywords-- Ad hoc Networks, DSR, AODV, Routing, Performance evaluation

I. INTRODUCTION

The wireless network can be classified into two types: Infrastructured or Infrastructure less. In Infrastructured wireless networks, the mobile node can move while communicating, the base stations are fixed and as the node goes out of the range of a base station, it gets into the range of another base station. In Infrastructureless or Ad Hoc wireless network, the mobile node can move while communicating, there are no fixed base stations and all the nodes in the network act as routers. The mobile nodes in the Ad Hoc network dynamically establish routing among themselves to form their own network 'on the fly'. A Mobile Ad Hoc Network is a collection of wireless mobile nodes forming a temporary/shortlived network without any fixed infrastructure where all nodes are free to move about arbitrarily and where all the nodes configure themselves. In this network, each node acts both as a router and as a host & even the topology of network may also change rapidly. Some of the challenges in this network include[1] a. Unicast/Multicast routing b. Dynamic network topology c. Network overhead d. Scalability e. QoS f. Stable routing g. Secure routing and h. Power aware routing.

II. ROUTING PROTOCOLS

A routing protocol is needed whenever a packet needs to be transmitted to a destination via number of nodes and numerous routing protocols have been proposed for such kind of ad hoc networks.

These protocols find a route for packet delivery and deliver the packet to the correct destination. The studies on various aspects of routing protocols have been an active area of research for many years. Many protocols have been suggested keeping applications and type of network in view. Basically, routing protocols can be broadly classified into two types as: Table Driven Protocols or Proactive Protocols and On-Demand Protocols or Reactive Protocols. In Table Driven routing protocols each node maintains one or more tables containing routing information to every other node in the network. All nodes keep on updating these tables to maintain latest view of the network. Some of the existing table driven protocols are DSDV [5, 10], DBF [6], GSR [12], WRP [11] and ZRP [15, 9]. In on-demand routing protocols, routes are created as and when required. When a transmission occurs from source to destination, it invokes the route discovery procedure. The route remains valid till destination is achieved or until the route is no longer needed. Some of the existing on demand routing protocols are: DSR [7, 8], AODV [3, 4] and TORA [13, 14]. The emphasis in this research paper is concentrated on the performance analysis of two prominent on-demand routing Protocols i.e. DSR and AODV.

2.1. Dynamic State Routing (DSR) [7, 8]

DSR is an Ad Hoc routing protocol which is based on the theory of source-based routing. This protocol is source-initiated rather than hop by-hop. This is particularly designed for use in multi hop wireless ad hoc networks of mobile nodes.
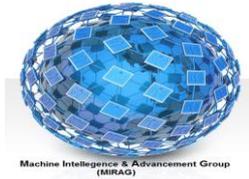
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This Protocol is composed of two essential parts of route discovery and route maintenance. Every node maintains a cache to store recently discovered paths. When a node desires to send a packet to some node, it first checks its entry in the cache. If it is there, then it uses that path to transmit the packet and also attach its source address on the packet. If it is not there in the cache or the entry in cache is expired (because of long time idle), the sender broadcasts a route request packet to all of its neighbors asking for a path to the destination. The sender will be waiting till the route is discovered. During waiting time, the sender can perform other tasks such as sending/forwarding other packets. As the route request packet arrives to any of the nodes, they check from their neighbor or from their caches whether the destination asked is known or unknown. If route information is known, they send back a route reply packet to the destination otherwise they broadcast the same route request packet. When the route is discovered, the required packets will be transmitted by the sender on the discovered route. Also an entry in the cache will be inserted for the future use. The node will also maintain the age information of the entry so as to know whether the cache is fresh or not. When a data packet is received by any intermediate node, it first checks whether the packet is meant for itself or not. If it is meant for itself (i.e. the intermediate node is the destination), the packet is received otherwise the same will be forwarded using the path attached on the data packet. Since in Ad hoc network, any link might fail anytime. Therefore, route maintenance process will constantly monitor and will also notify the nodes if there is any failure in the path. Consequently, the nodes will change the entries of their route cache.

*2.1.1 Characteristics:*

The benefits of DSR protocol are:

a) DSR uses no periodic routing messages, thereby reducing network bandwidth overhead, conserving battery power, and avoiding the propagation of potentially large routing updates throughout the ad hoc network.
b) It is able to adapt quickly to changes such as host movement.
c) There is no need to keep routing table so as to route a given data packet as the entire route is contained in the packet header.
d) The routes are maintained only between nodes that need to communicate.

e) Route caching can further reduce route discovery overhead. A single route discovery may yield many routes to the destination, due to intermediate nodes replying from local caches
f) The DSR protocol guarantees loop-free routing and very rapid recovery when routes in the network change.
g) In addition, DSR has been designed to compute correct routes in the presence of asymmetric (uni-directional) links.

