Efficient Routing Protocol For Mobile Ad Hoc Networks (MANET)

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Abstract

Mobile Ad Hoc Network (MANET) is distinguished from other networks mainly by its self configuring and optimizing nature. Due to the continuous change in topology and an open vulnerable media network, achieving security in ad hoc networks is very difficult. In MANET the main challenge for routing protocol is the mobility of the nodes. Routing protocols plays a major role in the performance of a network. Several routing protocols have been proposed for wireless ad hoc networks. Protocols are mainly classified in to three types: Reactive, Proactive and Hybrid routing protocol. Choosing an efficient routing protocol relies on certain performance metrics. This paper will discuss about the types of routing protocols used in MANET and their performance based on certain metrics.

Keywords—*Mobile adhoc networks, proactive routing protocol, reactive routing protocol, hybrid routing protocol.*

1. Introduction

Mobile Ad Hoc Networks (MANET) is distributed and self configuring wireless network. MANET does not have a predefined network infrastructure. Application of MANET is benefited in areas such as military services, disaster relief and mine site operations. Each node communicates with the other acting as routers. The co-operation and trust between the nodes are depended for the proper functioning of this network. Since the network topology in MANET changes unpredictably and rapidly it is highly vulnerable to various kinds of attacks. Attack prevention methods such as intrusion detection system [1], intrusion prevention [2], authentication and encryption [3] can be used in defense for reducing certain attack possibilities [4][5]. MANET is considered one of the most promising fields in research and development of wireless networks.
Wireless technologies are increasing day by day and so the usage.

MANET does not have a stable infrastructure so the maintenance of routing updates is important. In ad hoc mobile networks, routes are mainly multi hop because of the limited radio propagation range and topology changes frequently and unpredictably since each network host moves randomly. Routing in ad hoc networks has been a challenging task ever since the wireless networks came into existence. Wireless communication is established by nodes acting as routers and transferring packets from one to another in ad-hoc networks. Routing in these networks is highly complex due to moving nodes and hence many protocols have been developed. Therefore, routing is an integral part of ad hoc communications, and has received interests from many researchers [6]. Protocols using node to node authentication mechanism are more secure but the use of keys and digital signatures will be quite expensive. The major requirement of a routing protocol is to handle large number of mobile nodes with limited usage of bandwidth and energy. The rest of this paper is organized as follows: Section 2 will give an overview on types of routing protocols used in MANET. Section 3 compares the types of routing protocol with examples. Evaluation of the approach is discussed in Section 4. Section 5 concludes this paper.

2. Overview on Routing Protocols

Routing Protocols are divided into three categories: proactive routing protocol, reactive routing protocol and hybrid routing protocol.

2.1 Reactive Routing Protocol

Reactive routing protocols works based on demand request. The topology information is only transmitted by nodes on demand. When a node wants to transmit traffic to a host node an route request (RREQ) will be flooded to the host nodes. This has advantage and disadvantage. The advantage is that route request is made only when there is a transmission needed which will control the usage of high bandwidth compared to proactive routing protocols. The disadvantage is that there is a delay in transmission due to route request and control traffic overhead. Ad hoc On-demand Distance Vector (AODV) [7] is an example for reactive routing protocol. AODV consist of several control packets such as route requests, route

replies, and route errors during route discovery and maintenance. Route requests for a destination D are generated at the source node S when a route to D is requested for the first time, or when a route is broken due to link-failures. Route replies are transmitted in response to route requests, while route errors are generated when a route to a destination fails. The number of route error packets is typically low compared to the number of route requests and route replies, since the route errors are propagated only by the nodes in the route between S and D, whereas route requests and route replies could be propagated by any node in the network. AODV's routing overhead increases with the increase in distance between the source and destination. Also, destinations farther away require route requests to be propagated in a larger area. AODV's overhead increases with the number of sources and the number of destinations in the network.

