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Survey on Mobile Ad Hoc Network Routing Protocols – Reactive Approach

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Abstract: Wireless mobile ad-hoc network is characterized as network without any physical connections. In this network there is no fixed topology due to the mobility of nodes, interference, multipath propagation and path loss. Many Routing protocols have been developed for accomplishing this task. The purpose of this paper is to review existing mobile ad-hoc reactive routing protocols depending on reactive nature. This research paper provides an overview of these protocols by presenting their characteristics, functionality, benefits and limitations and then makes their comparative analysis so to analyze their performance. The objective is to make observations about how the performance of these protocols can be improved.

Index Terms: MANET, Routing Protocol

I. INTRODUCTION

Mobile Ad Hoc Network (MANET)[1] is a collection of communication devices or nodes that wish to communicate without any fixed infrastructure and pre-determined organization of available links. The nodes in MANET themselves are responsible for dynamically discovering other nodes to communicate. It is a self-configuring network of mobile nodes connected by wireless links the union of which forms an arbitrary topology. The nodes are free to move randomly and organize themselves arbitrarily thus, the network's wireless topology may change rapidly and unpredictably. Routing is a core problem in networks for sending data from one node to another. Such networks are aimed to provide communication capabilities to areas where limited or no communication infrastructures exist. MANET's can also be deployed to allow the communication devices to form a dynamic and temporary network among them. MANET is receiving attention due to many potential military and civilian applications. MANETs have several salient characteristics like Dynamic topologies, Bandwidth-constrained links, Energy constrained operation and limited physical security. Therefore the routing protocols for wired networks cannot be directly used for wireless networks. Some examples of the possible uses of ad hoc networking include students using laptop computers to participate in an interactive lecture, business associates sharing information during a meeting, soldiers relaying information for situational awareness on the battlefield and emergency disaster relief personnel coordinating efforts after a hurricane or earthquake. MANET uses multi-hop routing instead of a static network infrastructure to provide network connectivity.

II. MANET ROUTING PROTOCOL

MANET routing protocol can be classified as Proactive and Reactive routing protocol[2].

A. Proactive Routing Protocol

In proactive routing, each node has one or more tables that contain the latest information of the routes to any node in the network. Each row has the next hop for reaching a node/subnet and the cost of this route. Various table-driven protocols differ in the way the information about a change in topology is propagated through all nodes in the network. There exist some differences between the protocols that come under this category depending on the routing information being updated in each routing table.

B. Reactive Routing Protocol

Reactive routing is also known as on-demand routing protocol since they don't maintain routing information or routing activity at the network nodes if there is no communication. They do not maintain or constantly update their route tables with the latest route topology. If a node wants to send a packet to another node then this protocol searches for the route in an on-demand manner and establishes the connection in order to transmit and receive the packet. The route discovery usually occurs by flooding the route request packets throughout the network.

III. REACTIVE ROUTING PROTOCOLS

Following are few routing protocols, which belongs to reactive approach.

1) Dynamic Source Routing (DSR)

Dynamic Source Routing (DSR) [3] protocol is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes. DSR allows the network to be completely self-organizing and self-configuring, without the need for any existing network infrastructure or administration. The protocol is composed of the two main mechanisms of "Route Discovery" and "Route Maintenance", which work together to allow nodes to discover and maintain routes to arbitrary destinations in the ad hoc network. All aspects of the protocol operate entirely on demand, allowing the routing packet overhead of DSR to scale automatically to only what is needed to react to changes in the routes currently in use. The protocol allows multiple routes to any destination and allows each sender to select and control the routes used in routing its packets.

2) Ad hoc On-Demand Distance Vector (AODV)

Ad hoc On-Demand Distance Vector (AODV) [4] protocol is intended for use by mobile nodes in an ad hoc network. It offers quick adaptation to dynamic link conditions, low processing and memory overhead, low network utilization, and determines unicast routes to destinations within the ad hoc network. It uses destination sequence numbers to ensure loop freedom at all times (even in the face of anomalous delivery of routing control messages), avoiding problems (such as "counting to infinity") associated with classical distance vector protocols.

