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Routing protocols classification for Ad Hoc Networks

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Abstract: An ad hoc wireless network is collection of two or more devices or nodes or terminals with wireless communications. Networking capability can communicate with each other without the aid of any centralized administrator also the wireless nodes that can dynamically form a network to exchange information without using any existing fixed network infrastructure. And its an autonomous system in which mobile hosts connected by wireless links are free to be dynamically and some time act as routers at the same time. To facilitate communication within the network, a routing protocol used to discover routes between nodes. The primary goal of such Ad hoc network routing protocol is correct and efficient route establishment between a pair of nodes. so the messages may be delivered in a timely manner. Route construction should be done with minimum of overhead and bandwidth consumption. in this paper we presents routing protocols for ad hoc networks and classify these protocols based on a set of parameters. This paper provides an overview of different protocols by presenting their characteristics and functionality, and then provides a classification of these different routing protocols available for the transmission in ad hoc networks. In this paper we are presenting one example protocol for each category.

Key Words: Adhoc Networks, Wireless, Protocols, Routing.

I. INTRODAUCTION

Wireless network become very popular in the computing industry. There are two types of wireless networks, the first is infrastructured network and second is infrastructure less network commonly known as ADHOC network. The first type of network consists of fixed and wired gateways. While as second type is a multihop wireless network and have no pre-defined infrastructure. The nodes in adhoc networks are dynamic in nature i.e they are capable of moving and are connected in an arbitrary fashion with each other. The adhoc networks are widely used in many civilian forums, military, business and emergency etc. For example, In civilian forum we use it in electronic classrooms, convention centres, construction sites and special events like live concerts and festivals .Also some other areas of adhoc networks where it is used are participating in an interactive lectures, business associates sharing, soldiers relaying information about the situation awareness in a battlefield.

In this paper, we will discuss the current routing techniques/protocols and the classify them according to some certain set of parameters and characteristics, Which will give us an idea of designing some new technique/protocol in future. in this paper the following information provided in various sessions. 2. Various properties of Ad Hoc routing, 3. Classification for routing protocols, 4. Presentation of specified protocols, 5. Conclusion.

II. VARIOUS PROPERTIES OF AD-HOC ROUTING PROTOCOLS

The properties that are desirable in Ad-Hoc Routing protocols are.

A. *Distributed Operation:*

The protocol should be distributed to the network. It should not be dependent on a centralized controlling node. This is the case even for stationary networks also. The difference is that the nodes in an ad-hoc network can enter or leave the network very easily and because of mobility the network can be partitioned.

B. *Loop Free:*

To improve the overall performance, the routing protocol should guarantee that the routes supplied are loop free. This avoids any waste of bandwidth in the network.

C. *Demand Based Operation:*

To minimize the control overhead in the network and thus not waste the network resources the protocol should be reactive. This means that the protocol should react only when needed and that the protocol should not periodically broadcast control information.

D. *Unidirectional Link Support:*

The radio environments cause the formation of unidirectional links. Utilization of these links and not only the bi-directional links improves the routing protocol performance.

E. Unidirectional link support:

The radio environments cause the formation of unidirectional links. Utilization of these links and not only the bi-directional links improves the routing protocol performance.

F. Security:

The radio environment is especially vulnerable to impersonation attacks so to ensure the wanted behaviour of the routing protocol we need some sort of security measures. Authentication and encryption is the way to go and problem here lies within distributing the keys among the nodes in the ad-hoc network.

G. Power Conservation:

The nodes in the ad-hoc network can be laptops and thin clients such as PDA‟s that are limited in battery power and therefore uses some standby mode to save the power. It is therefore very important that the routing protocol has support for these sleep modes.

H. Multiple Routes:

To reduce the number of reactions to topological changes and congestion multiple routes can be used. If one route becomes invalid, it is possible that another stored route could still be valid and thus saving the routing protocol from initiating another route discovery procedure.

I. Quality of Service Support:

Some sort of Quality of service is necessary to incorporate into the routing protocol. This helps to find what these networks will be used for. It should be for instance real time traffic support. It should be noted that none of the proposed protocols have all these properties, but it is necessary to remember that the protocols are still under development and are probably extended with more functionality.

