Multicasting in mobile ad-hoc network

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Abstract

Mobile ad-hoc network is a short live temporary network established by two or more mobile nodes in the absence of any supporting infrastructure. Routing is one of the core issues in this type of network. Effort is going on to invent a suitable routing strategy for mobile ad-hoc network. Good numbers of papers have been reported proposing various thoughts and solutions. The contribution of this paper is to describe in detail different functions of mobile ad-hoc on-demand data delivery protocol with focus on multicast operation of the revised algorithm. The main objective of MAODDP is to offer an efficient routing strategy by utilizing the best characteristics from the existing routing protocols for mobile ad-hoc networks. MAODDP adopts a unique strategy of establishing route and delivering data simultaneously at the same time. We believe successful implementation of this algorithm could leads towards a solution which consume less bandwidth, increase battery life of the participating nodes while offering a better routing solution for mobile ad-hoc network.

1) Introduction

Recent advancements such as Bluetooth introduced a new type of wireless system known as mobile ad-hoc network.[1]. A mobile ad-hoc network is a collection of mobile nodes forming network in the absence of fixed infrastructure[2]. Absence of fixed infrastructure poses number of different challenges to mobile ad-hoc network. Typical challenges in the area include hidden terminal problem, security, bandwidth constraints and routing.[3]

Routing[4, 5] in mobile ad-hoc network can be performed if nodes are agreed to exchange packets. Multicasting[6-9], figure 1, in mobile ad-hoc network is an important aspect to be seen. Group communication (one-to-many or many-to-many) has become increasingly important in mobile ad-hoc network. Effective support of multicast is essential for most ad-hoc network applications. There are many applications where multicasting is an important task. In mobile ad-hoc network multicasts problems differ from those in wired networks because of the variable nature of the wireless medium, where the signal strength and propagation varies with the time and environment.

Figure 1 Multicasting in mobile ad-hoc network

In mobile ad-hoc network an efficient multicast model can ease effective communication among various groups in the network. At present multicast routing in mobile ad-hoc network is gained by adopting one of two approaches i.e. flooding and tree-based routing. Flooding offers the lowest control overheads with very high data traffic, while tree-based routing reduced data traffic in the network but requires many control data exchanges.

Mobile ad-hoc on-demand data delivery protocol[MAODDP][10] is a new addition in the family of on-demand protocol for mobile ad-hoc network. In comparison with tables
driven and on-demand protocols, MAODDP adopts an intermediate approach by focusing on establishing route and delivering data simultaneously at the same time. The contribution of this paper is to present a revised and more enhance version of MAODDP detailing its multicast and other functions. Rest of the paper is organized as follows. In section 2 a brief overview of the related work will be presented. Section 3 describe different functions of MAODDP, section 4 throws lights on future work and conclusion is given in section 5 while references are covered in section 6

2) Related Work

Routing is one of the unresolved issues in mobile ad-hoc network[11]. Concerning routing good numbers of papers[12-14] have been reported proposing various routing solutions for mobile ad-hoc network. Proposed solution could be classified into two main group’s table’s driven and on-demand routing protocols. Tables driven protocols[11, 15, 16], Destination sequence distance vector routing protocol (DSDV), Wireless routing protocol (WRP) and Cluster-head Gateway switch routing (CGSR), is one of the old ways of acquiring routing. These protocols maintain consistent overview of the network via continuous updates from the network. Each node uses routing tables to store the topology information of other nodes in the network. This information is used to transfer data among various nodes of the network. To ensure the freshness of the routing tables, these protocols adopts different sorts of mechanisms. One of the adopted approached is to broadcast “hello”, a special message containing node topology information, at fixed interval of time. On receiving this message each nodes updates their routing tables with fresh topology information of other participating nodes. Tables driven protocols might not be considered as an effective routing solution for mobile ad-hoc network. Nodes in mobile ad-hoc networks operate on low battery power and with limited bandwidth. Presence of high mobility, large routing tables and low scalability result in unnecessary consumption of network bandwidth and battery life of the nodes. Moreover continuous updates could create network overhead.

