www.ijecs.in
International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 4 Issue 4 April 2015, Page No. 11538-11544

A Review of Ad Hoc Routing Protocols

Showkat Ahmad Dar, Firdous Rashid , Dr. S.Palanivel

Abstract

Ad hoc network is a self configurable network where the mobile nodes act as routers and connected using wireless links. An ad hoc routing protocol is a standard that controls the movement of nodes. The primary goal of an ad hoc routing protocol is establishment of correct and efficient route between a pair of nodes; so that message may be delivered in time. This paper presents various types of ad hoc routing protocols along with their characteristics and functionalities
.

1. Introduction

The routing protocols are broadly classified into four major categories-

Proactive Routing protocols:-

In this the nodes exchanges the topological information or the tables among the network nodes. These are also called as Table Driven routing protocols. In this every node maintains routing table which containing information about the network topology even without requiring it. The routing tables are updated periodically whenever the network topology changes. Proactive Protocols are not suitable for large networks as they need to maintain node entries for each and every node in the routing table of every node.[9]

Reactive Routing Protocol:-

Reactive protocols establish routes to the destination only whenever there is a need. Because of this demanding nature, these are also called as On Demand Routing Protocols [13]. They do not need periodic transmission of topological information of the network. Reactive Protocols use a route discovery process to floodthe network with route query requests when a packet needs to be routed using source routing or distance vector routing.The on- demand routing protocols have two major components:

Route discovery: In this phase source node initiates route discovery on demand basis. Source nodes consults its route cache for the available route from source to destination otherwise if the route is not present it initiates route discovery. The source node, in the packet, includes the destination address of the node as well address of the intermediate nodes to the destination.

Route maintenance: Due to dynamic topology of the network cases of the route failure between the nodes arises due to link breakage etc, so route maintenance is done. Reactive protocols have acknowledgement mechanism due to which route maintenance is possible.

Hybrid Routing Protocol:-

Hybrid protocols combine features from both reactive and proactive routing protocols, [1,4] typically attempting to exploit the reduced control traffic overhead from proactive systems whilst reducing the route discovery delays of reactive systems by maintaining some form of routing table Routing Protocols with efficient flooding mechanism. Proactive tactic is used to discover and maintain routes to nearer nodes, while routes for far away nodes are discovered reactively.

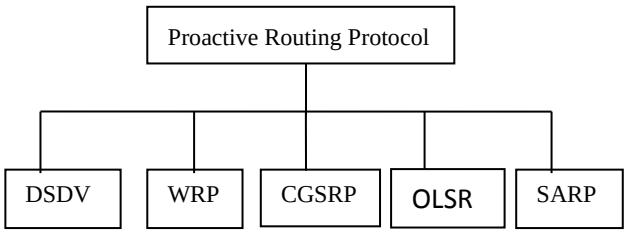
Hierarchical routing protocols:-

With 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 attributation for respective levels.[11]
The main disadvantages of such algorithms are:

- Advantage depends on depth of nesting and addressing scheme.
- Reaction to traffic demand depends on meshing parameters

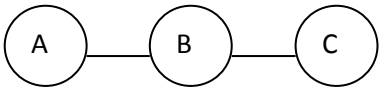
2. Description

2.1 Proactive Routing Protocols



A. DSDV (Destination-Sequenced Distance Vector):-

Destination sequenced distance vector routing (DSDV) [5] is adapted from the conventional Routing Information Protocol (RIP) to ad hoc networks routing. Each node acts as a router where a routing table is maintained and periodic routing updates are exchange, even if the routes are not needed [2]. It adds a new attribute, sequence number, to each route table entry of the conventional RIP. Using the newly added sequence number, the mobile nodes can distinguish stale route information from the new and thus prevent the formation of routing loops. Routing updates are exchanged even if the network is idle. Thus, it is not preferable for highly dynamic networks [10].



For example the routing table of Node A in this network is

Destination	Next Hop	No. of Hops	Seq. no.	Install Time
A	A	0	A 46	001000
B	B	1	B 36	001200
C	B	2	C 28	001500

Naturally the table contains description of all possible paths reachable by node A, along with the next hop, number of hops and sequence number. If a router receives new information, then it uses the latest sequence number. If the sequence number is the same as the one already in the table, the route with the better metric is used. Stale entries are those entries that have not been updated for a while. Such entries as well as the routes using those nodes as next hops are deleted.

