New Multicast Routing Protocol In Ad-Hoc Network

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Abstract- A MANET is a type of ad hoc network that can change locations and configure itself on the fly. Because MANETS are mobile, they use wireless connections to connect to various networks. This can be a standard Wi-Fi connection, or another medium, such as a cellular or satellite transmission. Once MANETs are restricted to a local area of wireless devices (such as a group of laptop computers), while others may be connected to the Internet. Multicasting is the transmission of data packets to more than one node sharing one multicasting address, the senders and receivers form the multicast group. This protocol provides the robust routes at the expense of increased overhead. This will lead to inefficiency when the network or group is large. The new trend of design of multicasting protocols in MANET is to reduce such overhead. Some efforts have been made in this field.

Keywords – Manet , Multicast protocol, New protocols over tree & mesh .

I. INTRODUCTION

Wired solutions have been around for a long time but there is increasing demand on working wireless solutions for connecting to the Internet, reading and sending E-mail messages, changing information in a meeting and so on. There are solutions to these needs, one being wireless local area network that is based on IEEE 802.11 standard. However, there is increasing need for connectivity in situations where there is no base station (i.e. backbone connection) available (for example two or more PDAs need to be connected). This is where ad hoc networks step in.

Manet :-Mobile Ad hoc Network (MANET) is a collection of independent mobile nodes that can communicate to each other via radio waves. The mobile nodes that are in radio range of each other can directly communicate, whereas others need the aid of intermediate nodes to route their packets. These networks are fully distributed, and can work at any place without the help of any infrastructure. This property makes these networks highly edible and robust.

Application areas:-

Some of the applications of MANETs are
• Military or police exercises.
• Disaster relief operations.
• Mine site operations.
• Urgent Business meetings
• Robot data acquisition

In recent years, a number of multicast protocols for ad hoc networks have been proposed. Based on the routing structure, they can broadly be classified into two categories: tree-based protocols and mesh- based protocols. In tree-based protocols, there exists a single path between any sender-receiver pair. Tree-based protocols have the advantage of high multicast efficiency (which is defined as the ratio of the total number of data packets received by all receivers to the total number of data packets transmitted or retransmitted by senders or intermediate nodes). However, tree-based protocols are not robust against frequent topology changes and the packet delivery ratio (which is defined as the ratio of the number of data packets delivered to all receivers to the number of data packets supposed to be received by all receivers) drops at high mobility. Mesh-based protocols provide redundant routes for maintaining connectivity to group members. The low packet delivery ratio problem caused by link failures is alleviated due to redundant routes. Mesh-based protocols are robust to node mobility. However, redundant routes cause low multicast efficiency.

II. MULTICASTING

Multicasting is the transmission of data packets to more than one node sharing one multicasting address, the senders and receivers form the multicast group. Actually, there could be more than one sender in a multicast group, so it is group-oriented computing. In wired networks, some well established routing protocols can provide efficient multicast, but when it comes to MANETs, these protocols may fail due to some unique characteristics of MANETs. When designing protocols for ad hoc network multicast, some key issues should be kept in mind. These include constant update of delivery paths, dynamic group membership, and as little state information as possible. Several multicast routing protocols have been proposed for MANET, which can be classified as either *tree-based* or *mesh-based* according to the kind of routes they create. In the former, all the routes forms a tree infrastructure with the source node as the root, thus there is only one single path between every pair of sender and receiver. Obviously, it's very efficient since the routing information needs to be maintained is very little. In the latter, a mesh infrastructure is maintained as the routing information, that is, more than one path between each sender and receiver pair exists, so it is more robust but less efficient. Both use similar routing discovery and maintenance methods. They use some kind of 'scoped flooding' to find the routes, and store the route information in the routing table of the intermediate nodes (always noted as *forwarding nodes*). The data delivery just follows this routing information. Routes are periodically updated and recovered when failure occurs. More recently, there are trends toward methods which aim to reduce the state information in the network and thus to reduce the overhead. Examples are *overlay-based approach*, *backbone-based approach*, and *stateless approach*, which all reduce the protocol states in some way.

