Comparative Study of Routing Protocols in MANET

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Abstract-**An ad hoc network is basically a collection of wireless nodes not having a permanent network. They are without any fixed infrastructure like access points or base stations. In ad hoc networks every node is willing to forward data for other nodes, and which nodes forward data is decided dynamically based on the network connectivity.Routing discovery is key responsible point for quality of services issues in mobile adhoc wireless network communication and performance of different routing protocol is different for parameters of quality of services of network communication. So it is question of research which routing protocol gives better quality of services for Mobile Adhoc network. Optimized Link State Routing and Access on Demand routing protocol are vital routing protocol of proactive and reactive routing protocol category. So AODV, DSR, DSDV and OLSR routing are studied and analyzed under different network scenario such as node density, mobility speed.**

Key Words—**MANET, AODV, OLSR, DSR, DSDV, NS-2 Simulator, RADAR, NS – 3 Simulator, Quality of Services Issues, Route Request Message (RREQ), Route Reply Message (RREP), Route Error Message (RERR), HELLO Messages.**

INTRODUCTION

Mobile Ad Hoc Network (MANET) that is connected by wireless links is a self-configuring network of mobile nodes. The devices freely move in any direction and links among these devices are changed frequently. An ad hoc network is basically a collection of wireless nodes not having a permanent network. They are without any fixed infrastructure like access points or base stations. In ad hoc networks every node is willing to forward data for other nodes, and which nodes forward data is decided dynamically based on the network connectivity. The term 'ad hoc' implies that the network is structured for a special, sometimes exclusive service designed for specific applications (e.g., disaster recovery, battlefield). Typically an ad hoc network is established for a finite amount of time [1].

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They are without any fixed infrastructure like access points or base stations. In ad hoc networks the communication is organized completely decentralized, unlike the communication in infrastructure based networks. To regulate or control the traffic there is no central authority. A node can be receiving and origination network traffic, also forwarding traffic on behalf of other nodes. And this kind of act can be performed by all nodes at the same time. The environment may change dynamically and the applications can me mobile as well, so it is so obvious that topology also keeps on changing.

1. Classification of Wireless Network

Wireless network are of many types according to their uses, applications and the very important the way in which they are been made and organised. Wireless networks are classified as mentioned in following ways.

1.1 Infrastructure-less (Ad-hoc) wireless network

In this case a network is formed dynamically through the cooperation of an arbitrary set of independent mobile nodes. Where each node participates in routing by forwarding data dynamically based on the network connectivity. It improves the Scalability of wireless networks compared to infrastructure based wireless networks because of its decentralized nature. In critical situations such as natural disasters, military conflicts or any emergency moment, ad-hoc networks are best suitable due to minimal configuration and quick operation.

1.2 Infrastructure-based wireless network

This type wireless network is pre-constructed infrastructure that is made of fixed and network nodes and delivered network services via these infrastructures. Most common example of infrastructure based wireless networks are Cordless Telephone Cellular Networks, Microwave Communication, Satellite Communication and RADAR Cellular Networks.

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1.3 Structured Wireless Network

The structured wireless sensor networks are those networks in which the sensor nodes are deployed in a well-planned manner.

1.4 Unstructured Wireless Network

The Unstructured wireless sensor networks are the one in which sensor nodes deployment is in an ad-hoc manner.

1.5 Ad-hoc Network

An ad hoc network is a collection of wireless mobile nodes that forms a temporary network without use of a predefined infrastructure or centralized administration [2]. In this environment it may be necessary for each wireless mobile node to convey other nodes in forwarding a packet to its destination node due to the limited transmission, limited bandwidth and limited battery power of wireless network interfaces. Nodes are connected with each other through a wireless link in ad-hoc network. Each mobile node operates not only as a host but also as a router forwarding packets for other mobile nodes in the network. The nodes are free to join and left the network due to infrastructure less wireless network. Whenever a node in the network is down or leaves the network that causes the link between other nodes is broken. The affected nodes in the network simply request for new routes and new links are established. Routing is playing important role in mobile ad-hoc network (MANETs). Routing is providing paths b/w source and destination by using routing algorithms [3].

