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MESH NETWORKING ROUTING TECHNIQUES

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ABSTRACT

Mesh Networking is based on routing techniques originally developed for battlefield communications. By pushing intelligence decision making to the edge of network, high performance and scalable networks can be built at very low cost. Mesh networking play an important role in the wireless community. It promises self-healing, multi-hop networking capability that lowers node costs and power consumption, and increase reliability in a real-world noisy environment.

KEYWORDS: Routing Techniques, Wireless Meshes Networks, Mobile Base Stations.

INTRODUCTION

As various wireless networks evolve into the next generation to provide better services, a key technology, wireless meshes networks (WMNs) which use mesh networking, has emerged recently. In mesh networking, nodes are comprised of mesh routers and mesh clients. Each node operates not only as a host but also as a router, forwarding packets on behalf of other nodes that may not be within direct wireless transmission range of their destinations. A mesh network is dynamically self-organized and self-configured, with the nodes in the network automatically establishing and maintaining mesh connectivity among themselves (creating, in effect, an ad hoc network). So mesh networking has to manage a network, which is highly dynamic, in terms of topology, location of nodes and routing path.

TYPES OF MESH NETWORKING

CLIENT MESHING

Client meshing enables wireless peer-to-peer networks to form between and among client devices (i.e., end users) and does not require any network infrastructure to be present. In this case, clients can hop through each other to reach other clients in the network.

INFRASTRUCTURE MESHING

Infrastructure meshing creates wireless backhaul mesh among wired Access Points and Wireless Routers. This reduces system backhaul costs while increasing network coverage and reliability.

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HYBRID MESHING

This is the combination of infrastructure and client meshing. Mesh clients can access the network through mesh routers as well as directly meshing with other mesh clients. While the infrastructure provides connectivity to other networks such as the Internet, Wi-Fi, WiMAX, cellular, and sensor networks; the routing capabilities of clients provide improved connectivity and coverage inside the WMN. The hybrid meshing will be the most applicable.

Node	1	2	3	4	5	6
Table Entry 1	2	1	1	3	4	2
Table Entry 2	3	3	2	5	6	5
Table Entry 3	NA	6	4	NA	NA	NA

Figure 1.(Fig From: "Wireless mesh networks: a survey" available online at www.sciencedirect.com)

We will examine how these tables are created in the next section. For now, let's look at what the table entries mean. Basically, each table entry is the number of a node that is within range of the node who owns the table. For example, looking at the table, we can tell that nodes 2 and 3 are in range of node 1. If we look at this graphically, we can get a sense of why it is called mesh networking.

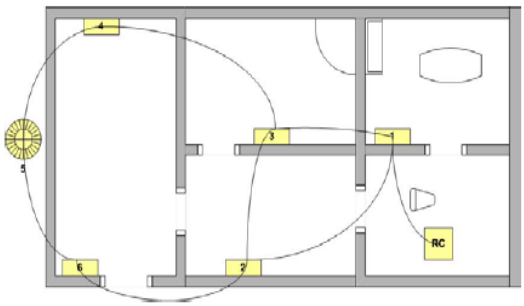

Figure 2.(Fig From: "Wireless mesh networks: a survey" available online at www.sciencedirect.)

In this drawing, each line represents a valid communication path. You can easily see, using this drawing, two different paths from the remote control to the light. With the tables in place, the actual operation of a mesh network is quite simple. The remote control will send an enumerated message to the light to turn on. How the remote knows that the light is actually node number 5 will be discussed later. For now, let's assume it does. The message traffic will happen like this: Node 1 receives message from remote control and re-transmits the message to nodes 2 and 3. Nodes 2 and 3 will then transmit the message to nodes 6 and 4, respectively. Lastly, nodes 6 and 4 will transmit the message, via different paths, to node 5, the light.