In on-demand protocols[17, 18], Ad-hoc On-Demand Distance Vector routing (AODV), Dynamic source routing (DSR) and Temporary ordered routing algorithm (TORA), if a source node requires a route to the destination for which it does not have route information. It initiates a route discovery process which goes from one node to the other till it reaches to the destination or an intermediate node, have route to the destination. This is the responsibility of the route request receiver node to reply back to the source node about the possible route to the destination. Source node uses establish route for data transmission to the destination node. These protocols differ on storing the previously known route information and use of the established route. In on-demand protocols large numbers of route request could cause network overhead and may results in unnecessary bandwidth usage.

One other type of existing routing techniques is GPS-enabled ad-hoc routing algorithm, In this types of routing nodes are equipped with positioning system devices (e.g. Global positioning System receivers) that make them aware of their position, this enables “directional” routing, however positional solutions differ on how the topology information of the destination could be obtained. Some of the drawbacks of this technique are, need extra hardware and depends on the extra hardware limitation and scalability.

3) Mobile Ad-hoc on Demand Data Delivery Protocol (MAODDP)

Mobile ad-hoc on demand data delivery protocol adopts the approached of route establishment and data delivery simultaneously at the same time. One of the main features of MAODDP is to offer a routing solution while addressing other routing related issues as shown in figure 2. MAODDP builds routes using a route request and data delivery process. When a source node desires a route to a destination for which it does not already have a route, it broadcasts a route request and data delivery package. Nodes receiving this package update their routing tables with fresh topology information of other participating nodes. MAODDP builds routes using a route request and data delivery process. When a source node desires a route to a destination for which it does not already have a route, it broadcasts a route request and data delivery package. Nodes receiving this package update their routing tables with fresh topology information of other participating nodes.

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received before, it just discard the package and do not forward it to any other node.

**Mobile ad-hoc on demand data delivery protocol**

As the acknowledge packet propagates back to the source node, it setup forward pointers to the destination. Once the source node received the acknowledge packet, it may begin to forward data packets to the destination using the established route. If the source later receives a route request and data package from any other nodes to the same destination containing a greater sequence number or contains the same sequence number with a smaller hop-count, it updates its routing table for that destination and starts using the better route.

As long as the route remains active, it will continue to be maintained. A route is considered active if the data packets periodically traveling from the source to the destination along the previously established path. Once the source stops sending data packets, the links will time out and eventually be deleted from the intermediate node routing tables. If the source does not hear from the destination node before the expiry time, it consider previous attempt to send packet as unsuccessful and can either rebroadcast the package or postponed it for some later time.

Overall operation of MAODDP relies on three basic functions: Route discovery and data delivery process; route table management; and local connectivity management. Creating a route from a given node to a destination node requires establishment of a sequence of links from the source to the destination. The method use to accomplish this is route discovery and data delivery process, routing tables are used to hold the topology information of other nodes in the network while local connectivity management is required to keep up to-date with the current status of all other neighbouring nodes. Some of the primary objectives of MAODDP are as follows.

- Broadcast information On demand (only when it is needed)
- Delivery of data as soon as route is found.
- Real time communication
- Maximizing the battery life of the participating nodes.
- Make best possible use of available bandwidth

### 3.1) Route Discovery and Data Delivery Process

Route discovery and data delivery process figure 3, is initiated whenever a source wants to transmit data to any other node for which it has no routing information in its routing table. Every node maintains two separate counters, Sequence number and a broadcast-id. The source node initiates the route discovery and data delivery process by broadcasting route discovery and data delivery package. The package contains route request and data packet. Route request contains the following fields.

\[
<\text{source address, source-sequence number, broadcast-id, dest-addr, dest-sequence number, hop-count}>\]

Source address and source sequence number in the package are used to identify the source and to store the fresh information about the source node in the routing tables of other nodes. These store information is used to setup a reverse path back to the source nodes. Broadcast-id helps intermediate nodes to identify the fresh route request. When a node receive the package, if it is the destination node, it issue an acknowledge packet back to the source node, if it is an intermediate node and has a route to the destination, it forwards the package to the destination node. If the receiving node find the sequence number and broadcast_id similar to the one received before, it discard the package and do not forward it to any other node.

