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A REVIEW OF ROUTING PROTOCOLS IN MOBILE AD HOC NETWORKS

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ABSTRACT: The widespread use of mobile and handheld devices is likely to popularize ad hoc networks (MANET), in which there is no requirement of any fixed wired infrastructure for intercommunication. An important and essential issue for mobile ad hoc networks is the design of routing protocols. The growing interest in mobile ad hoc network techniques has resulted in many routing protocol proposals. In this paper we will survey the routing protocols proposed for mobile ad hoc networks (MANET).

Keywords: routing protocols, MANET.

1. INTRODUCTION

With the advances in research and use of wireless communication technologies, high performance and cost effective wireless devices are widely used in mobile applications. Where infrastructure based cellular system is a traditional model for wireless communication, here in this paper we focus on a network that does not depend on a fixed infrastructure and is called mobile ad hoc network (MANET).

MANET [1] is a self-organizing and self-configuring multi-hop wireless network. The nodes in MANET move randomly, resulting in rapid and unpredictable changes in network topology. Additionally, because of limited transmission range of mobile nodes in a MANET, some nodes cannot communicate directly with each other. Mobile nodes act not only as a host but also as a router to maintain routes to destination and forwards data packets for other nodes also in the network.

Routing in mobile ad hoc network faces many challenges such as node mobility, dynamic topology, limited bandwidth and energy. The routing protocols for mobile ad hoc networks have to adapt quickly to frequent and unpredictable topology changes and must be effective in proper utilization of network resources. Scalability issue is another challenge for ad hoc routing protocols with excessive routing message overhead caused by the increase in number of wireless nodes in the network. Routing table size is also a concern in MANETs because larger size routing tables imply a large control packet size and hence larger link overhead.

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Routing protocols generally use either distance-vector or link-state routing algorithms [2]. Both types find shortest paths to destinations. In distance-vector routing (DV), a vector which contains the cost (hop distance) and path (next hop) to all the destinations is kept and exchanged at each wireless node. Routing Protocols using Distance Vector algorithm suffer from slow route convergence and a tendency to create loops in mobile environments. The link-state routing (LS) algorithm short out the problem by maintaining global information regarding network topology at each router through periodical flooding of link information about its neighbors.

Many protocols have been proposed for MANETs, with the goal of achieving efficient routing. The emphasis in this research paper is concentrated on the survey and comparison of various Routing protocols proposed for MANETs. In section II we have discussed basic features and mechanism of various routing protocols under the category Proactive/Table Driven, Reactive/On Demand and Hybrid routing protocols. Finally, in section III a conclusion is presented.

2. OVERVIEW OF ROUTING PROTOCOLS IN AD HOC NETWORKS

2.1. Proactive/Table Driven Routing Protocol

In proactive routing [3] [4] [13], one or more tables are maintained at each node which contains the latest information of the routes to other nodes in the network. Each row in the table has the next hop for reaching to a node or subnet and the cost of this route. The table-driven protocols are different in the way the information about change in topology is propagated through all nodes in the network. Proactive routing protocols use two different kinds of table updating methods. One is periodic update and another is triggered update. Because of the need to broadcast the routing tables or updates the proactive routing protocols

waste bandwidth and power in the network. As the number of nodes in the MANET increases, the size of the table is increased; this can increase the load in the network. Fisheye State Routing (FSR) [5] and Destination Sequenced Distance Vector (DSDV) [7] are Proactive routing protocols proposed for MANET.

Fisheye State Routing (FSR): The Fisheye State Routing (FSR) [5, 6, and 13] is a proactive unicast routing protocol which is based on Link State (LS) routing algorithm. FSR routing protocol effectively reduced routing overhead to maintain network topology information. It uses the "fisheye" technique proposed by "Kleinrock and Stevens" [16], where the technique was used to reduce the size of information required to represent graphical data.

In FSR each nodes maintain a link state table based on the updated information received from neighboring nodes. Each node keeps a full topology map of the network. This table is periodically exchange with local neighbors only. The key improvement in FSR is to use different update time intervals for different entries in the routing table, which results in decrement in the size of link state update messages. Link state updates corresponding to the nodes within a smaller scope are propagated with higher frequency.

As compared to other link state protocols, FSR exhibits a better scalability regarding the size of network because it doesn't strive for keeping all nodes in the network on the same knowledge level about link states.