2. *Routing*

Routing is a process of determining a path between source and destination on basis of request of data transmission. It is known that generally in multi-hop networks the source node cannot reach the sink directly. So, intermediate sensor nodes have to take part to relay their packets. The Routing table generated from the routing process provides the solution. It contain options for listed nodes in the table for any available or given packet destination. Routing table is the task of the routing algorithm along with the help of the routing protocol for their construction and maintenance. Routing Protocol's main goal is to support some routing techniques which is used to overcome the limitations of MANETs [4].

2.1 Types of routing protocol

The routing protocols can be classified in reactive routing protocol and proactive routing protocols.

2.1.1 Reactive Routing Protocols

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 there is no route found then, it finds a path to the destination by route discovery process. AODV is example of reactive routing protocol.[5]

2.1.2 Proactive Routing Protocols

Proactive routing protocol aim is 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 [6]. Examples of proactive routing are Destination Sequenced Distance Vector (DSDV), Optimized Link State Routing (OLSR).

2.1.3 AODV Routing Protocol

Being a reactive routing protocol AODV uses traditional routing tables, one entry per destination and sequence numbers are used to determine whether routing information is up-to-date and to prevent routing loops.
The maintenance of time-based states is an important feature of AODV which means that a routing entry which is not recently used is expired. The neighbors are notified in case of route breakage. The discovery of the route from source to destination is based on query and reply cycles and intermediate nodes store the route information in the form of route table entries along the route[7] .Control messages used for the discovery and breakage of route are as follows:

- Route Request Message (RREQ)
- Route Reply Message (RREP)
- Route Error Message (RERR)
- HELLO Messages.

2.1.3.1 a) Route Request (RREQ)

A route request packet is flooded through the network when a route is not available for the destination from source. The parameters are contained in the route request packet are presented in the following table:

RREQ Field

Source_ Address	Source_ sequence	Broadcast_ Id	Destination_ address	Destination_ Sequence	Hop_ Count

Figure 1: RREQ Format

A RREQ is identified by the pair source address and request ID, each time when the source node sends a new RREQ and the request ID is incremented. After receiving of request message, each node checks the request ID and source address pair. The new RREQ is discarded if there is already RREQ packet with same pair of parameters.
A node that has no route entry for the destination, it rebroadcasts the RREQ with incremented hop count parameter.

A route reply (RREP) message is generated and sent back to source if a node has route with sequence number greater than or equal to that of RREQ.

2.1.3.1. b) Route Reply (RREP)

On having a valid route to the destination or if the node is destination, a RREP message is sent to the source by the node. The following parameters are contained in the route reply message:
RREP Field:

Source_address	Destination_Address	Destination_Sequence	Hop_count	Lifetime

Figure 2: RREP Format

Originator IP Address- The IP address of the node which originated the RREQ for which the route is supplied.
Destination IP Address- The IP address of the destination for which a route is supplied.
Destination Sequence Number- The destination sequence number associated to the route.
Hop Count- The number of hops from the Originator IP Address to the Destination IP Address. For multicast route requests this indicates the number of hops to the multicast tree member sending the RREP.
Lifetime- It is the time in milliseconds for which the nodes receiving the RREP consider the route to be valid.[8]
Importance of Sequence Number in AODV:

1. To avoid using old/broken routes
2. To determine which route is newer
3. To prevent formation of loops

2.1.3.1.c Route Error Message (RERR)

The neighborhood nodes are monitored. When a route that is active is lost, the neighborhood nodes are notified by route error message (RERR) on both sides of link.

2.1.3.1.d Hello Messages

The HELLO messages are broadcasted in order to know neighborhood nodes. The neighborhood nodes are directly communicated. In AODV, HELLO messages are broadcasted in order to inform the neighbors about the activation of the link. These messages are not broadcasted because of short time to live (TTL) with a value equal to one.

