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Review and Analysis of Reactive Routing Protocols in Mobile Ad Hoc Network (MANET)

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Abstract

Mobile Ad Hoc Networks (MANETs) are key elements of wireless networking having mobile nodes which associate on an extemporaneous or ad hoc basis. Mobile nodes are free to move randomly. MANETs are both self-forming and self-healing, enabling peer-level communications between mobile nodes without reliance on centralized resources or fixed infrastructure. A centralized arbitrator or server does not present in an ad hoc network. In MANET, it was assumed that each mobile node is moving with relative speed in random directions. Because of that there is no long term guaranteed path from any one node to other node.

1. Introduction

Mobile networks represent dynamic, autonomous system of mobile nodes connected by wireless links where each node works as a router.

Wireless networking is a technology that enables two or more computers to communicate using standard network protocols, but without network cabling. And now there exist network protocols that are developed just for Wireless networks. Thus, it can categorize wireless network in primarily following two categories –

a) Network with existing infrastructure: is a network where exists a wireless access point or earlier wireless hardware support for each node to connect to networks. Here nodes do not participate in any kind of transit services. They communicate to access points to send & receive packets from other nodes. In this kind of network different access point can follow different wireless protocol like 802.11b or 802.11g and still can communicate with each other. There exist wireless products based on this kind of technology.

b) Ad hoc network is a network where there is no existence of wireless infrastructure for networking, instead each node communicates with each other using their sole transmitter-receiver only. In this kind of network, each node does participate voluntarily in transit packet that flow to and from different nodes. Each node does follow same routing algorithm to route different packets. Thus, this kind of network has limited the homogenous feature. There are not many wireless products that follow this proposed technology [6].

2. Routing in Manets

A Mobile Ad Hoc Network or spontaneous network is an infrastructure-less, self-

organized and multi-hop network with rapidly changing topology causing the wireless links to be broken and re-established on-the-fly. A major thrust area of research is that the Routing Protocol should respond rapidly to the drastic topological changes in the network area. In these networks, each node can act as a router. Because of limited bandwidth of nodes, the source and destination may have to communicate via intermediate nodes. Main limiting factors in routing are Interference, Dynamic Topology, and Routing overhead with asymmetric links.

Routing in MANETs has been an active area of research and in recent years numerous protocols have been introduced for addressing the problems of routing, reviewed in later sections. These protocols are divided into two broad classes – Reactive and Proactive protocols [7].

In Reactive or also known as on demand RPs. Routes are created according to need only. The application of this protocol can be seen in the Dynamic Source Routing Protocol (DSR) and the Ad-hoc On-demand Distance Vector Routing Protocol (AODV) [1]. AODV and DSR are discussed in [5] for comparison of two on-demand routing protocols for Ad hoc networks.

In case of Proactive or Table-driven RPs the nodes/hosts keep updating their routing tables by periodical messages. Destination Sequenced Distance Vector Protocol (DSDV) and Optimized Link State Routing Protocol (OLSR) working is similar to proactive routing protocols. All these protocols are quite insecure because attackers can easily obtain information about the network topology.

3. Classification of Routing Protocols

This paper will discuss the classification of existing wireless ad hoc routing protocols, their characteristic features & types. The Routing Protocols for ad hoc [2] wireless networks can be divided into three categories based on the routing information update mechanism. They could be Reactive (On-demand), Proactive (Table-driven) or Hybrid [3] routing protocols as shown in figure 1.

The table-driven ad hoc routing approach is like the connectionless approach of forwarding packets, with no regard to when and how frequently such routes are desired.

This is not the case, however, for on-demand routing protocols. When a node using an on-demand protocol desires a route to a new destination, it will have to wait until such a route can be discovered. On the contrary, routing information is constantly broadcasted and maintained in table-driven routing protocols, a route to every other node in the ad hoc network is always available, regardless of whether it is needed.

In this paper, the concept is presented a critical analysis of the Reactive Routing secure routing protocols. Firstly, a comparison between the two broad classes of routing protocols based on their routing methodology and other network parameters is discussed.

