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Comparision Estimation of Various Routing Protocol in Mobile Ad-hoc Network: A Survey

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Abstract— *Mobile Ad-Hoc network (MANET) is a continuously self-configuring, infrastructure-less network of mobile devices connected without wires. Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently. Each must forward traffic unrelated to its own use, and therefore be a router. The primary challenge in building a MANET is equipping each device to continuously maintain the information required to properly route traffic and hence require routing protocol. The wireless links in this network are highly error prone and can go down frequently due to mobility of nodes, interference and less infrastructure. Therefore, routing in MANET is a critical task due to highly dynamic environment. Numbers of different routing protocols are proposed. This research paper try to classify all routing protocols and focus on routing information update mechanism with their characteristics, functionality, merits, demerits and their comparative study to find out their performance. For researchers some observations have been made from theoretical analysis to improve performance of protocols. .*

Keywords— *MANET, Routing protocol, Proactive Routing, Reactive routing, Hybrid Routing*

I. INTRODUCTION

Wireless network is divided into two type

A] Infrastructure Based Network:

This is type of network in which two or more mobile nodes are communicate with each other by using base station or physical medium. This is centralized network [1].

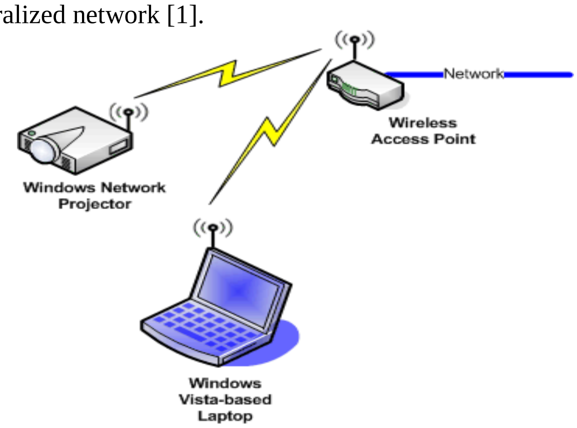

Fig 1: Infastructurebased Network

B] Infrastructure Based Network or Ad-hoc network:

Ad-hoc network is the network in which two or more mobile nodes can communicate with each other without any base station or infrastructure, hence also called infrastructure less network [2].

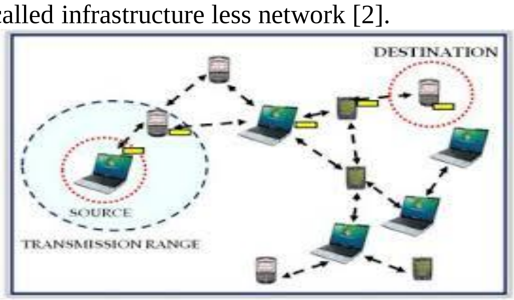

Fig 2: Ad-hoc Network

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A MANET is an autonomous collection of mobile users that communicate over relatively bandwidth constrained wireless links. Since the nodes are mobile, the network topology may change rapidly and unpredictably over time. The network is decentralized, where all network activity including discovering the topology and delivering messages must be executed by the nodes themselves, i.e., routing functionality will be incorporated into mobile nodes.
There are several issues within ad- hoc networks that make them very complicated to integrate with the existing global internet. The problems are addressed below.

1. Error-prone channel state
2. Hidden problem
3. Exposed terminals problem
4. Routing
5. Quality of service
6. Power consumption
7. Security
8. Control Overhead
9. Scalability

II. ROUTING IN MANET

Routing, is an act of moving information from a source to a destination trough intermediate nodes, is fundamental issue for networks. Numerous widely used routing algorithms are proposed for wired networks. Routing is mainly classified into static and dynamic routing. Static routing refers to routing strategies set in the router, manually or statistically. Dynamic routing refers to routing strategies learned by an interior or exterior routing protocol [3]. Routing in MANETs has been an active area of research and in recent years numerous protocols have been introduced for addressing the problems of routing, reviewed in later sections. Routing in MANET depends on many factors including topology, selection of routes, initiation of request, and specific underlying characteristics that could serve as a heuristic in finding the path quickly and efficiently. The low resource availability in these networks demands efficient utilization and hence the motivation for optimal routing in ad hoc networks. Also, the highly dynamic nature of these networks imposes several restrictions on routing protocols specifically design for them [4].