III. CLASSIFICATION FOR ROUTING PROTOCOLS

There are number of routing protocols currently available in adhoc networks. There is a need for a general technique to classify protocols available. Traditionally classification was done by dividing protocols to table driven and to source initiated. Table Driven routing protocols attempts to maintain consistent up to date routing information for each and every node in the network. These protocols require to maintain a consistent view. The area in which they differ are the number of necessary routing related tables and the methods by which changes in network structure are broadcast.

A very different approach from table driven routing scheme is source initiated routing. This type of routing creates routes only when needed by the source node. When a node needs a route to a destination, it initiates a route discovery process with in the network. This process is completed once route is found or all possible route permutations has been established, it is maintained by a route maintenance procedure until either the destination becomes inaccessible along every path from the source or until the route is no longer required. An efficient classification was introduced by Feeney. This classification is based on to divide protocols according to following criteria, reflecting fundamental design and implementation choices.

Communication model: What is the wireless communication model? Multi-or single channel?

Structure: Are all nodes treated uniformly? How are distinguished nodes selected? Is the addressing hierarchical or flat?

State Information: Is network-scale topology information obtained at each node?

Scheduling:Is route information continually maintained for each destination?

This model does not care for if a protocol is unicast , multicast or geocast. Also it does not deal with how links are measures. In order to overcome this, Finnish Defence force naval academy modified the model by introducing,,Type cast routing and Cost function routing. There are no measures taken to classify the protocols according to power consumption and awareness in routing protocols. In order to overcome this, we add power aware routing to this model.

Before you begin to format your paper, first write and save the content as a separate text file. Keep your text and graphic files separate until after the text has been formatted and styled. Do not use hard tabs, and limit use of hard returns to only one return at the end of a paragraph. Do not add any kind of pagination anywhere in the paper. Do not number text heads-the template will do that for you.

Finally, complete content and organizational editing before formatting. Please take note of the following items when proofreading spelling and grammar:

A. Communication Model :

The routing protocols presently available can be categorised according to communication model to protocols that are designed for multi-channel or single channel. The example of multichannel protocol is clustered Gateway switched routing (CGSR).Single channel presumes one shared media to be used.

B. Structure :

Structure of a network can be classified according to node uniformity. Some protocols treat all the nodes uniformly, other make distinctions between different nodes. In **uniform protocols** there is no hierarchy in network, all nodes send and respond to routing control messages at the same manner. In **non-uniform protocols** there is an effort to reduce the control traffic burden by separating nodes in dealing with routing information. Non-uniform protocols fall into two categories: protocols in which each node focuses routing activity on a subset of its neighbors and protocols in which the network is topologically partitioned. These two different methods for non-uniformity are called **neighbor selection** and **partitioning** respectively. With neighbor selection mechanism, every node has its own criteria to classify network nodes to near or to remote nodes. In partitioning protocols that differentiation is to use hierarchical node separation. Hierarchical protocols have some upper-level and lower-level nodes and certain information difference between them.

C. State Information:

Protocols may be described in terms of the state information obtained at each node and / or exchanged among nodes. **Topology-based protocols** use the principle that every node in a network maintains large-scale topology information. This principle is just the same as link-state protocols use. **Destination based** protocols do not maintain large-scale topology information. They only may maintain topology information needed to know the nearest neighbors. The best known such protocols are distance-vector protocols, which maintain a distance and a vector to a destination (hop count or other metric and next hop).

D. Scheduling :

The way to obtain route information can be a continuous or a regular procedure or it can be trigged only by on demand. On that basis the protocols can be classified to proactive and on-demand protocols. Proactive protocols, which are also know as table -driven protocols, maintain all the time routing information for, all known destinations at every source. In these protocols nodes exchange route information periodically and / or,in response to topology change .In on-demand that is in reactive protocols the route is only calculated on demand basis. That means that there is no unnecessary routing information maintained. The route calculation process is divided to a route discovery and a route ma intenance phase. The route discovery process is initiated when an source needs a route to a destination. The route maintenance process deletes failed routes and re-initiates route discovery in the case of topology change.

