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Qualitative and Quantitative Based Comparison of Proactive and Reactive Routing Approaches in MANET

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Abstract- In recent years, a broad research has been done in the domain of Mobile Ad-hoc Networks (MANETs). Due to the bounded resources in MANETs, to develop a reliable and efficient routing approach is still a threat or issues. There are distinct aspects appropriate for research like synchronization, power consumption, routing, bandwidth consideration, etc. This paper concentrates on routing approach which is the major challenging concern due to the change in topology of ad-hoc networks. Under a number of network scheme, such as network topology and size, it is difficult to figure out which routing protocol may perform well. In this paper we contribute an outline of broad range of the current routing approaches, with a special focus on their functionality and characteristics. Also based on the routing information and methodologies the comparison is provided, which can be use to make decisions of routing. Performance of all the routing protocols are 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.

Keywords- MANETs, Routing Protocol, Dynamic Topology, Synchronization, Performance

I. INTRODUCTION

Wireless network is a computer network in which computers or nodes are connected in wireless medium and data packets are sent from one node to other node. Wireless networks are branched into two sections: Infrastructure networks and Ad-hoc networks as presented in figure 1.

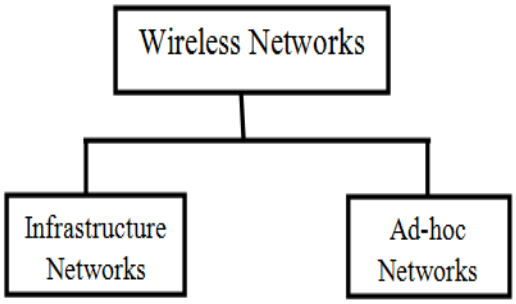

Figure 1: Wireless Network Categories

A. INFRASTRUCTURE NETWORKS:

In this type of network an Access Points (AP) act as a central organizer for every node. Through AP any node can join the network. The association between Basic Set Services (BSSs) is organized by AP so that the path is accessible when it is demanded. The major disadvantage of infrastructure network is that we have to always maintain the routing table. Figure 2 illustrates an infrastructure network.

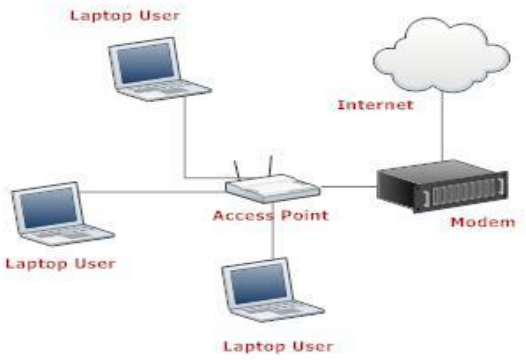

Figure 2: Infrastructure Network

B. AD-HOC NETWORKS:

Wireless Ad-Hoc network is a distributed variety of wireless network. The network does not commit on a foregoing infrastructure, so it is called as ad-hoc network. This type network does not have a central coordination point or a certain topology. So, forwarding and collecting packets are also difficult as compared to infrastructure networks. With the extensive success in wireless network application like tablets, handheld computers, cell phones and PDAs, scientists are inspired to raise the performance and network task. Supporting mobility in MANETs is one of the major designing challenges for wireless Ad-hoc network. The node's mobility in MANETs raises degree of connection flexibility and complications of routing protocols. Yet, the flexibleness of nodes to leave, join and transmission of data to network increase security challenges. A MANET is the group of distinct mobile nodes which are linked together in a wireless medium having dynamic topology [16]. Each node has constrained sources such as memory, processing power, battery and. MANET can be easily used in battlefields, natural disasters etc., where it is very difficult to use wired network. Figure 3 illustrates a Mobile Ad-Hoc Network.

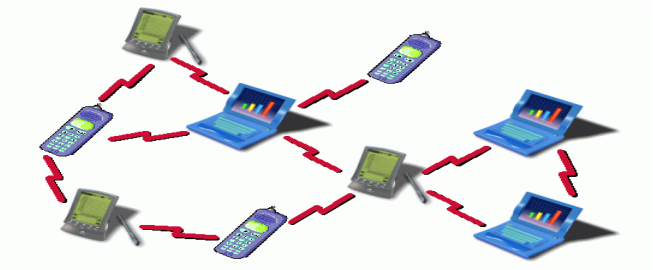

Figure 3: MANET

II. ROUTING APPROACHES IN MANET

Routing approaches for MANETs can be divided into three classes on the basis of routing information update technique. They could be Proactive (Table-driven), Reactive (On-demand) and Hybrid. Figure 4 shows the three classes of routing approaches in MANET. Proactive routing technique maintains an updated topological map of the whole network. In this approaches all the paths are maintained all the times so routes can be found anytime. The main properties of proactive approaches are that it uses the low latency in discovering the new path. It uses the more bandwidth to update routing knowledge. Reactive approach does not initiate for finding the paths. By flooding a query it establishes routes on demand. When finding a route it uses bandwidth only when there is a need for discovering the routes. So, its latency is high. In this approach due to flooding there is a network overhead for query for finding the routes. Hybrid approach merges the advantages of above two approaches [5], [11].