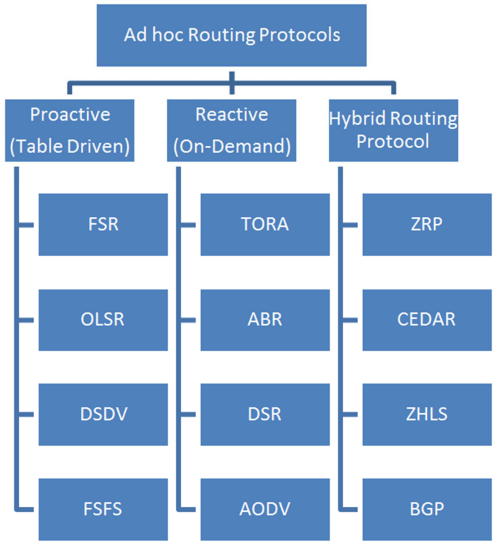

Figure 1. *Classification of Routing Protocol.*

4. Reactive Manet Routing Protocol

Reactive routing protocols are intended to maintain routing information about 'active' routes only. According to which there is no unnecessary routing information maintained. The route identification process is parted into two categories one is a route discovery and second is a route maintenance phase. The first one i.e. route discovery process is initiated when a source wants to send some message or information to a destination using some path. The second one i.e. path maintenance process deletes failed paths and re-initiates path discovery in the case of topology change. For example-DSR and AODV. This type of protocol finds a route on demand by flooding the network with Route Request packets. The main disadvantages of such algorithms are:

1. High latency time in route finding.
2. Overabundance flooding can lead to network clogging.

Number of protocols is used as a Reactive Protocols. Some of them are as listed below.

a) ABR - Associativity-Based Routing
b) Ad hoc On-demand Distance Vector (AODV) (RFC 3561)
c) Dynamic Source Routing (RFC 4728) [4]

Dynamic Source Routing (DSR) Protocol

Source routing is one of the most important features of DSR, in which the sender knows the complete hop-by-hop route to the destination. These paths are stored in a path cache. Packet header in the data packet stores the information of source route [10]. In the ad hoc network when a node attempts to send a data packet to a destination, a node does not already know the route, but node uses a route discovery process to randomly determine its route. The main activity of the Route discovery process is that it floods the network with route request (RREQ) packets. Each node received an RREQ rebroadcasts it, unless it is the destination, or it has a route to the destination in its route cache. These kinds of nodes after receiving PREQ packets replies to the RREQ with a route

reply (RREP) packet that again send back to the original source. RREQ and RREP packets are source routed. The RREQ keeps the information about the path traversed inside the network and the RREP gives routes itself back to the source by traversing this path in backward direction. The path adopted by the RREP packet is cached at the source for further use. The source node is notified using a route error (RERR) packet which gives the information about breakage of any link on a source route.

The source removes any route using this link from its cache. The source can initiate a new route discovery process if this route is still needed for transmission. DSR makes very aggressive use of source routing and route caching. There is no need for special mechanisms to detect routing loops. Also, any forwarding node caches the source route in a packet it forwards for possible future use. Again, number of additional optimizations have been invented and have been examined to be very effective by the authors of the protocol. It can describe then as follows:

Salvaging: An intermediate node can use an alternate route from its own cache when a data packet meets a failed link on its source route.

a. Gratuitous Route Repair Mechanism: A source node after receiving an RERR packet piggybacks the RERR in the following RREQ. This helps clean up the caches of other nodes in the network that may have the failed link in one of the cached source routes.
b. Promiscuous Listening Mechanism: When a node overhears a packet not addressed to it, node checks whether the packet could be routed via itself to find a shortest possible route. If so, the node sends a gratuitous RREP to the source of the route with this new, better route. This mechanism additionally helps a node to learn different routes without participating in the routing process directly i.e. each node has the routing information of remaining nodes in the network.