2.2 Proactive Routing Protocol

A proactive routing protocol makes the node to update the routing table regularly even when there is no transmission made. The challenging part in wireless or mobile ad hoc networks is the mobility of the nodes. Since the nodes are mobile and act as a router of itself the routing table need to be updated regularly. An example of proactive routing protocol is Optimized Link State Routing (OLSR) [8] protocol. It helps the nodes to keep the updated route information and there will be no delay in route setup. Nodes obtain routes by periodic exchange of topology information with other nodes and maintain route information all the time. OLSR protocol is a variation of the pure Link-State Routing (LSR) protocol and is designed specifically for MANET. OLSR protocol achieves optimization over LSR through the use of MultiPoint Relay (MPR) to provide an efficient flooding mechanism by reducing the number of transmissions required. Unlike LSR, where every node declares its links and forward messages for their neighbors, only nodes selected as MPR nodes are responsible for advertising, as well as forwarding an MPR selector list advertised by other MPRs [base paper]. The OLSR protocol work most efficiently in the dense networks. The OLSR drawback is that it use constantly the bandwidth but AODV is trying to keep the bandwidth usage low for the maintaining of the routes. In the addition, the OLSR must keep the topology information in the topology set, MPR information in MPR selector set and also update the state information about the links and neighbours. So the OLSR must maintain the information about the hosts that it does not need. Large signalling traffic and power consumption is a disadvantage in proactive routing protocol.

2.3 Hybrid Routing Protocol

Hybrid routing protocol is a combination of proactive and reactive routing protocol. This protocol overcomes the limitation of both proactive and reactive protocol and combines the merits. It acts both as a proactive routing protocol when comes to dense networks and as a reactive protocol for large networks. Hybrid routing protocol [6] basically helps MANET for maintaining a large network. Zone Routing Protocol (ZRP) [9] is an example for hybrid routing protocol.

ZRP combines the merits of both proactive and reactive routing protocol. As the name implies ZRP works based on zones. The concept is, proactive routing protocol features are used for limited zone or dense area network and reactive routing protocol is used for area beyond the zone. ZRP consist of two main sub routing protocols:

- IntrA-zone Routing Protocol (IARP)
- IntEr-zone Routing Protocol (IERP).

IARP refers to the dense network that is the limited zone proactive routing component. IERP refers to the network beyond the zone which refers the reactive routing component. IARP maintains the topology information with regular updates within the routing zone of the node and IERP works only when the destination node is beyond the zone or belongs to another area network. The architecture of ZRP protocol is given in Figure 1

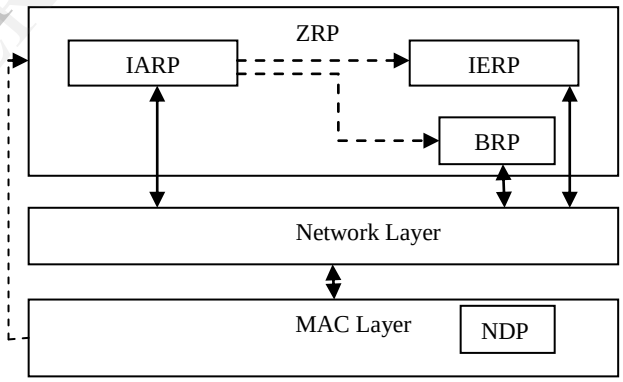


Fig 1 ZRP Architecture

Bordercast Routing Protocol (BRP) direct query request to the border of the zone. This protocol works similar to broadcasting packets. Neighbour Discovery Protocol (NDP) provided by the Media Access Control layer is used in detecting new neighbour nodes and link failures.

ZRP protocol reduces the traffic overhead compared to proactive and reactive routing protocols. It's mainly used for large networks.

