ROUTING PROTOCOLS IN WIRELESS Ad-Hoc NETWORKS

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ABSTRACT:

Mobile Ad Hoc Network is a collection of wireless nodes communicating with each other without any wired infrastructure. This is very popular domain of research due to their ad hoc nature. Multiple network hops are required to deliver and exchange data across a network. Each Mobile node is also acting as a router which will forward the packets to their nearest hop and thus finally the packet reaches to the destination. Routing protocols designed for fixed network are not capable to withstand ad hoc nature such as such as mobility and less bandwidth. In this paper, various routing protocols available on ad hoc network are studied.

KEY WORDS: Wireless, Network, Protocol, Firewall

1. INTRODUCTION:

Wireless networks can be classified in two types: - infrastructure network and infrastructure-less (ad hoc) networks. Infrastructure network consists of a network with fixed and wired gateways. In contrast to infrastructure based networks, in ad-hoc networks all nodes are mobile or may be sensor nodes and can be connected dynamically in an arbitrary manner [1]. Wireless Ad Hoc networks are also much more dynamic and unpredictable because connectivity depends on the movements of nodes, terrain, changes in the mission (e.g. for a military application or a first responder application), node failures, weather, and other factors. As a result, it is difficult to accurately characterize normal behavior. MANETs offer several advantages over traditional networks including reduced infrastructure costs, ease of establishment and fault tolerance, as routing is performed individually by nodes using other intermediate network nodes to forward packets [2], this multi-hopping reduces the chance of bottlenecks, however the key MANET attraction is greater mobility compared with wired solutions. There are a number of issues which affect
the reliability of Ad-hoc networks and limit their viability for different scenarios; lack of centralised structure within MANET requires that each individual node must act as a router and is responsible for performing packet routing tasks; this is done using one or more common routing protocols across the MANET [3].

The mobility of nodes is also a major factor within MANETs due to limited wireless transmission range; this can cause the network topology to change unpredictably as nodes enter and leave the network [4]. Security of MANETs is another major deployment concern; due to the mobility and wireless nature of the network malicious nodes can enter the network at any time, the security of the nodes and the data transmitted needs to be considered [5]. Due to these issues ad-hoc networks are not appropriate for most general usage of mobile devices, where internet access is the key requirement; in these situations wireless devices typically connect into the wired infrastructures through access points (AP) to reduce the unreliability of the wireless domain [6].

Some of the challenges in MANET include [7]:
1) Unicast routing
2) Multicast routing
3) Dynamic network topology
4) Speed
5) Frequency of updates or Network overhead
6) Scalability
7) Mobile agent based routing
8) Quality of Service
9) Energy efficient/Power aware routing
10) Secure routing.

2. WIRELESS AD HOC NETWORKS:

Wireless ad hoc network is a special structure of the wireless communication network, whose communication relies on their cooperation among the nodes and achieves it in the manner of wireless multi-hop and has the properties of self-organizing and self-managing.
An ad hoc network typically refers to any set of networks where all devices have equal status on a network and are free to associate with any other ad hoc network devices in link range. Very often, ad hoc network refers to a mode of operation of IEEE 802.11 wireless networks. According to their application types of Wireless ad hoc networks are classified into three types namely Mobile ad-hoc Network, Wireless Sensor Network, Wireless Mesh Network.

3. ROUTING PROTOCOLS:

A 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 ad hoc networks. Routing protocols between any pair of nodes within an ad hoc network can be difficult because the nodes can move randomly and can also join or leave the network. This means that an optimal route at a certain time may not work seconds later.

