Performance Evaluation of Reactive & Proactive routing protocols for representation of an ideal Hybrid Routing Protocol in mobile Ad-Hoc Network

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***Abstract*— An Ad-Hoc network is a collection of mobile wireless nodes, forming a temporal network without the help of any centralized administration. Nodes in mobile ad-hoc network are free to move and organize themselves in an arbitrary fashion. Each user is free to roam about while communicating with others. In mobile Ad-hoc network, the reactive and proactive routing protocols face many challenges which is cause of low performance eg. Frequently changing topologies, connection brakes etc. for facing these types of challenges, this paper evaluates a lot of reactive and proactive routing protocols under low to high range of CBRs links with GloMoSim to extract the good property of each routing protocol for representing an ideal hybrid routing protocol which may providing good performance in every circumstances for mobile Ad hoc network. This paper evaluated a simulation result in the basis of following parameters- I) Average End-to-End Delay. II) Throughput. III) Energy Consumption.**

Keywords- Ad-Hoc Network, AODV, DSR, Bellman ford, WRP Protocols.

I. INTRODUCTION

In this new era of communication, the advent of mobile computing has revolutionized our information society. The proliferation of new, powerful, efficient and compact communicating devices like personnel digital assistants (PDAs), pagers, laptops and cellular phones, having extraordinary processing power paved the way for advance mobile connectivity. We are moving from the Personal Computer age to the Ubiquitous Computing age in which a user utilizes, at the same time, several electronic platforms through which he can access all the required information whenever and wherever needed. A mobile ad hoc network (MANET) sometimes called a wireless ad hoc network or a mobile mesh network is a wireless network, comprised of mobile computing devices (nodes) that use wireless transmission for communication, without the aid of any established infrastructure or centralized administration such as a base station or an access point[1, 2, 3, 4]. Ad hoc wireless networks can be deployed quickly anywhere and anytime as they eliminate the complexity of infrastructure setup. A survey of protocols is given in[5]. Most of these protocols are either proactive or reactive in approach.

However, both the approaches have their own limitations[6, 7]. For example, the proactive protocols use excess bandwidth in maintaining the routing information while, the reactive ones have long route request delay. Reactive routing also inefficiently floods the entire network for route determination. Mobile users can maintain their connectivity by accessing this infrastructure from home, from the office, or while on the road. Such mobility support is not available in all locations where mobile communication is desired. Access points may not be set up due to high cost, low expected usage, or poor performance. This may happen during outdoor conferences or in emergency situations like natural disasters and military maneuvers in enemy territory. If mobile users want to communicate in the absence of a support structure, they must form an ad hoc network.

Paper Outline- The rest of the paper is organized as follows. Descriptions of proactive and reactive routing protocols are given in section II. Scenarios, simulation parameters and simulation environment are described in section III. Results are discussed and analyzed in section IV. Finally section V concludes this paper along with future work.

II. RELATED ROUTING PROTOCOLS

Firstly the most popular Ad-hoc routing protocols are briefly reviewed that are the direct candidates for the routing protocol in ad hoc mobile networks, and then analyze their characteristics and propose routing protocol suitable for small/large-scale wireless networks. Traditional ad hoc routing can be divided into tow categories: on-demand (or reactive) and table-driven (or proactive) protocols.

A. On Demand Routing Protocols (Reactive)

On-demand routing protocols were designed with the aim of reducing control overhead, thus increasing bandwidth and conserving power at the mobile stations. In contrast to table-driven routing protocols, the routes are only created as and when required. There is no updating of every route table in the network. Instead, it only maintains the freshness of routes that are being used or being set up. If a source node requires a route to the destination for which it does not have route information, it starts a route discovery process, which goes from one node to the other until it arrives at the destination or a node in-between has a route to the destination. The established route is maintained by a route maintenance procedure until either the destination becomes unreachable or the route is no longer desired. Reactive routing protocols for mobile ad hoc networks are also called "on-demand" routing protocols. In a reactive routing protocol, routing paths are searched only when needed. A route discovery operation invokes a route-determination procedure. The discovery procedure terminates either when a route has been found or no route available after examination for all route permutations. In reactive protocols, a route path is established only when a node has data packets to send. Some of the best known on-demand protocols are Ad-hoc On Demand Distance Vector routing (AODV)[1],Dynamic Source Routing(DSR)[2], Location-Aided Routing Protocol (LAR1)[3].