E. Type of Cast:

Protocols can be assumed to operate at unicast, multicast, geocast or broadcast situations.In **unicast protocols** one source transmits messages or data packets to one destination. That is the most normal operation in any network. The unicast protocols are also the most common in ad hoc environment to be developed and they are the basis on which it is a possibility to construct other type of protocols. Unicast protocols have thought some lacks when there is a need to send same message or stream of data to multiple destinations. So there is an evitable need for multicast protocols. **Multicast routing protocols** try to construct a desirable routing tree or a mesh from one source to several destinations. These protocols have also to keep up with information of joins and leave ups to a multicast group. The purposes of geocast protocols are to deliver data packets for a group of nodes which are situated on at specified geographical area. That kind of protocol can also help to alleviate the routing procedure by providing location information for route acquisition. Broadcast is a basic mode of operation in wireless medium. Broadcast utility is implemented in protocols as a supported feature. Protocol only to implement broadcast function is not a sensible solution. That is the reason not to classify protocols to broadcast protocols. But it is worth to mention if a protocol is not supporting that method.

IV. PRESENTATION OF SPECIFIED METHODS

In this paper I am trying to specify brief explanation about one protocol for each category of classification, i.e Multicast Ad Hoc On-Demand Distance Vector Routing (MAODV)[7] in shared tree based category, Bandwidth-Efficient Multicast Routing(BEMR)[5] in source tree based category, Preferred-Link-Based Multicast(PLBM)[3] in receiver initiated, Forwarding Group Multicast via Receiver Advertising (FGMP-RA)[3] in soft state category, Core-Assisted Mesh Protocol(CAMP)[8] in hard state category, Lantern-Tree-Based Multicast(LTM)[5] Application dependent Multicast Routing Protocols.

