ISSN:0975-9646

Survey on Geographical Routing Protocols in Network-Centric Warfare Paradigm

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Abstract: Mobile Ad hoc Network (MANET) allows portable devices to establish communication independent of a central infrastructure. The wireless links in this network are highly error prone and can go down frequently due to mobility of nodes. Therefore, routing in MANET is a critical task due to highly dynamic environment. Efficient Routing Protocols will make MANET reliable. Protocols are of three kind i.e. Proactive, Reactive and hybrid.. Several Routing Protocols for MANET are Dynamic Source Routing (DSR), Ad hoc On-demand Distance Vector (AODV), Destination Sequence Distance Vector (DSDV) and Temporally Ordered Routing Algorithm (TORA).This paper presents the overview, characteristics, functionality, benefits and limitations and makes their comparative analysis, so to analysis their performance. The objective is to make observations about how the performance of these protocols can be improved.

Keywords: Ad hoc on-demand Distance Vector, Routing protocols, Time Complexity.

INTRODUCTION

In MANET mobile nodes communicate with each other using multi-hop wireless links without infrastructure. Every node in the network act as a router as well as packet forwarding agency for other nodes. A central challenge in the design of MANET is the development of dynamic routing protocols that can efficiently find routes between two communicating nodes. Due to high level of dynamism, reliable, fast and energy efficient routing of data packets from the source to the destination is important. One cannot rely on use of access points or other infrastructure for routing, thus leaving only one option of building multi-hop routes from source to destination. . Energy consumption in MANET is very critical issue. Mobile devices have limited battery power and processing power. In MANET, Routing Protocols can be divided into three categories:

Proactive Routing Protocols or Table Driven Routing Protocols, Reactive Protocols or Demand Routing Protocols and Hybrid Routing Protocols. Proactive Routing Protocols contain consistent and up-to-date routing information to all nodes which is maintained at each node. Reactive Protocols the routes are created, when required, when source wants to send to a destination, it invokes the route discovery mechanisms to find the path to the destination.

ROUTING PROTOCOLS

Routing Protocol is needed whenever a packet needs to be transmitted to a destination via number of nodes and numerous Routing Protocols have been proposed for such kind of network. These Protocols find a route for packet delivery and deliver the packet to the correct destination. The studies on various aspects of Routing Protocols have been an active area of research for many years. Basically, Routing Protocols can be broadly classified into three types as Table Driven Protocols or Proactive Protocols, On-Demand Protocols or Reactive Protocols and Hybrid Protocols.

1. Table-driven or Proactive Protocols: Proactive routing protocols attempt to maintain consistent, up-to-date routing information between every pair of nodes in the network by propagating, proactively, route updates at fixed intervals. Representative proactive protocols include: Destination-Sequenced Distance- Vector (DSDV) routing, Clustered Gateway Switch Routing (CGSR), Wireless Routing Protocol (WRP), Optimized Link State Routing (OLSR) and The Fisheye State Routing (FSR).
2. On-Demand (or) Reactive routing protocols: protocols that fall under this category do not maintain the network topology information. They obtain the necessary path when it is required, by using a connection establishment process. Hence these protocols do not exchange routing information periodically. Some of the existing routing protocols that belong to this category are DSR, AODV, TORA, ABR, SSA, FORP, PLBR.
3. Hybrid Routing Protocols: Purely proactive or purely reactive protocols perform well in a limited region of network setting. However, the diverse applications of ad hoc networks across a wide range of operational conditions and network configuration pose a challenge for a single protocol to operate efficiently.

DSDV

In DSDV, packets are transmitted between mobile nodes by using Routing Tables which are stored at mobile node. Each Routing Table, at each of the mobile node contain list of all available destinations and the number of hops to each. Upon receiving the routing information, routes with more recent sequence numbers are preferred as the basis for making forwarding decisions of the paths with the same sequence number; those with the shortest hop distance will be used. That information (i.e. next hop and hop distance) is entered in the routing table, along with the associated sequence number tag. When the link to the next hop has failed, any route through that next hop is immediately assigned a one infinite hop distance and its sequence number is updated. When a node receives a broadcast with an infinite 1 metric, and it has a more recent sequence number to that destination, it triggers a route update broadcast to disseminate the important news about that destination. The advantage is it is quite suitable for creating ad hoc networks with small number of nodes. The DSDV protocol is proven to guarantee loop-free paths to each destination at all instants. DSDV requires a regular update of its routing tables, which uses up battery power and a small amount of bandwidth even when the network is idle. DSDV is not suitable for highly dynamic networks.

CLUSTER-HEAD GATEWAY SWITCH ROUTING (CGSR)

Cluster-head Gateway Switch Routing (CGSR) Protocol is a hierarchical protocol based upon the DSDV Routing algorithm using a cluster head to manage a group of action nodes. The algorithm works in a very simple manner. Then which in turn transmits it to the gateway of the destination cluster. The node consults its routing table to find the next hop in order to reach the cluster-head selected in step one and transmits the packet to that node.

AODV (AD HOC ON-DEMAND DISTANCE VECTOR)

AODV is a variation of destination sequenced distance vector (DSDV) routing protocol which is collectively based on DSDV and DSR. If aims to minimize the requirement of system –wide broadcasts to its extreme. It does not maintain routes from every node to every other node in the network rather they are discovered as and when needed and maintained only as long as they are required. The neighbors without a valid route to the destination establish a reverse route and rebroadcast route request packet. The route maintenance is done by exchanging beacon packets at regular intervals. This protocol adapts to highly dynamic topology and provide single route for communication.

