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Performance Evaluation Of Ad-Hoc On Demand Routing Protocol (AODV) Using NS-3 Simulator

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***Abstract*: The AODV – On Demand Distance Vector Routing Protocol is one of several routing protocols for Mobile Ad-hoc networking. Wireless ad-hoc routing protocol such as AODV are currently an area of much research among the networking community. Ad hoc network routing algorithm is establishing a route between a pair of nodes in the network correctly and efficiently. In this paper we show the feature of AODV Routing Protocol and also include simulation experiment and result analysis of AODV in ns-3.**

I. INTRODUCTION

ROUTING

The requirement of ad hoc routing protocol was felt because ad hoc networks are self organizing, decentralized. Also the possibilities of change in topology make the necessity of ad hoc routing protocol more prominent. For a node its trivial to communicate with a direct neighbor, but to communicate with a node at some distance, a node must have prior knowledge about the network. As in a pure flooding mechanism, all the nodes retransmit each packet received, which leads to poor resource consumption as available bandwidth is used very badly and the rate of collision is significantly high. The ad hoc routing protocols are generally classified in two broad categories, the reactive protocols and the proactive protocols. A detailed description of routing protocols for ad hoc networks is presented in this chapter.

AD-HOC ROUTING

The main goal of an ad hoc network routing algorithm is to correctly and efficiently establish a route between a pair of nodes in the network. So that a message can be send according to the expected Quality of Service (QoS) parameters such as Packet Delivery Ratio (PDR), Routing Overhead and End-to-End Delay. The establishment of a route among the nodes should be done with minimum overhead and bandwidth consumption. The highly dynamic topology changing nature of mobile ad hoc networks creates difficulty and complexity to routing among the mobile nodes within the network. Some important criteria and considerations used in designing routing protocols include [3].

- ✓ Simple and ease of implementation.
- ✓ Routes should be loop-free, optimal paths; computing efficient with minimum overhead and possibly multiple routes should be available between each pair of nodes to increase robustness.
- ✓ Secure and reliable.
- ✓ Supporting Quality of Service requirements (PDR, End-to-End delay, Control Overhead).
- ✓ Scalable.

II. CLASSIFICATION OF ROUTING PROTOCOL

Routing Protocol is classified into two approaches: proactive routing protocol and reactive routing protocol.

A.PROACTIVE (TABLE DRIVEN) ROUTING PROTOCOL

Proactive routing protocol aim to keep consistent and up-to-date routing information between every pair of nodes in the network. Each node in the network maintains this routing information in one or more routing tables. So this protocol is called table driven approach. Proactive routing have the advantage that routes are available at all times. But these protocols have more routing overhead due to its periodic update message procedure. Examples of proactive routing are Destination Sequenced Distance Vector (DSDV), Optimized Link State Routing (OLSR).

B.REACTIVE ROUTING PROTOCOL

While Reactive routing protocols have less overhead comparative Proactive routing protocol because it maintains information for active routes only in the network. It means routes are determined on demand. Source node needs to send data packets to some destination first it checks its route table whether it has a route or not. If no route exists it finds a path to the destination by route discovery process. AODV is example of reactive routing protocol.

III. AD HOC ON-DEMAND DISTANCE VECTOR ROUTING PROTOCOL

The Ad Hoc On-Demand Distance Vector (AODV) Routing Protocol provides route discovery process on demand in mobile ad hoc networks. This routing protocol uses control message such as Route Request (RREQ), Route Reply (RREP) for route Discovery phase and Route Error (RERR) for route maintenance [4].

ROUTE REQUEST (RREQ)

Message Route Request message contains following fields which has been shown in figure

Type	**Flags**	**Reserved**	**Hopcount**
RREQ ID			
Destination IP Address			
Destination Sequence Number			
Source IP Adress			
Source Sequence Number			

- ✓ Type: It represents message type and value is 1.
- ✓ Flags: It contains various flags such as Join flag, repair flag, destination only flag, gratuitous RREP flag.
- ✓ Hop Count: The number of hops from the source ip Address to the node for handling the request.
- ✓ RREQ ID: A RREQ Message uniquely identified by Rreq id.
- ✓ Destination Ip Address: It denotes the ip address of destination node.
- ✓ Destination Sequence Number: It denotes the previously received by source node towards the destination node.
- ✓ Source Ip Address: It denotes the ip address of source node.
- ✓ Source Sequence Number: Sequence number of source node.

