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RESEARCH ARTICLE

Routing Protocols in MANET: Comparative Study

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Abstract— A Mobile Ad Hoc Network (MANET) is composed of mobile nodes without any infrastructure like wireless access points or base stations. MANET describes wireless, mobile and multi-hop networks that operate without the benefit of any existing infrastructure except for the nodes themselves. The main goal of an ad hoc network routing protocol is to establish correct and efficient route between a pair of mobile nodes so that messages delivered within the active route timeout interval. Several protocols are introduced for improving the routing mechanism to find route between any source and destination host across the network. This paper describes and compares various routing protocols used in MANET, viz. proactive, reactive and hybrid routing protocols.

Keywords— MANET, AODV, DSDV, DSR, OLSR

I. INTRODUCTION

Wireless networking is a technology that enables two or more computers to communicate using standard network protocols, but without network cabling. We can categorize wireless network in primarily following two categories. Two types of wireless networks[1]:

- *Infrastructured network:* A network with fixed and wired gateways.
- *Infrastructureless (ad hoc) network:* All nodes of these networks behave as routers and take part in discovery and maintenance of routes to other nodes.

A mobile ad hoc network (MANET) is a collection of mobile devices that can communicate with each other without the use of a predefined infrastructure or centralized administration. A MANET can be constructed quickly at a low cost. Due to mobility of nodes, it becomes difficult to perform routing in a MANET as compared to a conventional wired network[3].

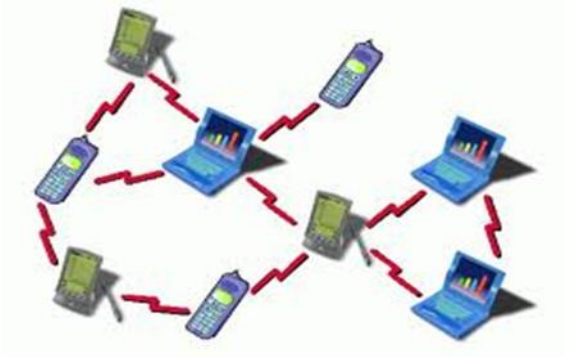

Fig. 1. Mobile Ad-Hoc Network

II. ROUTING IN MANET

The entire routing concept includes two functions: determining optimal routing paths and transferring the packets through the network. Because of the dynamic topology of the ad-hoc networks, routing packets between any pair of nodes becomes difficult. Multi cast routing is another challenge because the multi cast tree is no longer static due to the random movement of nodes within the network. Routes between nodes may contain multiple hops which is more complex.

Routing Protocols Terminology

Routing is the process of information exchange from one host to the other host in a network. Routing is the mechanism of forwarding packet towards its destination using most efficient path. In Ad-hoc network each host node acts as specialized router itself. A routing protocol maintains a routing table to keep information about the linking node and neighbors. Researchers have proposed several routing protocols for both wired and wireless networks. They lie into four distinct categories depending on their properties:

A. **Centralized Vs. Distributed**

In centralized algorithms, all route selection are made at a central node, while in distributed algorithms, the evaluation of route is shared among the network nodes.

B. **Static Vs. Adaptive**

In static algorithms, the route used by source-destination pairs is fixed being independent of traffic conditions. Here route for transitions change only in response to a node or a link failure. Such types of algorithms cannot achieve high throughput under a wide variety of traffic input patterns. Most major packet networks use some form of adaptive routing which in response to congestion may change the route between the source and destination.

C. **Flat Vs. Hierarchical**

A flat addressing is one of the pre-requisite for the flat routing approach. Each underlying node participating in routing plays an important role and all nodes have same responsibilities means no special gateway nodes are present. In contrast, hierarchical routing usually assigns different roles to network nodes.

D. **Proactive (Table-Driven) Vs. Reactive (On-Demand-Driven) Vs. Hybrid**

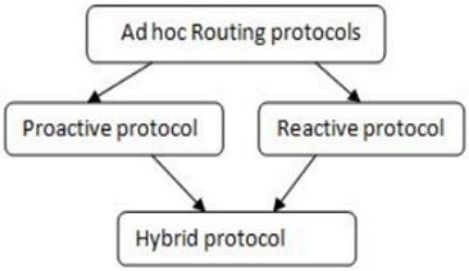

Fig. 2. Classification of Routing Protocols

• *Proactive routing protocol*

These types of protocols are called table driven protocols in which fresh lists of destinations and their routes are maintained by periodic distribution of routing tables throughout the network and this category of protocol always strives to maintain consistent and updated routing information at each node. Packets are transferred over the predefined route specified in the routing table. The proactive routing protocols use link-state routing algorithms which frequently flood the link information about its neighbors and the main drawback of proactive routing protocol is that all the nodes in the network always maintain an updated table. Proactive protocols have lower latency in comparison to reactive protocols. Example Protocols: DSDV, OLSR (Optimized Link State Routing)

