EFFICIENT ROUTING IN MOBILE AD-HOC NETWORKS USING MULTICASTING ROUTING PROTOCOLS

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ABSTRACT
Efficient routing mechanism is a challenging issue for group oriented computing in Mobile Ad Hoc Networks (MANETs). The ability of MANETs to support adequate Quality of Service (QoS) for group communication is limited by the ability of the underlying ad-hoc routing protocols to provide consistent behavior despite the dynamic properties of mobile computing devices. This paper presents a study of one to one and many to many communications in MANETs and provides a comparative performance evaluation of Unicast and Multicast routing protocols. AODV and DSR are used as unicast protocols and MAODV and ODMRP are used as represent multicast routing protocols. Problems in ad hoc networks are the scarcity of bandwidth, short lifetime of the nodes due to power constraints, dynamic topology caused by the mobility of nodes. These problems put in force to design a simple, scalable, robust and energy efficient routing protocol. In this paper I will discuss different types of routing protocols for mobile ad hoc networks and their deployment issues. In this paper, I will classify the protocols that tried to pose general ideas of how applying routing concept in MANETs.

Keywords: Routing, Mobile Ad-Hoc Networks.

1. INTRODUCTION

A mobile ad hoc network is a self-organizing network comprising wireless mobile nodes that move around arbitrarily and can able to communicate among themselves using wireless radios, without the aid of any preexisting infrastructure [1]. Each participating mobile node can act as sender, receiver and even as a router at the same time and able to build, operate and maintain these networks [2]. Due to limited radio coverage of these wireless devices efficient support of group oriented communication is extremely critical in most MANET applications. In MANET group communications issues differ from those in wired environments for the following reasons: The wireless medium has variable and unpredictable characteristics. The signal strength and propagation fluctuate with respect to time and environment resulting disconnection of the network at any time even during the data transmission period [3]. The strength of the received signal depends on the power of the transmitted signal, the antenna gain at the sender and receiver, the distance between two mobile nodes, the obstacles between them, and the number of different propagation paths the signals travel due to reflection. Further node mobility also creates a continuously changing communication topology in which existing routing paths break and new ones form dynamically. Since MANETs have limited channel bandwidth availability and low battery power, their algorithms and protocols must conserve both bandwidth and energy [3]. Wireless devices usually use computing components such as processors, memory, and I/O devices, which have low capacity and limited processing power. Thus their communication protocols should have lightweight computational and information storage capability fulfilling some key features like robustness, simplicity and energy conserving. In-group oriented communication system, routing protocols can be classified into two main categories [5, 6] based on the number of senders and receivers in MANETs. Unicast communication is the point-to-point transmission with one sender and one receiver. This can also introduce significant traffic overhead, sender and router processing, power consumption, high packet latency and poor throughput in the network. To minimize these overhead, multicast and broadcast Ad- Hoc routing protocols play an important role. Multicast communications are both one-to-many and many-to-many traffic pattern i.e. to transmit a single message to a select group of recipients This paper compares two variants of Ad-Hoc routing protocols: unicast DSR and AODV and multicast MAODV and ODMRP protocols. Wireless applications, like emergency searches, rescues, and military battlefields where sharing of information is mandatory, require rapid deployable and quick reconfigurable routing protocols, because of these reasons there are needs for multicast routing protocols. There are many characteristics and challenges that should be taking into consideration when developing a multicast routing protocols, like: the dynamic of the network topology, the constraints energy, limitation of network scalability, and the different characteristics between wireless links and wired links such as limited bandwidth and poor security [1,2,3].Generally there are two types of multicast routing protocols in wireless networks. Tree-based multicast routing protocol. In the tree-based multicasting, structure can be highly unstable in multicast ad-hoc routing protocols, as it needs frequent re-configuration in dynamic networks, an example for these type is Multicast extension for Ad-Hoc On-Demand Distance Vector (MAODV)[4] and Adaptive Demand-Driven Multicast Routing protocol (ADMR)[5]. The second type is mesh-based multicast protocol. Mesh-based multicast routing protocols are more than one path may exist between a source receiver pair, Core-Assisted Mesh Protocol (CAMP) and On-Demand Multicast Routing Protocol (ODMRP)[7] are an example for these type of classification. This paper is organized into four parts: Section 2, describes about some unicast routing protocols. Section 3, describes about tree-based multicast routing protocols like MAODV and covered some mesh based multicast routing protocols like ODMRP and patch ODMRP and finally Section 4,gives the conclusion of all these protocols.