Example:
1. A had a route to D initially.
Assume that A does not know about failure of link C-D because RERR sent by C is lost.

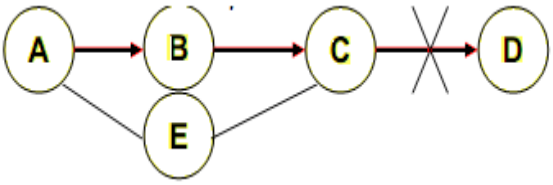


Figure 3: Route Maintenance

Now C performs a route discovery for D. Node A receives the RREQ (say, via path C-E-A).
Node A will reply since A knows a route to D via node B.
Results in a loop (for instance, C-E-A-B-C).But because of usage of sequence number, A will not use the route A-B-C, because the sequence numbers will be lower than what A receives from A

2.1.3.2 Properties

The advantage of AODV compared to classical routing protocols like distance vector and link-state is that AODV has helped to reduce the number of routing messages in the network. AODV achieves this by using a reactive approach. This is very much necessary in an ad-hoc network where topology is dynamic. AODV only support one route for each destination.
AODV uses hello messages at the IP-level. This means that AODV does not need support from the link layer to work correctly.

2.1.3.3 Discovery of Route

When a source node does not have routing information about destination, the process of the discovery of the route starts for a node with which source wants to communicate. The process is initiated by broadcasting of RREQ as shown in figure 3. On receiving RREP message, the route is established. If multiple RREP messages with different routes are received then routing information is updated with RREP message of greater sequence number.

2.1.3.4 Setup of Reverse Path

The reverse path to the node is noted by each node during the transmission of RREQ messages. The RREP message travels along this path after the destination node is found. The addresses of the neighbor node from which the RREQ packets are received are recorded by each node.

2.1.3.5 Setup of Forward Path

The reverse path is used to send RREP message back to the source but a forward path is setup during transmission of RREP message. This forward path can be called as reverse to the reverse path. The data transmission is started as soon as this forward path is setup. The locally buffered data packets waiting for transmission are transmitted in FIFO-queue.

2.1.4 DSR Routing Protocol

The difference in DSR and other routing protocols is that it uses source routing supplied by packet's originator to determine packet's path through the network instead of independent hop-by-hop routing decisions made by each node.
The packet in source routing which is going to be routed through the network carries the complete ordered list of nodes in its header through which the packet will pass. Fresh routing information is not needed to be maintained in intermediate nodes in design of source routing, since all the routing decisions are contained in the packet by themselves.

2.1.4.1 DSR Route Discovery and Maintenance

DSR protocol is divided into two mechanisms which show the basic operation of DSR. The two mechanisms are:
Route Discovery
Route Maintenance
When a node S wants to send a packet to destination D, the route to destination D is obtained by route discovery mechanism. In this mechanism the source node S broadcasts a ROUTE REQUEST packet which in a controlled manner is flooded through the network and answered in the form of ROUTE REPLY packet by the destination node or from the node which has the route to destination. The routes are kept in Route Cache, which to the same destination can store multiple routes. The nodes check their route cache for a route that could answer the request before repropagation of ROUTE REQUEST. The routes that are not currently used for communication the nodes do not expend effort on obtaining or maintaining them i.e. the route discovery is initiated only on-demand. [10]
The other mechanism is the route maintenance by which source node S detects if the topology of the network has changed so that it can no longer use its route to destination. If the two nodes that were listed as neighbors on the route moved out of the range of each other and the link becomes broken, the source node S is notified with a ROUTE ERROR packet. The source node S can use any other known routes to the destination D or the process of route discovery is invoked again to find a new route to the destination.