AODV Routing Protocol

The Ad Hoc On-demand Distance Vector Routing (AODV) protocol is a reactive unicast routing protocol for mobile ad hoc networks. In AODV, routing information is maintained in routing tables at nodes. Every mobile node keeps a next-hop routing table, which contains the destinations to which it currently has a route. A routing table entry expires if it has not been used or reactivated for a pre-specified expiration time. It discovers a route whenever it is needed via a route discovery process. It adopts a routing algorithm based on one entry per destination i.e. it records the address of the node which forwards the route request message. AODV possess a significant feature that once the algorithm computes and establishes the route between source and destination, it does not require any overhead information with the data packets during routing. Moreover the route discovery process is initiated only when there is a free/ available route to the destination. Route maintenance is also carried out to remove state /unused routes.

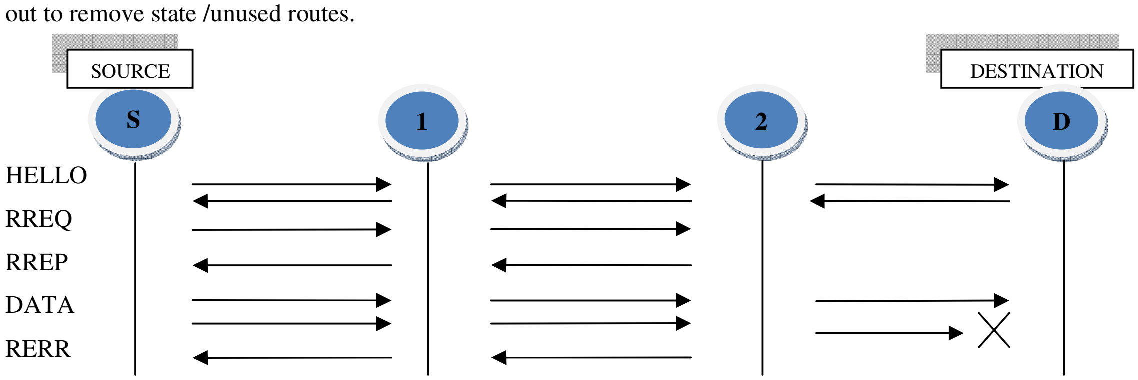

Figure 1. AODV Protocol Messaging

Hello message may be used to detect and monitor links to neighbors. If hello messages are used, each active node periodically broadcasts a hello message that all its neighbors receive. Because nodes periodically send hello messages, if a node fails to receive several hello messages from a neighbor, a link break is detected. When a source has data to transmit an unknown destination, it broadcast a route request(RREQ) for that destination. At each intermediate node, when a RREQ is received a route to the source is created. If the receiving node has not received this RREQ before, is not the destination and does not have a current route to the destination, it rebroadcast the RREQ. If the receiving node is the destination or has a current route to the destination, it generates a Route Reply(RREP). The RREP is unicast in a hop by hop fashion to the source. As the RREP propagates, each intermediate node creates a route to the destination. When the source receives the RREP, it records the route the destination and can begin sending data. If multiple RREPs received by the source, the route with the shortest hop count is chosen.

DSR Routing Protocol

The DSR is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes[8][9][10]. DSR allows the network to be completely self-organizing and self-configuring, without the need for any existing network infrastructure or administration. The protocol is composed of the two main mechanisms of "Route Discovery" and "Route Maintenance', which work together to allow nodes to discover and maintain routes to arbitrary destinations in the ad hoc network it guaranteed loop-free routing, operation in networks containing unidirectional links, use of only "soft state" in routing, and very rapid recovery when routes in the network change. In DSR, Route Discovery and Route Maintenance each operate entirely "on demand". In particular, unlike other protocols, DSR requires no periodic packets of any kind at any layer within the network. For example, DSR does not use any periodic routing advertisement, link status sensing, or neighbor detection packets, and does not rely on these functions from any underlying protocols in the network. This entirely on demand behavior and lack of periodic activity allows the number of overhead packets caused by DSR to scale all the way down to zero, when all nodes are approximately stationary with respect to each other and all routes needed for current communication have already been discovered.