III. CLASSIFICATION OF ROUTING PROTOCOL

Numbers of different protocols are proposed by researchers.
All routing protocol cannot fit in all different scenarios and traffic patterns so they are further classified into other category.

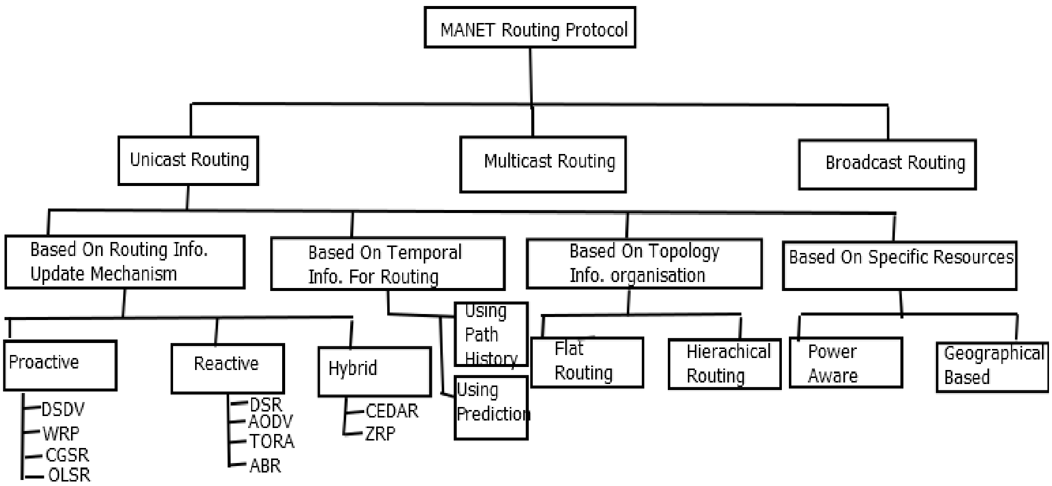

Fig 3: Classification of Routing Protocols

In MANET most of applications are based on unicast communication. In unicast source mobile node transmit data packet to destination. While forwarding data packet dispatch node use the destination address in the data packet to look it up in routing table. In this paper we just consider the unicast routing information update mechanism protocols. Remaining is not considered here.

A] Proactive (table-driven) Unicast Routing Protocol:

In Proactive unicast routing protocol each node in MANET maintains routing information to every other node in network to compute shortest path from the source to every destination node, which consumes lots of bandwidth. Such routing information is kept in many different types of tables. Such tables are time to time updates if network topology changes or a node moves from network.

1] Destination-Sequenced Distance Vector (DSDV)

Destination-Sequenced Distance-Vector Routing (DSDV) is a table-driven routing scheme for ad -hoc mobile networks based on the Bellman-Ford algorithm. It was developed by C. Perkins et.al in 1994. The main contribution of the algorithm was to solve the routing loop problem. Each entry in the routing table contains a sequence number. If a link presents the sequence numbers are even generally, otherwise an odd number is used. The number is generated by the destination, and the emitter needs to send out the next update with this number. Routing information is distributed between nodes by sending *full dumps* infrequently and smaller incremental updates more frequently [4, 21].

Merits:

- It is quite suitable for creating ad- hoc networks with small number of nodes.

Demerits:

- DSDV requires a regular update of its routing tables, which uses up battery power and a small amount of bandwidth even when the network is idle.
- Whenever the topology of the network changes, a new sequence number is necessary before the network re-converges, thus, DSDV is not suitable for highly dynamic networks.

2] Optimized Link State Routing (OLSR)

The Optimized Link State Routing Protocol (OLSR) [8] is an IP routing protocol optimized for mobile ad-hoc networks,
this can also be used on other wireless ad-hoc networks. OLSR is a proactive link-state routing protocol, which uses Hello and Topology Control (TC)messages to discover and then disseminate link state information throughout the mobile ad-hoc network. Individual nodes use this topology information to compute next hop destinations for all nodes in the network using shortest hop forwarding paths. Link-state routing protocols such as OSPF and IS-IS elect a *designated router* on every link to perform flooding of topology information.

Merits:

- Routes to all destinations within the network are known and maintained before use.
- Having the routes available within the standard routing table can be useful for some systems and network applications as there is no route discovery delay.
- The routing overhead generated, while generally greater than that of a reactive protocol, does not increase with the number of routes being used.
- Default and network routes can be injected into the system by HNA (Host and Network Association) messages allowing for connection to the internet or other networks within the OLSR MANET cloud.
- Timeout values and validity information is contained within the messages conveying information allowing for differing timer values to be used at differing nodes.