ROUTE REPLY (RREP) MESSAGE

RREP Message contains following fields which has been shown in figure

Types	**Flags**	**Reserved**	**Prefix Size**	**Hop count**
Destination IP Address				
Destination Sequence Number				
Source IP Address				
Life Time				

- ✓ Type: Its value 2.
- ✓ Flags: It contains flags such as Repair flag, Acknowledgement required.
- ✓ Reserved: Its value ignored on reception.
- ✓ Hop Count: It denotes the number of hops b/w source node and destination node.
- ✓ Destination Ip Address: It denotes the ip address of destination.
- ✓ Destination Sequence Number: This sequence number associated to the route.
- ✓ Source Ip Address: This ip address of the node which generate RREQ message.
- ✓ Lifetime: It denotes the time in milliseconds the RREP is valid.

ROUTE DISCOVERY PROCESS

When a source node wants to send data packets to destination node. First it checks in routing table route to the destination node. If route is available it uses the route for transmission if not then it will initiate route discovery process to determine route. In route discovery process source node first creates a RREQ packet and broadcasts its neighboring nodes. RREQ message contains various fields shown in figure. Each RREQ message is uniquely identifies by source ip address and RREQ id that used to detect duplicates RREQ.

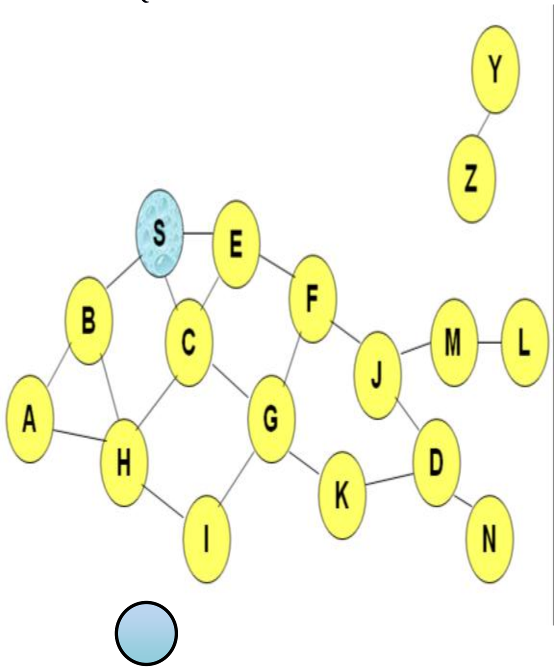
When any neighboring node receives RREQ message first it creates reverse route to the source node and also increments the hop count value in the RREQ message by one. If neighboring node does not have a valid route to the destination node it simply broadcast RREQ message in the network. If any intermediate node does have a valid route to the destination it means it have destination sequence number greater or equal in the RREQ message and generates RREP message. This RREP message unicasts to the next Hop towards the source node by using reverse route that was created by RREQ message. If the destination node itself creating RREP message it sets hop count value is equal to zero.. When any node receives a RREP message it creates a forward route to the destination for data transmission. If the source node receives more than two RREP message it will select greater sequence number and smallest hop count.

When any link breaks in the network then node creates RERR message and send it to the source node. If source node receives RERR message then it create new route to the destination node.

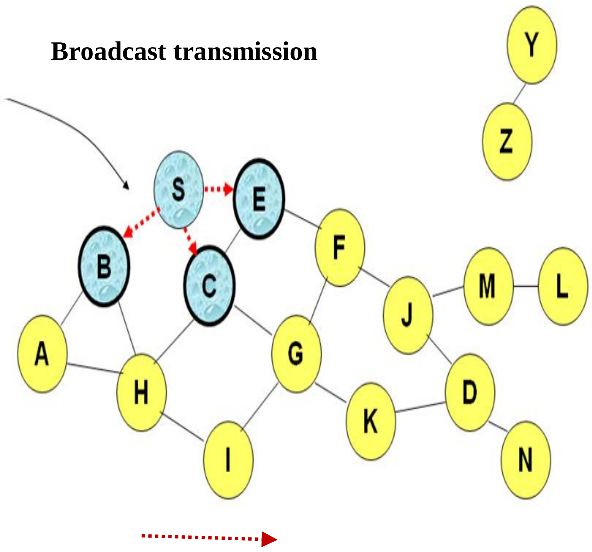
CONCEPT OF SEQUENCE NUMBER IN AODV

Sequence number is important parameter in AODV routing protocol [5]. Sequence number is monotonically increasing number that is maintained by originator node of RREP and RREQ message.