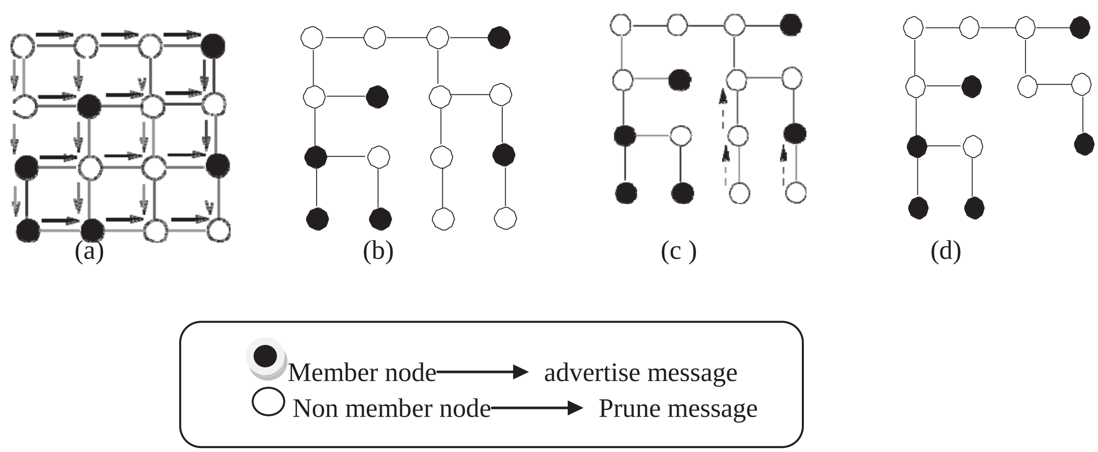

Fig.1*Multicast tree construction of DVMRP. (a) Broadcast of* Advertise *message. (b) Source-based short- est path tree among all nodes. (c) Unicast of* prune *message. (d) Source-based multicast tree*

Multicasting Protocols in Mobile Ad Hoc Networks.

MANET is a highly dynamic environment, so the traditional well established multicasting protocols cannot be deployed directly to it. Some modification and extension should be made while considering all the constraints, such as dynamic network topology, limited bandwidth and power. The new protocols should avoid global flooding, should dynamically build the routes, and should update both routes and memberships periodically.

Tree-based Multicasting Routing Protocols

2.1 MAODV: Multicast Operation of the Ad-hoc On-Demand Distance Vector Routing Protocol

MAODV is a multicast extension of AODV. In MAODV, all members of a multicast group are formed into a tree (which includes non-member nodes required for the connection of the tree), and the root of the tree is the group leader. Multicast data packets are propagated among the tree. The core of the MAODV protocol is about how to form the tree, repair the tree when a link is broken, and how to merge two previously disconnected tree into a new tree. GRPH is the group hello packet, it is periodically broadcasted by group leader to let the nodes in the tree to update its distance to the group leader.

MAODV maintains a sequence number for the multicast group that is initialized by the group leader and increased periodically. The primary responsibility of the group leader is to periodically broadcast Group Hello (GRPH) messages across the network and to maintain the group sequence number. A GRPH message contains the group sequence number, multicast group address and corresponding group leader IP address. The sequence number is used to ensure that routes discovered to the multicast group are always the most current ones available. Given the choice between two routes to a multicast tree , a requesting node selects the one with greater sequence number.

Advantages: With the unicast route information, the multicast tree can be constructed more quickly and efficiently.

Disadvantages: The group leader continues flooding Group Hello messages even if no sender for the group exists.

2.2 AMRIS: Ad Hoc Multicast Routing Protocol Utilizing Increasing Id-numbers

AMRIS is a tree-based Ad hoc Multicast protocol and two stages in AMRIS are Initialization and Maintenance. In AMRIS each node has msm-id (multicast session member ID) .The *msm id* indicates the logical height of a node in the multicast delivery tree rooted at the sender that has the smallest *msm id* (*Sid*) in the tree. All other nodes in the tree have an *msm id* that is higher than that of its parent. In case of a multiple sender environment, the *Sid* is elected among the senders. AMRIS uses the underlying *MAC* layer beaconing mechanism to detect the presence of neighbors. AMRIS is Periodical beacons detect link disconnections.

Advantages: 1. The concept of increasing id-numbers is useful for constructing and maintaining a multicast tree. 2. It may incur very low overhead for a node to join or rejoin the session if it chooses a potential parent node which happens to be a tree node.

Disadvantages: 1. Joining and rejoining of a node may take long time and waste much bandwidth since each node tries potential parent nodes arbitrarily. 2. The usage of periodic beacons consumes bandwidth.

2.3 BEMRP: Bandwidth-Efficient Multicast Routing Protocol

Ad hoc networks operate in a highly bandwidth-scarce environment, and hence bandwidth efficiency is one of the key design criteria for multicast protocols. Bandwidth efficient multicast routing protocol tries to find the nearest forwarding node, rather than the shortest path between source and receiver. Hence, it reduces the number of data packet transmissions. To maintain the multicast tree, it uses the hard state approach, that is, to rejoin the multicast group, a node transmits the required control packets only after the link breaks. Thus, it avoids periodic transmission of control packets and hence bandwidth is saved. To remove unwanted forwarding nodes, route optimization is done, which helps in further reducing the number of data packet transmissions.