Unlike other on-demand routing protocols, In MAODDP only destination node is responsible to issue an acknowledged message back to the source node. On the other hand, if the source node does not hear any thing back from the...
destination node within set time limit it considered the route discovery and data delivery process as unsuccessful and can either reinitiate the process or can postponed it for some time later.

3.2) Route Table Management

In addition to the source and destination sequence numbers, other useful information is stored in the route table entries of each node. In each route table entry the address of active neighbours through which packets for the given destination are received is also maintained. A route entry in the route table is recorded active if use by any other active neighbour which is followed by the acknowledge packet from the destination.

A node maintains a route table entry for each destination of interest. Each route table entry contains the following information.

- Destination address
- Next Hop
- Sequence number for the destination
- Active neighbours for this route
- Expiration time for the route table entry

If a new route is offered to a node, the node compares the destination sequence number of the new route to the destination sequence number of the current route. The route with the greater sequence number is chosen. If the sequence numbers are the same, then the new route is selected only if it has a smaller metric to the destination.

3.3) Local Connectivity Management

There are three possible ways for a node to know about other nodes in the network. In MAODDP each nodes issue a 'hello' message on joining the network. This message contains the useful information which helps node to find out their neighbours, other nodes and hop-counts to the neighbouring node. Route request along with data packet is used as a source for all the nodes to update their routing tables with the fresh routing information. Acknowledge packet issued by the destination nodes helps other nodes to re-verify the already stored route information in their routing tables.

3.4) Multicasting

MAODDP maintains routes for as long as the route is active. This includes maintaining a multicast tree for the life of the multicast group MAODDP adopts multicast tree based routing approach as shown in figure 4. Therefore, if a node wants to join a multicast group, it broadcast route request and data delivery package in a similar manner as describe in section 3.1.

The only difference is the addition of flag ‘A’ in route request header along with the destination ID known to node, indicating that the node wants to be added in the group. Any node receiving this package that is a member of the multicast tree and has a fresh enough sequence number for the multicast group may forward it to the destination node. Destination on receiving package issue acknowledge message as describe above in section 3.1. the nodes forwarding the package set up pointers in their multicast route tables. As the source node receives the acknowledge package it keeps track of the route with the fresh sequence number, and beyond that the smallest
hop count to the next multicast group member. After the specified expiry period, the source node will broadcast an activation message to its selected next hop. This message serves the purpose of activating the route. A node that does not receive this message will timeout and delete the pointer. If the node receiving the activation message is not already a part of the multicast tree, it will also have been keeping track of the best route from the package it received. Hence it must also broadcast activation message to its next hop, and so on until a node that was previously a member of the multicast tree is reached.

5. on Going Work

We are in the process of writing simulator to implement MAODDP. Some of the important tasks in accomplish the final product is to evaluate the performance of existing routing strategies for mobile ad-hoc network. This type of studies will be helpful for us not only to further modify the design of MAODDP but also to provide a better ground for running various sets of simulation under different network environments. Our future plan is to implement the MAODDP in order to obtain a clear view of its performance particularly in respect of bandwidth and battery life i.e. how feasible the approach is in reducing the bandwidth and maximizing the battery life of the participating nodes.

6. Conclusion

We have presented an extended version of previously presented mobile ad-hoc on-demand data delivery protocol. We have also described different functions of the protocol with a brief description of MAODDP multicast operation. We believe once implemented protocol can be able to support all types of routing while offering a better routing solution for mobile ad-hoc network.

7. References


