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Comparative Review Study Of MANET Routing Protocols

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Abstract

Mobile Ad-hoc Networks(MANET) are the assembly of mobile nodes that inter-communicate on shared wireless channels without any fixed infrastructure or any centralized control. It's a self configuring network where each node must function as a router. These mobile nodes move arbitrarily and form irregular topologies. Routing is consequently a prime challenge in ad-hoc networks. Many routing protocols have been proposed to date where each one has its own advantages and pitfalls and thus used in different scenarios. These protocols mainly belong to three categories namely proactive, reactive and hybrid. This paper provides an overview and comparison of some of the protocols by presenting their characteristics, functionality, benefits and limitations.

Keywords- AODV, CBRP, DSDV, DSR, MANET.

1.Introduction

Ad-hoc means "formed for a particular purpose". Thus MANET's are the purpose specific networks which are configured on the fly when there exists limited or no communication infrastructure. They do not require a pre-existing architecture for communication purpose and do not rely on any type of wired infrastructure; thus in an ad hoc network all communication occurs

through a wireless median. MANETs can be deployed to allow the communication devices to form a dynamic and temporary network among them. It is used in areas of Sensor networks for environmental monitoring, Rescue operations in remote areas, Remote construction sites, and Personal area Networking, Emergency operations, Military environments, Civilian environments etc [1]. Due to the dynamic nature of these networks and rapidly changing topologies routing is very crucial issue to deal with. An Ad-hoc routing protocol is a convention or standard that controls, how nodes come to agree which way to route packets between computing devices in a MANET [2]. There are many routing protocols that are being used currently in MANET. These protocols are divided in three categories.

1.1. Proactive Routing Protocol (Table-Driven)

This type of protocols maintains a list of destinations and their routes at each node. The proactive routing protocols use link-state routing algorithms which frequently flood the link information about its neighbors [3]. The main disadvantage of such algorithms is that overhead involved in maintaining the routing table is high.

1.2. Reactive Routing Protocol (On Demand)

The reactive routing protocols are based on some sort of query-reply dialog [4]. Routes are discovered on demand and are not known beforehand as in proactive protocols. Thus the overhead of maintaining routing table is reduced.

1.3. Hybrid routing protocol

The routing is initially established with some proactively prospected routes and then serves the demand from additionally activated nodes through reactive flooding [3]. Scalability is the important feature provided by these protocols.

The remainder of the paper is organized as follows. Section II provides the overview of some renowned routing protocols of MANET namely DSDV, AODV, DSR, TORA, CBRP. This section briefly describes the working mechanism of these protocols, their advantages and limitations. Comparison of the above mentioned protocols is done on various grounds in section III followed by the conclusion in section IV.

2. Overview of routing protocols

In this section an overview of five MANET routing protocols is done.

2.1. Destination sequence distance vector routing protocol (DSDV)

DSDV [5] is developed on the basis of Bellman–Ford routing algorithm with some modifications[4]. It is proactive protocol where each network node maintains a routing table which contains the next-hop for, and number of hops to, all reachable destinations. Routing tables are updated by periodical broadcasts in case of any changes in the topology. To make the protocol loop free DSDV uses sequence number stored in routing tables. Every node maintains

a monotonically increasing sequence number for itself. It also maintains the highest known sequence number for each destination in the routing table (called "destination sequence numbers"). The routing updates can be "Event Driven" or "Time Driven". These routing table updates can be sent via "full dump" or "incremental updates". In incremental updates, only those information are sent which have changed since last updates. Full Dump means sending whole routing table [6]. In a relatively stable network, incremental updates are used while in fast changing network full dumps are preferable. DSDV requires a regular update of its routing tables, which uses up battery power as well as bandwidth even when the network is idle. Whenever the topology of the network changes, a new sequence number is necessary before the network re-converges; thus DSDV is not suitable for highly dynamic networks [1].

2.2. Ad-Hoc on demand distance vector routing protocol (AODV)

The Ad-hoc On-Demand Distance Vector (AODV) algorithm enables dynamic, self-starting, multihop routing between participating mobile nodes wishing to establish and maintain an ad-hoc network. AODV allows mobile nodes to obtain routes quickly for new destinations, and does not require nodes to maintain routes to destinations that are not in active communication [7]. When any source node wants to send a packet to a destination, it broadcasts a route request (RREQ) packet. Each node in turn forwards RREQ packet until the destination node itself is reached or the node which has a fresh route to destination is reached. A route reply (RREP) packet is then unicasted back to source node through established reverse route. Nodes monitor the link status of next hops in active routes. Whenever a link break in an active route is found, a route error (RERR) message is used to notify other nodes that the link is lost. The AODV routing protocol is a combination of DSDV and DSR algorithm. It uses the periodic broadcasting and sequence numbering procedure of DSDV and a route discovery procedure of DSR. However, there are two important differences between DSR and AODV. The most distinguishing feature is that in DSR the routing packet carries full routing information, whereas in AODV the packets carry the destination address only. This causes AODV to have potentially less routing overheads than DSR. The other difference is that the route reply packets in AODV carry the destination IP address and the sequence number whereas in DSR it contains the address of every node along the route. The advantage of AODV is that it is adaptable to high mobility networks. However due to route discovery latency AODV is not suitable for large size networks.