The limitations of this protocol can be summarized as:

a) The DSR protocol is mainly efficient for mobile ad hoc networks with less than two hundred nodes. This is not scalable to large networks.
b) DSR requires significantly more processing resources than most other protocols.
c) The Route Maintenance protocol does not locally repair a broken link. The broken link is only communicated to the initiator.
d) Packet header size grows with route length due to source routing.
e) Flood of route requests may potentially reach all nodes in the network.
f) Care must be taken to avoid collisions between route requests propagated by neighboring nodes.
g) The contention is increased if too many route replies come back due to nodes replying using their local cache. The Route Reply Storm problem is there.
h) An intermediate node may send Route Reply using a stale cached route, thus polluting other caches. This problem can be eased if some mechanism to purge (potentially) invalid cached routes is incorporated.

2.2 Ad Hoc on Demand Distance Vector Routing (ADOV)[3, 4]

AODV is a variation of Destination-Sequenced Distance-Vector (DSDV) routing protocol which is collectively based on DSDV and DSR. It aims to minimize the requirement of system-wide broadcasts to its extreme. It does not maintain routes from every node to every other node in the network rather they are discovered as and when needed & are maintained only as long as they are required. The key steps of algorithm used by AODV for establishment of unicast routes are explained below.
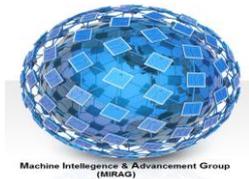
International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459 (Online), An ISO 9001:2008 Certified Journal,Volume 3, Special Issue 2, January 2013)

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2.2.1 Route Discovery:

When a node wants to send a data packet to a destination node, the entries in route table are checked to ensure whether there is a current route to that destination node or not. If it is there, the data packet is forwarded to the appropriate next hop toward the destination. If it is not there, the route discovery process is initiated. AODV initiates a route discovery process using Route Request (RREQ) and Route Reply (RREP). The source node will create a RREQ packet containing its IP address, its current sequence number, the destination's IP address, the destination's last sequence number and broadcast ID. The broadcast ID is incremented each time the source node initiates RREQ. Basically, the sequence numbers are used to determine the timeliness of each data packet and the broadcast ID & the IP address together form a unique identifier for RREQ so as to uniquely identify each request. The requests are sent using RREQ message and the information in connection with creation of a route is sent back in RREP message. The source node broadcasts the RREQ packet to its neighbours and then sets a timer to wait for a reply. To process the RREQ, the node sets up a reverse route entry for the source node in its route table. This helps to know how to forward a RREP to the source. Basically a lifetime is associated with the reverse route entry and if this entry is not used within this lifetime, the route information is deleted. If the RREQ is lost during transmission, the source node is allowed to broadcast again using route discovery mechanism.

2.2.2 Setting up of Forward Path:

When the destination node or an intermediate node with a route to the destination receives the RREQ, it creates the RREP and unicast the same towards the source node using the node from which it received the RREQ as the next hop. When RREP is routed back along the reverse path and received by an intermediate node, it sets up a forward path entry to the destination in its routing table. When the RREP reaches the source node, it means a route from source to the destination has been established and the source node can begin the data transmission.

2.2.3 Route Maintenance:

A route discovered between a source node and destination node is maintained as long as needed by the source node. Since there is movement of nodes in mobile ad hoc network and if the source node moves during an active session, it can reinitiate route discovery mechanism to establish a new route to destination.

Conversely, if the destination node or some intermediate node moves, the node upstream of the break initiates Route Error (RERR) message to the affected active upstream neighbors/nodes. Consequently, these nodes propagate the RERR to their predecessor nodes. This process continues until the source node is reached. When RERR is received by the source node, it can either stop sending the data or reinitiate the route discovery mechanism by sending a new RREQ message if the route is still required.

2.2.4 Characteristics:

The benefits of AODV protocol are as under:
a) The routes are established on demand and destination sequence numbers are used to find the latest route to the destination. The connection setup delay is lower.
b) It favors the least congested route instead of the shortest route and it also supports both unicast and multicast packet transmissions even for nodes in constant movement.
c) It also responds very quickly to the topological changes that affects the active routes.
d) d. It does not put any additional overheads on data packets as it does not make use of source routing.
e) It provides loop free routes.

