A Survey on Current & Traditional Routing Protocols for Ad Hoc Wireless Networks

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Abstract

Routing is needed to find a path between source and destination and to forward the packets appropriately. Routing protocols are developed for the wired networks such as the wired Internet are inadequate, as they not only assume mostly fixed topology but also have high overheads. This has lead to several routing proposals specifically targeted for ad hoc networks.
An Ad Hoc network is a set of wireless mobile nodes forming a dynamic autonomous network through a fully mobile infrastructure. The nodes communicate with each other without the intervention of centralized access points or base stations, so each node acts both as a router and as a host. The Traditional algorithms (Traditional routing protocol) have not been designed with a highly dynamic topology, the asymmetric links, or the interference in mind. Routing in wireless ad-hoc networks cannot rely on layer three knowledge alone. A good routing protocol for the network environment has to dynamically adapt to the changing network topology.

Keywords

Ad Hoc network, wireless networks, Traditional routing algorithms protocol, routing protocol

1. INTRODUCTION

A Routing protocol is a protocol which will tell how the routers communicate with each other, and also they will be broadcasting the information which enables them to select the routes between the two nodes in a computer network, the choice of the route is being done by the routing algorithms. Routing protocols used in Traditional routing algorithms i.e. wired networks cannot be directly applied to ad hoc wireless networks. For the above reasons, we need to design new routing protocols for ad hoc networks.
The Traditional algorithms have not been designed with a highly dynamic topology, asymmetric links, or interference in mind. Routing in wireless ad-hoc networks cannot rely on layer three knowledge alone. Information from lower layers concerning connectivity or interference can help routing algorithms to find a good path.

An Ad Hoc network is a set of wireless mobile nodes forming a dynamic autonomous network through a fully mobile infrastructure. The nodes communicate with each other without the intervention of centralized access points or base stations, so each node acts both as a router and as a host. Routing is one of the challenging issues in mobile ad-hoc network. And also a good routing protocol for the network environment has to dynamically adapt to the changing network topology.

2. TRADITIONAL ROUTING PROTOCOLS

Traditional routing algorithms do not work at all well in the highly dynamic environment of ad-hoc networks, so extensions of existing or completely new algorithms have to be applied. In the traditional routing approach the Internet, routers present within the central parts of the network are owned by a few well-known operators and are therefore assumed to be somewhat trustworthy. Furthermore, because the topology in such a network can be highly dynamic, traditional routing protocols can no longer be used. Thus, Ad Hoc network has much harder security requirements than the traditional network and the routing in Ad Hoc networks is an especially hard task to accomplish securely, robustly and efficiently.

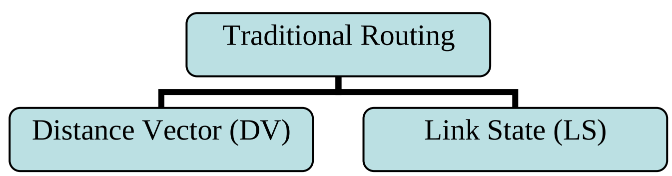

Figure 1.Types of Traditional Routing Protocols

A. How Routing is Done in Traditional Routing Protocols
In the Traditional Routing environment, routers use routing protocol to logically locate themselves, and draw a network topology. Using this Approach, routers defines the routing table. This routing table contains the information for helping the router in making the decision such as where to forward received packets. Routing protocols helps to build routing tables, as soon as these protocols exchange data between routers, containing information about the network. Each protocol acts in different way. The forwarding decision is taken, depends on the number of hops. As the best route the shortest path is being chosen.
A routing protocol sets up a routing table in routers. A node makes a local choice depending on global topology.

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B. Types

Distance Vector (DV):

In this case each node maintains a table giving the distance from itself to all possible destinations. Each of the nodes periodically broadcasts update packets to each of the neighbors. Here Bellman-Ford algorithm [2] is being used in order to find out the shortest path to determine the correct next hop of its neighbors. Each node updates the local routing table according to the distance vector algorithm based on these advertisements.

Routing table at node 5 :

Destination	Next Hop	Distance
0	2	3
1	2	2
...	...	...

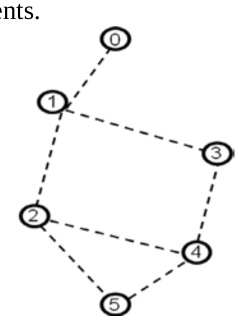

Figure 2.Example of Distance Vector

Link State (LS):

Link-state algorithms flood their information about neighbors periodically. In this case each node maintains a view of the network topology with a cost for each link. Here each node periodically broadcasts the cost of its outing links to all other nodes. And a shortest-path algorithm is being used in order to choose the next hop for each destination.

