Qualitative Based Study of Hybrid Routing Protocols in MANET

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Abstract: Mobile ad-hoc network (MANET) is the collection of various mobile nodes which are connected together over a wireless medium having no fixed infrastructure. In recent years, a broad research has been done in the domain of Mobile Ad-hoc Networks (MANETs). Ad hoc routing protocols for MANETs are classified into: proactive, reactive and hybrid approaches. Hybrid routing approach is introduced to overcome the shortcomings of both reactive and proactive routing approaches. It merges the advantages of both proactive and reactive approaches. In this paper we have discussed the qualitative and quantitative based comparison of hybrid routing protocol with proactive and reactive routing approaches.

Keywords: MANET, Wireless Networks, Routing Protocol, Dynamic Topology, Synchronization

I.   INTRODUCTION

Ad-hoc networks are mobile wireless networks having no fixed infrastructure. There are no fixed routers – instead each node acts as a router and forwards traffic from other nodes. MANETs are self configured and topology changes frequently. The rate of change of topology depends on the velocity of the nodes. MANET is also called as the mobile mesh network. The node's mobility in MANETs raises degree of connection flexibility and complications of routing protocols. MANET can be easily used in battlefields, natural disasters etc where it is very difficult to use the wired network. With the progress in wireless communication as well as the portability of the mobile device is increasing day by day importance of ad-hoc network is increasing continuously. In MANETs nodes are free to join and leave the network at any point of time to maintain the connection. Some of typical application includes [1]:

- Emergency and Rescue operation
- Aircrafts
- Military application
- Wireless sensor networks
- Collaborative and distributed computing
- Sensor network

- Exhibitions
- Commercial use
- Personal area network and Bluetooth

II. ROUTING PROTOCOLS TERMINOLOGY

No specific routing decisions or routing protocols are necessary if only two nodes wish to communicate to each other and are placed very nearby. Whereas, if several mobile nodes want to communicate out of the transmission range, then the main role of routing protocol comes into picture. As in this scenario some severe decision has to be performed, such as, choosing the optimal path from sender to receiver. These decision making tasks are very crucial, because mobile nodes work on battery power. To minimize the power consumption it is necessary to send the data with minimum delay. To obtain the least packet drop quality of service support is also needed. For effective utilization of bandwidth, compression might be associated which could be supported by protocol. Some other aspects which must be taken into account while selecting a routing protocol for MANETs are given below:

A. MULTICASTING:
Multicasting is the capability to deliver data packets to numerous nodes simultaneously. It is just like broadcasting concept other than the case that broadcasting is accomplished to entire nodes present in the network. It is crucial because it takes minimum time to transmit data packets to various nodes.

B. LOOP FREE:
A routing loop is very popular problem with numerous types of networks, especially computer networks. To enhance the performance, routing approach should assure that the paths given are loop free. This prevents misuse of CPU consumption or bandwidth.

C. MULTIPLE PATHS:
The protocol should grant multiple paths establishment. If due to some reason one of the path gets destroyed, then the data packets could also be sent through some other path.

D. DISTRIBUTED VS CENTRALIZED:
In distributed approach, the decision of route is shared with the network nodes. Whereas in centralized approach, all route selections are performed by a pivotal node.

E. STATIC VS ADAPTIVE:
In static algorithms, the path used by sender- receiver pairs is fixed being separate from traffic conditions. Here path for passage changes only in a link failure or response to a node. Under a broad range of traffic input arrangements such types of algorithms cannot obtain high throughput. In contrast, adaptive algorithms in response to traffic may change the path between the sender and receiver.

F. FLAT VS HIERARCHICAL:
For the flat routing approach, flat addressing is one of the pre-requisite. Each elemental node taking part in routing plays an extensive role and no particular gateway nodes are present, i.e. all nodes have same responsibilities. In other hand, hierarchical routing commonly appoints distinct roles to network nodes.

III. ROUTING APPROACHES IN MANET

The inadequate and limited resources in MANETs have made designing of an efficient and reliable routing strategy a very challenging task. An intelligent routing algorithm is required to efficiently use these limited resources while at the same time being adaptable to the changing network conditions such as network size, traffic density, nodes mobility, network topology and broken routes. Routing approaches in MANET are generally categorized as table driven or proactive, on-demand or reactive and hybrid protocols.
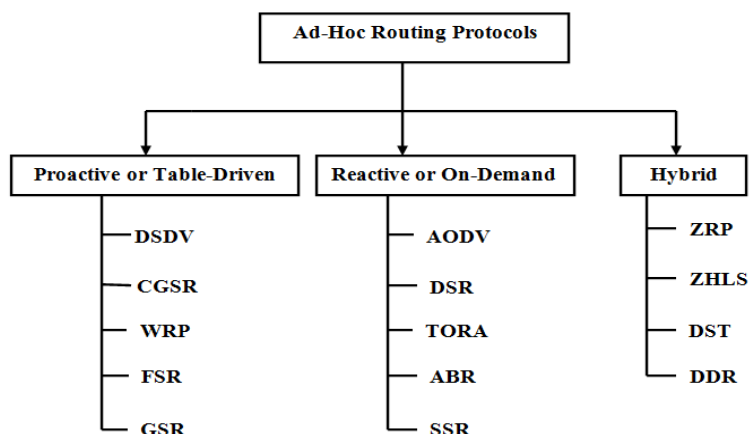
FIGURE 1: Classification of Routing Protocols