The limitations of AODV protocol are summarized below:

a) The intermediate nodes can lead to inconsistent routes if the source sequence number is very old and the intermediate nodes have a higher but not the latest destination sequence number, thereby having stale entries.
b) The periodic beaconing leads to unnecessary bandwidth consumption.
c) It expects/requires that the nodes in the broadcast medium can detect each others' broadcasts.
d) The various performance metrics begin decreasing as the network size grows.
e) It is vulnerable to various kinds of attacks.

III. PERFORMANCE METRICS

There are number of qualitative and quantitative metrics that can be used to compare reactive routing protocols. Most of the existing routing protocols ensure the qualitative metrics. Therefore, we have used the packet delivery ratio as quantitative metrics for analyzing the performance of aforementioned routing protocols.
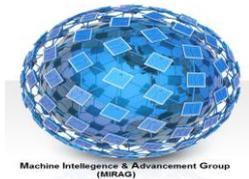
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The packet delivery ratio is defined as fraction of successfully received packets, which survive while finding their destination. This performance metric determines the completeness and correctness of the routing protocol.

IV. SIMULATION MODEL

IEEE 802.11 is used as the MAC layer protocol. The simulation experiments are carried over Network Simulator 2 (version 2.32) installed in Fedora 13. The results have been derived by writing a *tcl* script and generating corresponding *trace* and *nam* files. Both UDP agents have been used to analyze the traffic. The mobility model used is random waypoint model in an area. The area configurations used is 1000 meter x 750 meter. The packet size is 512 bytes. The packets start their journey from a random location to a random destination with a randomly chosen speed. The simulation run time is 500 seconds during analysis.

An extensive simulation model having scenario of 25 and 50 mobile nodes with maximum number of connections 10 have been used to study inter-layer interactions and their performance implications. Same scenario has been used for performance evaluation of both DSR and AODV protocols. Table-1 gives evaluation parameters for simulations.

Table 1
Evaluation parameters

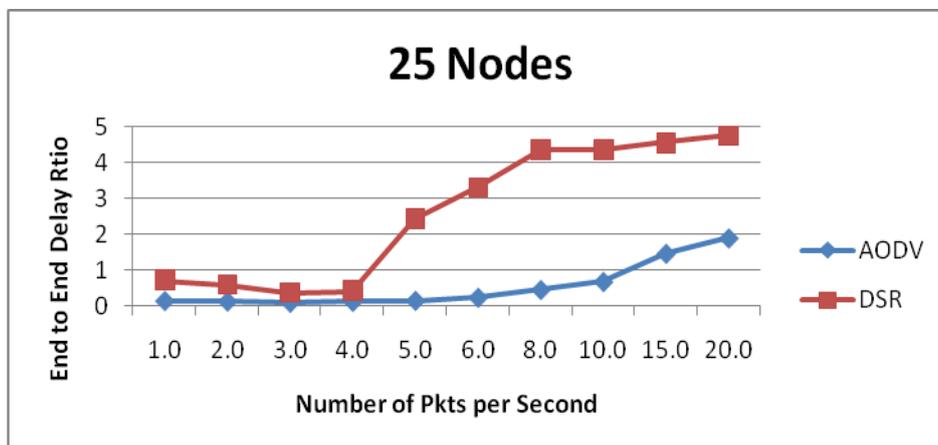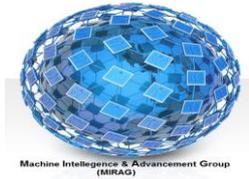| Simulator	Network Simulator 2.32
Mobile Nodes	25, 50
Routing Protocol	AODV & DSR
Channel	Wireless
Simulation Time	500 Sec.
Area for Simulation	1000m X 750m
Speed	10 m/s
Pause Time	50
Number of Connections	10
Number of Packets delivered per sec.	1.0,2.0,3.0,4.0,5.0,6.0,8.0,10.0,15.0 & 20.0

Figure 1: End to end delay ratio versus no. of packets per second

In this figure the End to End Delay Ratio is compared in DSR and AODV protocol using number of Packets per second as a parameter. This performance metric has been evaluated using 25 nodes with 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 8.0, 10.0, 15.0 and 20.0 number of packets in per seconds. The results shows that the End to End Delay Ratio is though increasing with the increase in number of packets but still the performance of AODV is much better than DSR in almost all cases.