• *Reactive routing protocol*

These types of protocols[5] are also called as On Demand Routing Protocols where the routes are not predefined for routing. Reactive protocols establish a route to a destination on demand. The route discovery mechanism is based on flooding algorithm which employs on the technique that a node just broadcasts the packet to all of its neighbors and intermediate nodes just forward that packet to their neighbors. Reactive protocols have higher latency and smaller routing overheads as compared to proactive protocols. Example Protocols: DSR, AODV

• *Hybrid routing protocol*

Hybrid protocols are the combinations of reactive and proactive protocols and take advantages of these two protocols and thus combine the advantages of both. Example Protocol: ZRP (Zone Routing Protocol).

III. COMPARISON OF VARIOUS PROACTIVE ROUTING PROTOCOLS

i) Destination-Sequenced Distance-Vector (DSDV) protocol

In DSDV, each node is required to transmit a sequence number, which is periodically increased by two and transmitted along with any other routing update messages to all neighboring nodes[7]. On reception of these update messages, the neighboring nodes to decide whether to ignore the update or to make the necessary changes to its routing table based on the following algorithm:

Step 1: Receive the update message.
Step 2: If any one of the two conditions given below satisfies, then update the routing table:
i) Sn> Sp
ii) Sn=Sp, Hop count is less
Otherwise, ignore the update message.
Where, Sn is the sequence number of new message
& Sp is the sequence number of existing message.

Advantages:

- Suitable for small number of nodes,
- Other protocols have borrowed similar techniques (e.g. AODV).

Disadvantages:

- No formal specification, no significant commercial implementation
- Need regular update of its routing tables, (battery power problem)
- Congestion control is bad.

ii) Optimized Link State Routing(OLSR) Protocol

The Optimized Link State Routing Protocol (OLSR) is an IP routing protocol optimized for mobile ad hoc networks, which uses HELLO and TC (Topology Control) messages to discover and then disseminate link state information throughout the mobile ad hoc network. This protocol inherits the stability of the link state algorithm and has the advantage of having routes immediately available when needed due to its proactive nature[6]. OLSR minimizes the overhead caused by flooding of control traffic by using only selected nodes, called Multi-Point Relays (MPR), to retransmit control messages. It minimizes the number of retransmissions required to flood a message to all nodes in the network.

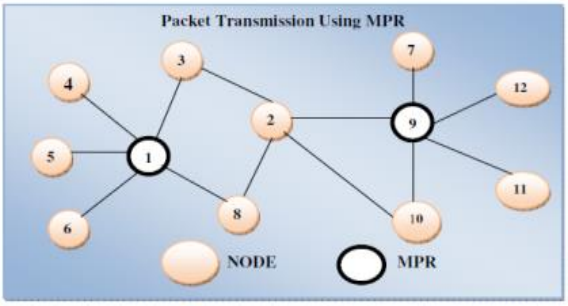

Fig. 3. Packet Transmission Using MPR

Advantages:

- No route discovery delay.
- Greater throughput.
- Increase in number of routes does not increase routing overhead.

Disadvantages:

- OLSR protocol periodically sends the updated topology information throughout the entire network.
- Greater bandwidth required.
- More processing power required to compute optimal paths.

Table 1. Comparison of various proactive routing protocols

Protocol	**DSDV**	**OLSR**
Scalability	No	No
Reliability	Yes	Yes
Throughput	Decrease with mobility	Better when compared to DSDV
Load Balancing	No	No
Congestion Control	No	No

IV. COMPARISON OF VARIOUS REACTIVE ROUTING PROTOCOLS

i) Dynamic Source Routing(DSR) Protocol

Dynamic source routing protocol (DSR) is an on-demand protocol based on source routing designed to restrict the bandwidth consumed by control packets in ad hoc wireless networks by eliminating the periodic table-update messages required in the table-driven approach. The major difference is that it is beacon-less and hence does not require periodic hello packet (beacon) transmissions. In DSR every mobile node in the network needs to maintain a route cache where it caches source routes that it has learned. The basic approach of this protocol (and all other on-demand routing protocols) during the route construction phase is to establish a route by flooding Route Request packets in the network. DSR protocol is based on two mechanisms: Route Discovery and Route Maintenance.