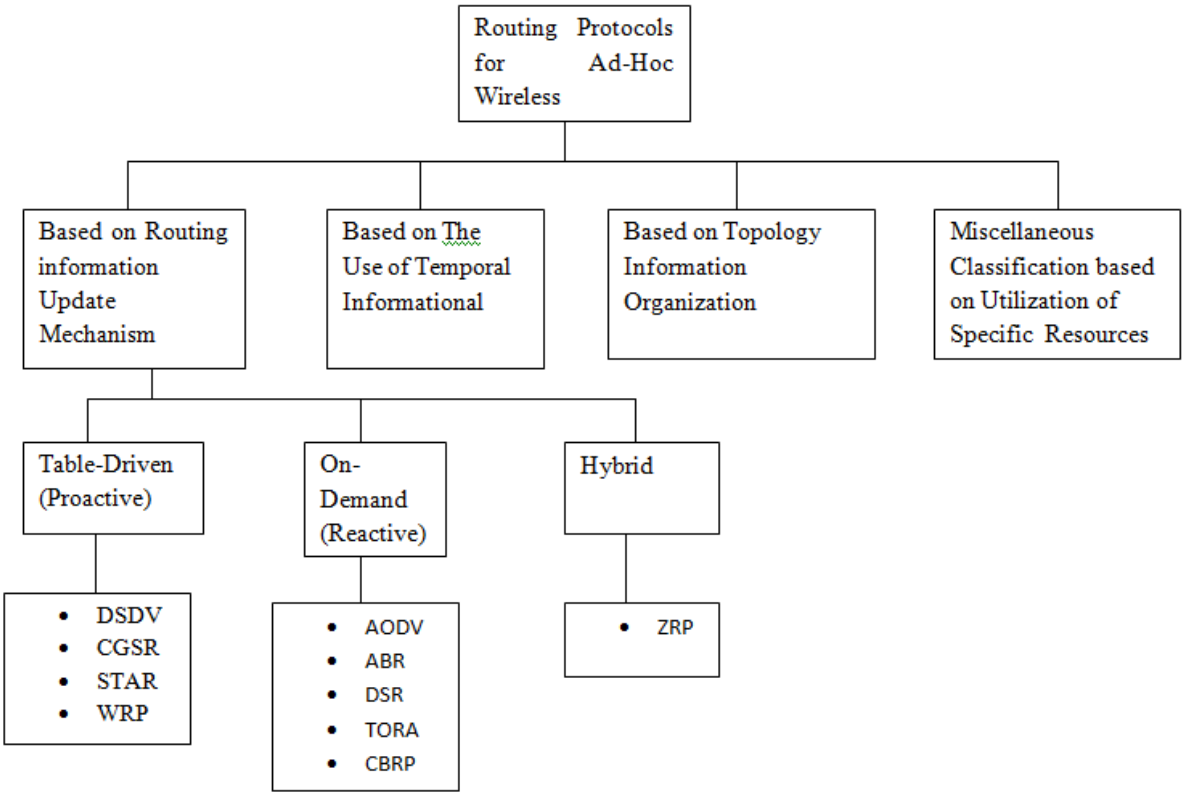

Figure :- Classification of Routing Protocols

Discussed below are three categories that existing ad-hoc network routing protocols fall into:

1. Table Driven Protocols
2. On Demand Protocols
3. Hybrid Protocols

3.1 Table Driven or Proactive Protocols:-

In Table Driven routing protocols each node maintains one or more tables containing routing information to every other node in the network. All nodes keep on updating these tables to maintain latest view of the network. Some of the existing table driven or proactive protocols are: DSDV [8], [9], DBF [10], GSR [11], WRP [12] and ZRP [13].

Proactive routing protocols maintain a table for each node representing the entire network topology which is regularly updated in order to maintain the freshness of routing information. At any given time, any node knows how to reach another node of the network. This approach minimizes the route discovery delay at the cost of exchanging data periodically, which consumes network bandwidth. Proactive protocols are preferred for small networks because of low

routing, table lookups. Destination Sequenced Distance Vector (DSDV), Optimized Link State Routing (OLSR), Topology dissemination Based on Reverse-Path Forwarding (TBRPF), Open Shortest Path First – MANET (OSPF-MANET), Fish-eye State Routing (FSR) are some of proactive routing protocols.

3.1.1 Destination-Sequenced Distance-Vector (DSDV) :

DSDV protocol is a distance-vector protocol with extensions to make it suitable to MANET. Every mobile node maintains a routing table which lists all the available destinations, the metric and next hop to each destination and a sequence number generated by the destination node. Using such routing table stored in each mobile node, the packets are transmitted between the nodes of an ad hoc network. Each node of the ad hoc network updates the routing table with advertisement periodically or when significant new information is available to maintain the consistency of the routing table with the dynamically changing topology of the ad hoc network [1].