Advantages [13]:-

- DSDV protocol provides loop free paths.
- DSDV reduces the Count to infinity problem.
- Incremental updates reduce extra traffic in the network as compared to full dump updates.
- Amount of space is reduced in the routing table by maintaining only the best path instead of maintaining multiple path to every destination.

Disadvantages [13]:-

- Wastage of bandwidth occurs due to needless advertising of routing information if there is node change in the network topology.
- Multi path Routing is not supported in DSDV.
- More bandwidth is required in maintaining the routing table's advertisement for larger network as it requires more bandwidth.

B. WRP(Wireless Routing Protocol):-

The Wireless Routing Protocol (WRP) is table driven routing protocol [8,15].In this protocol enhanced Bellman-Ford Distance Vector routing algorithm is used. For each four tables are maintained i.e. distance table, link-cost table, routing table and message retransmission list (MRL) table. Routing table contains the distance to a destination node, the ancestor and the descendant along the paths to the destination, and state identification, tag field.

The main drawback of distance vector algorithm i.e. routing loops and count to infinity problem is detect with the help of routing table. In link-cost table a mobile node creates an entry for each neighbor. In WRP, using update messages, mobile nodes exchange routing tables with their neighbors. The update messages can be sent either periodically or whenever link state changes happen. The MRL provides the information about which neighbor has not acknowledged an update message.

A Hello message is send by the node to ensure its connectivity. When a node receives an update message, according to the updated information distance table of the node is modified .A node checks the reliability of its neighbors after identifying any link change.

Advantages:-

- It has faster convergence
- Fewer table updates are involved
- Algorithm is simple in functionality.

Disadvantage:-

- Bandwidth usage is increased due to the complexity of maintenance of multiple tables demands a larger memory and throughout the entire network .

C. (CGSRP)Cluster head gateway switch routing protocol:-

Cluster head gateway switch routing uses hierarchicalnetwork topology. The nodes are organized into smallclusters [6].

Each cluster is having cluster-head which coordinate the communication among members of each cluster head.

Advantages [3,7]:-

- Handles issues like channel access ,bandwidth allocation in the network.
- The better bandwidth utilization.

Disadvantage [3,7]:-

- Frequent cluster head changes can adversely affect routing. It degrades the performance as the system is busy in cluster head selection rather than data transmission.
- Power consumption occurs more at the cluster-head as compared to other nodes.

D. OLSR (Optimized Link State Routing):-

OLSR is a proactive routing protocol for mobile ad hoc networks. The protocol inherits the stability of the link state algorithm and has the advantage of having routes immediately available when needed due to its proactive nature.[16] OLSR minimizes the overhead caused by flooding of control traffic by using only selected nodes, called Multi-Point Relays (MPR), to retransmit control messages.

This technique significantly reduces the number of retransmissions required to flood a message to all nodes in the network. Upon receiving an update message, the node determines the routes (sequence of hops) toward its known nodes. Each node selects its MPRs from the set of its neighbors saved in the Neighbor list. The set covers nodes with a distance of two hops. The idea is that whenever the node broadcasts the message, only the nodes included in its MPR set are responsible for broadcasting the message. OLSR uses HELLO and TC messages.

The Topology Control (TC) messages for continuous maintain of the routes to all destinations in the network, the protocol is very efficient for traffic patterns where a large subset of nodes is communicating with another large subset of nodes, and where the [source, destination] pairs change over time. The HELLO messages are exchanged periodically among neighbor nodes, to detect the identity of neighbors and to signal MPR selection.

The protocol is particularly suited for large and dense networks, as the optimization is done by using MPRs which work well in this context. The larger and more dense a network, the more optimization can be achieved as compared to the classic link state algorithm. OLSR uses hop-by-hop routing, i.e., each node uses its local information to route packets .

Advantages [16]:-

- OLSR does not need central administrative system to handle its routing process.
- The link is reliable for the control messages, since the messages are sent periodically and the delivery does not have to be sequential.
- OLSR is suitable for high density networks.
- It does not allow long delays in the transmission of packets.

Disadvantages [16]:-

- OLSR protocol periodically sends the updated topology information throughout the entire network.
- It allows high protocol bandwidth usage.