•At node 5, based on the link state packet, topology table is constructed:

	0	1	2	3	4	5
0	1	1	0	0	0	0
1	1	1	1	1	0	0
2	0	1	1	0	1	1
3	0	1	0	1	1	0
4	0	0	1	1	1	1
5	0	0	1	0	1	1

•Dijkstra's Algorithm can then be used for the shortest path

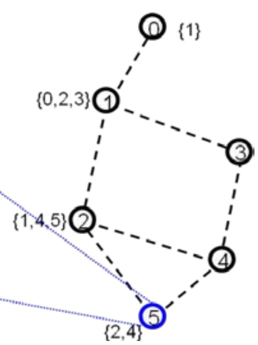

Figure 3.Example of Distance Vector

C. Problems in Traditional Routing Protocols

Dynamic of the topology:

When the topology of the network is fixed or changing slowly, the path established between a source and destination node can be used by any packet going from the same source to the same destination. Therefore, even though the overall overhead of establishing the routing path is relatively high the cost is paid only once.

Limited performance of mobile systems

Periodic updates of routing tables need energy without contributing to the transmission of user data sleep modes difficult to realize. And also limited bandwidth of the system is reduced even more due to the exchange of routing information.

Asymmetric links

Asymmetric links (Connection in wireless network may be not symmetric) are present in wireless networks for a variety of physical, logical, operational, and legal reasons: The transmission range is limited by the node hardware, Power limitation, Interference etc.

3. WIRELESS ROUTING PROTOCOLS

Wireless Routing Protocol (WRP) is a proactive unicast routing protocol for mobile ad-hoc networks (MANET). Wireless Routing Protocol is a table-based protocol with the goal of maintaining routing information among all nodes in the network. It used an enhanced version of the distance-vector routing protocol, which used the Bellman-Ford algorithm to calculate paths.

A. Method

In this case mobiles inform each other of link changes through the use of update messages. An update message is sent only between neighboring nodes and contains a list of updates, as well as a list of responses indicating which mobiles should acknowledge the update. Mobiles send update messages after processing updates from neighbors or detecting a change in a link to a neighbor. In the event of loss of a link between two nodes, the nodes send update messages to their neighbors. The neighbors then modify their distance table entries and check for new possible paths through other nodes. Any new paths are relayed back to the original nodes so that they can update their tables accordingly. If a node is not sending message, it must send a HELLO message within the specified time period to ensure connectivity. Lack of messages from the node indicate the failure of that link, this may cause a false alarm.

B. Overcomes the Problems of Traditional Routing Protocols

WRP, similar to DSDV, inherits the properties of the distributed Bellman-Ford algorithm. To counter the count-to-infinity problem and to enable faster convergence, it employs a unique method of maintaining information regarding the shortest distance to every destination node in the network and the penultimate hop node on the path to every destination node.

Since WRP, like DSDV, maintains an up-to-date view of the network, every node has a readily available route to every destination node in the network. It differs from DSDV in table maintenance and in the update procedures.

While DSDV maintains only one topology table, WRP uses a set of tables to maintain more accurate information. The tables that are maintained by a node are the following: distance table (DT), routing table (RT), link cost table (LCT), and a message retransmission list (MRL).

4. CLASSIFICATION OF ROUNTING PROTOCOLS

Wireless network is an emerging new technology which allows the users to access information and services electronically, regardless of their geographic position. Wireless networks can be classified in two types: the infrastructured network and the infrastructureless [4] (ad hoc) networks.
Infrastructured network consists of a network with fixed and wired gateways. A mobile host communicates with a bridge in the network (called base station) within its communication radius. The mobile unit can move geographically while it is communicating. When it goes out of range of one base station, it connects with new base station and starts communicating through it. This is called handoff [3]. In this approach the base stations are fixed.
In contrast to infrastructureless based networks, in ad hoc networks all the nodes are mobile and that can be connected dynamically in an arbitrary manner. All nodes of these networks behave as routers and take part in discovery and maintenance of routes to other nodes in the network.
This paper discusses about the routing protocols for Ad Hoc wireless networks. These routing protocols can be broadly classified into four categories: Based on Topology Information Organization, Based on the Use of Temporal Information for Routing, Based on Routing Information Update Mechanism, and Miscellaneous Classifications Based on Utilization of Specific Resources.