Advantages: 1. It achieves higher multicast efficiency. 2. The path optimization process eliminates redundant paths gradually that leads to higher efficiency and lower packet transfer delay. 3. It incurs low control overhead at low mobility.

Disadvantages: 1. Joining and rejoining of a node take long time and consume high bandwidth. 2. The failure of a shared link affects several receivers.

2.4 ADMR: Adaptive Demand-Driven Multicast Routing

The Adaptive Demand-Driven Multicast Routing protocol (ADMR) is a new on-demand ad-hoc network multicast routing protocol which discovers multi-hop routes between multicast receivers and senders. ADMR consists of 3 phases are Multicast State Setup, Multicast Packet Forwarding, Multicast State Maintenance .Like other tree based multicast routing protocols, it builds a source based tree to form a multicast group but unlike others, it does not utilize any periodic control packet transmissions such as periodic flooding or neighbor sensing. It performs both its route discovery and route maintenance functions on demand, and automatically prunes unneeded multicast

forwarding state, and expires its multicast mesh when it detects that the multicast application has become inactive.
Advantages: 1. It utilizes the application data sending pattern to avoid periodic control messages. 2. It can adapt to the change of mobility.
Disadvantages: 1. The joining and rejoining processes waste bandwidth and take time. 2. The occasional flooding of multicast packets is an overhead.

2.5 DDM: The Differential Destination Multicast Protocol

Differential Destination Multicast (DDM):- The Differential Destination Multicast (DDM) [27] is an efficient source based tree approach which is designed for only small multicast group. In this protocol, source node has the knowledge of all the members of the multicast group as their information is embedded in the data packets which are to be transferred to the destinations. DDM falls under the category of stateless multicast protocols since no multicast routing information is required to be maintained by the intermediate nodes in the network. It depends on the underlying unicast routing protocol for forwarding the packets from source to destinations.
Advantages: 1. No storage overhead is required for group members when DDM operates in stateless mode. 2. No control overhead is incurred on the multicast routing structure.
Disadvantages: 1. It has to rely on underlying unicast routing protocols. 2. It is not mentioned how a receiver knows who the sender is. 3. It requires a specific packet header and this increases complexity.

2.6 MCEDAR: Multicast Core-Extraction Distributed Ad Hoc Routing

The MCEADR (Multicast Core Extraction Distributed Ad-hoc Routing) Multicast routing algorithm addresses both the issues of robustness and efficiency in one framework. It does not differentiate between the senders and receivers of a Multicast group. characteristics of MCEDAR is Robustness of a mesh, Efficiency of a tree based forwarding protocol, Involves only a subset of nodes (core nodes) in multicast route management, Independent of the underlying unicast routing protocol.
Advantages: 1. The underlying mesh structure is robust to high mobility. 2. When multiple groups coexist, the core graph can work as a backbone and hence reduces the total control overhead for these groups.
Disadvantages: 1. High control overhead is incurred on the partitioning procedure. 2. since the data forwarding tree is built among core nodes (not actual group members), it has non- optimal paths. 3. If a node leaves its dominating core node and attaches to another core node, it may miss interested packets. 4. The failure of a core node affects those nodes that delegate it to join the group.

Mesh-based Multicast Routing Protocols

2.7 ODMRP: On-Demand Multicast Routing Protocol B.

In ODMRP, a source periodically floods an advertising packet in the network. A receiver responds to this packet by using backward learning. The nodes on the path from the receiver to the source form a mesh of forwarding nodes for the multicast group and thus ODMRP is one of the well established protocols.
Advantages: 1. It proposes an effective "forwarding group" concept. 2. The offering of shortest paths reduces data delivery latency. 3. The mobility prediction scheme lowers control overhead at mobility.
Disadvantages: 1. It suffers from excessive flooding when there is a large number of senders. 2. The duplicate transmissions waste bandwidth at low mobility.

2.8. DCMP: A Dynamic Core Based Multicast Routing Protocol

The *dynamic core based multicast routing protocol for ad hoc wireless networks* (DCMP) proposes a shared-mesh based approach for multicast communication. DCMP combines a mesh network approach with a tree routing concept: multiple core based trees are interconnected by a mesh. DCMP classifies senders into three categories: *Active sources* keep their multicast relations up to date by periodically flooding the network with control packets. *Passive sources* never actively participate in multicast delivery path creation. Passive sources are always associated with a core active source that forwards data packets for them.
Advantages: It has a high packet delivery ratio with less control overhead.
Disadvantages: 1. For passive senders, the paths between them and receivers are sub -optimal. 2. The failure of a core node affects several passive senders. 3. An active sender with higher ID may not have any chance to be a passive sender (unfairness).