Demerits:

- Does not include any provisions for sensing of link quality.
- OLSR requires a reasonably large amount of bandwidth and CPU power to compute optimal paths in the network.
- OLSR removes some of the redundancy of the flooding process, which may be a problem in networks with moderate to large packet loss rates however the MPR mechanism is self-pruning.

3] Wireless Routing Protocol (WRP)

The Wireless Routing Protocol (WRP) [20] is a proactive unicast routing protocol for MANETs. WRP uses an enhanced version of the distance-vector routing protocol, which uses the Bellman-Ford algorithm to calculate paths. Because of the mobile nature of the nodes within the MANET, the protocol introduces mechanisms which reduce route loops and ensure reliable message exchanges. The wireless routing protocol (WRP), similar to DSDV, inherits the properties of the distributed Bellman-Ford algorithm. To solve the count-to-infinity problem and to enable faster convergence, it employs a unique method of maintaining information regarding the shortest path to every destination node and the penultimate hop node on the path to every destination node in the network. Since WRP, maintains an up-to-date view of the network, every node has a readily available route to every destination node in the network. 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 re-transmission list (MRL).

Merits:

- It has faster convergence and involves fewer table updates.
- No loop in routing the packets.
- Lower number of updates upon link failure reports sent only to neighbours.
- Overhead grows as O (n) – n is the number of nodes.

Demerits:

- Messages may be large.
- Maintenance of four tables.

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- Hello packets required- cannot go into sleep mode overhead
- Scalability still an issue.

4] Cluster Gateway Switched Routing (CGSR)

Cluster head Gateway Switch Routing (CGSR) [15]uses as basis the DSDV Routing algorithm . The mobile nodes are aggregated into clusters and a cluster-head is elected. All nodes that are in the communication range of the cluster-head belong to its cluster. A gateway node is a node that is in the communication range of two or more cluster-heads. In a dynamic network cluster head scheme can cause performance degradation due to frequent cluster-head elections, so CGSR uses a Least Cluster Change (LCC) algorithm. In LCC, cluster-head change occurs only if a change in network causes two cluster-heads to come into one cluster or one of the nodes moves out of the range of all the cluster-heads.

The general algorithm works in the following manner. The source of the packet transmits the packet to its cluster-head. From this cluster-head, the packet is sent to the gateway node that connects this cluster-head and the next cluster-head along the route to the destination. The gateway sends it to that cluster-head and so on till the destination cluster-head is reached in this way. The destination cluster-head then transmits the packet to the destination. Each node maintains a cluster member table that has mapping from each node to its respective cluster-head. Each node broadcasts its cluster member table periodically and updates its table after receiving other nodes broadcasts using the DSDV algorithm

Merits

- Partial co-ordination between nodes by electing cluster heads. Hence better bandwidth utilization is possible.
- Easy to implement priority scheduling schemes with token scheduling and gateway code scheduling.

Demerits

- Too frequent cluster head selection can be an overhead and cluster nodes and gateway can be a bottleneck.
- Power consumption at the cluster head node is also matter of concern because battery draining rate at the cluster head is higher than normal node.

B] Reactive (on-demand) unicast routing protocols

These protocols take a lazy approach to routing. In contrast to table-driven routing protocols all up-to-date routes are not maintained at every node, instead the routes are created as and when required. When a source wants to send to a destination, it invokes the route discovery mechanisms to find the path to the destination. The route remains valid till the destination is reachable or until the route is no longer needed.

1] Dynamic Source routing protocol (DSR)

DSR [16] is a source-routed on-demand routing protocol. A node maintains route caches containing the source routes that it is aware of. The node updates entries in the route cache as and when it learns about new routes. The two major phases of the protocol are: route discovery and route maintenance. When the source node wants to send a packet to a destination, it looks up its route cache to determine if it already contains a route to the destination. If it finds that an unexpired route to the destination exists, then it uses this route to send the packet. But if the node does not have such a route, then it initiates the route discovery process by broadcasting a route request packet. The route request packet contains the address of the source and the destination, and a unique identification number. Each intermediate node checks whether it knows of a route to the destination. If it does not, it appends its address to the route record of the packet and forwards the packet to its neighbors. To limit the number of route requests propagated, a node processes the route request packet only if it has not already seen the packet and it's address is not present in the route record of the packet. A route reply is generated when either the destination or an intermediate node with current information about the destination receives the route request packet. A route request packet reaching such a node already contains, in its route record, the sequence of hops taken from the source to this node.