A. Based on Topology Information Organization

Based on Topology Information Organization Routing Protocols are further categorized into the following categories: Table-Driven, On-Demand and Hybrid Routing.

Table-Driven (Pro-active) Routing:
In Table-driven routing protocols each node maintains one or more tables containing routing information to every other node in the network. All nodes update these tables so as to maintain a consistent and up-to-date view of the network. When the network topology changes the nodes propagate update messages throughout the network in order to maintain consistent and up-to-date routing information about the whole network. These routing protocols differ in the method by which the topology change information is distributed across the network and the number of necessary routing-related tables. The following protocol exists under table-driven ad hoc routing protocols:

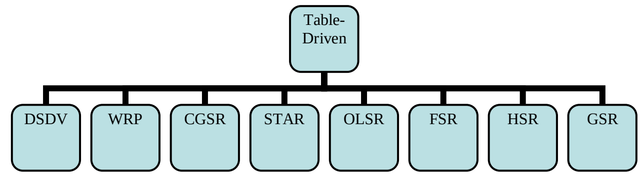

Figure 4.Table Driven Routing Protocols

DSDV (Destination-Sequenced Distance-Vector Routing Protocol):
Destination-Sequenced Distance-Vector (DSDV)[12] is one of the earliest protocols developed for ad hoc networks. Primarily design goal of DSDV was to develop a protocol that preserves the simplicity of RIP, while guaranteeing loop freedom. It is well known that Distributed Bellman-Ford (DBF) [2], the basic distance vector protocol, suffers from both short-term and long-term routing loops (the counting-to-infinity problem) and thus exhibits poor convergence in the presence of link failures. DSDV requires nodes to periodically transmit routing table updates packets regardless of the network traffic. When the number of nodes in the network grows the size of the routing tables and the bandwidth required to update them also grows. This overhead is considered as the main weakness of DSDV.
DSDV use distance vector shortest-path routing as the underlying routing protocol. It has a high degree of complexity especially during link failure and additions. Maximum settling time is difficult to determine in DSDV. DSDV does not support multi-path routing. Fluctuation is another problem of DSDV. DSDV assumes that all nodes are trust worthy and cooperative. Once the false sequence has been established the attacker will continuously send out new packets to update the value. Therefore more hosts will be cheated as a single misbehaving node can pose a serious threat for the entire network.

WRP (Wireless Routing Protocol):
Wireless Routing Protocol (WRP) is another distance vector protocol optimized for ad hoc networks. WRP belongs to a class of distance vector protocols called path finding algorithms. The algorithms of this class use the next hop and second-to-last hop information to overcome the counting-to-infinity problem; this information is sufficient to locally determine the shortest path spanning tree at each node
In WRP there is a quite complicated table structure. Each node maintains four different tables as in many other table-driven protocols only two tables are needed. These four tables are: 1) distance table, 2) routing table, 3) linkcost table and 4) message retransmission list (MRL) table.
CGSR (Cluster-head Gateway Switch Routing Protocol):
CGSR use distance vector shortest-path routing as the underlying routing protocol. It has the certain degree of complexity during link failure and additions. In CGSR

cluster heads and gateway nodes have higher computation and communication load than other nodes. The network reliability may also be affected due to single points of failure of these critical nodes. Hence instead of invoking cluster head reselection every time the cluster membership changes clustering algorithm is introduced.