2.1.5 DSDV Routing Protocol

It eliminates route looping, increases convergence speed, and reduces control message overhead.DSDV is a distant vector routing protocol. Each node has a routing table that indicates for each destination, which is the next hop and number of hops to the destination. Each node periodically broadcasts routing updates.[9]

*2.1.5.1 DSDV Route Discovery and Maintenance*In

DSDV, each node maintains a next-hop table, which it exchanges with its neighbours. There are two types of next-hop table exchanges: periodic full-table broadcast and event-driven incremental updating. The relative frequency of the full-table broadcast and the incremental updating is determined by the node mobility. In each data packet sent during a next-hop table broadcast or incremental updating, the source node appends a sequence number. This sequence number is propagated by all nodes receiving the corresponding distance-vector updates, and is stored in the next-hop table entry of these nodes. A node, after receiving a new next-hop table from its neighbour, updates its route to a destination only if the new sequence number is larger than the recorded one, or if the new sequence number is the same as the recorded one, but the new route is shorter.[11]

A sequence number is used to tag each route. It shows the freshness of the route: a route with higher sequence number is more favourable. In addition, among two routes with the same sequence number, the one with fewer hops is more favourable. If a node detects that a route to a destination has broken, then its hop number is set to infinity and its sequence number updated but assigned an odd number: even numbers correspond to sequence numbers of connected paths.

3. System and user interaction

While comparing the protocols performance on system we generally use NS-2 or NS-3simulator, by using largenumber of nodes in network. Here a use case scenario is describing an interaction between a user and a system. A use case contains a textual description of all of the ways that the intended users could work with the software through its interface. The use case diagrams describe system functionalityas a set of tasks that the system must carry out and actors who interact with the system to complete the tasks.

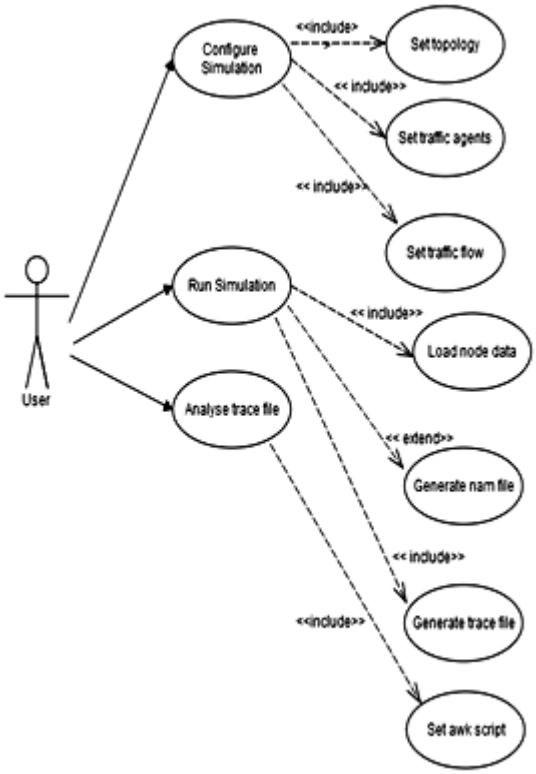
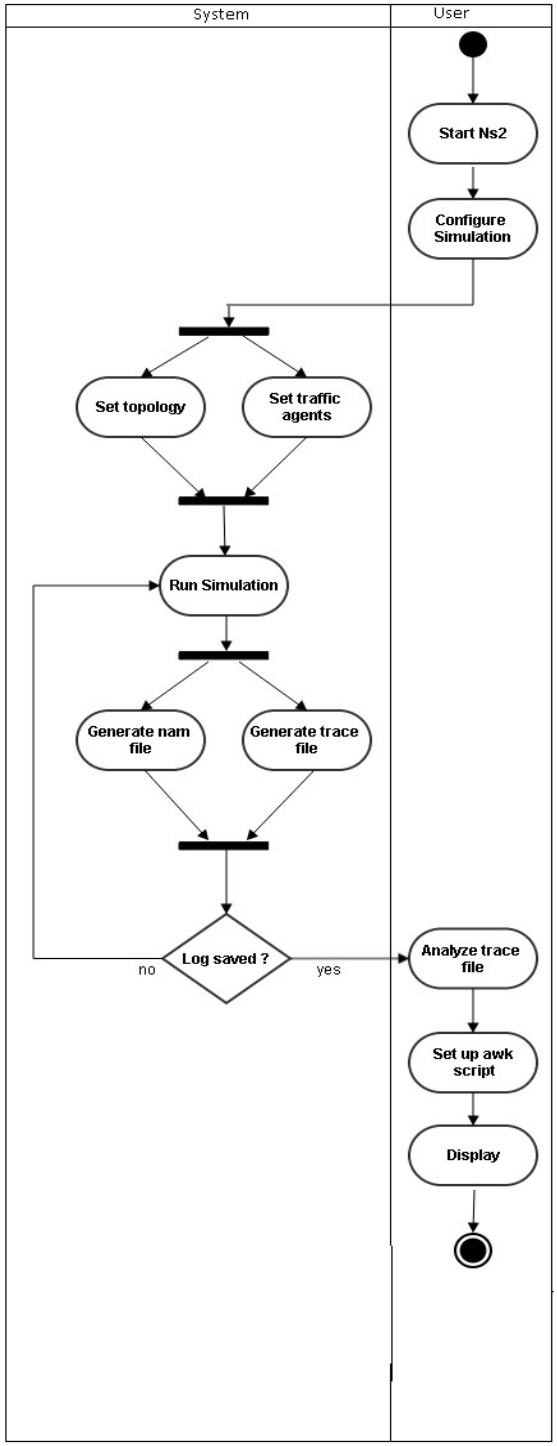