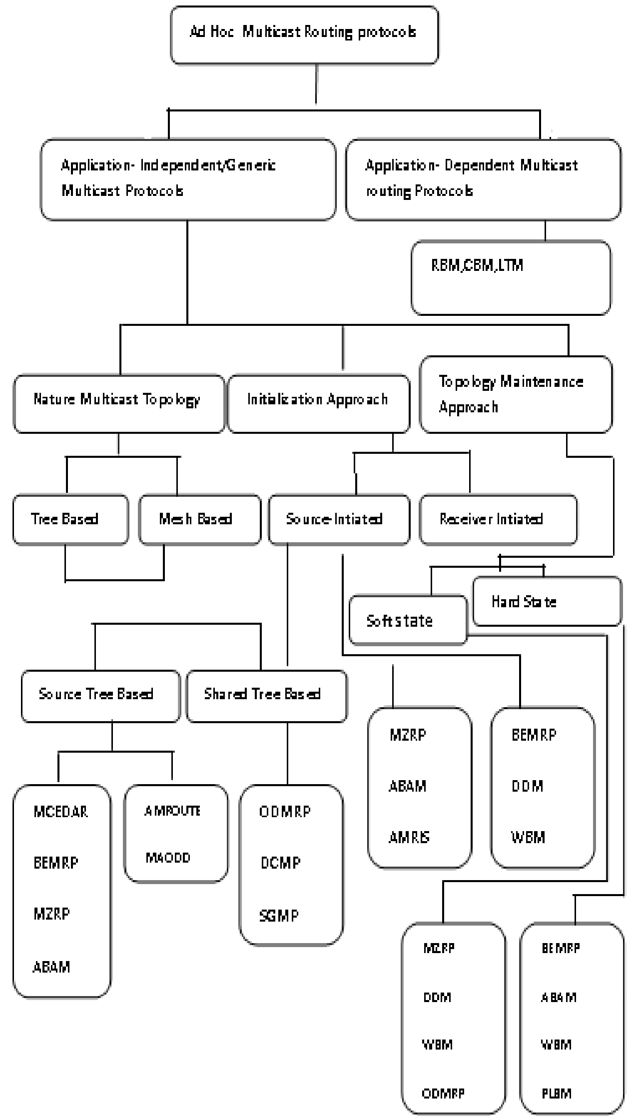

Figure: 1 Classifications of Multicast Routing Protocols

A. Multicast Ad Hoc On-Demand Distance Vector Routing (MAODV):

Multicast ad hoc on demand distance vector (MAODV)[7] routing protocol tries to provide unicast, multicast and broadcast capability to its users. It is derived from AODV [1]. It is a tree protocol whereby routes are discovered on demand and use a broadcast discovery mechanism. Multicast and unicast routing information help each other to learn new routes. The multicast group leader maintains a group sequence number and broadcasts it periodically, which is very important to keep the routing information fresh. A node wishing to join a multicast group generates a route request with its join flag set. If the multicast group leader is known, it can be found in the request table and the request is unicast to the leader. Otherwise, the request has to be broadcast. Only the leader or members of the multicast group with a higher sequence number than that in the join request may respond to the request by generating a route reply and unicasting it back to the requester. Other nodes may rebroadcast or forward the packet. If the requester does not receive a route reply after a certain number of attempts, it becomes a group leader.

Nodes receiving join request update their route and multicast tables with the downstream next hop. Nodes are receiving reply messages update their tables with the, upstream next hop information. They increment hop counts and forward the message to the node that has originated the request, which eventually receives several route replies, selects the best one in terms of highest sequence numbers and lowest hop count and enables that route by unicasting a multicast activation message to its next hop neighbouron the selected path. Intermediate nodes receiving the activation message enable their multicast table entries for the requester. If they are already in multicast group members, further propagation of the message is not necessary. Otherwise, they unicast it upstream along the best route according to the replies they received previously. Nodes having generated or forwarded replies, but not received any activation, delete their entries after a timeout. Figure 4.1 illustrates the three phases of such a join operation in MAODV. The maintenance of the tree is accomplished by means of an expanding ring search started by the downstream node with a fresh join request, which contains the hop distance of the requester to the group leader and the last known sequence number. This request can be answered only by those tree members which are closer to the group leader and have a greater sequence number for the session. Nodes wishing to leave the group prune,themselves by unicasting a multicast activation message to their next hop with the prune flag set.

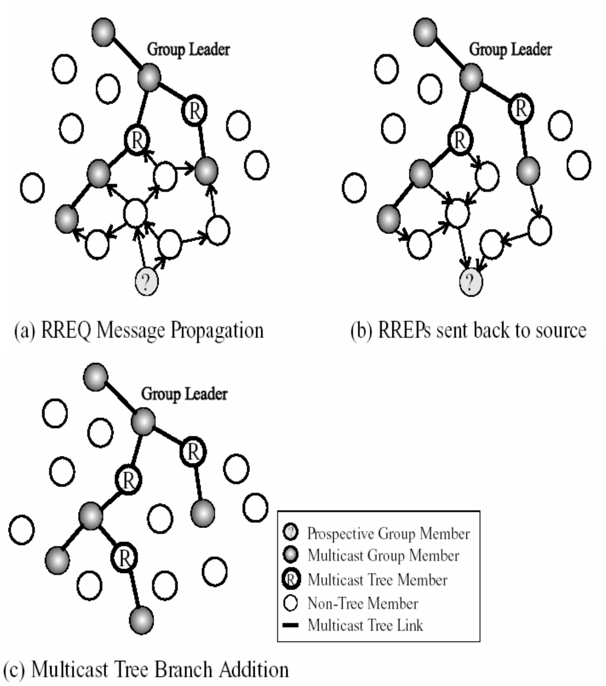

Figure. 2 Multicast join operation of MAODV

B. Bandwidth-Efficient Multicast Routing[BEMR]:

Bandwidth-efficient multicast routing (BEMR) [5] tries to achieve bandwidth efficiency by utilizing a small number of control packets and multicast efficiency by decreasing the number of transmissions for packet delivery in the multicasting process. For this purpose, newly joining nodes try to find the nearest forwarding multicast member and tree reconfiguration is done only when a link break is detected, avoiding the periodic transmission of control packets. When new node broadcasts a join request, each node receiving the request adds it's ID and increments the hop count before flooding it back to the network. The hop count indicates the number of new nodes that need to be added to the multicast group in order to create a path from the group to the node originating the request. Forwarding nodes receive some of these requests, choose the best hop alternative and send a reply packet along the selected path. The requester eventually receives multiple replies, chooses the best hop alternative and sends a reserve packet along the same path. All nodes on this path become forwarding nodes. The route setup process is illustrated in Figure 4.2. To leave a session, nodes send prune messages to their upstream neighbors. If the neighbor does not have any other downstream multicast member, it also leaves the session.