3) Temporally-Ordered Routing Algorithm (TORA)

Temporally-Ordered Routing Algorithm (TORA) [5] is a distributed routing protocol for mobile, multihop, wireless networks. Its intended use is for routing of Internet Protocol (IP) datagrams within an autonomous system. The basic, underlying algorithm is neither a distance-vector nor a link-state; it is one of a family of algorithms referred to as "link reversal" algorithms. The protocol's reaction is structured as a temporally-ordered sequence of diffusing computations, each computation consisting of a sequence of directed link reversals. The protocol is highly adaptive, efficient and scalable; and is well- suited for use in large, dense, mobile networks. In these networks, the protocol's reaction to link failures typically involves only a localized "single pass" of the distributed algorithm. This desirable behavior is achieved through the use of a physical or logical clock to establish the "temporal order" of topological change events. The established temporal ordering is subsequently used to structure (or order) the algorithm's reaction to topological changes.

4) Cluster Based Routing (CBR)

Cluster Based Routing (CBR) [6] protocol divides the nodes of the ad hoc network into a number of overlapping or disjoint 2-hop- diameter clusters in a distributed manner. A cluster head is elected for each cluster to maintain cluster membership information. Inter- cluster routes are discovered dynamically using the cluster membership information kept at each cluster head. By clustering nodes into groups, the protocol efficiently minimizes the flooding traffic during route discovery and speeds up this process as well. Furthermore, the protocol takes into consideration the existence of uni-directional links and uses these links for both intra-cluster and inter-cluster routing.

5) Associativity Based long-lived Routing (ABR)

Associativity Based long-lived Routing (ABR) [7] is a simple and bandwidth-efficient distributed routing protocol which does not attempt to consistently maintain routing information in every node. In an ad hoc wireless network where mobile hosts are acting as routers and where routes are made inconsistent by mobile hosts' movement, we propose an Associativity-based routing scheme where a route is selected based on nodes having associativity states that imply periods of spatial, temporal, connection and signal stability. In this manner, the routes selected are likely to be long-lived and hence there is no need to restart frequently, resulting in higher attainable throughput. Our proposed protocol is based on source-initiated on-demand routing. Route requests are broadcast on a per-need basis. To discover shorten the route discovery time when the association property is violated, the localized- query and quick-abort mechanisms are respectively incorporated into the protocol. The association property also allows the integration of ad hoc routing into a base station oriented wireless LAN environment, providing the fault tolerance in times of base station failures.

6) Relative Distance Micro-discovery Ad Hoc Routing (RDMAR)

Relative Distance Micro-discovery Ad Hoc Routing (RDMAR) [8] protocol is highly adaptive, bandwidth-efficient and scaleable. A key concept in its design is that protocol reaction to link failures is typically localised to a very small region of the network near the change. This desirable behaviour is achieved through the use of a novel mechanism for route discovery, called Relative Distance Micro-discovery (RDM). The concept behind RDM is that a query flood can be localised by knowing the relative distance (RD) between two terminals. To accomplish this, every time a route search between the two terminals is triggered, an iterative algorithm calculates an estimate of their RD, given an average nodal mobility and information about the elapsed time since they last communicated and their previous RD. Based on the newly calculated RD, the query flood is then localised to a limited region of the network centred at the source node of the route discovery and with maximum propagation radius that equals to the estimated relative distance. This ability to localise query flooding into a limited area of the network serves to increase scalability and minimise routing overhead and overall network congestion.

7) Location-Aided Routing (LAR)

Location-Aided Routing (LAR) [9] aims to decrease overhead of route discovery by utilizing location information for mobile hosts. Such location information may be obtained using the global positioning system GPS. We demonstrate how location information may be used by means of two Location-Aided Routing (LAR) protocols for route discovery. The LAR protocols use location information (which may be out of date, by the time it is used) to reduce the search space for a desired route. Limiting the search space results in fewer route discovery messages.

8) Ad hoc On-demand Multipath Distance Vector (AOMDV)

The main idea in Ad hoc On-demand Multipath Distance Vector (AOMDV) [10] is to compute multiple paths during route discovery. It is designed primarily for highly dynamic ad hoc networks where link failures and route breaks occurs frequently. When single path on-demand routing protocols such as AODV is used in such networks, a new route discovery is needed in response to every route break. Each route discovery is associated with high overhead and latency. This inefficiency can be avoided by having multiple redundant paths available. Now, a new route discovery is needed only when all paths to the destination break. AOMDV is using routing information already available in underlying AODV protocol as much as possible. Thus little additional overhead is required for the computation of multiple paths.