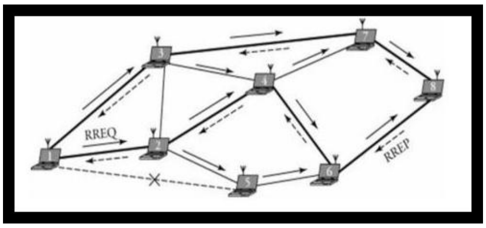

Fig 1: shows the process of signals with AODV from node 1 to node 8.

TEMPORALLY ORDERED ROUTING ALGORITHM (TORA)

Temporally Ordered Routing Algorithm (TORA) is a uniform, destination-based, reactive protocol. A destination- oriented directed acyclic graph is built for each destination. If connectivity changes result in a node losing its entire outbound links, the node "reverses" the direction of some or its entire inbound links. TORA assumes that each node is informed of link-status changes for any of its immediate neighbors. This has the effect of creating a series of directed links from the original sender of the query packet to the node that initially generated the update packet. When it was discovered by a node that the route to a destination is no longer valid, it will adjust its height so that it will be a local maximum with respect to its neighbors and then transmits an update packet. If the node has no neighbors of finite height with respect to the destination, then the node will attempt to discover a new route as described above. When a node detects a networks partition. It will generate a clear packet that results in reset of routing over the ad hoc network.

TORA'S reliance on synchronized clocks limits in applicability. If the external time source fails, the algorithm ceases to operate. Also route rebuilding may not occur as quickly due to oscillations. During this period this can lead to lengthy delays while for the new routes to be determined.

DSR (DYNAMIC SOURCE ROUTING)

The dynamic source routing (DSR) protocol is an on-demand routing protocol based on source routing. In the source routing technique, a sender determines the exact sequence of the nodes through which to propagate a packet. The list of intermediate nodes for routing is explicitly contained in the packet's header. In DSR every mobile node in the network needs to maintain a route cache where it caches source routes that it has learned. When a host wants to send a packet to some other host, it first checks its route cache for a source route to the destination. In the case a route is found, the sender and route maintenance are the two major parts of the DSR protocol.

Route discovery: the source node starts by broadcasting a route request packet that can be received by all neighbor nodes within its wireless transmission range. The route request contains the address of the destination host, referred to as the target of the route discovery, the source address, a route record field and a unique identified number. At the end, the source host should receive a route reply packet containing a list of network nodes through which it should propagate the packets, supposed the route discovery, process was successful. During the route discovery process, the route record field is used to accumulate the sequence of hops already taken, first of all the sender initiates the route record as a list with a single elements containing itself. The next neighbor node appends itself to the list and soon.

Route maintenance: route maintenance can be accomplished by two different process:-

i). Hop-by-hop acknowledgement at the data link layer allows an early and retransmission of lost or corrupt packets.

ii). End-to-end acknowledgement may be used if wireless transmission between two hosts does not work equally well in both directions. As long as a route exists by which the two end hosts are able to communicate, route maintenance is possible.

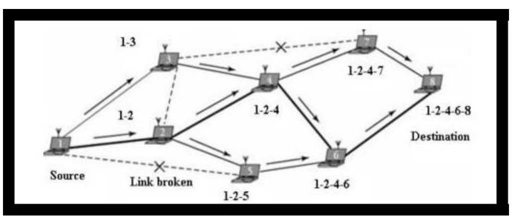

Fig 2: DSR Communication signaling from node 1 to node 8

COMPARISON OF DSR, AODV AND TORA

DSR, AODV and TORA are proposed to reduce the control traffic overhead and improve scalability. In the appendix, their main differences are listed. DSR exploits source routing and routing information caching. A data packet in DSR carries the routing information needed in its route record field. DSR uses flooding in the route discovery phase.

In AODV, the link failure notification is forwarded as layers the source node is not reached. After having learned about the failure the source node may reinitiate the route discovery protocol. TORA supports multiple routes. It retains multiple route possibilities for a single source/destination pair. Bandwidth is conserved because of the fever route rebuilding.

PERFORMANCE METRICS

The following different quantitative metrics have been considered to make the comparative study of their routing protocols through simulation.

Routing overhead: This metric describes how many routing packets for route discovery and route maintenance need to be send so as to propagate the data packets.

Average delay: This metric represents average end-to-end and indicates how long it took for a packets to travel from the source to the application layer of the destination. It is measured in seconds.

Throughput: This metrics represents the total number of bits forwarded to higher layers per second. It is measured in bps. It can also be defined as the total amount of data a receiver actually receiver to obtain the last packet.

Packet Delivery Ratio: The ratio between the amount of incoming data packets and actually received data packets.

TABLE - I: Low Mobility and Low Traffic

Protocol	Routing Overhead	Average end-to-end delay	Packet delivery ratio
DSR	Low	Average	High
AODV	Low	Average	High
TORA	Moderate	Low	High

TABLE - II: High Mobility and High Traffic

Protocol	Routing Overhead	Average end-to-end delay	Packet delivery ratio
DSR	Average	Average	Average
AODV	Very high	Average	Average
TORA	High	More	Low

TABLE - III: Other Parameters

Parameters	DSR	AODV	TORA
Overall Complexity	Medium	Medium	High
Routes maintained	Route cache	Route table	Route table
Route Configure	Easy route notify source	Easy route notify source	Link Reversal
Route Metrics	Shortest path	Freshest & shortest path	Shortest path

CONCLUSION

This paper provides the descriptions of several routing scheme proposed for mobile ad hoc networks. The performance analysis of various on-demand/reactive routing protocols (DSR, AODV, and TORA) on the basis of above mentioned performance metrics. The result after analysis here reflected in Table-I and Table-II. The first table is description of parameter selected with respected to low mobility and low traffic. The second table is description of parameter selected with respected to high mobility and high traffic. The Table-III is described of other important parameters that make a protocol robust and steady in most cases overhead in some cases DSR and AODV outperformance TORA.

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