2. UNICAST ROUTING PROTOCOLS

Unicast communication is point-to-point communication with one sender and one receiver. Two well-known examples of unicast routing protocols are DSR and AODV.

2.1. Dynamic Source Routing (DSR)

The Dynamic Source Routing (DSR) algorithm is an innovative approach to routing in a MANET in which nodes communicate along paths stored in source routes carried by the data packets. It is referred to as one of the purest examples of an on-demand protocol. In DSR, mobile hosts maintain route caches that contain the source routes which the mobile host is aware of. Entries in the route cache are continually updated as new routes are learned. The protocol consists of two major phases: route discovery and route maintenance. When a mobile host has a packet to send to some destination, it first consults its route cache to determine whether it already has a route to the destination. If it has a route to the destination, it will use this route to send the packet. If the mobile host does not have such an unexpired route, it initiates route discovery by broadcasting a route request packet containing the address of the destination, along with the source mobile hosts address and a unique identification number. Each node receiving the packet checks whether it knows of a route to the destination. If it does not, it adds its own address to the route record of the packet and then forwards the packet along its outgoing links. To limit the number of route requests propagated on the outgoing links of a mobile host, a mobile host only forwards the route request if it has not yet seen the request. A route reply is generated when the route request reaches either the destination itself, or an intermediate node that in its route cache contains an unexpired route to the destination. By the time the packet reaches either the destination or such an intermediate node, it contains a route record with the sequence of hops taken. Figure 2 illustrates the formation of the route as the route request propagates through the network. If the node generating the route reply is the destination, it places the route record contained in the route request into the route reply. If the responding node is an intermediate node, it appends its cached route to the route record and then generates the route reply. To return the route reply, the responding node must have a route to the initiator. . Figure 3 shows the transmission of route record back to the source node.

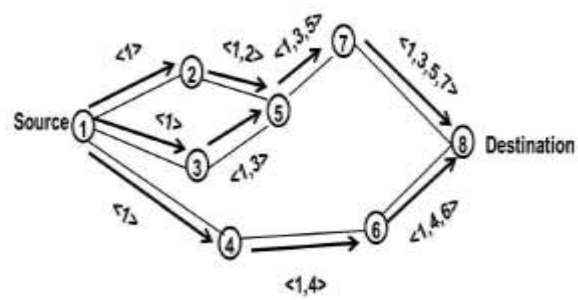

Figure 1: Route Discovery in DSR.

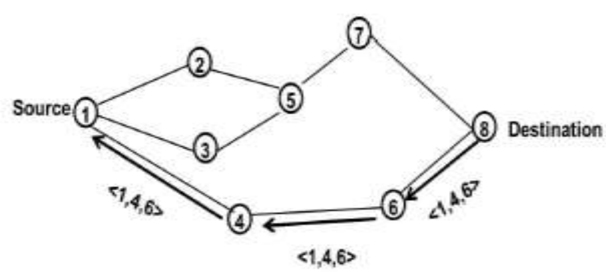

Figure 2: Propagation of route reply in DSR.

2.2 The Ad Hoc On-Demand Distance Vector routing (AODV)

The Ad Hoc On-Demand Distance Vector routing (AODV) protocol is another type of unicast routing protocol. It borrows the basic on-demand mechanism of Route Discovery and Route Maintenance from DSR, plus the use of hop-by-hop routing, sequence numbers, and periodic beacons from DSDV. AODV minimizes the number of required broadcasts by creating routes only on-demand basis as opposed to maintaining a complete list of routes When a source mobile host desires to send a message and does not already have a valid route to the destination, it initiates a path discovery process to locate the corresponding mobile host. It broadcasts a route request (RREQ) packet to its neighbors, which then forwards the request to their neighbors, and so on, until either the destination or an intermediate MH with a "fresh enough" route to the destination is reached. Figure 4 illustrates the propagation of the broadcast RREQs across the network. AODV utilizes destination sequence numbers to ensure all routes are loop-free and contain the most recent route information. Each node maintains its own sequence number, as well as a broadcast ID which is incremented for every RREQ the node initiates Together with the node's IP address, this uniquely identifies an RREQ. Once the RREQ reaches the destination or an intermediate node with a fresh enough route, the destination/intermediate node responds by unicasting a route reply (RREP) packet back to the neighbor from which it first received the RREQ (Figure 5). As the RREP is routed back along the reverse path, nodes along this path set up forward route entries in their route tables that point to the node from which the RREP came. Routes are maintained as If a source mobile host moves, it is able to reinitiate the route discovery protocol to find a new route to the destination. If a mobile host along the route moves, its upstream neighbor notices the move and propagates a link failure notification message (an RREP with infinite metric) to each of its active upstream neighbors to inform them of the breakage of that part of the route. These mobile hosts in turn propagate the link failure notification to their upstream neighbors, and so on until the source node is reached. The source mobile host may then choose to re-initiate route discovery for that destination if a route is still desired.