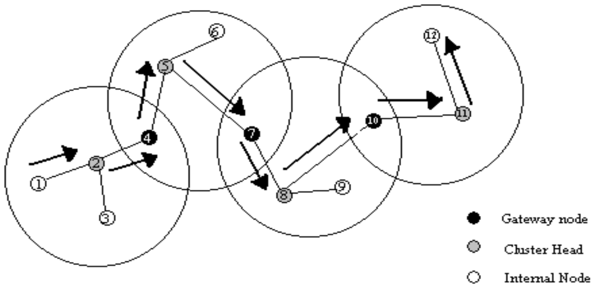

Figure 5.Example of CGSR routing from node 1 to node 12

STAR (Source Tree Adaptive Routing):
STAR requires new neighbours and leaving neighbours are detected in finite time Unlike some other link state protocol STAR does not follow any approach to clear outdated information from the routing table. This leaves a number of different side effects on the protocol performance. Over time routing tables will grow bigger. No doubt it will have its own negative impact on the available resources such as bandwidth. Likewise it could also degrade node performance. In situations where in already established network nodes have to look for destination of interests an extra amount of time is added to the initial node search process. Moreover, if nodes decided to search for a suitable route, the same response query packet will receive at all intermediate receiver’s nodes. As a consequence the whole network will be slow down. Chances are as time passes the network performance will reach to such an extent where rebooting the entire network become necessary.
In STAR the link state information does not time out which makes it difficult to predict anything about the stability of the recorded links. STAR claims to reduce the routing overhead but protocol specification is silent about its effect on network resources such as bandwidth and battery power.

OLSR (Optimized Link State Routing):
Optimized Link State Routing (OLSR)[14] is an optimized version of traditional link state protocol such as OSPF. It uses the concept of Multipoint Relays (MPRs). Only the nodes selected as MPRs by some node are allowed to generate link state updates. Moreover, link state updates contain only the links between MPR nodes and their MPR-Selectors in order to keep the update size small. Thus, only partial topology information is made available at each node. However, this information is sufficient for each to locally compute shortest hop path to every other node because at least one such path consists of only MPR nodes. Due to the nature of mobile ad-hoc network it is expected that network transmission would meet different types of error. Absence of effective error recovery mechanism could make it difficult to utilize OLSR at best.

FSR (Fisheye State Routing):
FSR show better results in a small network. However, its efficiency could reduce as the network grows. In other words accuracy of information decreases as the distance between the nodes increases. Having an integrated node consist wider information than other nodes and reduces the response ability of other nodes in the network. It also reduces the view of the other nodes in comparison with the centre node. In addition, this semi integrated structure is not suitable for mobile ad-hoc network environment.

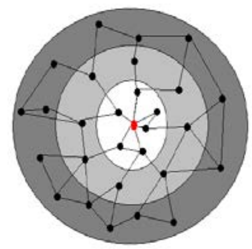

Figure 6.Accuracy of information in FSR

HSR (Hierarchical State Routing):
Continuously changing hierarchical addresses makes it difficult to locate and keep track of nodes. This makes it difficult to achieve routing at a lower expense. It is expected that most of the time nodes will be busy locating different addresses. This also requires nodes to advertise their routes on frequent basis. It has been mentioned before that such scheme adds an extra burden on available network resources. Moreover, absence of efficient maintenance and error recovery mechanisms could also pose additional requirements in the address management of HSR.

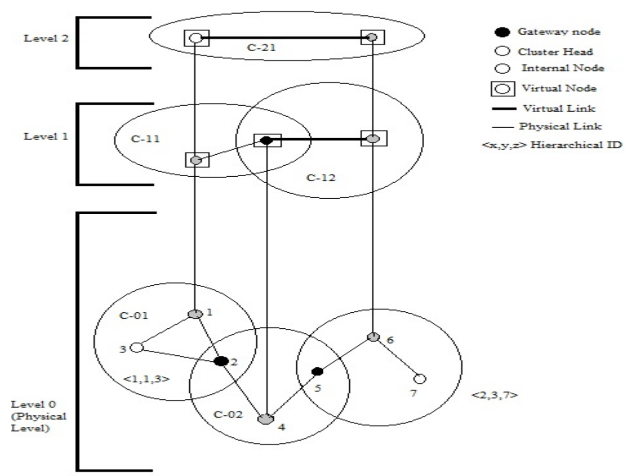

Figure 7.An example of clustering in HSR

GSR (Global State Routing):

The update message size in GSR is relatively large compared to those in some other scheme. Large message size and propagation delay wastes a considerable amount of network bandwidth. That makes it difficult to predict GSR performance on different size of network. It is not clear why routing information in GSR stored inside three tables besides maintaining neighbour list. This approach is different from traditional link state routing protocol such as DSDV which uses single table for same purpose. Keeping information inside three different tables limits node performance to certain extent. Not limited to route or address management, these tables have their due affects on battery life of mobile nodes. Efficient retrieval of already stored addresses requires a search operation. Having distributed information could slow down the whole search process. Likewise storing new information could yield the same affect.