2.9. ACMRP: Adaptive Core Multicast Routing Protocol

The Adaptive Core Multicast Routing Protocol (ACMRP) is proposed for multicast routing in ad hoc networks. ACMRP is on demand core-based multicast routing protocol that is based on a multicast mesh. In ACMRP, a core is not well-known and it adapts to the current network topology and group membership. The enhanced adaptivity minimizes the core dependency and, accordingly, improves performance and robustness of ACMRP. A multicast mesh is created and maintained by the periodic flooding of the adaptive core. Since the flooding traffic is evenly maintained and a mesh provides rich connectivity among group members, ACMRP can achieve efficiency, scalability, and effectiveness. We evaluate scalability and performance of ACMRP via simulation.

Advantages: 1. It incurs low control overhead. 2. The proposed adaptive core mechanism enhances overall performance.

Disadvantages: 1. Every node must have the ability to encapsulate and decapsulate data packets. 2. A node not interested in a group may be the core node for the group.

2.10 . MANSI: Multicast Protocol for Ad Hoc Networks with Swarm Intelligence

MANSI relies on only one core node to build and maintain the mesh and applies swarm intelligence to tackle metrics like load balancing and energy conservation. Swarm intelligence refers to complex behaviors that arise from very simple individual behaviors and interactions. Although each individual has little intelligence and simply follows basic rules using local information obtained from the environment, globally optimized behaviors emerge when they work collectively as a group. MANSI utilizes this characteristic to lower the total cost in the multicast session.

The sender that first starts sending data takes the role of the core node and informs all nodes in the network of its existence. Reply messages transmitted by interested nodes construct the mesh. Each forwarding node is associated with a height which is identical to the highest ID of the members that use it to connect to the core node. After the mesh creation, MANSI adopts the swarm intelligence metaphor to allow nodes to learn better connections that yield lower forwarding cost. Each member P except the core node periodically deploys a small packet, called FORWARD ANT, which opportunistically explores better paths toward the core.

MANSI also incorporates a mobility-adaptive mechanism. Each node keeps track of the normalized link failure frequency (nlff) which reflects the dynamic condition of the surrounding area. If the nlff exceeds the threshold, the node will add another entry for the second best next hop into its join messages. Then the additional path to the core node increases the reliability of MANSI.

Advantages: 1. The swarm intelligence makes MANSI applicable to different performance metrics. 2. It utilizes a mobility-adaptive mechanism to adapt to the degree of mobility.

Disadvantages: 1. Implementation complexity is high. 2. Swarm intelligence may be not useful at high mobility.

2.11. NSMP: Neighbor Supporting Ad Hoc Multicast Routing Protocol

NSMP utilizes the node locality concept to lower the overhead of mesh maintenance. For initial path establishment or network partition repair, NSMP occasionally floods control messages through the network. For routine path maintenance, NSMP uses local path recovery which is restricted only to mesh nodes and neighbor nodes for a group. The initial mesh creation is the same with that in MANSI. Those nodes (except mesh nodes) that detect reply messages become neighbor nodes, and neighbor nodes do not forward multicast packets.

Advantages: 1. A new member can join a group more quickly than other soft-state protocols. 2. It strikes a balance between routing efficiency and path robustness.

Disadvantages: 1. It takes long time on mesh maintenance since each member waits for a period to select the best path. 2. More non-group nodes are involved in a multicast session.

2.12. CAMP: The Core-Assisted Mesh Protocol

CAMP is a receiver-initiated protocol. It assumes that an underlying unicast routing protocol provides correct distances to known destinations. CAMP establishes a mesh composed of shortest paths from senders to receivers. One or multiple core nodes can be defined for each mesh, and core nodes need not be part of the mesh, and nodes can join a group even if all associated core nodes are unreachable. For ensuring the shortest paths, each node periodically looks up its routing table to check whether the neighbor that relays the packet is on the shortest path to the sender. The number of packets coming from the reverse path for a sender indicates whether the node is on the shortest path. A special message will be issued to search a mesh node and the shortest path can be reestablished. At last, to ensure that two or more meshes eventually merge, all active core nodes periodically send messages to each other and force nodes along the path that are not members to join the mesh.

Advantages: 1. It constructs a mesh without control packet flooding. 2. With correct routing information, shortest paths are included in the mesh and the joining procedure incurs very low overhead.
Disadvantages: 1. It has to rely on certain unicast routing protocols. 2. High storage overhead is incurred for each node due to several maintained data structures. 3. The periodic message exchanges among cores are a high overhead. 4. Non- group nodes may be involved since they may act as cores.

III. EXPERIMENT AND RESULTS

NEW Technologies of Multicast Routing Protocols in MANET.