AD-HOC on Demand Distance Vector (AODV)

AODV stands for Ad-hoc On demand Distance Vector. AODV is distance vector type routing [9] where it does not involve nodes to maintain routes to destination that are not on active path. If end points are valid, AODV does not play its part. Different route messages like Route Request, Route Replies and Route Errors are used to discover and maintain links. UDP/IP is used to receive and get messages. AODV uses a destination sequence number for each route created by destination node for any request to the nodes. A route with maximum sequence number is selected. To find a new route the source node sends the Route Request message to the network till destination is reached or a node with the fresh route is found. Then Route Reply is sent back to the source node. The active route nodes, passes hello messages periodically to its immediate neighbor for communication with each other. If a node does not receive a reply then, it deletes the node from its list and sends Route Error to all the members in the active members in the route.

We can maintain the states of the node uniquely and time based, regarding utilization of individual routing table entries. A routing table entry is expired if not used recently. Each routing table entry maintains a set of Predecessor nodes, which are used to indicate the set of neighboring nodes which use that entry to route data packets. When the next-hop link breaks, these nodes are notified with RERR packets. Each predecessor node, in turn, forwards the RERR to its own set of predecessors, thus effectively erasing all routes using the broken link.

Associativity-Based Routing (ABR)

ABR is a source initiated on-demand routing protocol. It is free from problematic issues like deadlock, packet duplicates and loops. It only maintains routes for sources that desire routes. However, ABR does not employ route re-construction based on alternate route information stored in intermediate nodes (thereby avoiding stale routes). Routing decisions are always performed at the destination and one of the best routes will be selected and applied while all other possible routes remain passive at a time. Its distinct feature is the use of associativity ticks which is required to only form routes based on the stability of nodes, under the fact that there is no use to form a route using a node which will be moving out of the topology and thus making the route to be broken. ABR has three modes of operation [8] namely route discovery phase, route reconstruction phase and route deletion.

5. Comparison of Protocols

MANET is infrastructure less network comprise of mobile nodes as dynamic network without any centralized administration. For such a dynamic changing network topology it needs efficient dynamic routing protocols. This research paper compares the performance of three on-demand routing protocols namely AODV, ABR, DSR listed in table 1. The differences in the protocol mechanics can lead to different performance scenario.

Table 1. *Routing parameters of AODV, ABR and DSR.*

Item	Parameters of AODV	Parameters of ABR	Parameters of DSR
Multicast Capability	Yes	No	No
Routing Philosophy	Reactive	Reactive	Reactive
Loop Free	Yes	Avoids packet duplicates. No route reconstructions	Yes
Possibilities of Multiple Route	No	No	Yes
Route Storage	Route Table	Route Table	Route Cache
Routing Metric	Shortest Path	Degree of association stability	Shortest Path
Utilize Route Cache	Yes	Yes	No
Unidirectional Link	No	No	Yes
Update Period	Event Driven	Periodically	Event Driven

6. Results and Analysis

The performance metrics of AODV and DSR protocols are studied along with impact of mobility by changing the path in random direction, packet loss, Packet Delivery Ratio.

According to this study the results are as shown in table 2:

Table 2. *Comparative results of AODV and DSR.*

S.N.	Metric	AODV	DSR
1.	Packet Delivery Ratio	LESS	HIGH
2.	Packet loss	SAME	SAME
3.	Throughput	LESS	HIGH
4.	Aggregate good put	LESS	HIGH

7. Conclusion

The performance of routing protocols AODV and DSR depends heavily on much kind of design scenarios. One of these designs is shown here. In this paper, there is evaluation the working of Reactive Protocols. These routing protocols are compared in term of packet delivery ratio, routing overhead, throughput and average end to end delay. Parameters that are used to evaluate the working of both routing protocol different number of nodes over different area size with different pause time. All routing protocols perform well according to performance metrics that have been selected. For packet loss ratio, AODV and DSR perform equally well. For average good put, DSR submits more number of bits on to the network. For packet delivery ratio metric, performance of DSR routing protocol is better than AODV. DSR perform well in terms of throughput. But for average end to end delay, DSR is lower in performance than AODV, when the nodes equal to 10. Hopefully, the result of this study can be used as reference for the future work.

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