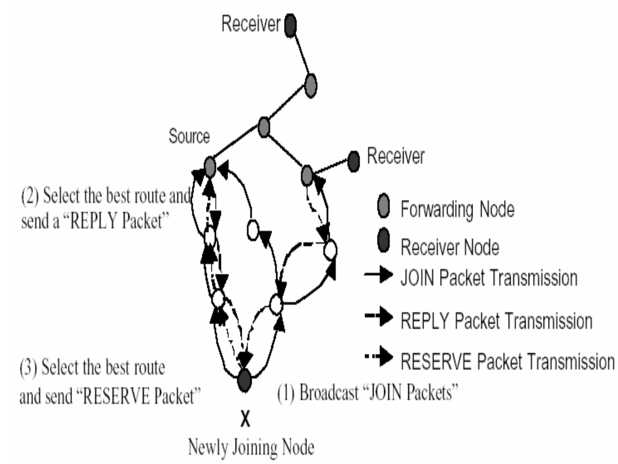

Figure.3 Route setup in BEMR

The routes in BEMR can later be optimized by removing unnecessary forwarding nodes. The optimization process creates a shorter route when a forwarding node or receiver receives a multicast packet with a smaller hop count, as a result of moving into the range of an upstream forwarding node. In this case, the node sends a reserve packet to the new upstream node and a leave packet to the old one. There are two schemes in BEMR to recover from link failures. In the first scheme, the upstream node detects the failure and looks for a new route to the lost downstream node by flooding a broadcast-multicast control packet locally. When the downstream node receives this packet, it sends a reserve packet back and rejoins the multicast group. In the second scheme, the downstream node tries to reconnect to the multicast group by flooding a join packet locally. When nodes from the multicast group receive the packet, they reply. The downstream node selects its new upstream node and sends a reserve packet to it.

C. Preferred-Link-Based Multicast[PLBM]:

The preferred-link-based multicast (PLBM)[3] protocol uses the notion of preferred links and facilitates the two-hop local topology information for efficient multicast routing .Each node maintains a list of its two-hop neighbours, which is kept up-to-date by means of small control packets called beacons and transmitted periodically by every node. Each node also maintains information on the multicast tree. A node wishing to join the multicast tree checks its list of neighbours to see whether the multicast source, a multicast member or a forwarding node is around. If this is the case, it sends a join confirm packet to this neighbour. Otherwise, it checks the same list to see whether there are neighbours which can be preferred to send a join query. The decision on the eligibility of the neighbours is made by an algorithm originally developed for the PLBR protocol, which is the unicast ancestor of PLBM. According to one implementation of this algorithm, preference is given to those neighbours with a higher neighbour degree. As higher degree neighbours can reach more nodes, a few of them is sufficient to cover all the nodes in the two-hop neighbourhood, which reduces the number of broadcasts. A subset of the eligible nodes are inserted into the preferred list field of the join query, which is then sent away to be further forwarded by those nodes. Upon receiving the join request, nodes on the preferred list sends a join reply if it is already connected to the multicast tree. Otherwise, it forwards the packet after generating its own preferred list. When the originator of the join request receives a reply, it sends a,join confirm packet to the node which has sent the reply. Intermediate nodes receiving the join confirm packet mark themselves as connected and forward the packet. They also store the information on the next two-hop both upstream and downstream for this connection. Figure 4.3 illustrates the propagation of the join queries of two ordinary nodes towards the multicast source, the join replies sent in response to the second query by two, forwarding nodes and a join confirm packet sent by a node which discovers a forwarding node within its two-hop neighbourhood.