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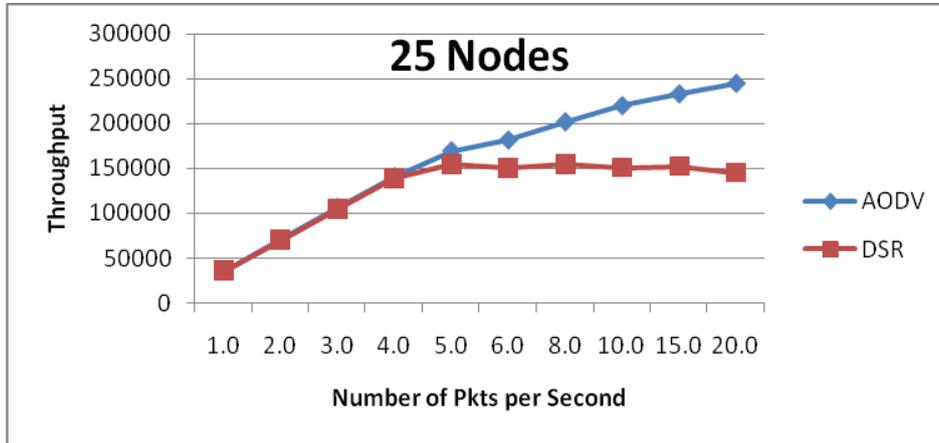

Figure 2: Throughput versus no. of packets per second

Here in figure 2 the performance of throughput is compared for DSR and AODV by increasing the congestion of packets. The results show that during the congestion AODV gives good performance than DSR.
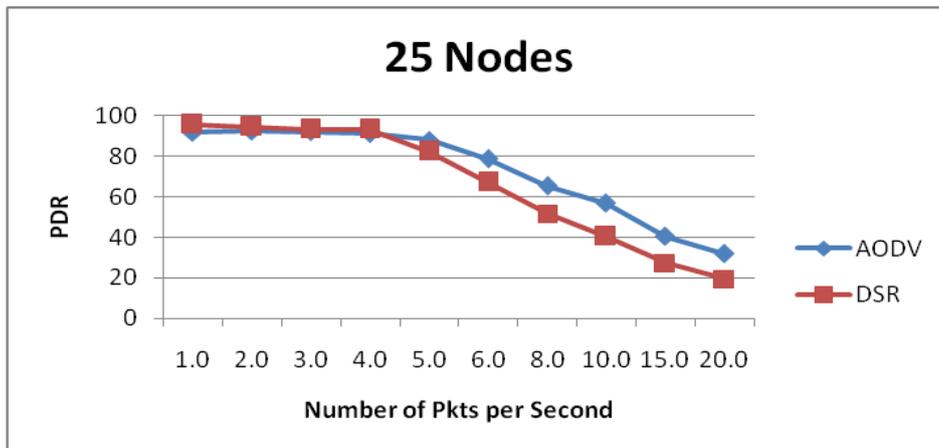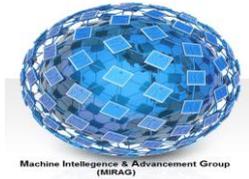

Figure 3: Packet delivery ratio versus no. of packets per second

In figure 3 packet delivery ratio has been evaluated for DSR and AODV protocols using 25 nodes and by increasing the congestion.

Till 4 packets the PDR for DSR and AODV is same but as soon as the packets are increasing the PDR stars to decline but for AODV the declining is less in compare to DSR.

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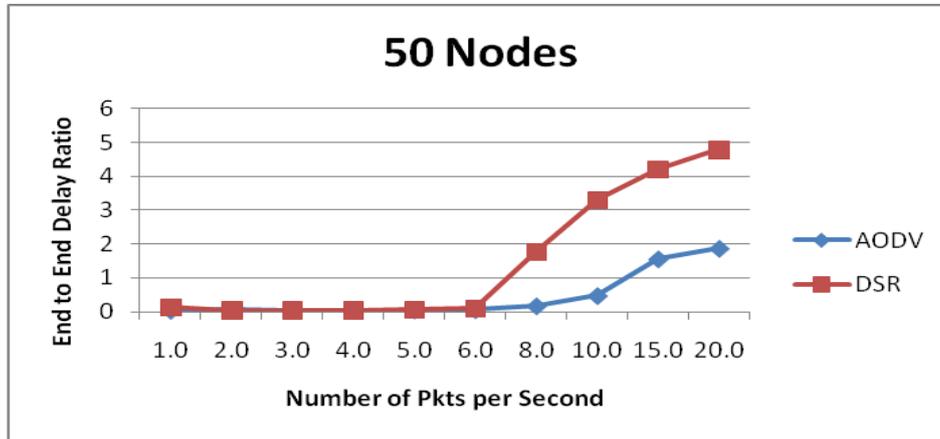