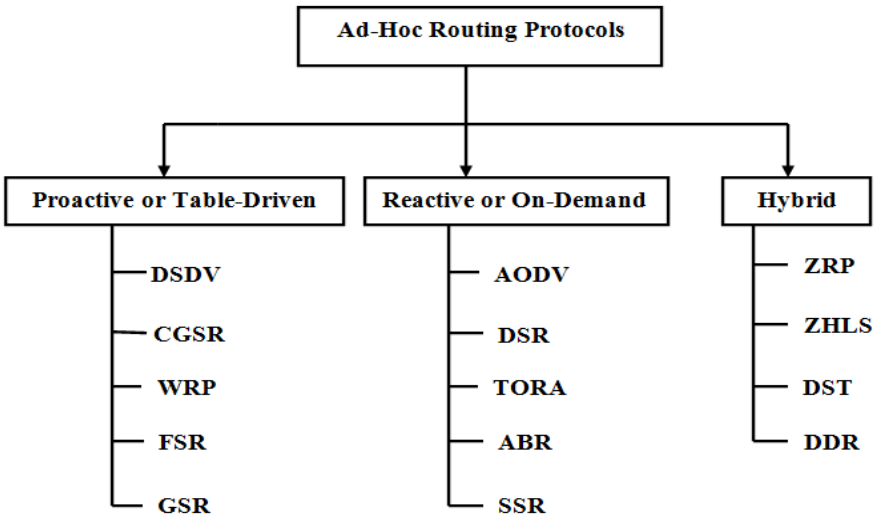

Figure 4: Classification of Routing Protocols

III. PROACTIVE ROUTING PROTOCOLS

Proactive routing protocols are also known as the Table Driven routing protocols. In this routing protocol each node keeps routing knowledge about every other node. Routing information is generally stored in routing tables and is generally refreshed as the changes in network occur. So, routes are always available in this type of protocols. These protocols have less latency but use more bandwidth. The protocols under this class maintain various numbers of tables. Moreover, they are not suitable for large networks. DSDV, CGSR, WRP, FSR, GSR etc. are various proactive routing protocols [8].

Proactive Protocol	Predecessor protocol	Enhancement Regarding Predecessor
DSDV	DBF	Provide single shortest path
CGSR	DSDV	Reduces network traffic load
WRP	DBF	Performance problem
FSR	LS	Improved flooding
GSR	GSR	Exchange link-state information at different interval for different scope dist.
DBF: Distributed Bellman Ford, LS: Link State Routing		

TABLE 1: Proactive Routing Protocols

A. DESTINATION SEQUENCED DISTANCE VECTOR (DSDV):

DSDV is based on Bellman-Ford routing approach. In DSDV, packets relay between mobile nodes with the help of routing tables which are saved at mobile node. The routing table has the directory of all useful terminal nodes and the number of hops required to reach every terminal node. Terminal nodes create the sequence number (SN) which is appended in the table entry.

Advantages:

- Routing loop issue is solved
- Count to infinity issue is minimised
- It doesn't maintain the multiple path to every destination node, it maintains only best path

Disadvantages:

- DSDV always updates it's routing table, if network is in idle state then also it uses bandwidth and small amount of battery power
- SN is necessary whenever the topology of network changes.
- DSDV is not relevant for highly topological change in networks.

B. CLUSTER GATEWAY SWITCH ROUTING PROTOCOL (CGSR):

CGSR is based on the concept of cluster head (CH). Its structure is hierarchical. It uses a distributed cluster-head selection approach to select the cluster-head. In this approach, CH performs the important role. Every node send the messages to the CH, then CH send it with the help of gateway node to the other cluster then to CH of other cluster and so on, until the target CH is reached.

Advantages:

- Better bandwidth utilization
- Routing is performed only over cluster-head so; it reduces the size of distance vector table.

Disadvantages:

- Higher time is spent in selection of gateways and cluster-heads
- Change in cluster-heads may result in multiple path breaks

C. WIRELESS ROUTING PROTOCOL (WRP):

Every node keeps four tables: routing table, link-cost table, distance table and message retransmission list table (MRL). Whenever, an updated message is communicated to neighbor nodes then WRP updates routing tables. SN of the update message and retransmission counter is kept in the MRL. Node transmit updated message after identifying a change in the link or after processing updates from their neighbors.