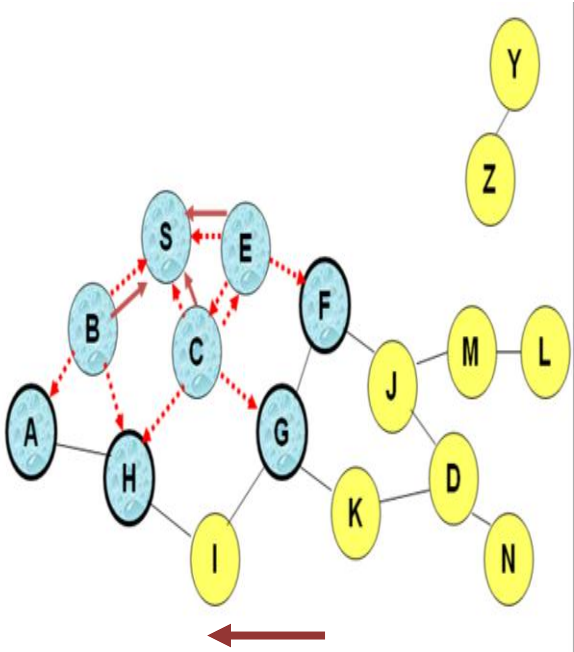
ROUTE REQUEST AND ROUTE REPLY IN AODV



Represents a node that has received RREQ for D from S

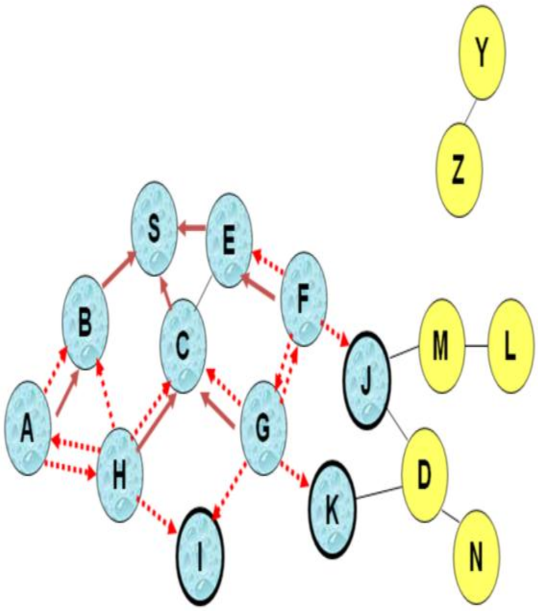


Represents transmission of RREQ

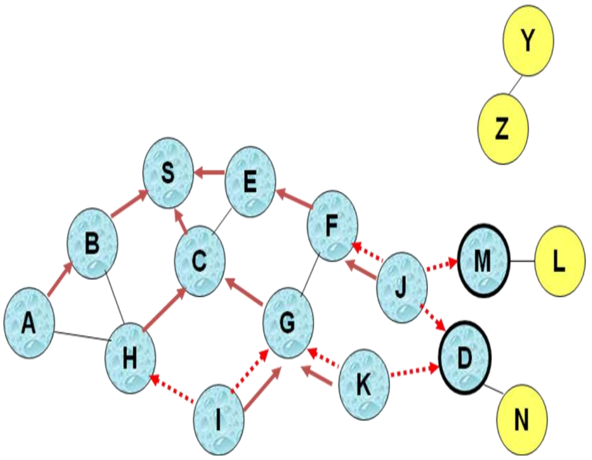


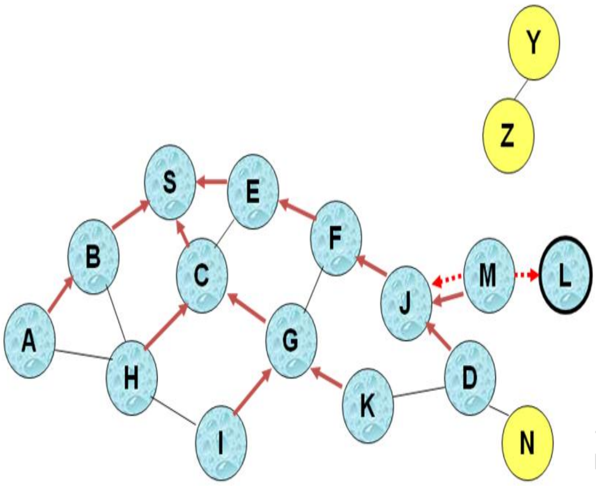
Represents links on reverse path

- ✓ Reverse path setup in AODV



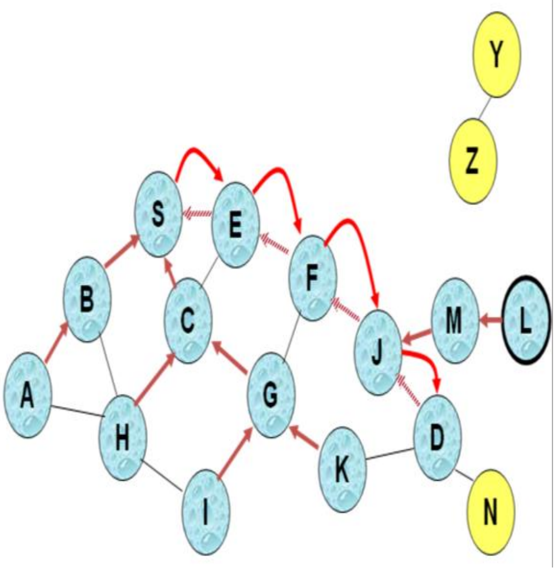
Node C receives RREQ from G and H, but does not forward it again, because node C has already forwarded RREQ once





Node D does not forward RREQ,
because Node D is the intended target of the RREQ

- ✓ Forward Path Set up in AODV



Forward links are setup when RREP travels along the reverse path

IV. RESULTS & ANALYSIS

EXPERIMENTS

I have done simulation in Ns-3 Network Simulators.

NS-3 NETWORK SIMULATOR

Ns-3 Simulator the Network Simulator (NS-3) is discrete-event in which simulation core and different models are implemented in C++ [6]. ns-3 has built in library which can be linked statically and dynamically to a C++ program. NS-3 is not supported backward NS-2. All API of Ns-3 are implemented in python programming language.

Ns-3 is a free open source software that provides to study of the internet protocols and large scale network system. Software organization of Ns-3 shown in figure 5.1. Source code of ns-3 is organized in Src directory. Src/core, src/simulator, src/common these three important simulation modules are generic simulation core used by different network system.

Parameter	**Value**
Simulator	NS – 3
Number Of Nodes	30
Simulation Time	100 Sec
Simulation Area	1000X1000
Packet Size	1000 Bytes
Packet Rate	5 packet/sec
Mobility Model	Random Way Point Mobility Model
Routing Protocol	AODV
Speed, Pause	10 m/s, 2 sec

Experimental Simulation Setup Parameters

RESULT

The results are observed in experimental process of routing protocol in environment of ns3 are shown in following tables.

Routing Protocol	**Data Packet**	**Control Packet**	**Routing Overhead**	**Average End to End Delay (sec)**
AODV	99	495	83.33	.0013

Simulation results: Routing Overhead and Avg. End to End Delay for AODV Routing Protocol

Mobility Speed (m/s)	AODV (PDR %)
20	100
40	97.92
60	97.76
80	98.38
100	98.93

Simulation results of PDR (%) for AODV with speed (m/s)