Route Discovery: DSR uses this process to find the route and to transmit the data from a source to destination where the source node is unaware of the destination route.

Route Maintenance: Route maintenance can be achieved 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.

Advantages:

- No need to keep routing table to route a given data packet.
- Guaranteed loop-free routing.
- Use of only "soft state" in routing.
- Rapid recovery in case of change of routes in the network.

Disadvantages:

- One of the major disadvantages of DSR protocol is in implementing the route discovery process.
- Not scalable to large networks.
- Processing resources required are more in comparison to other protocols.

ii) AODV Routing Protocol

AODV (Ad hoc On-Demand Distance Vector Routing) is a variation of destination sequenced distance vector (DSDV) routing protocol which is collectively based on DSDV and DSR. Its aim is to minimize the requirement of system wide broadcasts. 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[4]. The major difference between AODV and Dynamic Source Routing (DSR) stems out from the fact that DSR uses source routing in which a data packet carries the complete path to be traversed. AODV uses a simple request–reply mechanism for the discovery of routes.

Advantages:

- Routes are established on demand and destination sequence numbers are used to find the latest route to the destination.
- Lower delay for connection setup.

Disadvantages:

- AODV doesn't allow handling unidirectional links.
- Multiple Route Reply packets in response to a single Route Request packet can lead to heavy control overhead.

Table 2. Comparison of various reactive routing protocols

Parameters	AODV	DSR
Scalability	No	No
Reliability	Yes	Yes
Throughput	Poor for more than 20 mobile nodes	Decrease as mobility increases
Load Balancing	No	No
Congestion Control	No	No
Overall Complexity	Medium	Medium
Routing Philosophy	Flat	Flat
Routes Maintained	Route Table	Route Cache
Loop Free	Yes	Yes
Multiple Route Support	No	Yes
Overhead	Low	Medium
Protocol Type	Distance Routing	Source Routing
Route Reconfiguration	Erase Route; Notify Source	Erase Route; Notify Source
Expiry of Routing Information	Yes	No

V. COMPARISON OF AD-HOC ROUTING PROTOCOLS

Table 3 shows advantages and disadvantages of proactive, reactive & hybrid routing protocols while table 4 shows comparison between these three types of protocols based on various parameters.

Table 3. Pros and cons of proactive, reactive & hybrid routing types

Protocols	Advantages	Disadvantages
Proactive Protocols	Information is always available. Latency is reduced in the network.	Overhead is high. Routing information is flooded in the whole network.
Reactive Protocols	Path available when needed. Free from loops and overhead is low.	Latency is increased.
Hybrid Protocols	Suitable for large networks and up to date information available.	Complexity increases.

Table 4. Comparison of proactive, reactive & hybrid routing types

Parameters	Proactive	Reactive	Hybrid
Network Organization	Flat/ Hierarchical	Flat	Hierarchical
Routing Scheme	Table Driven	On-demand	Both
Latency	Low due to routing tables	High due to flooding	Inside zone low; outside similar to reactive protocols
Communication Overhead	High	Low	Medium
Scalability Level	Low; Usually upto 100 nodes	Upto few hundred nodes; Not suitable for large networks	Designed for large networks; Upto 1000 or more nodes
Availability of Routing Information	Always available; stored in tables	Available when required	Combination of both
Periodic Updates	Yes needed whenever the topology of the network changes	Not needed as route available on demand	Yes needed inside the zone
Storage Capacity	High due to the routing tables	Low generally depends upon the number of routes	Depends on the size of zone
Mobility Support	Periodical Updates	Route Maintenance	Combination of both
Delay level	Small routes are pre-determined	Higher than proactive	Small for local destinations. Large as reactive protocols for interzone.

VI. CONCLUSION

Mobile ad hoc network is a collection of mobile nodes, forming temporary network, without using any infrastructure and provide cheap communications. This paper has discussed the classification of routing protocols and done comparative analysis for wireless ad hoc networks routing protocols. Each protocol has their own merits and

demerits. DSDV has low end-to-end delay compared to other protocols. When the network load is low, AODV performs better in case of packet delivery ratio but it performs badly in terms of average End-to-End delay and throughput. Overall, DSR outperforms AODV because it has less routing overhead when nodes have high mobility.

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