3.1.2 CLUSTERED GATEWAY SWITCH ROUTING (CGSR):-

It consists of clustering method, called Least Cluster Change which is combined with either “lowest id”, “maximum links”, to form clusters and elect clusterheads. The method focuses on cluster stability. CGSR explicitly specifies requirements on the link layer and medium access method. Inter-cluster communication requires a CDMA system, such that each cluster is assigned a different node. Within each cluster, TDMA is used. The protocol uses a sequence number method to gain loop free routes and avoid stale routing entries. In CGSR, a packet is routed alternating between cluster heads and gateways [14].

3.1.3 SOURCE TREE ADAPTIVE ROUTING (STAR):-

The simulations have been done without stating the simulation software used. Comparison was against a so called “simple routing protocol”, which always chooses the shortest path. It is unclear if this should be regarded as an optimal routing algorithm. The result shows some advantages (fewer route repairs need to be done), but also drawbacks (longer routes on average, since not all links can be used, and a short distance between hops is encouraged due to the stability criteria). Overall performance measures like routing overhead, throughput or packet latency have not been considered. So it is very unclear, if there is any benefit at all, or if the advantage of fewer repairs and reduced broadcast is consumed by the longer pathlength or multiple route requests [14].

3.1.4 WIRELESS ROUTING PROTOCOLS (WRP):-

WRP is related to the DBF algorithm. Routing update messages are only sent locally to the neighbor set. They contain all the routing information the originating node knows of. Of course not the whole routing table is sent in each update. Only changes are transmitted, either by receiving an update from another node, or of a link in the neighborhood have changed. WRP is a proactive routing protocol, since routes are maintained all the time and no special route requests by source nodes need to be performed [14].

3.2. On Demand or Reactive Protocols:-

In these protocols, routes are created as and when required. When a transmission occurs from source to destination, it invokes the route discovery procedure. The route remains valid till destination is achieved or until the route is no longer needed. Some of the existing on demand routing protocols are: DSR [15], AODV [16] and TORA [17].
In reactive routing protocols, nodes are not aware of the network topology. Routing table is constructed on-demand. They find routes by flooding network with route requests. This leads to higher latency due to the fact that the route has to be discovered, however it minimizes control traffic overhead. Usually, reactive routing protocols are better suited in networks with low node density and static traffic patterns. Since the traffic patterns are static, the first request encompasses the route discovery, while the subsequent use the previous discovery to route the traffic. On the other hand, proactive protocols are more efficient in dense networks with bursty traffic due to the continous exchange of topology information, reducing route discovery delay. Reactive protocols are preferred for high mobility networks. Dynamic Source Routing (DSR), Ad hoc On-Demand Vector (AODV) and some other extensions derived from AODV are reactive routing protocols.

3.2.1 Ad- Hoc On-Demand Distance Vector Routing (AODV):-

AODV uses bandwidth efficiently (by minimizing the network load for control and data traffic), is responsive to changes in topology, is scalable and ensures loop free routing. AODV uses traditional routing tables, one entry per destination. This is in contrast to DSR, which can maintain multiple route cache entries for each destination. Without source routing, AODV relies on routing table entries to propagate an RREP back to the source and, subsequently, to route data packets to the destination. AODV uses sequence numbers maintained at each destination to determine freshness of routing information and to prevent routing loops. All routing packets carry these sequence numbers [1].

3.2.2 ASSOCIATIVELY BASED ROUTING (ABR):-

ABR is an on-demand routing protocol: Routes are discovered with a Broadcast Query request. From these requests, the destination learns all possible routes, and replies along a selected route to the source. If a route breaks, several route reconstruction methods can be applied, depending if the source, the destination or an intermediate node moves out of reach. Further, ABR maintains a “degree of associativity” in form of associativity ticks [14].

3.2.3 Dynamic Source Routing (DSR):-

DSR is an on-demand protocol, which uses source routing. In this case, this means, that each packet carries the complete route to its destination in its header (which introduces some overhead). It was first described in [18]. Since DSR works on demand, a route must be discovered through a Route Discovery Mechanism before use. Discovered routes may be cached and routes may be overhead by a node. If
Broken links are detected, a corresponding Route Error message is transmitted through the network and a route maintenance mechanism takes over to fix the broken routes, if possible. The DSR protocol not only learns about the destination, but on how to get to each individual node along the route.