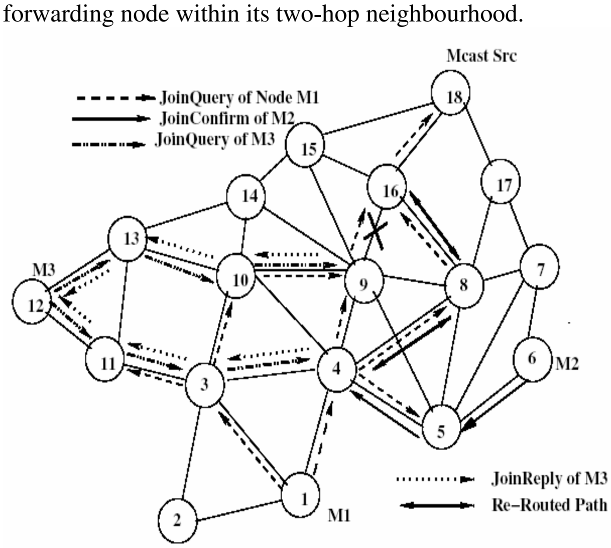

Figure.4 Examples for the join process of various types of nodes in PLBM

Disconnected paths in PLBM are repaired by using the list of two-hop neighbours and the two-hop connection information of the tree. A node with downstream multicast members tries to connect to any tree node in its two-hop neighbourhood. If there are no such nodes, it initiates a join query and also sends another message to its downstreamnodes to prevent them from sending their own join queries and keep the subtree connected.

D. Forwarding Group Multicast via Receiver Advertising (FGMP-RA) :

The forwarding group multicast protocol (FGMP)[3] introduces the forwarding group concept .which is later adopted by ODMRP. The main difference between FGMP and ODMRP is that the latter is a source-initiated protocol. Figure 4.4 shows Forwarding group and tables in FGMP.FGMP keeps track of the nodes participating in packet forwarding, which are called the forwarding group. It uses this group, which is periodically refreshed, to limit the region of flooding. It uses flags instead of upstream or downstream link status information and makes use of the inherent broadcast capability of the wireless medium by exploiting the fact that in such an environment it is sufficient if a node just knows whether it has to forward data packets or not. Its multicast forwarding activities are based on nodes rather than links. FGMP is a hybrid protocol between flooding and shortest tree multicast routing. The maintenance of its forwarding group can apply two schemes. In the receiver advertising scheme, join requests are issued by receivers periodically, which flood the global network.

When these arrive at the server, it updates its member table with the new members, creates a forwarding table from existing routing tables and finally broadcasts the forwarding table. Only those nodes that are among the next hop neighbours in the forwarding table take the,packet into consideration. They set their forwarding flags, create their own forwarding tables and broadcast them in a similar manner until all receivers are reached. Figure 2.6 illustrates an example for this process. The sender advertising scheme works similarly but in the opposite direction, i.e., receivers periodically broadcast joining tables, which are forwarded upstream towards the sender. It is noteworthy that forwarding tables are not,stored at the nodes. They are just temporarily created and broadcast.