2.3. Dynamic source routing protocol (DSR)

Dynamic source routing protocol (DSR) [8] is an on-demand routing protocol that uses "source routing". It is composed of the two main mechanisms of "Route Discovery" and "Route Maintenance". DSR does not require broadcasting of periodic packets of any kind at any layer within the network. For instance, DSR does not use any periodic routing table advertisement, link status sensing. This reduces the amount of overhead in transmitting broadcasts significantly when the network is stable. As nodes begin to move more or as topology pattern changes that

are not affecting routes currently in use are ignored and do not trigger reaction from the protocol. An advantage of DSR is that the nodes can store multiple routes in their route cache, which means that the source node can check its route cache for the existence of a valid route before initiating route discovery, in case a valid route is found there is no need for route discovery. Multiple routes are also advantageous for load balancing purposes. It is also very beneficial in network with low mobility. Since the routes stored in the route cache will be valid longer.

2.4. Temporally ordered routing algorithm (TORA)

TORA is a reactive routing protocol with some proactive enhancements where a link between nodes is established creating a Directed Acyclic Graph (DAG) of the route from the source node to the destination [4]. This protocol uses a "link reversal" model in route discovery. TORA does not continuously implement a shortest-path estimation and thus the metric used to set up the routing structure does not represent a distance. TORA defines a new metric termed as height where no two nodes may have the same height. Links between nodes are assigned directions ("upstream" or "downstream") based on the relative values of a metric associated with each router. This forms a routing structure that is used to forward packets to the destination. Data flows from nodes with higher heights to nodes with lower heights which forms a loop free and multipath routing structure. A route discovery query is broadcasted and propagated throughout the network until it reaches the destination or a node that has address to destination . As the query response packet termed as update packet(UPD) propagates back, each intermediate node updates its TORA table with the route and height to the destination node. The source node then uses the height to select the best route towards the destination. TORA is designed to minimize the communication overhead associated with adapting to network topological changes[9].

2.5. Cluster-based routing protocol (CBRP)

Unlike the routing protocols described so far in CBRP the nodes are organized in a hierarchy. The protocol divides the nodes of the ad-hoc network into a number of overlapping or disjoint clusters. Each cluster has a cluster-head and member nodes. These clusterheads coordinate the whole routing process and are also connected to clusterheads of other clusters through gateway nodes. 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 unidirectional links and uses these links for both intra-cluster and inter-cluster routing [10]. This protocol has a attribute of scalability however, in hierarchical routing protocols, the overheads associated with cluster formation and cluster maintenance is a drawback.

3. Comparison of the protocols

Various routing protocols are given in Table I with their features and characteristics. The first column indicates the grounds on which the comparison is done followed by the features of DSDV, AODV, DSR, TORA, CBRP. Study reveals that each protocol performs proficiently in some particular scenarios. In DSDV, CBRP and TORA, broadcasting is done periodically to maintain routing updates but in AODV, only hello messages are sent to its neighbors to sustain local connectivity. DSDV needs to broadcast periodic updates in the routing table anytime the topology changes occur on the other hand in DSR updates are sent only if the routes currently in use are affected by topology change. Hence routing overhead will be minimum in DSR and highest in DSDV. For static networks routing table updates and routing table size will be minimum so DSDV will be best suited for such networks. In CBRP only clusterheads are flooded with the routing updates which reduces network traffic. Thus network is well scalable if it uses CBRP. TORA and DSR provides multiple routes to destination. Thus before initiating the route discovery process source node will look into its routing table for any existing route to destination which minimizes bandwidth usage. DSR appends entire route address in its data packets and so the packet size increases in DSR as the network size increases while in AODV packets does not contain full route address. Hence DSR is well suited for smaller networks as compared to AODV.

TABLE I
COMPARISON OF ROUTING PROTOCOL

Performance constraints	DSDV	AODV	DSR	TORA	CBRP
Category	Table driven or Proactive	On-demand or reactive	On-demand or reactive	Hybrid	Hybrid/Hierarchical
Periodical Broadcast	Yes	Yes / Hello messages	No	Yes	Yes
Protocol algorithm	Distance vector	Distance vector	Source routing	Link reversal	Clustering
Routing Overhead	High	Moderate	Minimum	Moderate	Moderate
Loop free	yes	Yes	Yes	Yes	Yes
Multiple routes	No	No	Yes	Yes	Yes
Suitable for	For smaller and relatively static networks	For moderate size and highly dynamic networks like VANET	For small size networks with moderate mobility	For large size networks with low mobility	For large size networks with moderate mobility

5. Conclusion

Mobile Ad-hoc Networks, called MANETs, are becoming useful as the existing wireless infrastructure is expensive and inconvenient to use. They are going to become integral part of next generation mobile services. In this paper some traditionally used routing protocols of MANET are compared. The understanding of the basic protocols, their algorithms, advantages and limitations is essential for understanding the routing mechanism in MANET's. This will lend a hand in developing new protocols for more robust environments and for more stressful conditions.

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