The main problem with Link State (LS) protocols is they releases a link state update for each such change, which floods the network and causes excessive overhead. FSR avoids this problem by using periodic, instead of event driven, exchange of the network topology information, reducing the control message overhead.

Destination Sequence Distance Vector (DSDV): The Destination Sequence Distance Vector (DSDV) [7] is a proactive unicast MANET routing protocol. DSDV is also based on the traditional "Bellman-Ford algorithm". However, its mechanism, to improve routing performance in mobile ad hoc networks is different.

The next hop towards a destination, the cost metric for the routing path to the destination and a destination sequence number that is created by the destination are stored as an entry in the routing table of DSDV. Sequence numbers are used in DSDV to differentiate stale routes from fresh ones and avoid formation of route loops.

The route updates of DSDV can be either time-driven or event-driven. Every node periodically sends updates including its routing information to its neighbors. While a significant change occurs from the last update, a node can transmit the changed routing table in an event-triggered style.

Comparison of FSR and DSDV: Although belonging to the same routing category for MANET, FSR and DSDV have different features. In DSDV, updates to maintain up-to-date and consistent routing information for mobile nodes are transmitted in an event-triggered style. In contrast to using event-triggered updates, the updates in FSR are exchanged periodically between neighboring nodes and the update frequency is dependent on the distance between nodes.

DSDV and FSR are different in for loop-free feature. In DSDV, a destination sequence number is used to avoid network route loops. FSR inherits its loop free feature from traditional Link State routing algorithm.

FSR and DSDV have the same time and communication complexity. As compared with DSDV, FSR has higher storage complexity.

2.2. Reactive/On-Demand Routing Protocol

Reactive protocols [3, 4, and 6] do not maintain or constantly change their routing tables with the latest route topology. Instead, when a source node wants to transmit a data, it floods a query into the network to find out the route to the destination. The discovered route is stored until the destination node becomes inaccessible or until the route is no longer required. The protocols in this category are different in the way they handle cache routes, the mechanism they use for route discovery and how route replies are handled. Reactive protocols are considered efficient when the route discovery is employed. As compared to the total communication bandwidth, the network traffic caused by the route discovery mechanism is low. Dynamic Source Routing (DSR) [8] and Ad hoc On-Demand Distance Vector routing (AODV) [9] are reactive routing protocols proposed for MANET.

Dynamic Source Routing (DSR): The Dynamic Source Routing protocol (DSR) [6][8][13] is a simple and efficient reactive routing protocol designed for use in MANET. DSR support the self-organizing and self-configuring nature of MANET without having require-ment of existing network infrastructure or administration. The DSR protocol allows wireless nodes to dynamically discover a source route across multiple hops to any destination in ad hoc network. The routing performance of DSR is degraded by increased traffic overhead as a result of storing complete routing information into each data packet.

The DSR protocol is composed of two algorithms which work together for discovery and maintenance of source routes in the mobile ad hoc network.

1. Route Discovery is the mechanism by which a source node wishing to send a packet to a destination node obtains a source route to the destination. Route Discovery is used only when source node attempts to send a packet to another node and does not already know a route to the destination.

2. Route Maintenance is the mechanism by which source node is able to detect the failure of source route to destination because of change in network topology. When Route Maintenance indicates a source route is not in existence, source node can attempt to use any other route it happens to know to destination, or can invoke Route Discovery mechanism again to find a new route.

Both Route Discovery and Route Maintenance mechanism of DSR are used on demand. When a source node wants to send a data packet, it firstly checks its route cache. If the required route is available in the cache, the routing information is included in header of the data packet before sending it. Otherwise, the source node initiates a route discovery mechanism by flooding route request packets.

Ad Hoc On-Demand Distance Vector Routing (AODV): AODV [9] [13] is a reactive routing protocol which is collectively based on DSDV and DSR. Its objective is to minimize the requirement of system-wide broadcasts. It does not maintain routes from every node to every other node in the network. The routes to other nodes in the network are discovered as and when needed. The routes are maintained only as long as they are required. Every mobile node maintains a next-hop routing table, which contains the destinations to which it currently has a route. An entry in routing table expires if it has not been used for a pre-specified expiration time. AODV adopts the destination sequence number technique used by DSDV in an on-demand way.