E. SARP (Source Tree Adaptive Routing Protocol):-

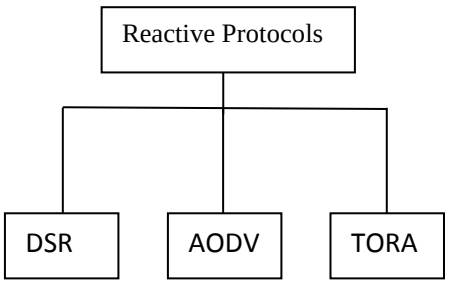
The key feature of this protocol is that it applies Least Overhead Routing Approach (LORA) rather than the optimum routing approach (ORA) which is followed by the previously described protocols [12]. Consequently, the nodes running TORA send updates only when ii necessary and not periodically.

Particularly, each node sends routing information updates only when it detects new nodes, when it loses all paths to a particular destination, or when detects some topology changes which may lead into routing loops.

The nodes send the updates in the form of a source tree, which contains its own preferred paths to all destinations. Upon receiving the source trees from neighbor, a node aggregate these source trees with its information about its adjacent links to produce a partial topology graph. The combination of this topology graph and its own source tree produces its new source tree. Then the node can use this source tree for the routing process. This way every node in the network should have a path to every destination.

If a node does not have a path to a particular destination which the node wants to sendpackets to it, the node triggers a path absence message to its neighbors. A neighbor which has a path to this destination sends its own source tree in response. Otherwise, a neighbor forwards the message to its neighbors and so on until some alternate path is replied. This is considered as the link break maintenance mechanism in STAR.

2.2 Reactive Routing Protocols



A. (DSR) Dynamic Source Routing :-

DSR is a reactive routing protocol that discovers and maintains routes between nodes [2]. In the route discovery, DSR floods Route Request Packet to the network. Each node that receives this packet, first add its address to it and then forwards the packet to the next node. When the targeted node or a node that has route to the destination receives the Route Request, it returns a Route Reply to the sender and a route is established. Each time a packet follows an established route, each node has to ensure that the link is reliable between itself and the next node. In the Route maintenance, DSR provides three successive steps: link layer acknowledgment, passive acknowledgment and network layer acknowledgment. When a route is broken and one node detects the failure, it sends a Route Error packet to the original sender

Advantages [16]:-

- Protocol uses a reactive approach which eliminates the need to periodically flood the network with table update messages.
- 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 intermediate nodes also utilize the route cache information efficiently to reduce the control overhead.

Disadvantages [16]:-

- The route maintenance mechanism does not locally repair a broken link.
- Stale route cache information could also result in inconsistencies during the route reconstruction phase.
- The connection setup delay is higher than in table-driven protocols
- The performance degrades rapidly with increasing mobility.

B. AODV (Ad Hoc on-Demand Distance Vector Routing):-

AODV provides on-demand route discovery in MANET [2]. Whenever the nodes need to send data to the destination, if the source node doesn't have routing information in its table, route discovery process begins to find the routes from source to destination.

Route discovery begins with broadcasting a route request (RREQ) packet by the source node to its neighbors. RREQ packet comprises broadcast ID, two sequence numbers, the address of source and destination and hop count. The intermediary nodes which receive the RREQ packet could do two steps: If it isn't the destination node then it'll rebroadcast the RREQ packet to its neighbors.

Otherwise it'll be the destination node and then it will send a unicast replay message, route replay (RREP), directly to the source from which it was received the RREQ packet. A copied RREQ will be ignored. Each node has a sequence number.

When a node wants to initiate route discovery process, it includes its sequence number and the most fresh sequence number it has for destination. The intermediate node that receive the RREQ packet, replay to the RREQ packet only when the sequence number of its path is larger than or identical to the sequence number comprised in the RREQ packet.

A reverse path from the intermediate node to the source forms with storing the node's address from which initial copy of RREQ. There is an associated lifetime value for every entry in the routing table. Suppose that some routes are not applied within their lifetime period, so these routes are expired and should be dropped from the table. But if routes are used, the lifetime period is updated so those routes are not expired. When a source node wants to send data to some destination, first it searches the routing table; if it can find it, it will use it. Otherwise, it must start a route discovery to find a route. It is also Route Error (RERR) message that used to notify the other nodes about some failures in other nodes or links.

Advantages [13]:-

- This protocol is having 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.

Disadvantages [2,13]:-

- 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 RouteReply packets in response to a single RouteRequest packet can lead to heavy control overhead.
- Unnecessary bandwidth consumption due to periodic beaconing.

C. TORA (Temporally Ordered Routing Algorithm):-

It is a highly adaptive, proficient and scalable distributed routing algorithm based on the concept of link reversal [14]. Principal feature of TORA is that control messages are localized to a very small set of nodes near the occurrence of a topological change.