Merits:

- Routes maintained only between nodes who need to communicate, reduces overhead of route maintenance.
- Route caching can further reduce route discovery overhead.
- A single route discovery may yield many routes to the destination, due to intermediate nodes replying from local caches.

Demerits:

- Packet header size grows with route length due to source routing.
- Flood of route requests may potentially reach all nodes in the network.
- Care must be taken to avoid collisions between route requests propagated by neighboring nodes insertion of random delays before forwarding RREQ.
- Increased contention if too many route replies come back due to nodes replying using their local cache Route Reply *Storm* problem, Reply storm may be eased by preventing a node from sending RREP if it hears another RREP with a shorter route

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2) Ad-hoc On-Demand Distance Vector Routing (AODV)

Ad hoc On-demand Distance Vector Routing (AODV) [10, 11] is an improvement on the DSDV algorithm. AODV minimizes the number of broadcasts by creating routes on-demand as opposed to DSDV that maintains the list of all the routes. To find a path to the destination, the source broadcasts a route request packet. The neighbors in turn broadcast the packet to their neighbors till it reaches an intermediate node that has recent route information about the destination or till it reaches the destination. A node discards a route request packet that it has already seen. The route request packet uses sequence numbers to ensure that the routes are loop free and to make sure that if the intermediate nodes reply to route requests, they reply with the latest information only.

When a node forwards a route request packet to its neighbours, it also records in its tables the node from which the first copy of the request came. This information is used to construct the reverse path for the route reply packet. AODV uses only symmetric links because the route reply packet follows the reverse path of route request packet. As the route reply packet traverses back to the source, the nodes along the path enter the forward route into their tables.

If the source moves then it can reinitiate route discovery to the destination. If one of the intermediate nodes move then moved nodes neighbour realizes the link failure and sends a link failure notification to its upstream neighbours and so on till it reaches the source upon which the source can reinitiate route discovery if needed.

Merits:

- Routes established on demand and that destination sequence numbers are applied to find the latest route to the destination. The connection setup delay is lower.

Demerits:

- Intermediate nodes can lead to inconsistent routes if the source sequence number is very old and the intermediate nodes have a higher but not the latest destination sequence number, thereby having stale entries.
- Multiple Route Reply packets in response to a single Route Request packet can lead to heavy control overhead.
- Unnecessary bandwidth consumption due to periodic beaconing.

3) Temporally Ordered Routing Algorithm (TORA)

The Temporally Ordered Routing Algorithm (TORA) is a highly adaptive, efficient and scalable distributed routing algorithm based on the concept of link reversal [9]. TORA is proposed for highly dynamic mobile, multihop wireless networks. It is a source-initiated on-demand routing protocol. It finds multiple routes from a source node to a destination node. The main feature of TORA is that the control messages are localized to a very small set of nodes near the occurrence of a topological change. To achieve this, the nodes maintain routing information about adjacent nodes. The protocol has three basic functions: Route creation, Route maintenance, and Route erasure.

Route Creation is done using QRY and UPD packets. The route creation algorithm starts with the height (propagation ordering parameter in the quintuple) of destination set to 0 and all other node's height set to NULL (i.e. undefined). The source broadcasts a QRY packet with the destination node's id in it. A node with a non-NULL height responds with a UPD packet that has its height in it. A node receiving a UPD packet sets its height to one more than that of the node that generated the UPD. A node with higher height is considered upstream and a node with lower height downstream. In this way a directed a cyclic graph is constructed from source to the destination [23].

Merits:

- By limiting the control packets for route reconfiguration to small region, it incurs less control overhead.

Demerits:

- Detection of partition and deletion result in temporary oscillation and transient loops.
- The local reconfiguration of paths results in non-optimal routes.

d) Associativity Based Routing (ABR):

The Associativity Based Routing (ABR) protocol is a new approach for routing proposed in [16]. ABR defines a new metric for routing known as the degree of association stability. It is free from loops, deadlock, and packet duplicates. In ABR, a route is selected based on associatively states of nodes. The routes thus selected are liked to be long-lived. All nodes generate periodic beacons to signify its existence. When a neighbor node receives a beacon, it updates its associativity tables. For every beacon received, node increments its associativity tick with respect to the node from which it received the beacon. Association stability means connection stability of one node with respect to another node over time and space. A high value of associativity tick with respect to a node indicates a low state of node mobility, while a low value of associativity tick may indicate a high state of node mobility. Associativity ticks are reset when the neighbors of a node or the node itself move out of proximity. The fundamental objective of ABR is to find longer-lived routes for ad hoc mobile networks. The three phases of ABR are Route discovery, Route reconstruction (RRC) and Route deletion.