Advantages:

- Count to infinity is solved

Disadvantages:

- More memory is required to maintain the four table
- Extra bandwidth and power is consumed due to periodic HELLO message

D. FISHEYE STATE ROUTING (FSR):

FSR is an absolute hierarchical routing approach. It is a proactive link-state routing protocol. Like link-sate, it keeps a complete topology map at every node. In this protocol, there is a regular transfer of HELLO packets and topology tables within the local neighbor only (instead of flooding entire network). As the distance to destination decreases, the topology table update frequency also decreases. Updates for close destination are propagated generally more than updates for a remote destination. Every node holds: Distance Table, Neighbor list, Next Hop Table and Topology Table.

Advantages:

- Maintain accurate routing information for immediate neighbours
- As the distance between data packets and destination node decreases accuracy increases

Disadvantages:

- Progressively limited details as distance increases
- Routing table size grows linearly with network size

E. GLOBAL STATE ROUTING (GSR):

GSR is identical to other link state routing protocols**.** This protocol tries to provide worth of link-state routing but with the integrity of distance vector protocols. This does not flood network with link-state updates. This

protocol regularly exchange collected link-state information with its neighbors. Sometime this is identical to STAR when optimal paths are required. To ensure the link-state table is up to date it uses sequence numbers. Entries with earlier sequence numbers are replaced with updated sequence number.

Advantages:

- GSR can provide optimal and loop free paths
- It can be used to support Quality of Service

Disadvantage:

- Reliability of Link layer is still required

TABLE 2 shows the comparison of some of existing proactive routing protocols [1]-[10].

Parameters	DSDV	CGSR	WRP	FSR	GSR
Route Selection	Link-State	Shortest Path	Shortest Path	Shortest Path	Shortest Path
Route	Single	Single or Multiple	Single	Single or Multiple	Single or Multiple
Route Computation	Distributed	Distributed	Distributed	Distributed	Distributed
Time Complexity	O(d)	O(d)	O(h)	O(d)	O(d)
Broadcast	Full	Full	Local	Limited	Local
Topology Structure	Flat	Hierarchical	Flat	Hierarchical	Flat
Update	Hybrid	Periodic	Hybrid	Periodic	Periodic
Source Routing	No	No may be Yes	No	No may be Yes	No may be Yes
Update Information	Distance Vector	Distance Vector	Distance Vector	Link State	Distance Vector
Beacon	Yes	No	Yes	Yes	Yes
Method	Broadcast	Broadcast	Broadcast	Broadcast	Broadcast
No. of Table	2	2	4	4	4
Loop Free	Yes	Yes	Yes, but not instantaneous	Yes	Yes
d= Diameter of network, h= Height of the routing tree					

TABLE 2: Comparison of Proactive Routing Protocols

IV. REACTIVE ROUTING PROTOCOLS

This protocol is known as on-demand routing protocol. Reactive approach does not initiate for finding the paths. By flooding a query it establishes routes on demand. When finding a route it uses bandwidth only when there is a need for discovering the routes. So, its latency is high. Following are the numerous well known reactive routing protocols: AODV, DSR, TORA, ABR and SSR [12]. The reactive routing approaches have mainly two phases [14].

***Route Discovery*:** It is the early phase for routing. This phase is focus on finding the route from source node to destination node. For this purpose, source node considers its route cache for the feasible route. Source node adds the addresses of all intermediary nodes and destination node. Intermediary nodes perform the important role to find the path from source to destination node.

Route Maintenance: In the case of change in network topology, the route failure issue appears due to link failure between the nodes, so route maintenance is done. Route maintenance is possible in reactive protocol due to acknowledgement mechanism. The latency of Reactive protocols is high due to route discovery mechanism.

Reactive Protocol	Predecessor Protocol	Enhancement regarding predecessor
AODV	DSDV	Minimize broadcast message
DSR	-	-
TORA	LMR	Converge quicker in portioned network
ABR	-	-
SSR	ABR	Enhance stability
LMR: Light Mobile Routing		

TABLE 3: Reactive Protocols

A. *AD-HOC ON DEMAND DISTANCE VECTOR ROUTING (AODV*):

AODV is fundamentally an enhancement of DSDV. It reduces the number of transmission, by creating paths based requirement, which is different from DSDV. A route request (RREQ) is broadcasted when a node want to transmit a data packet to destination node. To ensure the loop free path RREQ uses the SN and reply consist of updated information only.