The protocol has three essential functions: Route creation, Route maintenance and Route erasure. Route creation in TORA is made using QRY and UDP packets. The route creation algorithm starts by setting the height of destination to 0 and for all other nodes to NULL. The sourcebroadcasts a QRY packet with the destination node's id in it. A node with a non-NULL height responds with a UDP packet that has its height in it.

A node receiving a UDP packet sets its height is considered upstream and a node with lower height downstream. In this way a directed acrylic graph is constructed from source to the destination.

The subsequent formation of route on TORA is done by transferring request from source and receiving reply from destination.

During the route creation and maintenance phases, nodes use a height metric to establish a directed acyclic graph (DAG) rooted at destination. During the times of mobility the DAG is broken and the route maintenance unit comes into picture to reestablish a DAG routed at the destination.

Advantages [16]:-

- TORA supports multiple routes between source and destination. Hence, failure or removal of any of the

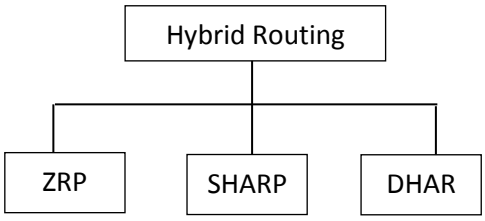
nodes quickly resolved without source intervention by switching to an alternate route to improve congestion.

- TORA does not require a periodic update, consequently communication overhead and bandwidth utilization is minimized.
- TORA provides the supports of link status sensing and neighbor delivery, reliable, in-order control packet delivery and security authentication.

Disadvantages [16]:-

- It depends on synchronized clocks among nodes in the ad hoc network.
- The dependence of this protocol on intermediate lower layers for certain functionality presumes that the link status sensing, neighbor discovery, in order packet delivery and address resolution are all readily available. This solution is to run the Internet MANET Encapsulation Protocol at the layer immediately below TORA.
- This will make the overhead for this protocol difficult to separate from that imposed by the lower layer.

2.3 Hybrid Routing



A. ZRP (Zone Routing Protocol):-

Zone routing protocol is a hybrid routing protocol which [9] effectively combines the best features of proactive and reactiverouting protocol. The key concept is to use a proactiverouting scheme within a limited zone in the r-hop neighborhoodof every node, and use reactive routing scheme for nodes beyondthis zone. An Intra-zone routing protocol (IARP) is used in thezone where particular node employs proactive routing whereasinter-zone routing protocol (IERP) is used outside the zone. Therouting zone of a given nodes is a subset of the network, withinwhich all nodes are reachable within less than or equal to thezone radius hops. The IERP is responsible for finding paths tothe nodes which are not within the routing zone. When a node Swants to send data to node D, it checks whether node D is withinits zone. If yes packet is delivered directly using IARP. If notthen it broadcasts (uses unicast to deliver the packet directly toborder nodes) the RREQ packet to its peripherals nodes. If anyperipheral nodes find D in its zone, it sends RREP packet;otherwise the node re broadcasts the RREQ packet to theperipherals nodes. This procedure is repeated until node D islocated.

Advantages [17]:-

- It reduces the control traffic produced by periodic flooding of routing information packets.
- reduces the wastage of bandwidth and control overhead compared to reactive schemes where RouteRequest flooding mechanisms are used.

Disadvantages [17]:-

- Large overlapping of routing zones.

B. SHARP (Sharp Hybrid Adaptive Routing Protocol):-

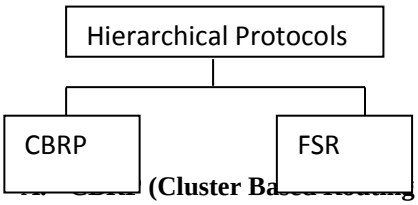
SHARP adapts between reactive and proactive routing by dynamically varying the amount of routing information shared proactively [11]. This protocol defines the proactive zones around some nodes. The number of nodes in a particular proactive zone is determined by the node-specific zone radius. All nodes within the zone radius of a particular node become the member of that particular proactive zone for that node. If for a given destination a node is not present within a particular proactive zone, reactive routing mechanism (query-reply) is used to establish the route to that node. Proactive routing, the proactive zone maintain routes proactively only with respect to the central node. In this protocol, proactive zones are created automatically if some destinations are frequently addressed or sought within the network. The proactive zones act as collectors of packets, which forward the packets efficiently to the destination, once the packets reach any node at the zone vicinity.