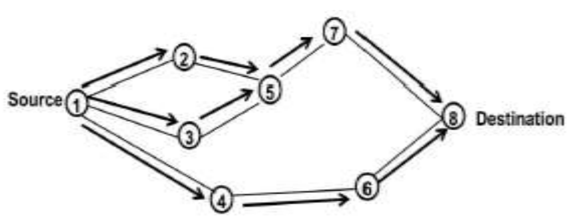

Figure 3: Propagation of RREQ in AODV

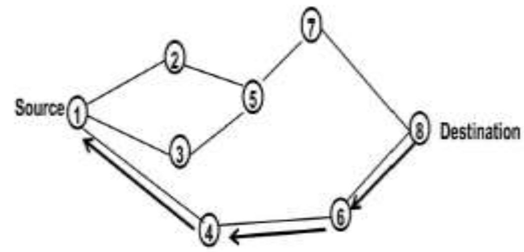

Figure 4: Path taken by the RREQ in AODV

3. MULTICAST ROUTING PROTOCOLS

Multicasting communication is both one-to-many and many to much communication. Two well-known examples of multicast routing protocols are MAODV and ODMRP.

3.1. Tree-based Multicasting

A tree-based multicast routing protocol establishes and maintains a shared multicast routing tree to deliver data from a source to receivers of a multicast group. A well known example of tree-based multicast routing protocols is MAODV.

3.1.1. Multicast Ad-hoc On-Demand Distance Vector Routing Protocol (MAODV)-MAODV [4] is a multicast extension for AODV protocol. MAODV based on shared trees on-demand to connect multicast group members. MAODV has capability of unicast, broadcast, and multicast. MAODV protocol can be route information obtained when searching for multicast; it can also increase unicast routing knowledge and vice-versa.When a node wishes to join a multicast group or it has data to send to the group but does not has a route to that group, it originates a route request (RREQ) message. Only the members of the multicast group respond to the join RREQ. If an intermediate node receives a join RREQ for a multicast group of which it is not a member or it receives a route RREQ and it does not have a route to that group, it rebroadcast the RREQ to its neighbors.

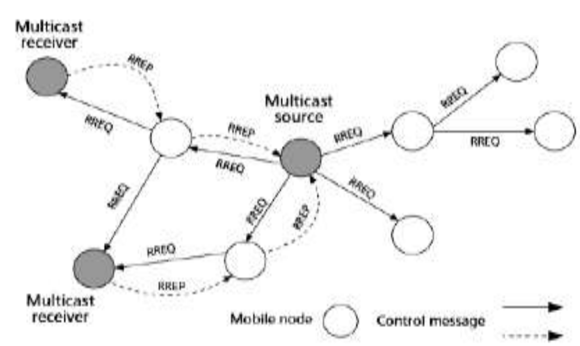

Figure 5: Path Discovery in the MAODV Protocol.

3.2. MESH-BASED MUTICASTING

A mesh-based multicast routing protocol sustains a mesh consisting of a connected component of the network containing all the receivers of a group. Example of mesh-based multicast routing approaches is On-Demand Multicast Routing Protocol (ODMRP).

3.2.1.On-Demand Multicast Routing Protocol(ODMRP)-ODMRP[7], is an on-demand mesh based, besides it is a multicast routing protocol, ODMRP protocol can make use of unicast technique to send multicast data packet form the sender nodes toward the receivers in the multicasting group. To carry multicast data via scoped flooding it uses forwarding group concept. The source, in ODMRP, establishes and maintains group membership. If source wishes to send packet to a multicast group but has no route to that group, it simply broadcasts JOIN_DATA control packet to the entire network. When an intermediate node receives the JOIN_DATA packet it stores source address and sequence number in its cache to detect duplicate. It performs necessary routing table updates for reverse path back to the source.