A MESH NETWORKING EXAMPLE

In this very simple example, there are 5 switches (nodes 1,2,3,4,6) and an outdoor light. Each of these "nodes" is equipped with a typical short-range radio link. A user in the lower right room wants to turn that light off with a handheld remote control.

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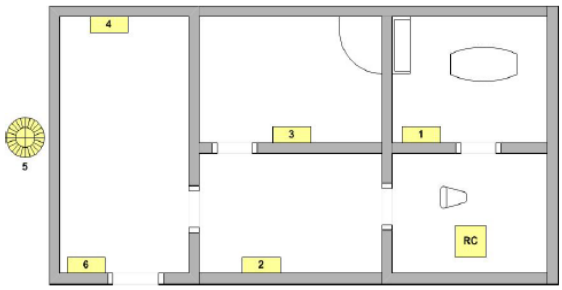

Figure 3.(Fig From: "Wireless mesh networks: a survey" available online at www.sciencedirect.com)

Typical radio circuitry currently available in the market does not have the range to get a message from the remote control to the light. Most of the embedded wireless industry, with a few exceptions, accepts this model (poor RF performance) as the only way to achieve low cost in Volume production.

For now, let's consider how we can get the message from the remote control to the light. One solution would be to "hop" the message between the nodes in the network until the message reaches node 5.

ENTER MESH NETWORKING

Since we can determine which "nodes" in this network are in range of the other "nodes" in the network, we could build a small table into each of the nodes that may look like this

Multi-hop routing does extend the range of embedded wireless networks. However, it also introduces multiple failure points into the network. The beauty of mesh networking is that it creates multiple paths within the network between any two points, eliminating the possibility that any single point of failure can prevent communications between those two points.

AUTOMATIC NETWORK DISCOVERY

It is actually quite straightforward to build the node tables automatically. The discovery process goes something like this: Node1 transmits a discovery packet, which is received by nodes 2 and 3. Nodes 2 and 3 respond to the packet, causing node 1 to place their addresses in its table. Then, nodes 2 and 3 each transmit the same discovery packet, and the process repeats as it propagates through the network. If a really smart and powerful node wanted to map the network, it could send another special command that would propagate through the network causing each node to send its node table. This information could be used for even smarter routing.

LOGICAL NETWORK DEFINITION

So it is fairly easy to automatically discover the physical nature of the network, i.e., which nodes can hear which nodes. But how does any particular node get assigned its address? And for that matter, how does the system, a lighting control system in this case, know which nodes are

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switches and which are lights? And which light node is the one in the garage? This "logical network definition" is largely application and product specific. The process by which it is accomplished determines the complexity and cost of the system installation.

MOTIVATION FOR MESH NETWORKING

RELIABILITY

Inherently shortens the distance between application end-points (in terms of improving link quality)by increasing the link to-link receive 'signal to noise' ratio.

REDUNDANCY

Provides alternate path ways throughout the mesh network in the event a router fails (local noise burst, loss of power, hardware failure, etc.)

PENETRATION

Prevents the negative effects of temporary fading, radio shadows, and noisy environments, which are inherent in wireless systems.

COVERAGE

Attaining greater communications reach with the support of intermediate routers.

MAJOR ISSUES OF MESH NETWORKING

There are two important requirements to effectively enable mesh networking:

- Support of highly mobile nodes (i.e., nodes that move so fast that the wireless links established from them to peers. end-user-to-switch and/or switch-to-switch. have extremely low duration thus giving the network little time to react to these rapid state changes).
- Ability to scale to a large number of nodes (i.e.,hundreds to thousands of nodes) ranging from stationary to highly mobile nodes.

CONCLUSION

Mesh networking technology will be the most widely deployed and powers the largest mobile mesh networks in the world. This report, presented some of the system-level challenges encountered in highly dynamic multi-hop wireless networks that include mobile base stations and mobile hosts. Our analysis is presented from the perspective of an system that features highly mobile nodes and that scales to a large number of nodes. In particular, we have addressed the three following challenging areas: topology management, the location model, and the routing model.

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