C. DHAR (Dual-Hybrid Adaptive Routing)

DHAR uses the Distributed Dynamic Cluster Algorithm (DDCA). The idea of DDCA is to dynamically partition the network into some non-overlapping clusters of nodes consisting of one parent and zero or morechildren [11]. Routing is done in DHAR utilizing a dynamic two level hierarchical strategy, consisting of optimal and least overhead table-driven algorithms operating at each level. DHAR implements a proactive least-overhead level-2 routing protocol in combination with a dynamic binding protocol to achieve its hybrid characteristics. The level-2 protocol in DHAR requires that one node generates an update on behalf of its cluster. When a level-2 update is generated, it must be flooded to all the nodes in each neighboring cluster. Level-2 updates are not transmitted beyond the neighboring clusters. The node with the lowest node ID in each cluster is designated to generate level-2 updates. The binding process is similar to a reactive route discovery process; however, a priori knowledge of clustered topology makes it significantly more efficient and simpler to accomplish the routing. To send packets to the desired destination, a source node uses the dynamic binding

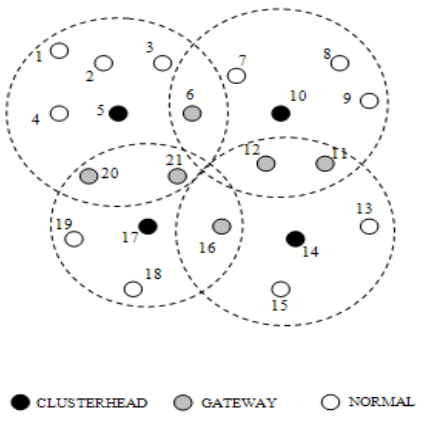
protocol to discover the current cluster ID associated with the destination. Once determined, this information is maintained in the dynamic cluster binding cache at the source node. The dynamic binding protocol utilizes the knowledge of the level-2 topology to efficiently broadcast a binding request to all the clusters. This is achieved using reverse path forwarding with respect to the source cluster.

2.4 Hierarchical routing protocols



(Cluster Based Routing Protocol):-

CBRP (Cluster Based Routing Protocol) is ahierarchical routing protocol, where the nodes are divided into clusters. Ituses clustering's structure for routing protocol [11]. Clustering is aprocess that divides the network into interconnectedsubstructures, called clusters. Each cluster has a cluster head ascoordinator within the substructure. Each cluster head acts as atemporary base station within its zone or cluster andcommunicates with other cluster heads. CBRP is a routing protocol designed to be used in mobilead hoc networks. The protocol divides the nodes of the adhoc network into a number of overlapping or disjoint 2-hopdiameterclusters in a distributed manner. Each clusterchooses a head to retain cluster membership information.There are four possible states for the node: NORMAL,ISOLATED, CLUSTERHEAD and GATEWAY. Initiallyall nodes are in the state of ISOLATED. Each nodemaintains the NEIGHBOR table wherein the informationabout the other neighbor nodes is stored cluster heads haveanother table (cluster heads NEIGHBOR) wherein theinformation about the other neighbor cluster heads isstored.



Advantages:-

- Good methods to decrease network traffic and routing overhead.
- Its two-level hierarchy CBRP is prefferable against routing protocols on flat networks, but it is far away from the scalebility of hierarchical routing protocols.

Disadvantages:-

- If networks and clusters become too big, the overhead per packet increases due to source routing.
- If the cluster size grows the size of HELLO messages and stored data structures increases.

B. FSR (Fisheye State Routing):-

Fisheye State Routing is an implicit hierarchical routing protocol [11]. Also considered a proactive protocol and is a link state based routing protocol that has been adapted to the wireless ad hoc environment. Relays on link state protocol as a base, and it has the ability to provide route information instantly by maintaining a topology map at each node. Thus it will maintain updated information from the neighbor node through a link state table.

The fisheye approach translates to maintaining accurate distance and path quality information about the immediate neighborhood of a node, with progressively less detail as the distance increases.

In this routing protocol, there are three major tasks

1) Neighbor Discovery: responsible for establishing and maintaining neighbor relationships.
2) Information Dissemination: responsible for disseminating Link State Packets(LSP), which contain neighbor link information, to other nodes in the network.
3) Route Computation: responsible for computing routes to each destination using the information of the LSPs.

Advantages:-

- This mechanism reduces the control overhead by disseminating topology information using the fisheye technique.
- It has also shown a good performance in terms of successful packet delivery in the presence of low mobility.