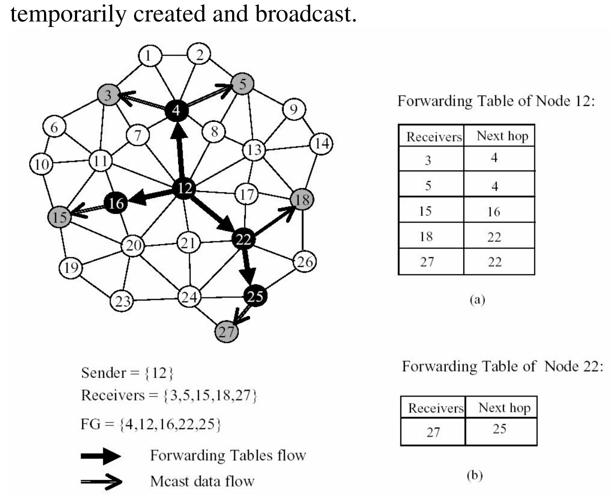

Figure.5 Forwarding group and tables in FGMP

E. Core-Assisted Mesh Protocol(CAMP):

The core-assisted mesh protocol (CAMP)[8] generalizes multicast routing trees into graphs by creating a shared mesh structure for each multicast group .Within a group, cores are used to limit the control traffic caused by join requests. Each node defines its predecessor in multicast mesh from which it receives data as its anchor i.e. anchors are those nodes that are expected to rebroadcast the multicast data they, receive to the routers downstream. Each node maintains a set of tables for routing, core-to group mapping as well as anchor and multicast group management. When a node updates its anchor or multicast table, it sends a reporting message to its all neighbours. The join mechanism is initiated by a host asking its router to join a group. Figure 4.5 shows Traffic flow from router *h* and non-member source *A* in CAMP. CAMP assumes the availability of routing information from a unicast protocol. Thus, the router checks if there are any data-forwarding members of that group among its neighbours. If this is the case, the router directly announces its membership. Otherwise, it broadcasts a join request, which contains the information on the intended relay node towards the group core. Any member router of the intended multicast group can send a,join acknowledgement. The requesting router and its relays become part of the group when they receive the first acknowledgement. Relays forward these replies towards their requester. A router leaves a multicast group if it has no member hosts and is not required as an anchor for any neighboring node for that group. According to this mechanism, routers have to be group members to forward data packets of their hosts. However, CAMP has a secondary join mechanism which allows non-member sources to forward data in one direction only. Figure 2.7 illustrates the traffic flow in each of these schemes, whereby the solid arrows represent the flow of real data and the dashed arrows indicate overhead.

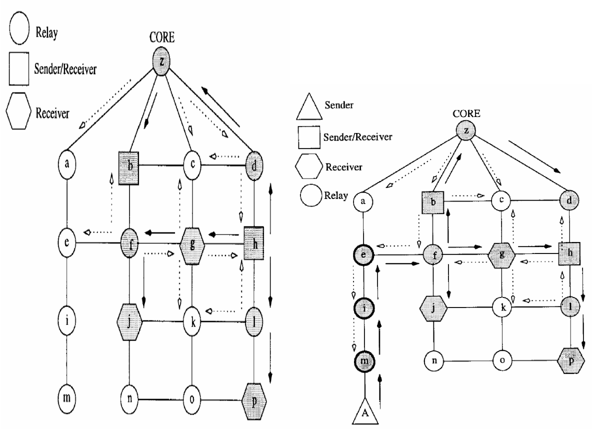

Figure.6 Traffic flow from router *h* and non-member source *A* in CAMP

Traffic flow from router *h* and non-member source *A* in CAMP CAMP uses a scheme based on the transmission of heartbeat messages to ensure that the mesh contains all the reverse shortest paths. When the number of packets a mesh member receives from a multicast source via the reverse shortest path is under a threshold, the mesh member sends a heartbeat message along that shortest path towards the source. A router receiving a heartbeat forwards it if its successor towards the source is already a mesh member. Otherwise, it sends a push join and waits for an acknowledgement. A router receiving a push join sends an acknowledgement if it is the intended relay, is already a group member and has a path to the target of the push join. Then it forwards it to the next relay towards that target. Following this scheme, CAMP guarantees that every receiver in a multicast group knows a reverse shortest path to each source of that group.

F. Lantern-Tree-Based Multicast[LTM]:

The lantern-tree-based multicast (LTM) [5] protocol is a resource management scheme which can serve as the bandwidth reservation module of an on-demand multicast routing protocol. Figure 4.6 shows A tree, a lantern-tree and a worst-case lantern-tree in LTM. It provides end-to-end calculation and allocation of bandwidth from a source to a group of destinations by means of multipath routing. The scheme provides a single path if bandwidth which is sufficient or a lantern-path if it is not. A lantern is defined as,one or more subpaths with a total bandwidth between a pair of two-hop neighbouring nodes. A lantern path is a path with one or more lanterns between a source and a destination. Finally, a lantern tree is defined as a multicast tree which contains at least one lantern-path between any of its source-destination pairs. Figure 2.13 illustrates the lantern tree concept.