Advantages:

- Less delay in connection setup
- Route are established on demand and latest route to destination is searched by destination sequence number

Disadvantages:

- If the source SN is very old then intermediary node can lead to inconsistent routes
- Unnecessary bandwidth consumption due to periodic beaconing

B. DYNAMIC SOURCE ROUTING (DSR):

DSR is an efficient and simple routing approach, which performs uniquely in multi-hop MANETs. With the use of DSR, the network is perfectly self-configuring and self-organizing, requires no existent network administration or infrastructure. This approach consists of mainly two phases: Route Discovery and Route Maintenance.

Advantages:

- To reduce the control overhead intermediary nodes take advantage of route cache information
- Routes are established on demand

Disadvantages:

- Higher connection setup delay
- Routing traffic is directly proportional to the length of path

C. TEMPORALLY ORDERED ROUTING ALGORITHM (TORA):

It is an efficient, more adaptive and extensible distributed routing protocol, which is based on the approach of link reversal. This protocol is recommended for multi-hop and highly changeable wireless networks. This approach is source-initiated and on requirement routing approach and it finds various paths from sender node to terminal node. This approach consists of mainly three phases: Route creation, Route maintenance and Route deletion. QUERY and UPDATE packet is used to route creation. To erase invalid routes a clear packet (CLR) is broadcasted through the network.

Advantages:

- Good in dense networks
- Multiple paths created

Disadvantages:

- With increase in mobility, performance degrades

D. ASSOCIATIVELY BASED ROUTING (ABR):

ABR describes a new kind of routing metric “degree of association stability” for MANETs. There are three major stages of this approach: Route discovery, Route reconstruction and Route deletion. Every mobile node has their own degree of stability; on the basis of this degree of stability a path is selected. Association stability of one node with respect to other node can be defined over time and space on the basis of connection stability. Path discovery is accomplished by a Broadcast Query-Reply (BQ-REPLY) cycle.

Advantages:

- Each node setup a beacon to represent its existence
- Route is stable

Disadvantages:

- Scalability issue
- High overhead

E. SINGLE STABILITY ROUTING (SSR):

This protocol selects a path on the basis of strength of signal between nodes and position establishment of nodes. SSR is composed of two cooperative approaches: Static Routing Protocol (SRP) and Dynamic Routing Protocol (DRP). The DRP keeps the Routing Table (RT) and Stability Table (SST). Strength of signal of neighbor nodes at SST is attaining by periodic beacon. Strength of signal is listed either as strong or weak. All communications are accepted by DRP and then processed.

TABLE 4 shows the comparison of some of existing reactive routing protocols [1], [11]-[15].

Parameters	AODV	DSR	TORA	ABR	SSR
Route Selection	Shortest and Updated Path	Shortest and Updated Path	Shortest Path	Signal Strength or Associativity and Shortest Path	Associativity and Stability
Route	Multiple	Multiple	Multiple	Single	Single
Route Computation	Broadcast	Broadcast	Broadcast	Broadcast	Broadcast
Time Complexity (initialization)	O(2d)	O(2d)	O(2d)	O(d+z)	O(d+z)
Time Complexity (post failure)	O(2d)	O(2d) or O(cache hit)	O(2d)	O(l+z)	O(l+z)
Broadcast	Full	Full	Local	Full	-
Topology Structure	Flat	Flat	Flat	Flat	Flat
Update	Event Driven	Event Driven	Event Driven	Event Driven	Event Driven
Source Routing	Yes	No	No	Yes	Yes
Update Information	Route Error	Route Error	Node's Height	Route Error	Route Error
Beacon	Yes	No	No	Yes	Yes
Method	Unicast	Unicast	Broadcast	Broadcast/Unicast	Broadcast
Loop Free	Yes	Yes	No (short lived loops)	Yes	Yes
Throughput	High	Low	Low	-	-
Route Reconfiguration	Erase Route, Notify Source	Erase Route, Notify Source	Link reversal, Route Repair	Localized Broadcast Query	Erase Route, Notify Source
d= Diameter of the network, z=Diameter of the directed path where the REPLY packet transits l= Diameter of the affected network segment					

TABLE 4: Comparison Table for Reactive Routing Protocol

V. CONCLUSION

A lot of research has been done in the area of MANET (Infrastructure less network) and wireless networks (infrastructure based). In this paper numerous of routing approaches for MANET are classified as proactive, reactive and hybrid routing protocols. The work has been made on the qualitative and quantitative based comparison of Proactive, Reactive and Hybrid routing approaches in the form of table. Each routing approach has unique features. We have to select the relevant routing protocol according to network environment. We wish that the taxonomy given in this paper will be advantageous and grant researchers a platform for deciding the right protocol for their work. Still MANETs have posed a huge challenge for the researchers due to dynamic topology and security threats, and none of the approach is quite secure and research is going on around the globe.

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