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Most Efficient Multicast structure for Wireless Mesh Networks

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***Abstract*— the wireless mesh network is an emerging technology that provides high quality service to end users. Furthermore, multicast communication is a key technology for wireless mesh networks. Multicast provides efficient data distribution among a group of nodes. However, unlike other wireless networks, such as sensor networks and MANETs, where multicast algorithms are designed to be energy efficient and to achieve optimal route discovery among mobile nodes, wireless mesh networks need to maximize throughput. To improve the throughput for multichannel and multi-interface mesh networks. Multicast communication, which intends to transmit the packets from the source to a set of nodes, draws less attention in the literature of mesh networks. efficient multicast, which cannot be readily achieved through combined unicast or simplified broadcast, is essential to wireless mesh networks and is worthy of thorough investigation. To build efficient multicast structure by reducing the overhead of route maintenance through DSR (Dynamic Source Routing). In DSR the routes are maintained only between the nodes which need to communicate. AODV attempts to improve on DSR by maintaining routing tables at the nodes so that data packets do not have to contain routes. And also the protocols such as DSR (Dynamic Source Routing), AODV (Ad-hoc On Demand Distance Vector) and Flooding are used to reduce the interference to improve the network capacity.**

***Keywords*—Multi-Channel Multi-Interface, Wireless Mesh Networks, Dynamic Source Routing, Destination Sequence distance vector, Ad-hoc On-demand distance Vector, Mobile Ad hoc Network**

I. INTRODUCTION

WIRELESS MESH NETWORKS

Multi-Channel Multi-Interface (MCMI) wireless mesh networks have been emerging as a new paradigm in multi-hop wireless networks. They enhance network-wise throughput by highly parallelizing packet forwarding, which is limited in single channel networks. In MCMI WMNs, neighbouring nodes try not to share occupying channel to maximize simultaneous packet transmissions when two neighbouring nodes occupy the same channel, only either of them communicates at a time. Wireless communications are known to have advantages in multicasts of having open communication media, air, shared by all nodes within a communication range as long as the nodes are tuned to the channel. However, notice that such an advantage will be gone with the maximized channel distribution. Especially, if the dominant communications in a network is multicast like in, military command networks and the maximized channel distribution may be even harmful.

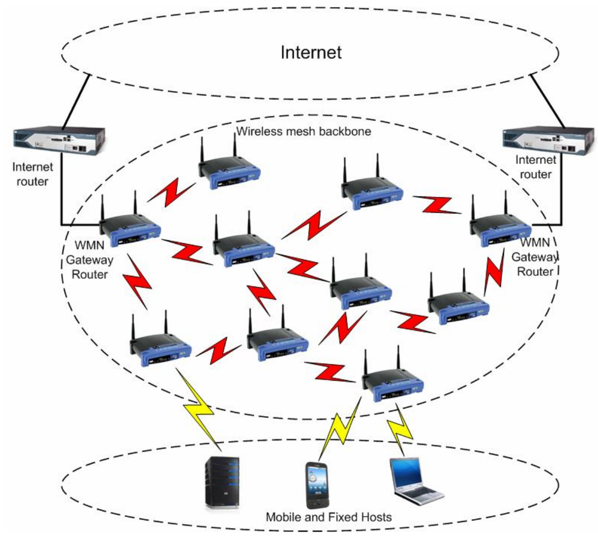

Figure 1: Wireless Mesh Network (WMN) Architecture

A MANET is a network composed of mobile nodes mainly characterized by the absence of any centralized coordination or fixed infrastructure, which makes any node in the network act as a potential router. MANETs are also characterized by a dynamic, random and rapidly changing topology. This makes the classical routing algorithms fail to perform correctly, since they are not robust enough to accommodate such a changing environment.

Consequently, more and more research is being conducted to find optimal routing algorithms that would be able to accommodate for such networks. Generally Wireless Mesh Network (WMN) is an emerging paradigm for the next-generation wireless Internet. In such networks, most of the nodes are either stationary or minimally mobile and do not have power constraints. Compared with their single-hop counterpart, wireless LANs, the WMNs are self-organized with the nodes automatically establishing ad hoc networks and maintaining their connectivity, which provides more reliability as well as larger coverage, and reduces equipment cost. Being used on the last mile for extending or enhancing Internet connectivity, commercial deployments of WMNs are already in the works, such as MIT Roof net and Seattle Wireless Mesh networks are characterized by the use of multiple channels and multiple interfaces to improve the system throughput.

The earliest research efforts on WMNs date back to the late 1990's, when a research project funded by DARPA (the US Defence Advanced Research Projects Agency) focused on developing low-power devices to enable large scale WSNs .Traditionally, WMNs were deployed for monitoring applications based on low-rate data collection .