Disadvantage:-

- Route table size grows linearly with network size

Out dated routes to remote destination

3. Conclusion

The field of Ad Hoc networks is very vast and there are various challenges that need to be met, so these networks are going to have widespread use in future.Different routing protocols are used under different network conditions. This paper presents an overview of various Ad Hoc routing protocols with their advantages and disadvantages.In this paper we have identified and reviewed a range ofliterature on the topic of Ad Hoc routing protocols, ourinitial work discussed a pair of survey papers from which we identified reactive, proactive, hybrid and hierarchical routing protocols. Our review focuses upon protocols which the

researchers claims the most popular Ad Hoc routing protocols.

References

[1]. Alex Hinds, Michael Ngulube, "A Review of Routing Protocols for Mobile Ad-Hoc NETworks (MANET)",International Journal of Information and Education Technology, Vol. 3, No. 1, February 2013.

[2]. AmithKhandakar, "Step by Step Procedural Comparison of DSR, AODV and DSDVRouting protocol", 2012 4th International Conference on Computer Engineering and Technology (ICCET 2012) IPCSIT vol.40 (2012) © (2012) IACSIT Press, Singapore.

[3]. AmrErgawy, "Routing Protocols Wireless for Ad Hoc Wireless Networks:Classifications of Protocols and A review of Table Driven Protocols.

[4]. Badr CHAHIDI, "Hybrid Routing Protocol For wireless sensor networks", IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 2, No 1, March 2012 ISSN (Online): 1694-0814.

[5]. Charles E. Perkins, "Highly dynamic destination sequenced distance vector routing for mobile computers", London England UK, 1994 ACM 0-89791-682-4/94/0008.

[6].Ching-Chaun Chiang, Routing in Clustered Multihop, mobile wireless networks with fading channel, Computer science department, university of California, los angeles, ca90024, usa

[7]. Ching-Chuan Chiang and Mario Gerla, "Routing and Multicast in Multihop, Mobile Wireless Networks ,"ARPA/ITO under Contract J-FBI-93-112 Computer Aided Design of High Performance Network Wireless Networked Systems, and by Intel under project "QoS Wireless Networks"

[8]. Chunhsiang Cheng, "A LOOP-FREE EXTENDED BELLMAN-FORD ROUTING PROTOCOL WITHOUTBOUNCING EFFECT",1989A CM 08979l-332-9/89/0009/022.

[9]. Dr. C. A. Dhote,"Hybrid Routing Protocol with Broadcast Reply forMobile Ad hoc Network",2010 International Journal of Computer Applications (0975 – 8887) Volume 1 – No. 10.

[10]. Guoyou He," Destination-Sequenced Distance Vector (DSDV) Protocol", Networking Laboratory Helsinki University of Technology ghe@cc.hut.fi

[11]. G.Vijaya Kumar et. al.," Current Research Work on Routing Protocols forMANET: A Literature Survey", (IJCSE) International Journal on Computer Science and Engineering Vol. 02, No. 03, 2010, 706-713.

[12]. J.J. GARCIA-LUNA-ACEVES, "Source-Tree Routing in Wireless Networks",Defence Advanced Research Projects Agency(DARPA) under grant F30602-97-2-0338.

[13]. MamtaDhanda, " Survey of Routing Protocols for Mobile Ad Hoc Networks", Volume 3, Issue 4, April 2013 ISSN: 2277 128X International Journal of Advanced Research in Computer Science and Software Engineering.

[14]. PritiGarg Comparative Performance Analysis of Two Ad-hoc Routing Protocols 2011 International Conference on Network and Electronics EngineeringIPCSIT vol.11 (2011) © (2011) IACSIT Press, Singapore.

[15]. Shree Murthy, "An Efficient Routing Protocol for Wireless Networks", Advanced Research Projects Agency (ARPA) under contract F19628-93-C-0175 Office of Naval Research under Contract No. N-00014- 92-J-1807.

[16].Tamilarasan-Santhamurthy,"A Quantitative Study and Comparison of AODV, OLSR andTORA Routing Protocols in MANET", IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 1, No 1, January 2012 ISSN (Online): 1694-0814.

[17]. TheofanisKilinkaridis, "Routing Protocols for Wireless Ad Hoc Networks Hybrid routing protocols", tkilinka@cc.hut.fi.

[18]. Young-BaeKo and Nitin H. Vaidya," Location-Aided Routing (LAR) in Mobile Ad Hoc Networks", Texas Advanced Technology Program grants 010115-248 and 009741-052-C.