On-Demand (Reactive) Routing:

On-demand (reactive) routing presents an interesting and significant departure from the traditional proactive approach. Main idea in on-demand routing is to find and maintain only needed routes. The obvious advantage with discovering routes on-demand is to avoid incurring the cost of maintaining routes that are not used. This approach is attractive when the network traffic is sporadic, bursty and directed mostly toward a small subset of nodes. Another, not so obvious consequence of on-demand routing is that routes may become suboptimal, as time progresses since with a pure on-demand protocol a route is used until it fails. This section discusses a few on-demand routing protocols. The following protocol exists under table-driven ad hoc routing protocols:

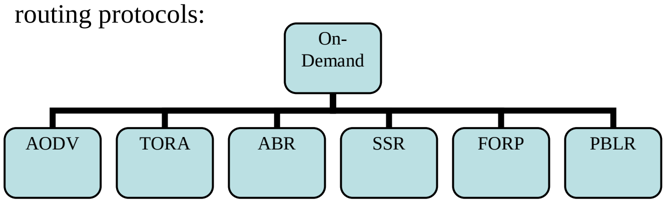

Figure 8.On- Demand Protocols

AODV (Ad-hoc On-demand Distance Vector Routing):

DV [13] is an on demand approach but still use periodic broadcast of ‘hello message’ to track neighbouring nodes. This periodic propagation causes network overhead in AODV. In AODV a route has to discover prior to the actual data packet transmission. This initial search latency may degrade the performance of interactive applications. Similarly the quality of path is not known prior to call set-up. It can be discovered only while setting up the path. Moreover quality of path must be monitored by all intermediate nodes in an active session at the cost of additional latency and overhead penalty. That makes AODV quite unsuitable for real life applications. AODV cannot utilize routes with asymmetric links between nodes and thus require symmetric links. Nodes in AODV store only route that are needed. Nodes use the routing caches to reply to route queries. These results in ‘uncontrolled’ replies and repetitive updates in hosts’ caches yet early queries cannot stop the propagation of all query messages w Source flooded all over the network.

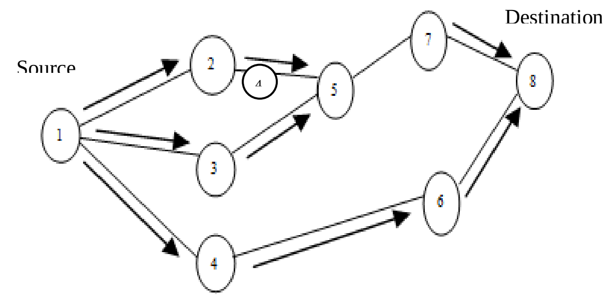

Figure 9a.Propagation of Route Request (RREQ) Packet

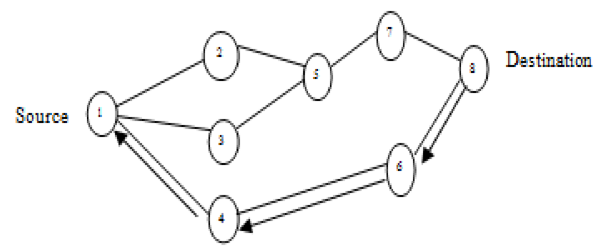

Figure 9b.Path taken by Route Reply (RREP) Packet

Figure 9.Route discovery in AODV

TORA (Temporary Ordered Routing Algorithm):

Temporally Ordered Routing Algorithm (TORA) [15] is another on-demand protocol. TORA’s route discovery procedure computes the multiple loop-free routes to the destination which constitute a destination-oriented directed acyclic graph (DAG). TORA is a distributed routing protocol which is based on a link reversal algorithm. TORA is designed to discover routes on demand.

ABR (Associativity Based Routing):

ABR adopts the basic idea of maintaining routing information via continuous beacon updates. It is fairly known that such schemes are not very impressive due to extra burden they pose on certain network resources. Moreover, due to the nature of mobile ad-hoc network, it is highly unlikely to maintain strong link connectivity among mobile nodes. ABR has used in some of the simulation studies. In general, results were mixed however in some studies, ABR showed weak performance in comparison with other simulated protocols.

SSR (Signal Stability Routing):
A partial route discovery mechanism is not valid to SSR. Therefore if a link failure is detected route discovery has to be initiated from the source. Broken links are locally detected but not repaired and the multiple flooding of Route Request messages restricts the bandwidth. One other weakness of SSR is the failure of the intermediate nodes to reply to route request which are forwarded towards the destination. This drawback adds more delay during the route discovery process.

PBLR (Preferred Link-based Routing):
It is a reactive routing protocol. PLBR uses a quick route repair mechanism to bypass the broken link using information about the next two hops from NNT.