Comparison of DSR and AODV: As reactive routing protocols for mobile ad hoc networks, DSR, and AODV were proposed to reduce the traffic overhead and improve scalability. DSR derive benefit from source routing and routing information caching. A data packet header in DSR carries the routing information needed in its route record field. AODV adopts the similar route discovery mechanism used in DSR, but stores the next hop routing information in the routing tables at each nodes. Therefore, AODV has less traffic overhead and is more scalable because of the size limitation of route record field in DSR data packets.

The DSR support unidirectional links and multiple routing paths, where as AODV doesn't support unidirectional links and multiple routing paths. As compared to DSR, wireless nodes using AODV periodically exchange hello messages with their neighbors to monitor link disconnections. This results in extra control traffic overhead. When a routing path disconnection is detected in AODV and DSR both, a node notifies the source node to re-initiate a new route discovery operation.

2.3. Hybrid Routing Protocol

Both the proactive and reactive protocols perform well for a network having less number of wireless nodes [3, 4, and 6]. As the number of wireless nodes increases in the network, the hybrid protocols are better to achieve higher performance. Hybrid protocols inherit the advantages of purely proactive and reactive protocols. Hybrid routing protocols use a reactive routing procedure at the network level while employing a proactive routing procedure in a node's local neighborhood. Zone Routing Protocol (ZRP) [7] and Zone-based Hierarchical Link State routing (ZHLS) [12] are hybrid routing protocols proposed for Mobile ad hoc network.

Zone Routing Protocol (ZRP): The Zone Routing Protocol (ZRP) [8, 20] is a hybrid routing protocol for mobile ad hoc networks. The hybrid protocols are proposed to decrease the control overhead of proactive routing approaches and reduce the latency caused by route search operations in reactive routing approaches.

In ZRP, the entire network is divided into routing zones according to distances between wireless nodes. Given a hop distance D and a node M, all nodes within hop distance at most D from M belong to the routing zone of M. Different routing approaches are used for inter-zone and intra-zone packets. Intra-zone Routing protocol (IARP) [14], the proactive routing approach, is used inside routing zones and Inter-zone Routing Protocol (IERP) [15], the reactive approach, is used between routing zones. The IARP maintains link state information for nodes within specified distance D. Therefore, if the source and destination nodes are in the same routing zone, a route is available immediately.

Zone-based Hierarchical Link State Routing (ZHLS): The Zone-based Hierarchical Link State routing (ZHLS) [12] is a hybrid routing protocol. In ZHLS, mobile nodes are aware about their physical locations with the help of a locating system like GPS. The ZHLS routing algorithm divides the network into non-overlapping zones based on geographical information.

ZHLS uses a hierarchical addressing scheme which contains zone ID and node ID information. A node finds its zone ID according to its location and the pre-defined zone map which is well known to all nodes in the network. If at least one physical link exists between two different zones then they are connected by a virtual link. A two-level network topology structure is defined in ZHLS routing protocol, one is the node level topology and another is the zone level topology. Similarly, there are two types of link state updates, one is the node level LSP (Link State Packet) and another is the zone level LSP. A node periodically broadcast a node level LSP which contains the node IDs of its neighbors in the same zone and the zone IDs of all other zones, to all other nodes in the same zone. As a result of periodic node level LSP exchanges, all nodes in a zone keep identical node level link state information. In ZHLS routing protocol, whenever the virtual link is broken or created, the gateway nodes broadcast the zone LSP throughout the network.

Comparison of ZRP and ZHLS: Both ZRP and ZHLS use different zone construction methods, which have critical effect on their performance. In ZRP routing protocol, the network is divided into overlapping zones according to the topology information for neighboring nodes of each node. In ZHLS the network is geographically divided into non-overlapping zones. Each node has a location system such as GPS and the geographical information is known to the nodes. The performance of a zone based routing protocol is affected by the size of the network and parameters used for zone construction. However, because zones heavily overlap, ZRP in general will results in more traffic overhead than ZHLS.

3. CONCLUSION

In this paper, an effort has been made to concentrate on the comparative performance study of various on demand, reactive and hybrid routing protocols (FSR, DSDV, DSR, AODV, ZRP and ZHLS). The survey indicates that AODV keeps on improving with denser mediums and at faster speeds. AODV is still better in Route updation and maintenance process.

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