The multicasting **p**rotocols in MANET discussed above are much more traditional. They have some disadvan-tages. When the network size or number of source nodes increases, their performance will decrease significantly. Take ODMRP for instance, which can exhibit a high package delivery ratio even at high mobility; it will suffer from higher control overhead when the application scales. With some analysis, we can find that, in ODMRP, the source node initially floods a *JoinReq* package to the whole network, then the expected group members will send back *JoinReply* packages along the reverse paths to the source. All the intermediate nodes will become *forwarding nodes* to establish the routes. The state information is maintained by pe-riodically flooding the *JoinReq* control package. This protocol provides the robust routes at the expense of increased overhead. This will lead to inefficiency when the network or group is large. The new trend of design of multicasting protocols in MANET is to reduce such overhead. Some efforts have been made in this field. We classified these new technologies into the following four categories.

A..Overlay-based multicasting. This method constrains the protocol states within the group members, to avoid the explosion of state information if it is kept in all the forwarding nodes.
B. .Backbone-based multicasting. In these protocols, the state information is confined within the virtual backbone only.
C..Stateless multicasting. In these protocols, there is no need to maintain any states in the forwarding nodes at all.
D. Other multicasting protocols. The protocols of this category use an explicit way to reduce the control overhead of some existing protocols. They are a form of direct extension of the traditional ones.

3.1. Overlay-based Multicasting Protocols

An overlay network is a computer network which is built on the top of another network. Nodes in the overlay can be thought of as being connected by virtual or logical links, each of which corresponds to a path, perhaps through many physical links, in the underlying network. For example, distributed systems such as cloud computing, peer-to-peer networks, and client-server applications are overlay networks because their nodes run on top of the Internet. The Internet was originally built as an overlay upon the telephone network while today (through the advent of VoIP), the telephone network is increasingly turning into an overlay network built on top of the Internet. The overlay node set is a subset of the underlying network while the overlay links are the virtual paths of the existing networks, which usually span multiple physical links. Overlay networks can be used to change part of the properties of underlying networks, facilitate deployment of new functionalities, and provide value-added network services. As it does not need to modify the lower level functionality, it can be used to quickly deploy emerging applications. Historically, IP is an ”overlay” on top of MAC layer to achieve global connectivity. VPN (virtual private network) has been deployed on top of IP layer to provide secure tunnelling services. MBoneand QBone have used overlay technique to quickly deploy multicast and quality-of-service (QoS) service on top of existing Internet infrastructure. X-Bone is a system for the automated deployment of overlay network. It operates at the IP layer and based on IP tunnel technique. The main focus is to manage and allocate overlay link and router resource to different overlays and avoid resource contention among the overlays.

HOW OVERLAY PROTOCOL IS BENEFICIAL?

In overlay multicast, the group members self-organize into an overlay multicast tree. The data replication, multicast routing, group management, and other functions are all supported at the application layer. In overlay multicast, the members need to continuously measure the overlay path conditions to find the best overlay path from the source to itself (best root path). In most of the previously proposed protocols, the members only measure the overlay links between themselves and the neighbor nodes in the mesh. So, a member can only realize the condition of the link connecting itself to its parent, not the path connecting itself to the root of the tree (*root path*). When an intermediate overlay link of a root path is broken, the node cannot realize this fact quickly.
Our goal is to design a protocol that can accurately measure the overlay path condition and help the group member to find a new parent node quickly when its original parent node is lost. Similar to the tree-first protocols, Host Cast also uses two steps: setting up an overlay tree and forming a mesh. However, contrary to the previous approaches, Host Cast constructs the multicast data delivery tree and control mesh at the same time. Each node in the mesh only has limited number of neighbors, which is enough for the group members to gradually improve the performance of the multicast tree. This can greatly reduce the amount of control traffic. Also, the design of mesh makes the group members measure the root path condition accurately and find a new parent quickly when some group members leave. Therefore, the multicast group can quickly converge again after the departure of group members.
In Figure 2, we can see that all the neighbors of source node have 0 as the adaptive value, so they will be first-level children of the source. The tree grows by including the nearest receiver to itself gradually. The source doesn't need to compute the whole tree. It can group the receivers (all the other group members) and send each first-level child a unicast packet with the subgroup receivers in the packet header.