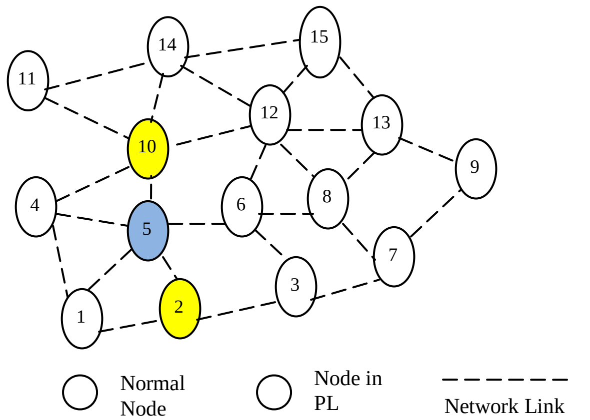

Figure 10.Example of Preferred Link-based Routing

Hybrid (both pro-active and reactive) Routing:
A hybrid protocol has the advantages of both distance vector and link state protocols and merges them into a new protocol. Typically, hybrid protocols are based on a distance vector protocol but contain many of the features and advantages of link state protocols.
Example: EIGRP (Enhanced Interior Gateway Routing Protocol).
The following protocol exists under table-driven ad hoc routing protocols:

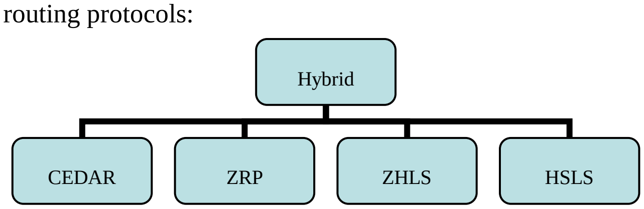

Figure 11.Hybrid Protocols

CEDAR (Core Extraction Distributed Ad Hoc Routing):
CEDAR is based on extracting core nodes, which together approximate the minimum dominating set: A dominating set (DS) of a graph is defined as a set of nodes that every node in the graph is either in the DS or is a neighbour of some node in the DS. There exists at least one core node within three hops.
Core broadcast: core nodes transmit any packet throughout the network in the unicast (Virtual link: the path between two core nodes).

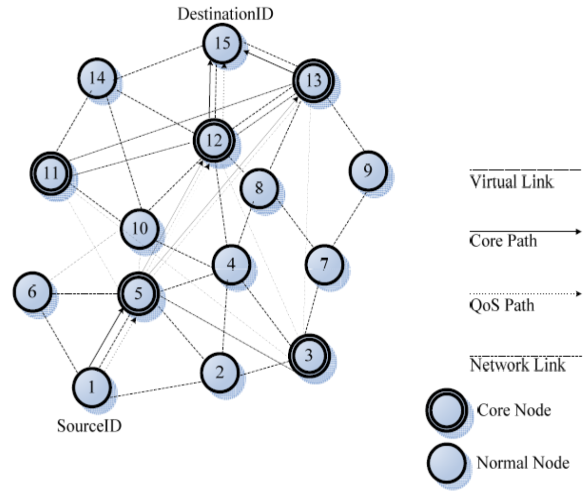

Figure12 Route Establishment in CEDAR

ZRP (Zone Routing Protocol):
Zone Routing Protocol (ZRP) [16] is a hybrid protocol with distinct proactive and reactive components working in cohesion. ZRP defines a zone for each node X which includes all nodes that are within a certain distance in hops, called zone radius, around the node X. Nodes that are exactly zone radius distance away from node X are called border nodes of X’s zone. A proactive link state protocol is used to keep every node aware of the complete topology within its zone. When a node X needs to obtain a route to another node Y not in its zone, it reactively initiates a route discovery which works similar to flooding except that it involves only X’s border nodes and their border nodes and so on. Route query accumulates the traversed route on its way outward from X (like in source routing) and when the query finally reaches a border node which is in destination Y’s zone, that border node sends back a reply using the accumulated route from the query. Depending on the choice of zone radius, ZRP can behave as a pure proactive protocol, a pure reactive protocol, or somewhere in between. While this is an attractive feature to adapt to network conditions by tuning a single parameter, zone radius, it is not straightforward to choose the zone radius dynamically.