However, current WMN applications can support more complex operations ranging from target tracking to health care. This thesis is motivated by the communication problems in WMNs that appear with the evolution from the low-rate, data-collection-based monitoring applications to more complex applications that require fast and efficient delivery of large amounts of data. The aim of the thesis is to identify the barriers to fulfil these requirements in the wireless domain and in the organization of the network and provide solutions to overcome these barriers.

Recent research has focused on how to assign channels to different wireless interfaces in unicast routing to improve system throughput in WMNs. However, the multicast communication, which intends to transmit the packets from the source to a set of nodes, draws less attention in the literature of mesh networks. They believe that efficient multicast, which cannot be readily achieved through combined unicast or simplified broadcast, is essential to wireless mesh networks and is worthy of thorough investigation. It is often necessary for a portion of end users to retrieve data packets from the Internet. The further sections give details of the DSR protocol components. The terms route cache and cache are interchangeably used throughout the document and both refer to the same route cache. On the other hand, previous researches are mostly focused on building of minimal path tree from the source node to multicast client nodes, and do not provide the entire practical procedure of multicasting. Moreover, they are not implemented on real environments but only evaluated on simulation tools.

Our multicasting protocol builds multicast paths while inviting multicast members, and allocates same channel to each of neighbouring members in a bottom up manner. While building paths, intermediate relaying nodes are minimally employed not only by path length but also by Current link quality. They have implemented our multicasting protocol with the real MCMI test beds, Net-X. They have shown that our scheme can reduce message overheads and delivery delays while guaranteeing successful message deliveries by performance evaluations.

II. OBJECTIVES

To design a multicast protocol for mesh networks that has the following characteristics:

1) It improves the system throughput by allowing simultaneous close-by transmissions with multi-channels and multi-interfaces, and
2) It assigns all the available channels to the interfaces instead of just the non-overlapping channels.

A multicast structure by minimizing the number of relay nodes and hop count distances between the source and destinations, and use dedicated channel assignment strategies to improve the network capacity by reducing the interference.

III. ORGANIZING THE MULTICAST CHANNEL

A mobile ad hoc network (MANET) is a type of wireless networks. This type depends on the mobile nodes and there is no infrastructure in such type. There are no routers, servers, access points or cables. Nodes (mobiles) can move freely and in arbitrary ways, so it may change its location from time to time. Each node may be a sender or a receiver, and any node may work as a router and do all router functions. This means that it can forward packets to other nodes. Many applications of MANET's are implemented and used until today like in: meeting conferences; military operations; search and rescue operations, all of them are examples of MANET networks (1-3). MAODV protocol keeps sending control packets within static periods, whether there is sending of data packets or not, and it is not concerned with the amount of these data packets.

IV. THE WIRED CONNECTION

Wired networks are very simple to setup (at least at low level). Wireless networks are very difficult to setup, to manage, to debug... Typical problem with wired networks like hardware install, software install, debug and so on become very critical with Wireless.

In wired networks they got IP addresses which help us to distinguish between different computers or networks. That's not so different from wireless networks, here are also IP addresses used, but there is a tiny difference.

While in wired networks they got wires to separate our networks physically they are not physically separated in wireless networks. This means more networks share one physical area. To be able to separate between different networks in a wireless network they got some parameters to help us knowing which computers or nodes are in our network group.

- **ESSID :** The ESSID is basically a name used to define a wireless network group, if you have ever used Windows file sharing or Samba you are familiar with Work Groups, an ESSID is very similar to that, it helps us to know which nodes are in our network.
- **CHANNEL:** The bandwidth used by a wireless devices is split into channels, this basically reduce radio noise produced from other wireless network groups in our area. Think on a walkie talkie, you got different channels, and when one channel is in use by someone you have to use another one, in a wireless network different network groups can share one channel, but when they get more it will get noisier.

There is one more parameter which is not so important but they will mention it here. Since there are wireless devices which can handle different data transmission rates, they need a way to deal a data transmission rate of which both devices are capably, when they negotiate.

V. WIRELESS NETWORK ACCESS MODES

There are two types of wireless networks; the difference is in how the nodes access each other.

- Ad Hoc mode (also called Independent mode), where you have independent networks with a BSS (Basic Service Set) each one. Each station has the same BSS. In this mode all nodes are independent from each other, every node can talk to all nodes close enough to send and receive radio signals. It's a decentralize network structure
- Infrastructure mode, where a number of networks (with a BSS each one) can communicate with each other by using an Access Point, it's a more centralized network, easier to manage. But if the Access Point fail's for some reason and there is no other to take over the whole network managed by this Access Point is down. Also there is a roaming function letting a station "attach" to the nearer Access Point.