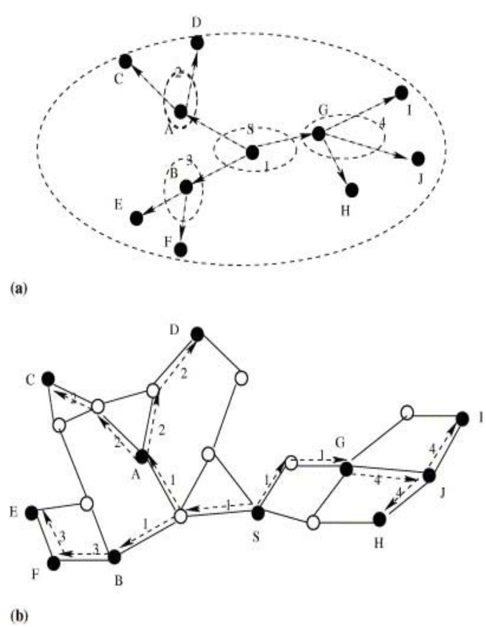

Fig.2:Hierarchical multicast trees. (a) Overlay multicast tree. (b) Overlay—driven hierarchical multicast tree.

3.2. Backbone-based Multicasting Protocols

The backbone-based multicasting protocols use another method to constrain the state information. They select some nodes to form a virtual backbone of the network, and the state information can only be held in the backbone nodes.

The adaptive backbone-based multicast protocol for ad hoc networks is such a protocol. It is based on a two-tier hierarchical approach. The backbone is composed of the core nodes which will forward the multicast data among themselves; the maintenance and forwarding of the membership are done only in the inside local group rooted at a core. This combines both the effectiveness of the flooding scheme and the efficiency of the tree scheme.

The adaptive backbone-based approach creates the *Adaptive Dynamic Backbone* (ADB) which allows the noncore nodes to be far away from the cores as long as the mobility in the nodes' local area is not that high.

At first, every member node will set itself to be a core and send out a *Hello* message to its neighbors. When a node receives this *Hello* message from other nodes, it will calculate the *height* value, which is some kind of metric such as detected link failure frequency, remaining power or degree of connectivity, *et al*. As an example, we can use the three-parameter tuple *(nlff*[1]*,degree,id)* as the *height* value (*nlff* is normal link failure frequency). Then it will decide whether it should remain a core or become another core's child based on the *height* values. If it chooses to be another core's child, it will record the core's information and when it sends out its next *Hello* message, it will indicate its core's information and also replace its original link failure frequency with a new accumulated *nlff*. In this method of message exchange, the cores are selected to form the backbone. The trees rooted at cores won't be too high with the limitation of 'accumulated *nlff* constraint' or 'hop limit constraint'. The height of a tree depends on the mobility of nodes in that area. Every node also maintains the *core forwarding table*. It can get some information about other cores which are not its parent core via *Hello* messages of its neighbors who do not belong to the same core. Then it just records the routing information to those other cores. In a *core-forward-update* period, every child sends its *core forwarding table* to its parent. At last these tables reach the cores, thus the cores know the routes to other cores. When a node wants to join a multicast group, it just sends out a *Join-Request* to its parent. If the parent is not already part of the forwarding tree, it keeps forwarding the message upstream and sets itself as a *forwarding node*, otherwise, it will ignore the message. In this way, a multicast forwarding tree is constructed, which is rooted at the core and spans all members in this local group. When sending data, the group member will locally broadcast the packet, and the forwarding nodes will rebroadcast the packet. When the data reaches the core, the core will relay it in the backbone range by encapsulating the packet into a *CORE-FORWARD* message and forwarding it to the next hop core(s) in its *core forwarding table*. When other cores get the message, they remove the *CORE-FORWARD* header and do the group level multicast as described before. The backbone topology is much more simple and stable compared with that of the whole network. But the cores are 'hot spots' of the network, and this will put limits on the horizontal scalability of the network, and the number of the local groups, because all the multicast packets will pass the same set of core nodes.

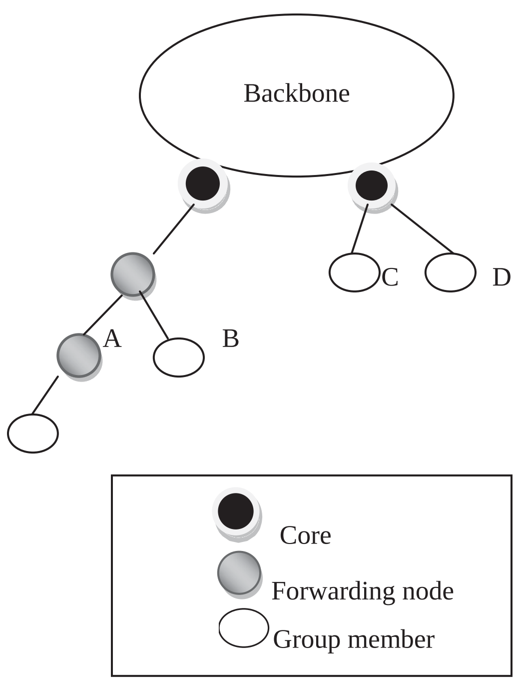

Figure. 3 Structure of the backbone network and forwarding tree.