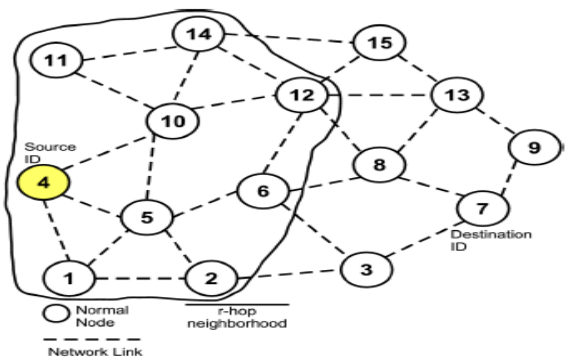

Figure 14.Example of Zone Routing Protocol

ZHLS (Zone-based Hierarchical Link State Routing Protocol):
ZHLS could perform better in specific zones but it is difficult to maintain consistency across the network. The protocol to some extent can provide a better solution in terms of reducing communication overhead and delay, but this benefit is subjected to the size and the dynamics of a zone. It is expected that with the increase in the size of network, ZHLS could create unpredictable large overhead.

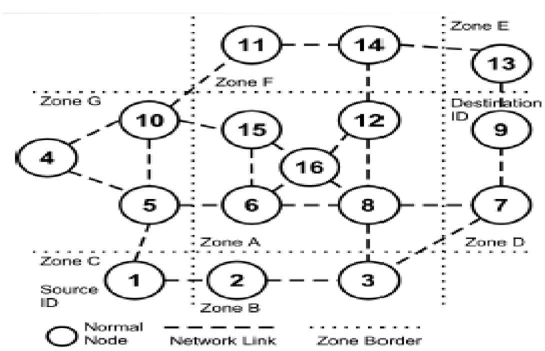

Figure 15.Example of Zone-based Hierarchical Link State Routing Protocol

Efficient connectivity among various zones is itself an issue. Therefore if connectivity among mobile nodes in a zone is sound, it could be expected that the situation in other zone or the worst case in neighbouring zone is not good enough. ZHLS proposed two different types of link state packets. In order to keep all nodes updated frequent propagation of this information is needed. Therefore, nodes should be capable of differentiating among various types of packets. That makes whole issue a bit complicated for the nodes.

HSLS (Hazy Sighted Link State protocol):
Hazy Sighted Link State (HSLS) protocol is a link state protocol based on limited dissemination. Though HSLS does not per se have any reactive component as in ZRP, it partially exhibits behavior typical of reactive protocols, specifically use of suboptimal routes. Main idea here is to control the link state dissemination scope in space and time. Closer nodes are sent link state updates more frequently compared to far away nodes. This idea is based on the observation that two nodes move slowly with respect to each other as the distance between them increases (also referred in the literature as the distance effect). So distant nodes through infrequent updates are only provided “hints” to route a packet closer toward the destination. As the packet approaches the destination, it takes advantage of progressively recent routing information that improves its chances of reaching the destination.

TABLE I Comparison of Table Driven and On Demand Protocols

Parameters	**On Demand**	**Table Driven**
Availability of Routing Information	Available when needed	Always available regardless of need
Routing Philosophy	Flat	Mostly Flat except for CGSR
Periodic route updates	Not Required	Yes
Coping with Mobility	Using Localized route discovery in ABR	Inform other nodes to achieve consistent routing tables
Signaling Traffic Generated	Grows with increasing mobility of active nodes as in ABR	Greater than that of On Demand Routing
QoS Support	Few Can Support QoS	Mainly Shortest Path as QoS Metric

B. Based on the Use of Temporal Information for Routing
Based on the Use of Temporal Information for Routing Protocols are further categorized into the following categories: Past Selection Using Past History, Path Selection Using Prediction.

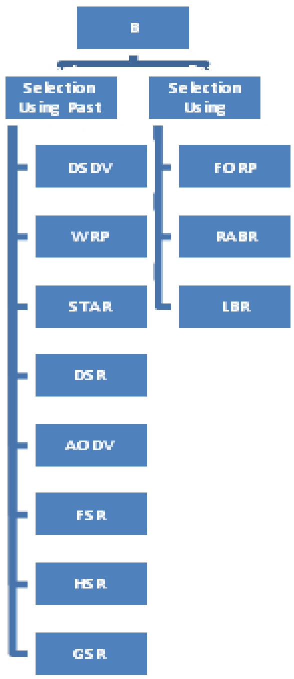

Figure 16.Protocols Based on the Use of Temporal Information for Routing

C. Based on Routing Information Update Mechanism

Based on Routing Information Update Mechanism Protocols are further categorized into the following categories:

Flat Routing, Hierarchical Routing.