IV.   HYBRID ROUTING PROTOCOLS

There is a compromise between table driven and on-demand routing protocols. Proactive or table driven protocols have less latency and more traffic, while reactive or on-demand protocols have more latency and less traffic. Hybrid routing approach is introduced to overcome the shortcomings of both reactive and proactive routing approaches. It merges the advantages of both proactive and reactive approaches. It uses table maintenance technique of proactive and route discovery mechanism of reactive protocols, so as to avoid overhead issue and latency in the network. Hybrid routing approach is relevant for large networks. This broad network is divided into sets of zones. Proactive and reactive approach can be applied inside and outside the zone respectively. There are numerous popular hybrid routing approaches for MANET like Zone Routing Protocol (ZRP), Zone-Based Hierarchical Link State Routing Protocol (ZHLS), Dynamic Source Tracing Protocol (DST) and Distributed Dynamic Routing Protocol (DDR) [3][4][5][6][7].

A.   ZONE ROUTING PROTOCOL (ZRP):
ZRP divides the nodes into two zones: Intra-zone and Inter-zone. When the destination node and source node both are in the same zone then ZRP uses the concept of intra-zone routing protocol and when destination node is out of the zone of source then ZRP uses the concept of inter-zone routing protocol. For Intra-zone routing it uses the proactive approach and for inter-zone routing it uses the reactive approach.
[3][4].
Advantage:
- Reduced transmission

Disadvantage:
- Overlapping zones

B.   ZONE-BASED HIERARCHICAL LINK STATE ROUTING PROTOCOL (ZHLS):
ZHLS is a hierarchical structured based protocol in which network is split into non-overlapping zones. In this approach, one unique zone ID and node ID is assigned to each node, which are computed using geographical information. Node level and zone level types of topological structure exist for network. Zone level LSP (Link State packet) and node level LSP are the two types of link state updates. Routing overhead of ZHLS is low as compared to DSR and AODV.
Advantage:
- Low control overhead

Disadvantage:
- Static zone map required

C.   DYNAMIC SOURCE TRACING PROTOCOL (DST):
DST is an efficient routing approach for use with MANETs. This approach reduces the routing overhead and provides the more throughputs. Every node of network is gathered into a number of trees. Two types of node are present in tree: root node and internal node. The design of the tree is controlled by root node. Every node should be on three distinct states: merge, route and configure, depending on the nature of task. DST comes up with two approaches to figure a path between a sender and a receiver pair: Hybrid Tree Flooding (HTF), Distributed Spanning Tree (DST) shuttling.

Advantage:
- Reduced transmission

Disadvantage:
- Root node

D. DISTRIBUTED DYNAMIC ROUTING PROTOCOL (DDR):

The DDR algorithm is composed of six phases: Preferred neighbor election, Intra-tree clustering, Inter-tree clustering, forest construction, zone naming and zone portioning. HARP is used to find the routes. To determine the stable path, inter-zone and intra-zone routing tables constructed by DDR are used by HARP.

Advantage:
- No zone coordinator or zone map

Disadvantage:
- Neighbours may become bottlenecks

Here table 1 shows the comparison of some of existing hybrid routing approach.

Parameters	ZRP	ZHLS	DST	DDR
Routing Structure	Flat	Hierarchical	Hierarchical	Hierarchical
Multiple Routes	No	Yes	Yes	Yes
Beacons	Yes	No	No	yes
Route information stored in	Intra-zone and Inter-zone tables	Intra-zone and Inter-zone tables	Route tables	Intra-zone and Inter-zone tables
Route metric	Shortest Path	Shortest Path	Forwarding using the tree neighbors	Stable routing

TABLE 1: Comparison of Hybrid Routing Protocols

V. COMPARISON BETWEEN THREE CATEGORIES OF ROUTING PROTOCOLS

Here in this section we have discussed the qualitative and quantitative based comparison between proactive, reactive and hybrid routing approaches in tabular form [2], [3]-[22].

Parameters	Proactive Protocol	Reactive protocol	Hybrid protocol
Routing structure	Mostly flat	Flat	Hierarchical
Routing scheme	Table Driven	On-demand	Combination of both
Routing overhead	High	Low	Medium
Latency	Low	High	Low for local destinations and high for Inter-zone
Scalability	Low	Not suitable for large networks	Designed for large networks
Storage Requirements	Higher	Dependent on no. of routes maintained or needed	Depends on size of each zone or cluster
Route Availability	Always available	Computed as per need	Depends on location of destination
Periodic Route Updates	Required always	Not required	Used inside each zone
Control Traffic	High	Low	Lower than other two types
Routing Information	Keep stored in table	Doesn't store	Depends on requirement
Mobility Support	Periodical updates	Route Maintenance	Combination of both

TABLE 2: Comparison between three Categories of Routing Protocols

VI. CONCLUSION

In this paper qualitative and quantitative based comparison of hybrid routing protocol has been done with proactive and reactive routing protocols on the basis of different metrics i.e. routing structure, routing scheme, routing overhead, latency, scalability, storage requirements, route availability, periodic route updates, control traffic, routing information and mobility support. Performance of all the routing protocols is considered as well. Further this consideration will benefit the researcher to get an outline of the existing protocols and advice which protocols may have better performance with respect to changing network scenario.

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