3.3. Stateless Multicasting Protocols

The multicasting protocols discussed so far have some state information maintained at the forwarding nodes to keep the routing structure. Recently, there is a shift towards designing stateless protocols for MANETs. These protocols do not require the routing information to be kept at forwarding nodes at all to further reduce overhead. The following two protocols use different methods to achieve this goal.

Differential Destination Multicast (DDM)

This is a stateless MANET multicast routing protocol for small communication groups. In DDM, the source node explicitly mentions the destination addresses by encapsulating them in the headers of the data packets. The intermediate nodes with the DDM agents on them will take charge of the delivery of the packets. In this way, the forwarding nodes won't need to keep any multicast routing information. But it is obvious that this protocol only suits the small size communication group because with the growth of the group, the packet header will become larger and larger and lose efficiency.

In DDM, the source node controls the membership information. This protocol has two modes. One is stateless, just as described above, in which the forwarding nodes rely on the underlying unicast protocol to forward every packet; the other is soft state. In soft state mode, the forwarding nodes will remember the destinations of the last packet sent and the corresponding next hop information. The following packets sent by the same source do not need to have the *destination headers*. They can be forwarded based on the in-band information at the forwarding nodes. Only when the destination list has some change, does the source need to notify the forwarding nodes; thus, the name *differential destination*. When a node is interested in some multicast group, it will unicast a *Join* message to the source node. The source node will decide whether to accept it according to some admission policy. It will then unicast the *ACK* message to the node and add it to the *member list (ML)*. This ML list kept in the source node should be refreshed periodically. The source will set a *POLL* flag in the outgoing packet every several packets. The destination nodes will unicast the *Join* message to the source on receiving this special packet to show its existence.

This protocol is not a general purpose multicast protocol, for it can't work well with large group size due to the header-encoded mechanism. But it can excel in the horizontal scalability, which is the growth of the number of the multicast groups.

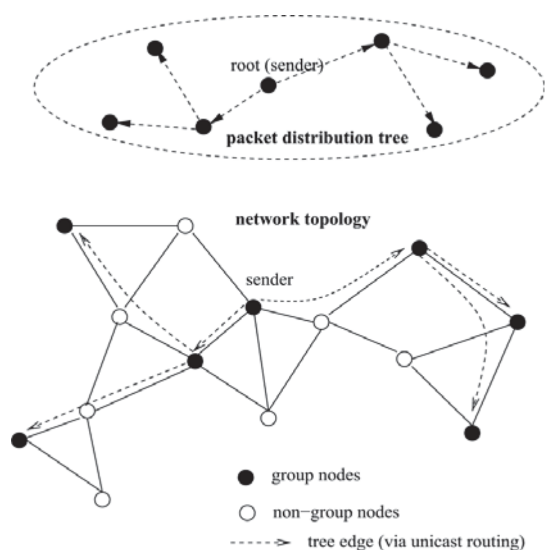

Figure 4 : DDM Hierarchical structures

Effective Location-Guided Tree Construction Algorithm (LGT)

LGT is another multicast protocol in MANET for small communication group. In this protocol, an upper overlay packet delivery tree is created on top of the underlying unicast protocol. The multicast packet is encapsulated in a unicast envelope and unicasted among the group members. The difference between LGT and DDM is that in DDM, the distribution tree is not controlled by the upper transport layer, but in LGT, the tree is constructed with the flexibility of adding upper layer's packet routing in order to minimize the overall bandwidth cost of the tree. Also the DDM requires all nodes to cooperate, but the LGT needs only the group member nodes to do so.

The operation of this protocol is similar to DDM. The source node will control the mem-bership of the group and send out packets with destination-included headers. The forwarding nodes will construct a data distribution tree based on the destination list they get from data packets. The tree is composed of all the group nodes. Then the forwarding nodes use the un-derlying unicast protocol to forward the packets. The main part of this protocol is the design of the tree construction algorithm. Two of these algorithms are developed. One is *location-guided k-ary tree (LGK)* algorithm, the other is *location-guided steiner tree (LGS)* algorithm. Both utilize the geometric location information of the destination nodes as the heuristics to construct the tree without knowing the global topology of the whole network. These algorithms are distributed; each node is responsible for the construction of the outgoing branch of its level and also data forwarding.

In LGK, the source node selects the *k* nearest destination nodes as its children and groups the remaining nodes to each child according to geometric proximity. It then sends a copy of the packet to each child. This child will do the same procedure to forward the packet until all destination nodes get the packet. In this way, the packets are forwarded along the *k*-ary tree to the destination via unicast routing. The LGS tree is constructed using a modified version of the *Takahashi-Matsuyama* heuristic. The difference is that it uses the geometric distance as the measurement of closeness and only the group member nodes can be used as the tree nodes. The source will select the nearest neighbor to form the first link of the tree These two algorithms are used under different conditions to achieve better performance. The LGS tree has lower bandwidth cost when the location information of the nodes is up-to-date. When that location information becomes difficult to keep up-to-date, the difference of cost between the two algorithms is not that significant. So the LGK should be used to take advantage of its lower distribution delay and computational complexity.