3.2.4 TEMPORALLY ORDERED ROUTING PROTOCOLS (TORA):-

TORA is a link reversal routing (LRR) algorithm and was introduced by Park and Corson. In this context “single pass” means, that by processing a single event, all route maintenance tasks (erroneous route deletion, search and establishment of new routes) can be combined. As in LRR algorithms in general, for each destination a destination-rooted DAG is constructed. A height gets associated with each node and thus upstream and downstream links can be identified to route traffic to the destination [14].

3.2.5 CLUSTER BASED ROUTING POTOCOL (CBRP):-

The Cluster head Gateway Switch Routing protocol differs from the other protocols as it uses hierarchical network topology, instead of a flat topology. As proposed by Chiang, it organizes nodes into clusters, which coordinate among the members of each cluster entrusted to a special node named cluster head. Least Cluster Change (LCC) algorithm [19] is applied to dynamically elect a node as the cluster head. Each node must keep a cluster member table where it stores the destination cluster head for each mobile node in the network. These cluster member tables are broadcast by each node periodically using the DSDV algorithm. CGSR is an extension of DSDV and hence uses it as the underlying routing scheme. It has the similar overhead as DSDV. However, it modifies DSDV by using a cluster (hierarchical) routing approach to route traffic from source to destination. CGSR improves the routing performance by routing packets through the cluster heads and gateways [20].

3.3 Hybrid Routing Protocols:-

Hybrid routing protocols are mixed design of two approaches mentioned above. The protocols typically use a proactive approach to keep routes to neighborhood nodes (nodes within the vicinity of the source). But for the nodes beyond the vicinity area the protocol behaves like a reactive one. Alternatively, multiple algorithms can be used simultaneously, if WMN is segmented into clusters. Within each cluster a proactive algorithm is used, whereas between clusters a reactive algorithm is used. The challenge is to choose a point, a point from which the protocol should change from proactive to reactive [21].

3.3.1 Zone Routing Protocol (ZRP) :-

Zone Routing Protocol is a hybrid routing protocol that divides the network into zones. ZRP provides a hierarchical architecture where each node has to maintain additional topological information requiring extra memory.

4. ROUTING COMPARISON:-

Parameters	Table-Driven (Proactive)	On-Demand (Reactive)	Hybrid
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
Delay	Low	High	Low for local destinations and high for Interzone
Scalability	100 nodes	>100	>1000
Control Traffic	High	Low	Lower that other two types
Routing Information	Keep stored in table	Doesn't store	Depends on requirements
Routing Philosophy	Mostly Flat	Flat	Hierarchical

The comparisons basically consider the characteristic properties of routing protocols in high load networks. In order to make flat addressing more efficient, the number of routing overheads introduced in the networks must be reduced. The hybrid routing protocols employ both reactive and proactive properties by maintaining intra-zone information proactively and inter-zone information reactively. Another way to reduce routing overheads is by using conditional updates rather than periodic ones. In on demand routing protocols, the flooding-based routing protocols such as DSR and AODV will also have scalability problems. In order to increase scalability, the route discovery and route maintenance must be controlled. Hybrid routing protocols such as the ZHLS may also perform well in large networks [20].

5. CONCLUSION:

In this paper, we have presented and discussed the taxonomy of routing protocols in mobile ad hoc networks and provided comparisons between them.
The protocols are divided into three main categories:

(i) source-initiated (reactive or on-demand)
(ii) table-driven (pro-active)
(iii) hybrid protocols

For each of these classes, we reviewed and compared several representative protocols. While there are still many challenges facing Mobile ad hoc networks related to routing and security. Each routing protocol has unique features.

Based on network environments, we have to choose the suitable routing protocol. The analysis of the different proposals has demonstrated that the inherent characteristics of ad hoc networks, such as lack of infrastructure and rapidly changing topologies, introduce additional difficulties to the already complicated problem of secure routing. The main differentiating factor between the protocols is the ways of finding and maintaining the routes between source destination pairs. The comparison we have presented between the routing protocols indicates that the design of a secure ad hoc routing protocol constitutes a challenging research problem against the existing security solutions. We hope that the taxonomy presented in this paper will be helpful and provide researchers a platform for choosing the right protocol for their work. At last we have provided the overall characteristic features of all routing protocols and described which protocols may perform best in large networks. Almost all the protocols we discussed in this paper have their own

characteristic features and performance parameter combinations where they out perform their competitors. Still mobile ad hoc networks have posed a great challenge for the researchers due to changing topology and security attacks, and none of the protocols is fully secured and research is going on around the globe.

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