Figure 4: use case diagram of system & user interaction

4. ***Conditions required for using Software:-***For using NS-2 or NS-3 simulator there are some pre conditions and post conditions are required to be set up for proper use of simulator. This is better described in following way:-

Actors	User
Brief Description	The configure simulation use case helps in the initialization of the parameters to be used in the steps of simulation.
Trigger	The parameters are initialized.
Pre-conditions	NS2 or NS3 simulation tool is running and initialized.
Post Conditions	Parameters initiated for the simulation
Priority	High
Frequency Of use	It is always used by the user to perform the initialization of parameters.

Use case name	Run Simulation
Use Case ID	UC_002
Actors	User, System
Brief Description	The run simulation use case helps in the simulation of the environment variables initialized
Trigger	The simulation is started by ns2 or Ns3 tool.
Pre-conditions	NS2 or NS3 simulation tool is running and initialized.
Post Conditions	Saving the trace file and nam file for the simulation.
Priority	High
Frequency Of use	It is always used to perform the simulation of parameters and topology initialized.



5. Activity Diagram

Activity diagram shows sequence and conditions for coordinating lower-level behaviors of nodes in network, rather than which classifiers own those behaviors.[6]
It is used for modeling the sequence of activities in a process.
It is a special case of a state machine in which most of the states are activities and most of the transitions are implicitly triggered by completion of the actions in the source activities.
Activity:
It represents the performance of task or duty in a workflow.
This diagram shows the complete working procedure of network with large no of nodes which can be used in simulator for comparing routing protocols.

CONCLUSION

Here investigation has been performed on various losses factor in mobile ad-hoc network by using network scenario on simulators .Comparative study of routing protocols have been done. From this comparison each routing protocol has its own advantage and disadvantage. For proactive routing protocol such as OLSR, each node maintains up-to-date routing information in the network,So connection setup times are fast. But these routing protocols have large amount of routing overhead in the network due to periodic update message. On demand routing protocol such

AODV reduces the traffic needed for routing but introduces delay due to route discovery process on demand. AODV routing protocol is highly adaptable in changing network topology.[6]

FUTURE WORK

Security is still the main issue in MANET as topology is open and changing frequently. Attacks are frequent in Ad-hoc networks so they should be minimised and there are many other routing protocol that can be compared on different parameters like packet delivery ratio and end to end delay.

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