Merits:

- Stable routes have higher preference compared to shorter routes, result in fewer path breaks.
- Reduce flooding due to reconfiguration of paths in network.

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Demerits

- Chosen path may be longer than the shortest path between the source and destination.
- Repetitive LQ broadcast may result in high delays during route repairs.

C] Hybrid routing protocol

This type of protocol the choice of proactive and of reactive routing depends on the hierarchic level in which a node resides. The routing is initially established with some proactively prospected routes and then serves the demand from additionally activated nodes through reactive flooding on the lower levels. The choice for one or the other method requires proper attribution for respective levels.

1) Core Extraction Distributed Ad-Hoc Routing protocol (CEDAR)

The core broadcast is used both for the propagation of increase/decrease waves, and for the establishment of the core path in the route computation phase. Many contemporary proposals for ad hoc networking require every node in the ad hoc network to perform route computations and topology management [5, 6,7]. In contrast, the spine architecture [4] only involves the nodes of an approximate minimum connected dominating set of the ad hoc network. Similarly, CEDAR also uses only the core nodes.

Moreover, we believe that the core provides the benefits of the spine architecture without incurring the high maintenance overhead of the spine. Following are the reasons for using a core-based infrastructure in CEDAR. QoS route computation involves maintaining local and some non-local link-state, and monitoring and reacting to some topology changes. Clearly, it is beneficial to have as few nodes in the network performing state management and route computation as possible.

Merits:

- It performs both routing and QoS path computational very efficiently with the help of core nodes.
- Increase and Decrease waves help in appropriate propagation of the stable high-bandwidth link information.
- Core broadcast provide reliable mechanism for establishing a path with QoS support.

Demerits;

- Route computation is carried out at the core nodes only; the movement of the core nodes adversely affects the performance of the protocol.
- Core node update information could cause a significant amount of control overhead.

2) Zone routing protocol

ZRP [9] was designed to speed up delivery and reduce processing overhead by selecting the most efficient type of protocol to use throughout the route. If a packet's destination is in the same zone as the origin, the proactive protocol using an already stored routing table is used to deliver the packet immediately. If the route extends outside the packet's originating zone, a reactive protocol takes over to check each successive zone in the route to see whether the destination is inside that zone. This reduces the processing overhead for those routes. Once a zone is confirmed as containing the destination node, the proactive protocol, or stored route-listing table, is used to deliver the packet.

In this way packets with destinations within the same zone as the originating zone are delivered immediately using a stored routing table. Packets delivered to nodes outside the sending zone avoid the overhead of checking routing tables along the way by using the reactive protocol to check whether each zone encountered contains the destination node. Thus ZRP reduces the control overhead for longer routes that would be necessary if using proactive routing protocols throughout the entire route, while eliminating the delays for routing within a zone that would be caused by the route-discovery processes of reactive routing protocols.

Merits:

- It reduces the control overhead compared to the Route Request flooding mechanism employed in on-demand and table-driven approaches.

Demerits:

- In the absence of query control, ZRP tends to produce higher control overhead.
- Query control must ensure that redundant or duplicate route request are not forwarded.
- Decision on zone radius has a significant impact on performance of protocol.

IV. COMPARISION OF PROTOCOLS

A] Comparison of Proactive Routing Protocols:

Following table shows comparative study of above discussed four proactive routing protocols with some important parameters.

Table 1: comparative study of proactive routing protocol

Parameters	DSDV	OLSR	CGSR	WRP
Routing Structure	Flat	Flat	Hierarchical	Flat

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Frequency of updates	Periodic and as required	Periodic	Periodic	Periodic
No. Of Tables	2	3	2	4
Hello Message	Yes	No	No	Yes
Critical Nodes	No	No	Yes	No
Scope	Large Network	Large Network	Medium Network	Medium Network
Route Freshness	Up-To-Date	Up-To-Date	Up-To-Date	Up-To-Date
Route Selection	Link-State	Link-State	Shortest Path	Shortest Path
Route Computation	Distributed	Distributed	Distributed	Distributed
Source Routing	No	No	May be Yes	No
Broadcast	Full	Full	Full	Local
Update	Hybrid	Periodic	Hybrid	periodic
Update Information	Distance Vector	Link State	Distance Vector	Link State
Loop free	Yes	Yes	Yes	Yes but not instantaneous
Bacons	Yes	Yes	No	Yes

B] Comparison of Reactive Routing Protocols:

Following table shows comparative study of above discussed four Reactive routing protocols with some important Parameters.