B. Table Driven Routing Protocols(Proactive)

A proactive routing protocol is also called "table driven" routing protocol. Using a proactive routing protocol, nodes in a mobile ad hoc network continuously evaluate routes to all reachable nodes and attempt to maintain consistent, up-to-date routing information. Therefore, a source node can get a routing path immediately if it needs one. In proactive routing protocols, all nodes need to maintain a consistent view of the network topology. When a network topology change occurs, respective updates must be propagated throughout the network to notify the change. Most proactive routing protocols proposed for mobile ad hoc networks have inherited properties from algorithms used in wired networks[11]. To adapt to the dynamic features of mobile ad hoc networks, necessary modifications have been made on traditional wired network routing protocols. Using proactive routing algorithms, mobile nodes proactively update network state and maintain a route regardless of whether data traffic exists or not, the overhead to maintain up-to-date network topology information is high. The differences between these protocols are the number of routing tables and the mechanism used to refresh the routing table. The proactive protocols Wireless Routing Protocol(WRP), Bellman Ford.

Wireless Routing Protocol

The Wireless Routing Protocol(WRP*)* proposed in[12] supports loop freedom. It requires each node to maintain four routing tables which causes a significant overhead at each node as the size of the network increases. Furthermore, WRP ensures its connectivity by using of hello messages. These messages are exchanged whenever there is no recent packet transmission. This process consumes a lot of bandwidth as well as power since each node is required to stay active at all times. Wireless Routing Protocol(WRP) is a proactive unicast routing protocol for mobile ad-hoc networks (MANETs). WRP has the same advantage as that of DSDV. In addition, it has faster convergence and involves fewer table updates. But the complexity of maintenance of multiple tables demands a larger memory and greater processing power from nodes in the ad hoc wireless network. At high mobility, the control overhead involved in updating table entries is almost the same as that of DSDV and hence is not suitable for highly dynamic and also for a very large ad hoc wireless network.

Bellman-Ford Routing Protocol

The Bellman–Ford algorithm computes single-source shortest paths in a weighted digraph. The algorithm is named after its developers, Richard Bellman If a graph contains a "negative cycle", i.e., a cycle whose edges sum to a negative value, then walks of arbitrarily low weight can be constructed, i.e., there may be no shortest path. Bellman-Ford can detect negative cycles and report their existence, but it cannot produce a correct answer if a negative cycle is reachable from the source. That means that every node maintains a route table.

III. SIMULATION ENVIRONMENT

Now a day, there are many network simulators that can simulate the MANET. In this paper GloMoSim-2.03 had selected as the simulator. GloMoSim can simulates networks with up to thousand nodes linked by a heterogeneous communications capability that includes multicast, asymmetric communications using direct satellite broadcasts, for multi-hop wireless communications using ad-hoc networking, and traditional Internet protocols. With the GloMoSim simulator AODV, BLLMAN FORD, DSR and WRP had analyzed in this paper. The Average End-to-End Delay, Throughput and Energy Consumption metrics are used in varying scenarios to evaluate the different protocols. The table given below lists the GloMoSim simulator parameters which used during simulation[13].

TABLE I. GLOMOSIM SIMULATOR PARAMETERS

PARAMETER	VALUE
Simulator	Glomosim-2.03
Seed	1
Terrain-dimensions	(1200,1200)
Simulation time	600s
No. of nodes	90
Protocol studied	AODV,BFD,DSR and WRP
Radio-bandwidth	200000
Node movement model	Random waypoint
Traffic type	CBR (UDP)
Mobility	0-10
Data link (MAC)	802.11
Application-statistics	Yes
TCP-statistics	Yes
Routing-statistics	Yes
N/W Layer-statistics	Yes
Mobility-statistics	Yes
Application	Telnet, FTP

IV. SIMULATION RESULTS AND DISCUSSION

Each protocol represents a different Ad-hoc routing strategy. This paper aims the performance analysis of four routing protocols AODV, BELLMAN FORD, DSR, and WRP and in basis of analyzed result to recommend two or more protocol for merging in hybrid routing protocol. This paper have evaluate both reactive and proactive routing protocols under low to high range of CBRs links with GloMoSim for representing the protocol which performing best in specific environment because when researchers think to combine two or more protocols for building a hybrid routing protocol then they can made their decisions in the basis of result analysis of this paper. This paper evaluated a simulation result in the basis of following parameters- I) Average end-to-end Delay. II) Throughput. III) Energy Consumption. The simulated results given below by graphs:

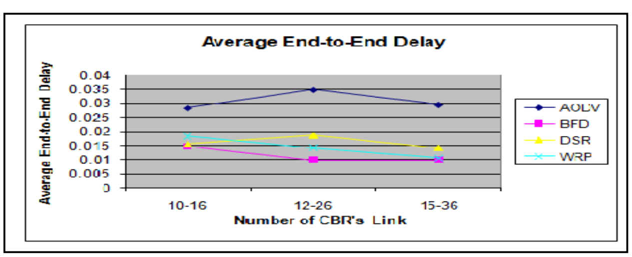

Figure 2. Average end-to-end delay in three CBR's link

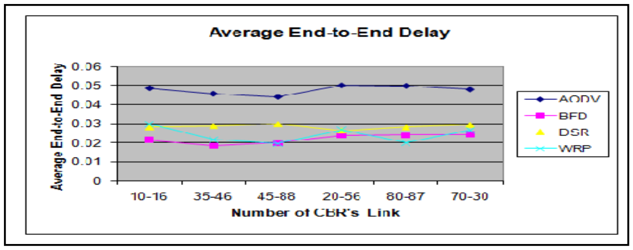

Figure 3. Average end-to-end delay in six CBR's link

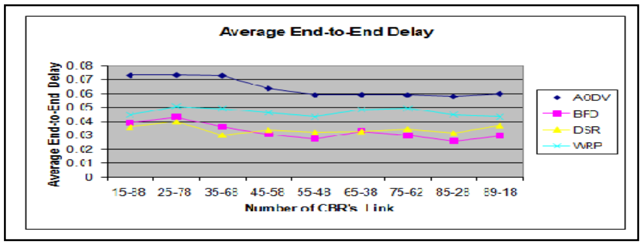

Figure 4. Average end-to-end delay in nine CBR's link

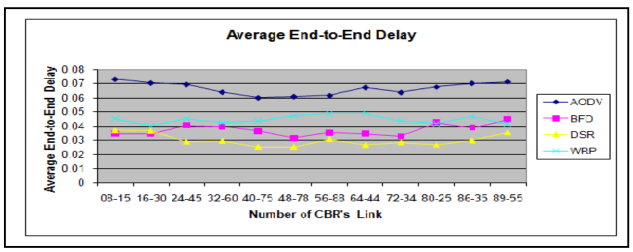

Figure 5. Average end-to-end delay in twelve CBR's link

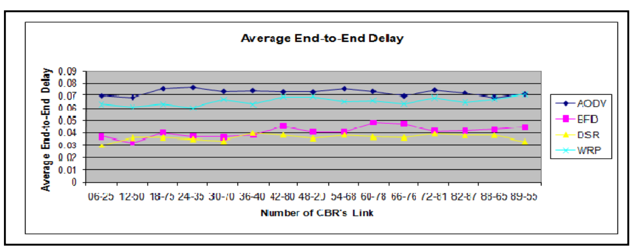

Figure 6. Average end-to-end delay in fifteen CBR's link

Figure 2, 3, 4, 5 & 6 shown the effect on Average End-to-End Delay after CBR's link varies on AODV, DSR, WRP and BFD