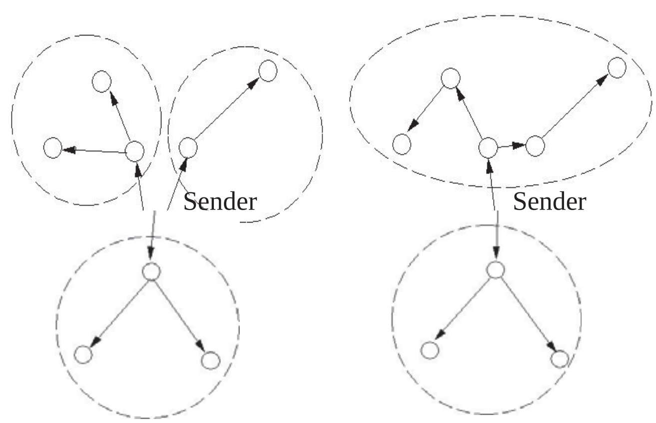

Figure5 a) LGK tree (k=3) *b) LGS tree*

3.4 Other Multicasting Protocols.

In some modification is made to ODMRP. It dynamically classifies the source nodes into *active* and *passive* modes; only the *active* ones perform the function of periodic routing refreshment. In this way, the new protocol named dynamic core based multicast routing protocol (DCMP), can successfully reduce the control overhead by reducing the number of forwarding nodes. The simulation shows that it can increase the multicast efficiency by 10 ¡ 15% compared with ODMRP. In DCMP, source nodes are classified into three categories, *active sources*, *core active sources*, and *passive sources*. The active sources are the same as the sources in ODMRP. They will broadcast *JoinReq* messages when they have data to send or to maintain the routing. The *passive sources* won't do this. When they have data to send, they will forward the data to the *core active sources* to which they belong, which are selected from the *active sources* to act as agents to one or more *passive sources* and are in charge of forwarding the *passive sources*' data to group members.

At first, every source is *active source*. It can broadcast the *JoinReq* packet when it has data to send, just like the operation in ODMRP with the exception that the packet has an additional flag called *CoreAcceptanceFlag*, which indicates whether this source can support some other *passive sources* or not, according to its own parameter *MaxPassSize*. For example, *A* broadcasts a *JoinReq* packet. When an *active source*, say, *B*, receives this packet, it will change its status to *passive source* if the following three conditions are met: (a) the *CoreAc-ceptanceFlag* in this packet is set to on; (b) the distance between these two sources *A* and *B* is less than the predefined parameter *MaxHop*; (c) the ID of source *B* (*ToBePassive source*) is less than the original source *A* (*ToBeCore source*). If so, it will reply a *PassReq* packet to *A*, and come into the *ToBePassive source* mode. After that it will neither become *core active source* for other nodes nor send *PassReq* to other nodes. The *ToBeCore source* node *A* will decide to be *B*'s core or not, then send back again another *Confirm* packet to let *B* know. In this method of message exchange, the intermediate nodes will create routing in their routing tables. When the *passive source* has data to send, it will forward it to its *core active source* along the already existing path. Due to the mobility of nodes, it is possible for the *passive source* to move too far away from its *core active source*. It can detect this by receiving the *core*'s *JoinReq* after its movement. It then will send the *PassReq* packet with the *CoreReq* field reset to the *core*.

The numbers of *passive active sources* and *core active sources* are bounded by the pa-rameters *MaxPassSize* and *MaxHop*. If the number of *passive active sources* is large, the control overhead can be reduced sharply, but the routing mesh will be of less robustness be-cause only the *active sources* are in charge of the maintenance of the routes, which may be deficient. This tradeoff should be considered when setting the parameters.

IV.CONCLUSION

This paper reduces the control overhead in the old methods to increase the performance. General multicast protocols often provide shortest paths between senders and receivers. Although shortest paths have low data delivery latency and low probabilities of link failures, they reduce multicast efficiency. Hence, the protocol should strike a balance between multicast efficiency and path lengths. Our emphasis on the new trends and technologies in this field classifies four categories according to their underlying principles. They use the *overlay networks* or *backbone* to limit the spread of state information, or even let the protocols be *stateless*. At last we take a look at two protocols which have their special efforts in the aspect of reliability. The overall control can be extended to a single protocol for further reliable operations so that, redundancy in the data delivery in the existence of the change of underlying topology is overcome.

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