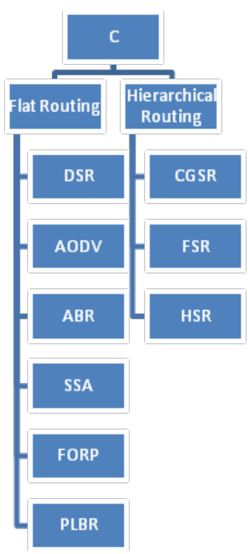

Figure 17.Based on Routing Information Update Mechanism

DSR (Dynamic Source Routing):

DSR is not designed to track topology changes occurring at a high rate. Two sources of bandwidth overhead in DSR are route discovery and route maintenance. These occur when new routes need to be discovered or when the network topology changes. In DSR this overhead can be reduced by employing intelligent caching techniques in each node at the expense of memory and CPU resources. The remaining source of bandwidth overhead is the required source route header included in every packet. This overhead cannot be reduced by techniques outlined in the protocol specification.

D. Miscellaneous Classifications Based on Utilization of Specific Resources

Miscellaneous Classifications Based on Utilization of Specific Resources, Protocols are further categorized into the following categories: Power-Aware Routing, Routing Using Geographical Information, and Routing with efficient flooding.

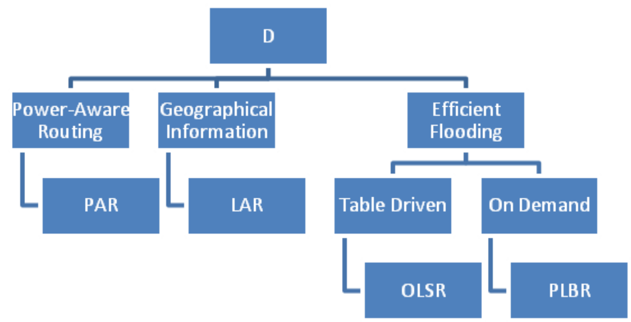

Figure 18.Miscellaneous Classifications Based on Utilization of Specific Resources

5. DISCUSSIONS: COMPARISON OF ROUNTING PROTOCOLS

TABLE II Characteristics of table-driven routing protocol

Table driven	DSDV	CGSR	WRP
Routing	Flat	Hierarchical	Flat
Loop-free	Yes	Yes	Yes, but not instantaneous
No. of required tables	2	2	4
Frequency of update transmissions	Periodically and as needed	Periodically	Periodically and as needed
Updates transmitted to	Neighbors	Neighbors and cluster head	Neighbors
Utilize hello message	Yes	No	Yes
Critical nodes	No	Cluster head	No

TABLE III Characteristics of on demand routing protocol

On-demand	AODV	DSR	TORA	ABR	SSA
Overall complexity	Mediu m	Mediu m	High	High	High
Overhead	Low	Mediu m	Mediu m	High	High
Routing philosophy	Flat	Flat	Flat	Flat	Flat
Loop-free	Yes	Yes	Yes	Yes	Yes
Multicast capability	Yes	No	No	No	No
Beaconing requirement s	No	No	No	Yes	yes
Multiple route support	No	Yes	Yes	No	No
Routes maintained in	Route table	Route cache	Route table	Route table	Route table
Route reconfigurati on methodolog y	Erase route; notify source	Erase route; notify source	Link reversal ; route repair	Localiz ed broadca st query	Erase route; notify source
Routing metric	Freshest and shortest path	Shortest path	Shortest path	Associa tivity and shortest path	Associa tivity

6. CONCLUSION

As a conclusion we can tell that some are of the protocols are of general types while rest varies from one scheme to the other. The contribution of this paper is to contribute a survey on different routing protocols. Here we tried to put our level best to give a clear picture with the help of the comparative study, in the tabular form. Apart from some of the existing protocols, about most of the schemes are discussed here in this paper. This may makes it harder to evaluate these schemes in comparison with some of the schemes that follow same operational pattern. This fact also poses an additional obstacle in their further development. It is a well known fact that ad-hoc network suffer with different issues. Some of the most prominent issues are bandwidth constraints and limited power of mobile devices. Most of the schemes mentioned above clearly lacks in handling this and some other issues. Therefore there is definitely need of a routing solution that can not only offer a better routing solution but also address some of the other routing related issues.

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