Table 2: comparative study of reactive routing protocols

Parameters	DSR	AODV	TORA	ABR
Routing Structure	Flat	Flat	Flat	Flat
Multiple Routes	No	Yes	Yes	No
Becons	No	Yes, Hello Message	No	Yes
Route Metric Method	Shortest Path or available Route Cache	Freshest and shortest path	Shortest Path or next available	Strongest associativity
Route Maintained in	Route Cache	Route Table	Route Table	Route Table
Route Reconfiguration	Erase Route the sequence no.	Erase Route then Seq. No. or local route repair	Link reversal and link repair	Localized Broadcast Query
Neighbour Detection	No	Hello Message	Hello Message	Hello Message
Route Selection	Shortest and Updated Path	Shortest and Updated Path	Updated Path	Shortest Path
Route Computation	Broadcast	Broadcast	Broadcast	Broadcast
Source Routing	No	Yes	No	Yes
Update	Event-Driven	Event-Driven	Event-Driven	Event-Driven
Update Information	Route Error	Route Error	Node’s Height	Route Error
Loop Free	Yes	Yes	No	Yes

C) Comparison of Hybrid Routing Protocol

Following table shows comparative study of above discussed four Reactive routing protocols with some important Parameters.

Table 3: comparative study of hybrid routing protocols

Parameters	CEDAR	ZRP
Routing Structure	Flat	Hierarchical
Multiple Routes	No	No
Becons	No	Yes
Route Metric Method	Core and QOS path	Shortest Path
Route Maintained in	Route Table	Intra and Inter zone table
Route Reconfiguration	Repair a broken link locally	Route Repair at point of failure and SN

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Route Selection	Shortest	Shortest
Loop Free	Yes	Yes
Source Routing	No	No

V. OBSERVATIONS

By analyzing all the type of protocol following observations has to be made.

A. Reactive routing protocols has low control overhead and has path optimality thus performs well as compared to proactive routing.

B. One important thing amongst reactive protocol is handling of recovery of failed routes. This can be approached from several directions as improving the speed of rebuilding the routes, choosing paths which are predicted to be more stable, based on prediction of failure and pre-emptive rebuilding of routes.

C. Another direction of optimization is the lowering of the cost of route discovery. One immediate way to perform this is by taking advantage of location information.

D. Another direction of work is to improve upon the transitory behaviour of the baseline protocols. There are some protocols which extend upon the baseline by considering various additional networking challenges, such as QoS [24], interference, channel assignment or intermittent connectivity.

E. Most of the recent work on table-driven protocols can be seen as improvements on these baseline distance vector and link state approaches. One direction of research is the adaptation of the routing decisions to the traffic.

F. Another class of protocols aims to improve the scalability of table-driven protocols. The sub-network approach, successfully applied on the wired Internet, cannot be directly applied in ad-hoc networks due to the much more variable connection structure.

G. Hybrid approaches are, in general, justified for large networks if a network is small, we can usually make a clear decision between source driven or table driven approaches performs a differential treatment of the network nodes based on either (a) zones or (b) the nodes participation in a backbone.

VI. CONCLUSION AND FUTURE WORK

In this paper we have discussed over the MANET routing protocols, investigate their characteristics and presented comparative study over the same. We basically focused on three major categories of MANET routing protocols such as proactive, reactive and hybrid routing protocols. We have discussed the different protocols under these categories with their advantages and disadvantages. From theoretical analysis it is find out that reactive and hybrid routing protocol performs well. Related to routing, MANET is still facing many research challenges. Every routing protocol in MANET having unique features and advantages, and hence depending on the network conditions we have to use suitable MANET routing protocol. QoS (Quality of Service) is also one of the main challenges of MANET routing protocol. For the further work, we will suggest to enhance QoS routing performance under the different network conditions and then based on it choose which protocol is best suit for MANET routing in an average under all networking conditions. Further we are suggesting improving the same protocol by using unique features.

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