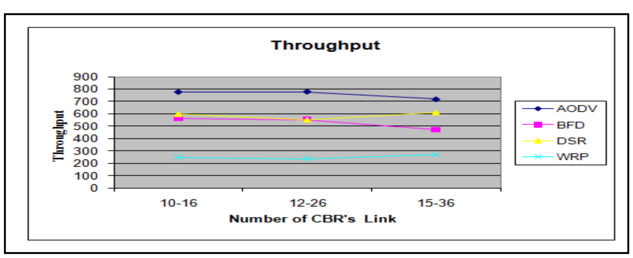

Figure 7. Throughput in three CBR's link

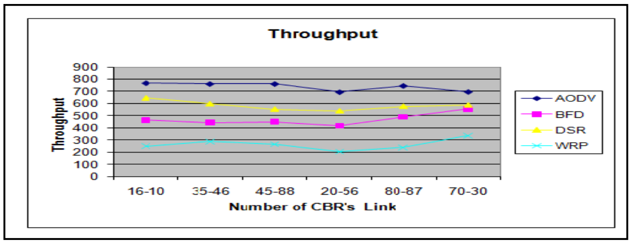

figure 8. Throughput in six CBR's link

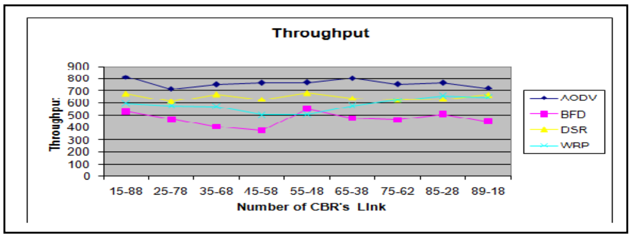

figure 9. Throughput in nine CBR's link

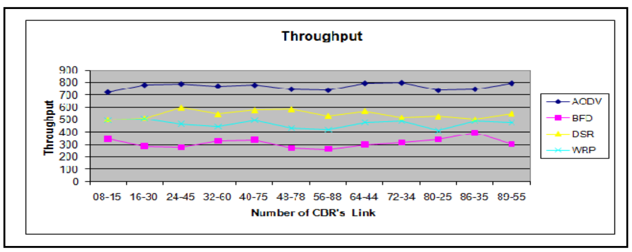

figure 10. Throughput in twelve CBR's link

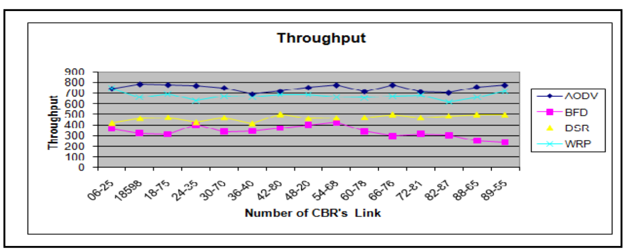

figure 11. Throughput in fifteen CBR's link

Figure 7, 8, 9, 10 & 11 shown the effect on Throughput after CBR's link varies on AODV, DSR, WRP and BFD