ANALYSIS

Performance Evaluation of routing protocol gives applicability and helps to identify that in which scenario AODV protocol is best suitable. I have calculated Packet Delivery Ratio, Routing Overhead and Average End-to-End Delay for AODV via simulation.

ROUTING OVERHEAD

The routing overhead describes how many routing packets for route discovery and route maintenance need to be sent. Routing overhead is the total number of routing packets divided by total number of delivered packets.[9]

AODV routing protocol has less routing overhead because AODV only maintains active route information in the network.

AVERAGE END-TO-END DELAY

Average end-to-end delay is measured by subtracting sending time from receiving time for each received packets. End-to-End delay includes all the possible delay such as buffering for route discovery process, queuing processing at the interface queue, propagation and transfer times.

Average End-to-End Delay tells possible Delay in the network b/w source and destination node and also provides quality of communication. AODV routes are determined when needed. So AODV has delay because AODV takes time to decide the route.

PACKET DELIVERY RATIO

Packet Delivery ratio is measured by dividing the total received packets to the destination by total sent packets. It describes packet loss rate. When more PDR it means routing is efficient.

Packet Delivery Ratio higher represents the better communication reliability. we can see AODV routing has more PDR because re-routing is less in AODV routing. When we increase mobility speed the lots of links are breaks and affect the packet delivery ratio.

V. CONCLUSION & FUTURE WORK

AODV routing protocol can be used in such environment where data stream must be reach coorectly and time is not an important factor as it takes time to find out routes when needed.

Also the combination of parameter is important to increase the performance as the result and performance are affected by all factors. AODV's performance is depend on the scenario like network size, number of nodes etc. Security is an issue in AODV upon which research work is going on so that AODV can give better performance

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