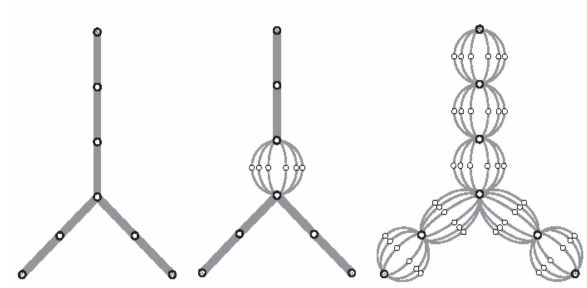

Figure.7 A tree, a lantern-tree and a worst-case lantern-tree in LTM

According to LTM, the source sends a lantern-path request. The path is created if such a lantern exists. The process is repeated until a possible lantern-path arrives at the destination. Then a lantern-path is constructed. The replying paths from the destination back to the source are merged together to construct the lantern tree. The advantages of the lantern-tree approach are task sharing and higher stability. Sub-paths are responsible for a portion of the total bandwidth requirement and also for a fewer number of bandwidth requirements.

V. CONCLUSION

In this article we provide descriptions of several routing schemes proposed for ad hoc wireless networks. We also provide a classification of these schemes according to the routing strategy. The presented classification model of routing protocols is a meaningful attempt to clarify the vast field of adhoc routing protocols. It is so because it tries to reveal the main design and implementation principles behind protocols. The classification is a little bit complicated and it is not always an easy task to classify a protocol according to that taxonomy, but the meaning of classifying is try to get some rough basis for protocol's performance evaluation. In future we will study category wise performance analysis of routing protocols.

VI. REFERENCES

[1] Charles Perkins and Elizabeth Royer. Ad hoc on demand distance vector (AODV)routing.http://www.ietf.org/internet-drafts/draft-ietf-manet-aodv-02.txt, November 1998. IETF Internet Draft

[2] Mingliang Jiang, Jinyang Li, Y.C. Tay, "Cluster Based Routing Protocol" August 1999IETFDraft.http://www.ietf.org/internet-drafts/draft- ietf- manetcbrp-spec-01 .txt

[3] Mohapatra, P., C. Gui and J. Li, "Group Communications in Mobile Ad Hoc Networks", IEEE Computer, Vol. 37, No. 2, pp. 52-59, February 2004.4. Lin, C. R. and J. S. Liu, "QoS

[4] Routing in Ad Hoc Wireless Networks", IEEE Journal on Selected Areas in Communications, Vol. 17, No. 8, pp. 1426-1438, August 1999.

[5] Gerla, M., C.-C. Chiang and L. Zhang, "Tree Multicast Strategies in Mobile, Multishop Wireless Networks", ACM Mobile Networks and Applications, Vol. 4, No.3, pp. 193-207, October 1999.

[6] Perkins, C. E. and E. M. Royer "Ad-Hoc On- Demand Distance Vector Routing", Proceedings of WMCSA '99 - the IEEE Workshop on Mobile Computing Systems and Applications, pp. 90-100, New Orleans, USA, 25-26 February 1999.

[7] Ji, L. and M. S. Corson, "Explicit Multicasting for Mobile Ad Hoc Networks", ACM Mobile Networks and Applications, Vol. 8, No. 5, pp. 535-549, October 2003

[8] Garcia-Luna-Aceves, J. J. and E. L. Madruga, "The Core-Assisted Mesh Protocol", IEEE Journal of Selected Areas in Communications, Vol. 17, No.8, pp. 1380-1394, August 1999.

[9] Lee, S. J., W. Su, J. Hsu and M. Gerla, "On- Demand Multicast Routing Protocol (ODMRP) for Ad Hoc Networks", IETF MANET Working Group Internet Draft (draft-ietf-manet-odmrp-02.txt), work-in-progress, January 2000.

[10] Das, S. K., B. S. Manoj and C. S. R. Murthy, "A Dynamic Core-Based Multicast Routing Protocol for Ad Hoc Wireless Networks", Proceedings of MobiHOC 2002 – the ACM International Symposium on Mobile Ad Hoc Networking & Computing, pp. 24-35