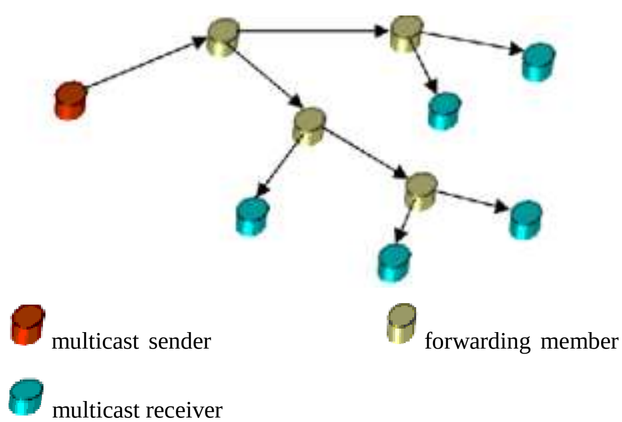

Figure 6: JOIN_DATA propagation

A multicast receiver constructs a JOIN_TABLE upon getting JOIN_DATA packet and broadcasts it to its neighbors. When a node receives a JOIN_TABLE, it resolves whether it is on the way to the source by consulting earlier cached data. Considering the matched entry this node builds new join table and broadcasts it. In this way JOIN_TABLE is propagated with the help of forwarding group members and ultimately it reaches to the multicast source. A multicast table is built on each node to carry multicast data. This process either constructs or revises the routes from sources to receivers and forms a mesh.

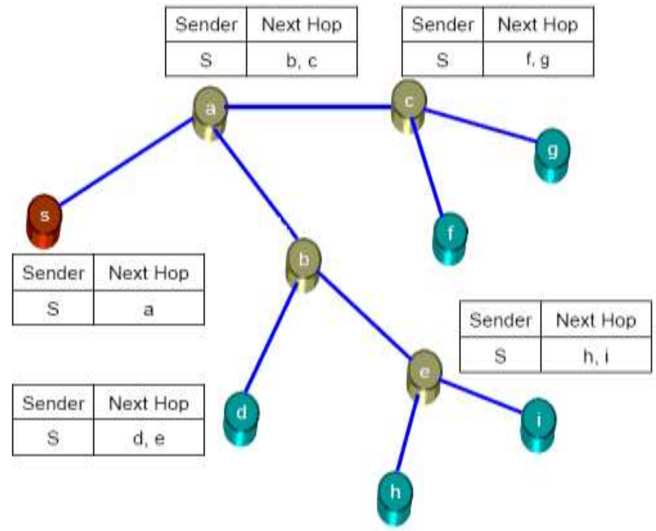

Figure 7: Multicast tables in ODMRP

3.2.2. Patch On-Demand Multicast Routing Protocol (Patch ODMRP)-

Patch ODMRP [8], it's an upper version of ODMRP protocol. Patch ODMRP works better with small networks and high mobility. Patch ODMRP uses a local patching scheme instead of frequent mesh reconfiguration, where it copes with mobility without reducing the Join-Req interval.

Figure 9: the official ODMRP mesh is shown in Figure 9(a), S node is the sender of the multicast group and R node is the receiver. Each FG node utilizes MAC layer to check for its neighbors, and comparing it with the forwarded routing table to check out if there is any unreachable node in the network. In Figure 9(b), node K detects that node J is unreachable as a result of the failure of the link JK. In this case, K node starts the patching procedure by flooding advertisement message (ADVT), advertising the upper loss. If J node supports more than one multicast groups, then it is added in the ADVT message. A node receiving the ADVT message updates its routing table entries for the source of the ADVT. In Figure 9(c), a PATCH packet is generated as a reply on the ADVT and is forwarded to K node, selecting L as a temporary FG node. If K receives more than one PATCH packet, it selects the shortest path to the multicast sender. The new mesh path is shown in Figure 9(d), K node marks L node as a new upper FG node[9].