Figure 4: End to End Delay Ratio versus no. of Packets per second

In figure 4 the End to End Delay Ratio is compared in DSR and AODV protocol using number of Packets per second as a parameter. This performance metric has been evaluated using 50 nodes with 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 8.0, 10.0, 15.0 and 20.0 number of packets in per seconds. The results shows that the End to End Delay Ratio is almost same up to 6 packets but after that End to End Delay Ratio is increasing very rapidly in the case of DSR.
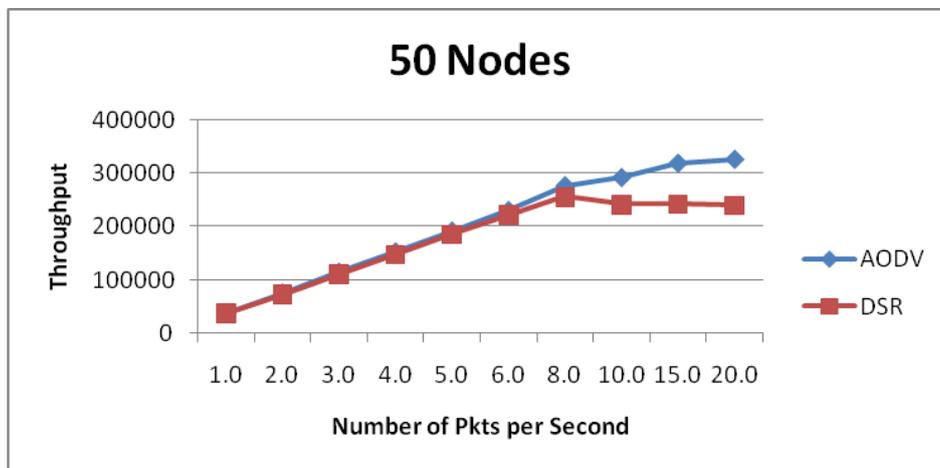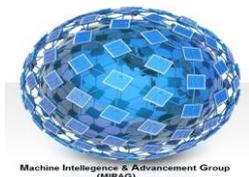

Figure 5: Throughput versus no. of packets per second

Here in figure 5 the performance of throughput is compared for DSR and AODV using 50 nodes during the congestion.

The results show up to 8 packets the throughput is same but after that it starts declining in the case of DSR.

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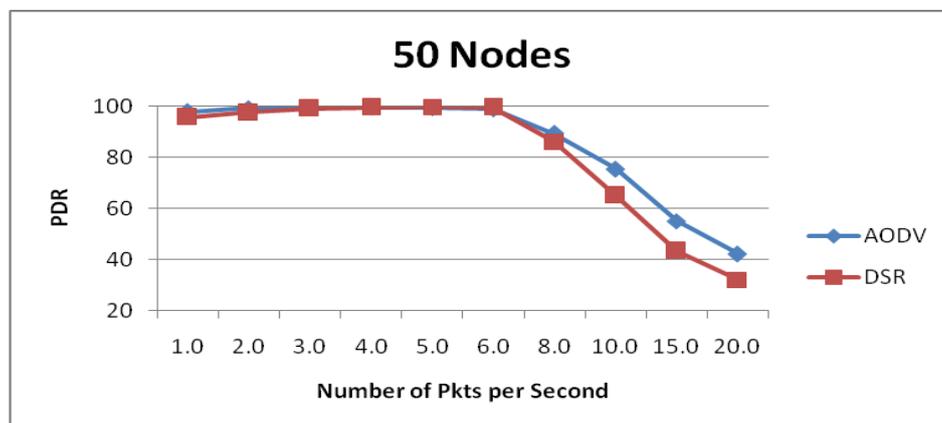

Figure 6: Packet delivery ratio versus no. of packets per second

In figure 6 packet delivery ratio has been evaluated for DSR and AODV protocols using 50 nodes and by increasing the congestion. Here till 6 packets the PDR for DSR and AODV is same but as soon as the packets are increasing the PDR stars to decline but for AODV the declining is less in compare to DSR.

V. CONCLUSION

In this research paper, an effort has been made to concentrate on the comparative study and performance analysis of two prominent on demand routing protocols i.e. DSR and AODV on the basis of packet delivery ratio, Throughput and End to End Delay Ratio. The results are presented with the help of graphs. The results show that the AODV protocol has outperformed the DSR protocol. When the experiments are done by using 25 nodes after 4 packets the performance of DSR starts to decline and in the case of 50 nodes after 6 packets the performance of DSR is decreasing. The parameters selected are most suited to check the environment for congested networks and data transmission at high speeds.

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