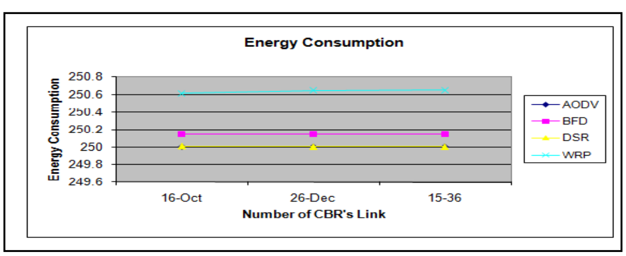

Figure 12. Energy Consumption in three CBR's link

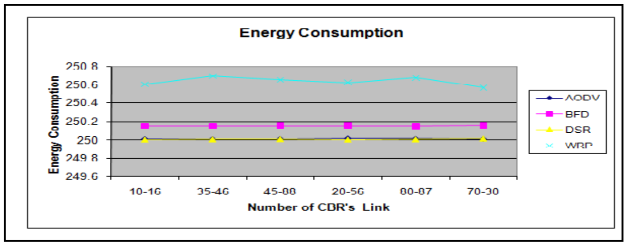

Figure 13. Energy Consumption in six CBR's link

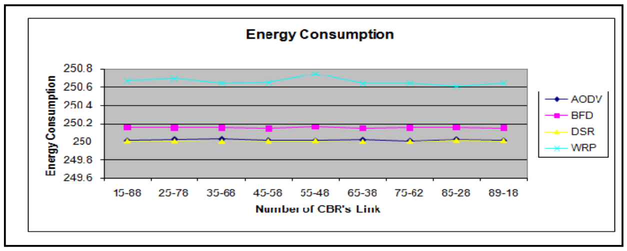

Figure 14. Energy Consumption in nine CBR's link

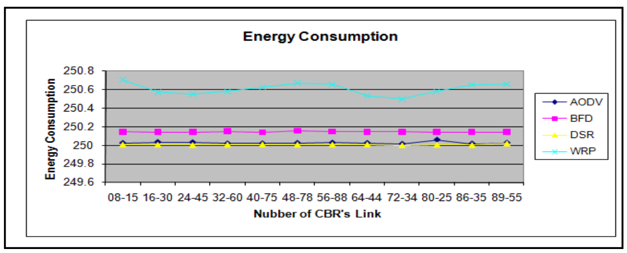

Figure 15. Energy consumption in twelve CBR's link

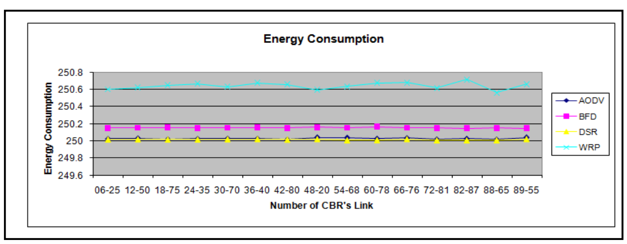

Figure 16. Energy Consumption in fifteen CBR's link

Figure 12, 13, 14, 15 & 16 shown the effect on Energy Consumption after CBR's link varies on AODV, DSR, WRP and BFD

A. Effect of varying CBR's links on Average end-to-end Delay, Throughput, and Energy Consumption

The graphs given for Average end-to-end Delay showed the behavior of the four routing protocols, respectively AODV, DSR, BFD and WRP. The most representative parameters for MANET are selected those are defined and simulated basic scenarios and finally by varying the number of CBR's link between 3, 6, 9, 12, 15 and according to simulation result best performance is shown by DSR and BELLMAN FORD having lowest average end-to-end delay in every case of varying CBR's link because in DSR intermediate nodes also utilize the route cache information efficiently to reduce the control overhead even though the protocol performs well in static and low-mobility environments. But in AODV the 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 scale entries. Also multiple route reply packets in response to a single route request packet can lead to heavy control overhead. Another disadvantage of AODV is that the periodic beaconing leads to unnecessary bandwidth consumption and in WRP requires large memory storage and resources in maintaining its tables. The protocol is not suitable for large mobile ad-hoc networks as it suffers from limited scalability. It concluded that when network size becomes complicated than DSR and BFD routing protocols is better performing as comparison to other protocols such as AODV and WRP protocols. The graphs given for throughput also shown the behavior of the four protocols when varying the number of CBR's link between 3, 6,9,12 and 15 and according to graphs AODV and DSR routing protocol given good performance as compared to WRP and Bellman Ford routing protocols because the AODV are connection setup delay is lower and DSR routes are established on demand and destination sequence numbers are used to find the latest route to the destination. The connection setup delay is lower and in DSR a route is established only when it is required and hence the need to find routes to all other nodes in the network as required by the table-driven approach is eliminated. The graphs had shown for Energy Consumption also gives the behavior of the four routing protocols, respectively AODV, DSR, BFD and WRP. The results obtained from simulation allowed concluding that generally pure on demand protocols such as AODV and DSR perform better than BFD and clearly better than WRP. Because BFD requires a regular updates of its routing tables, which uses up battery power and a small amount of bandwidth even when the network is idle. Since BFD is not suitable for highly dynamic networks and in WRP the complexity of maintenance of multiple tables demands a larger memory and greater processing power from nodes in the ad hoc wireless network, so according to simulated results that had shown corresponding with three parameters specified that BFD, AODV, and DSR can give better performance. So to elect two of them and emerge their good properties reformed new hybrid protocol can give better performance in every circumstance.

V. CONCLUSION

This paper presented a detailed performance evaluation of both reactive and proactive protocols corresponding to Average End-to-End Delay, throughput and Energy consumption for mobile ad-hoc wireless networks. The most representative parameter of GloMosim are selected with varying the number of CBR's links for evaluating the AODV, DSR, BELLMAN FORD and WRP routing protocols. This paper focused on recognizing the best performed protocols corresponding with taken performance metrics and recommends a hybrid routing protocol which is reformed combinations two or more protocols, according to shown simulated result the DSR and AODV performed best corresponding to throughput and energy consumption metrics. But according to Average End-to-End delay metrics the Bellman Ford is perform good as compare to other selected protocols because DSR utilize the route cache information efficiently to reduce control overhead and it perform always well in static and low mobility environments. As same AODV setup delay's lower and it use the destination sequence number to find the latest route to destination so reforming a hybrid routing protocol the selection of protocol from reactive and proactive category must be dependent on requirement of adapting network. In future work the author's will implement the hybrid routing protocol that will be give best alternatives in all aspects.

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