3. Comparison On Routing Protocol Types

Here below is a comparison table on the types of routing protocol used and the advantages and disadvantages

Table 1
Comparison on Types of Routing Protocol

Routing Protocol Type	Protocol Example	Advantage	Disadvantage
Reactive Routing Protocol	AODV	Lower routing overhead	Route setup latency Packet Flooding
Proactive Routing Protocol	OLSR	Lower route setup latency	High routing overhead Large power consumption
Hybrid Routing Protocol	ZRP	No route setup latency Low routing overhead	More Complex

4. Case Study and Evaluation

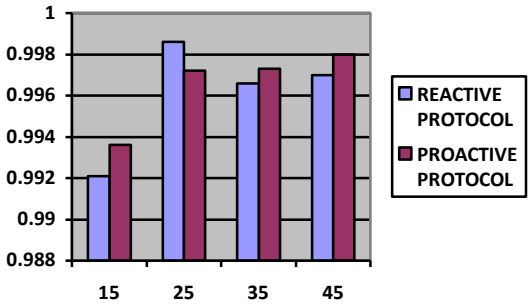
In this section methodology and metrics is considered to evaluate the performance of the types of routing protocols used in MANET.

The experiment is carried out using NS2 [10] as the simulation tool. NS2 is a discrete event network simulator which provides a detailed model of a wireless network with physical and link layer behavior of the network showing the node movements and packet transmission. For proactive routing protocol NS2 simulation with UM-OLSR is used. UM-OLSR [11] is an implementation of Optimized Link State Routing Protocol which supports functionalities of OLSR routing protocol. In the scenario 500 X 500 area used. For reactive protocol AODV is used as an example and the same scenario is used.

In order to evaluate the efficiency of the protocol two metrics for each simulation is taken

- Packet delivery ratio: The ratio between the number of packets originated by the application layer CBR sources and the number of packets received by the CBR sink at the final destination.
- Packet overhead: The number of transmitted routing packets; for example, a HELLO or TC message sent over four hops would be counted as four packets in this metric.

a) Packet Delivery Ratio



b) Packet Overhead

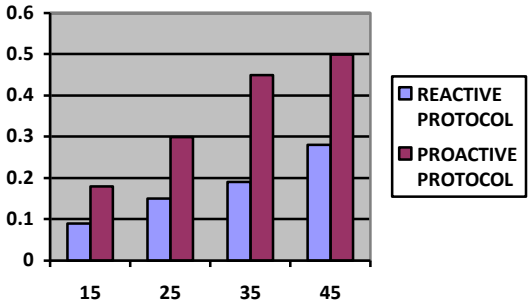


Fig 2 Performance Results

Figure 2a and 2b shows the packet delivery ratio and packet overhead, respectively. The packet loss will be less in proactive routing protocol when compared to the reactive protocol. The packet delivery ratio will be high for proactive routing protocol as the graph indicates. Packet overhead will be high in proactive routing protocol due to the continuous update of the topology information. The protocol will regularly update the routing table even though there is no traffic in the network. This is a disadvantage of proactive routing protocol.

In order to test the effectiveness, we evaluated our approach with four random network topologies. These four network topologies have 15, 25, 35, 45 nodes respectively. Figure 2 shows the performance results on proactive and reactive routing protocol for the metrics packet delivery ratio and packet overhead.

Hybrid routing protocol will combine the merits of proactive and reactive routing protocol and will overcome the limitations of these protocols such as the latency in path setup and routing overhead. Hybrid routing protocol is used for the large networks.

5. Conclusion

MANET is distinguished from other networks mainly by its self configuring and optimizing nature. Being the flexible network, MANET is exposed to various kinds of attacks especially the

routing attacks. Routing protocols plays a major role in the network performance such as throughput and packet delivery. Several protocols has been implemented in MANET. This paper briefly discuss about the types of routing protocols being used, proactive, reactive and hybrid protocol. Proactive routing protocol is efficient for MANET since it helps in updating the topology information in accordance with the fast mobility of the nodes. Regular routing update will help in the route identification and setup in mobile nodes. Proactive routing protocol is used in dense networks and there is a large power consumption in this protocol. Even if there is no traffic through the network the proactive routing protocol will update the route regularly thereby causing a high usage of bandwidth. Hybrid protocol is used to overcome the limitations of proactive and reactive routing protocol. Hybrid routing protocol is mainly used in large networks.

6. References

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