9) Flow State in the Dynamic Source Routing (FSDSR)

Flow State in the Dynamic Source Routing (FSDSR) [11] defines an extension to the Dynamic Source Routing protocol (DSR), a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes. DSR enables the sender of a packet to determine the sequence of nodes through with the packet must be forwarded to reach the intended destination node, and to route that packet along that sequence of hops by including a source route header in the packet. All aspects of the protocol operate entirely on-demand, allowing the routing packet overhead of DSR to scale automatically to only that needed to react to changes in the routes currently in use. The DSR extension defined in this document, known as "flow state", allows the routing of most packets without an explicit source route header in the packet, further reducing the overhead of the protocol while still preserving the fundamental properties of DSR's operation.

10) Dynamic NIx-Vector Routing (DNVR)

Dynamic NIx-Vector Routing (DNVR) [12] is a pure on-demand routing protocol. It acquires a loop-free route and maintains it on a demand basis as do other on-demand routing protocols. The DNVR protocol, however, has several distinct features from other on-demand routing protocols like Validation of the stored route information, Utilization of probes for efficient sensing of the network, Management of routing states in a timely fashion, Suppression of route requests for a conservative route discovery, Removal of address resolution and Use of a compact form of source routes.

11) Reliable Ad-hoc On-demand Distance Vector routing (RAODV)

Reliable Ad-hoc On-demand Distance Vector routing (RAODV) [13] is a co-operative security scheme based on local monitoring to solve the problem of attack by malicious as well as selfish nodes. RAODV is an approach to routing that incorporates reliability level of nodes into traditional routing metrics for finding path. RAODV is based on AODV with the assumption that nodes cannot impersonate and all other network conditions are good. RAODV behaves as AODV in the absence of attack and, detects and isolates misbehaving nodes in the presence of attack. Also it recovers from the attack when a misbehaving node leaves the network or becomes good. It does not need any special type of hardware like CONFIDANT and CORE.

12) Dynamic MANET On-demand (DYMO)

The Dynamic MANET On-demand (DYMO) [14] routing protocol enables reactive, multihop unicast routing among participating DYMO routers. The basic operations of the DYMO protocol are route discovery and route maintenance. During route discovery, the originator's DYMO router initiates dissemination of a Route Request (RREQ) throughout the network to find a route to the target's DYMO router. During this hop-by-hop dissemination process, each intermediate DYMO router records a route to the originator. When the target's DYMO router receives the RREQ, it responds with a Route Reply (RREP) sent hop-by-hop toward the originator. Each intermediate DYMO router that receives the RREP creates a route to the target, and then the RREP is unicast hop-by-hop toward the originator. When the originator's DYMO router receives the RREP, routes have then been established between the originating DYMO router and the target DYMO router in both directions. Route maintenance consists of two operations. In order to preserve routes in use, DYMO routers extend route lifetimes upon successfully forwarding a packet. In order to react to changes in the network topology, DYMO routers monitor routes over which traffic is flowing.

When a data packet is received for forwarding and a route for the destination is not known or the route is broken, then the DYMO router of the source of the packet is notified. A Route Error (RERR) is sent toward the packet source to indicate the route to that particular destination is invalid or missing. When the source's DYMO router receives the RERR, it deletes the route. If this source's DYMO router later receives a packet for forwarding to the same destination, it will need to perform route discovery again for that destination. DYMO uses sequence numbers to ensure loop freedom.

13) Admission Control enabled On-demand Routing (ACOR)

Admission Control enabled On-demand Routing (ACOR) [15] protocol is a reactive routing protocol designed to support quality of service (QoS) on the end to end route. ACOR is based on simple local cost functions at each node, and global cost function to represent the end-to-end cost of a route, in addition to a simple admission control mechanism for implicit resource reservation adapted to frequent changing of network topology.

IV. CONCLUSION

In this research paper, several existing routing protocols for MANET are described. Two categories of routing protocols also specified. Proactive and Reactive routing protocols. In proactive protocols, each node maintain up-to-date routing information to all the nodes in the network where in Reactive protocols a node finds the route to a destination when it desires to send packets to the destination. Several reactive protocols are discussed like DSR, AODV, TORA, CBR, ABR, RDMAR, LAR, AOMDV, DNVR, RAODV, DYMO and ACOR. RDMR and LAR have the same cost as the traditional flooding algorithm in the worst-case scenario. In ABR, destination nodes select routes based on their stability. It also allows shortest path route selection to be used during the route selection at the destination. It may perform better than the purely shortest path selection based routing protocols such as DSR. The connection setup delay is lower in AODV.

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