Ad hoc is the simpler method (and also the less scalable) and let many hosts communicate each other directly. The restrictive requirement is that all one are to be visible directly to reach a complete coverage of the network. The following figure represents how the different nodes are communicating in ad-hoc mode.

```
A - - - - - C
  \       /
|   \   /   |
     /\
|   /   \   |
  /       \
B - - - - - D
```

Figure 1.1 ad hoc modes

In an Infrastructure environment you use the Access Point to which all other hosts must connect to share the network.

```
                    ESS

A - - - | - Access Point - - Access Point -        | - - - D

B - - - |   BSS1                      BSS2         | - - - E

C - - - |                                          | - - - F
```

Figure 1.2 infrastructure modes

B and C could not see D, E and F, but they can communicate as well because all one are using the same ESS. Important: A, B and C could also not see each other.

VI. DESIGN ARCHITECTURE

Network that is considered in this work consists of n nodes. It is required to send data packets from source node S to destination node D, where S _ n and D _ n. Links connecting the nodes can be wired or wireless. The metric of optimization is number of hops i.e. the optimal distance between S and D will be the one with minimum no of hops. Network topology is established by sending the hello packets. These hello packets are broadcasted in case of wireless node. The node which is in the transmission region receives the hello packets and replies through the hello reply packet. The nodes which are replied through the hello reply are added to the neighbouring node list and are initialized to value 1 in the pheromone table.

Round trip time of hello packet is considered as the cost for the neighbouring link. When the packet is received from the unknown source a entry to the destination field is created. Due to the dynamic nature of the routing table it is implemented as two dimensional array of linked list. Three types of nodes are identified header node, root node and pheromone node.

- HEADER NODE: It consists of fields name, next pheromone and next header. Name- is used to store the IP address of the node. Next pheromone this is a pointer to the pheromone node. This is used to store the pheromone values of the node pointed by header node. Next header this is the pointer to the next header node used to store another node details.
- ROOT NODE: It contains name, time, row and column. Name: same as root node. Time: This is of type time t used to store the last accessed time of the routing table. This is field is used to proper decaying of routing table. Row and column: These are of type struck header node. Column is a pointer to the neighbouring nodes; row is a pointer to the destination nodes.
- PHEROMONE NODE: This structure is used to store the pheromone value. It contains pheromone, row and bottom. Pheromone -this field stores the content of pheromone value. Row and bottom this is a pointer to the pheromone node which is used to traverse the pheromone table.

- **ROUTING TABLE EFFECTIVE DECAY**

Current application needs the routing table to be decayed periodically as it is derived analogy from the termite pheromone trail that will be evaporated in the environment as time passes. Effective decay is applied to the application as a substitution to periodic decay. That is, decay is done only when it is accessed - effective decay. This has reduced an extra thread to the application and overhead of synchronization of this table between these threads. Effective decay is implemented using timestamps. The difference between two access times is used to find the period to which it has to be decayed

- **PACKETS**

Packets are used for sending the data to the other nodes. These packets are also used for the maintenance of the route by increasing the pheromone concentration of the link. No special packets are needed for route maintenance. The different packet formats used are. a) Data Packet contains type, source address, destination address, previous hop, next hop, data length, data and trail. B) Route Request / Reply / Data Ack contain type, source address, destination address, previous hop, next hop and trail. c) Hello / Hello Reply contains type, source address, destination address and time stamp

• *Type:* It is used for defining the type of the packet.

Type=0 hello packet type=1 hello reply packet

Type=2 route request packet (RREQ) type=3 route reply packet (RREPLY)

Type=4 Data packet type=5 Data acknowledgement packet

• *Source Addr:* It is used to store the IP address of the source node and *destAddr* is used to store the address of the destination node.

• *prevHop:* This field stores from where the packet has been received and *nextHop* is used to where the packet has to be transferred.

• *msgId:* This field is used to eliminate the duplicate packets and *dataLen* is used to store the length of the data packets and data field stores the data content.

• *Trail:* This field is of type character array; used to store the path that packet has traversed.

• *Timestamp:* This field is used to measure the round trip time of the hello packets.

VII. CONCLUSIONS

As two multicast algorithms, LCA and MCM are used to build multicast structure and channel assignment for the efficient multicast in WMN (Wireless mesh network), by using multichannel and multi-interfaces. And more effective multicast structure is constructed to minimize the number of the relay nodes and the communication delay. The dedicated channel assignment helps to further reduce the interference. Compared with previous multicast approaches, these algorithms are based on the multichannel and focus on the throughput improvement effectively. The performance evaluation shows that our algorithms outperform the single-channel multicast in terms of throughput and delay. To build efficient multicast structure by reducing the overhead of route maintenance through DSR (Dynamic Source Routing). AODV attempts to improve on DSR by maintaining routing tables at the nodes so that data packets do not have to contain routes. And also the protocols such as DSR (Dynamic Source Routing), AODV (Ad-hoc On Demand Distance Vector) and Flooding are used to reduce the interference to improve the network capacity.

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