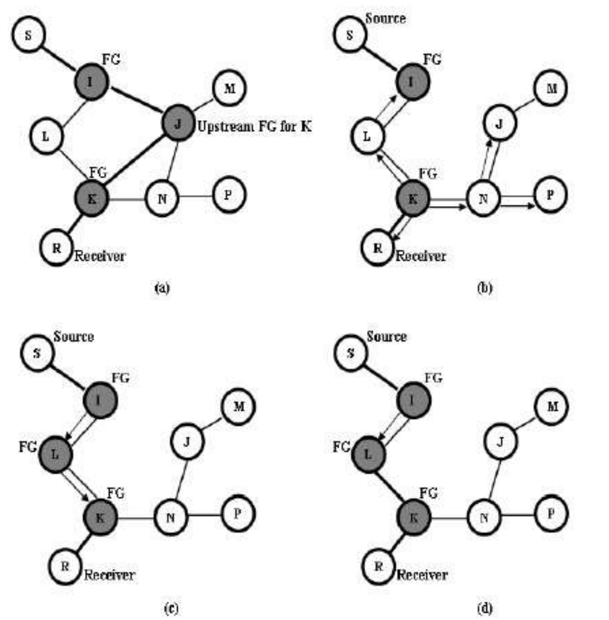

Figure 8: Patch ODMRP Process: (a) ODMRP protocol, (b) j node is not detected by node K, (c) PATCH packet from node I to node K and, (d) node K working Last FG node.

3.3. HYBRID MULTICASTING

It is the type of protocols which have the combination of both tree-based and mesh-based multicasting routing protocols.

3.3.1 Ad-Hoc Multicast Routing Protocol

AMRoute [10] based on shared tree and has two faces: mesh and tree. AMRoute identifies and designates certain nodes as logical cores that are responsible for initiating the signaling operation and maintaining the multicast tree to the rest of the group members. A non-core node only responds to messages. AMRoute does not address network dynamics and assumes the underlying unicast protocol to take care of it.

In Figure 10, core receives a JOIN_REQ packet from another core in the same multicast group. It replies with a JOIN_ACK. A new bidirectional tunnel is created between the two cores, and one of them is selected as a core after the mesh merger. When the mesh has been started up, the core starts the tree building process. The core start to send TREE_CREATE messages to all nodes in the mesh. The TREE_CREATE messages will be received only by the multicast group nodes. Then every TREE_CREATE message receiver in the multicast group will forwards messages it received to all mesh links except his parent. Then the TREE_CREATE is discarded and TREE_CREATE_ NAK is sent back to his parent. If there is node wants to leave the group, it is try to send a JOIN_NAK message to nodes that have connection with him.

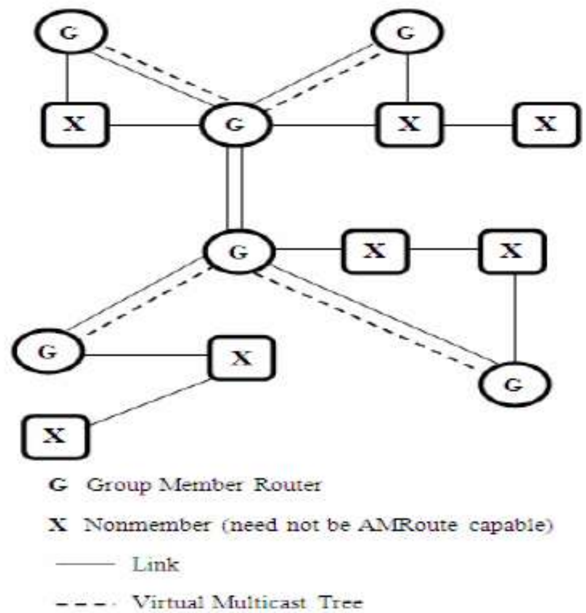

Figure 9: Virtual multicast tree formed by AMRoute

Using the mesh links, AMRoute starts building multicast tree. If there is any change in the network, multicast tree in AMRoute tries to keep the multicast delivery tree unchanged. The main disadvantage of this protocol is that it may have temporary loops and may create non optimal trees with host mobility [11].

4. CONCLUSION

Routing is an essential component of communication protocols in mobile ad hoc networks. The design of the protocols are driven by specific goals and requirements based on respective assumptions about the network properties or application area. This survey tries to review typical routing protocols and reveal their characteristics. This paper, present routing protocols in ad-hoc networks, a general view of these protocols are given. Any routing protocol in MANETs tries to overcome some difficult problems which can be categorized under basic issues or considerations. All protocols have their own advantages and disadvantages. One use the unicast protocols to reduce the overheads .One constructs multicast trees to reduce end-to-end latency. In the mesh-based protocols provide more robustness against mobility and save the large size of control overhead used in tree maintenance. Most protocols of this type rely on frequent broadcasting, which may lead to a scalability problem when the number of sources increases. Hybrid multicast provides which is tree based as well as mesh based and gives the advantage of both types. It is really difficult to design a multicast routing protocol considering all the above mentioned issues. Still it is an open problem for researchers to develop a single protocol which can satisfy as many goals as possible in the future.

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