Wireless Distribution Systems To Support Medical Response to Disasters

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ABSTRACT

We discuss the design of multi-hop access networks with multiple gateways that supports medical response to disasters. We examine and implement protocols to ensure high bandwidth, robust, self-healing and secure wireless multi-hop access networks for extreme conditions. Address management, path setup, gateway discovery and selection protocols are described. Future directions and plans are also considered.

In this study, we discuss the design of multi-hop wireless access networks with multiple gateways to support medical response to disasters. The access network in question consists of several access points (APs) forming a mesh network. Some of the APs are gateways providing the Internet connectivity via cellular WAN connectivity. (e.g. 1xEVDO, 1xRTT, GPRS). As can be seen in Figure 1, mobile clients (responder and patient wireless devices) associate with one of the APs and are able to communicate both with other mobile clients in the same subnetwork and with the outside world (i.e. Internet).

The hardware part of the APs is built on the Soekris boxes which are low power, low cost, compact communication computers. The box itself is able to support multiple interfaces such as ethernet, 802.11, 1xEVDO. As the operating system pebble, the trimmed version of the debian linux, is used.

We have a self-contained platform as in Figure 1 for network deployment that features a water resistant case, external antennae, a long life 12V battery source, and a single switch operation. We have also built a number of APs that support all the features described below.

Each of the mobile clients are assigned a unique IP address. A DHCP server on each AP is deployed. In a LAN environment with multiple DHCP servers, there are mechanisms to ensure the uniqueness of the IP addresses to each client.

In this current form, the APs use Wireless Distribution System (WDS), which is a standard in 802.11, to form a mesh network. Spanning Tree Protocol (STP) is enabled in order to ensure a loop free layer-2 packet forwarding.

Gateways that have outside internet connectivity broadcasts periodically a UDP advertisement to the APs. We call this protocol as gateway discovery protocol. Each of the APs update their routing tables with respect to these gateway advertisements and choose an appropriate gateway for each connection. This part is called the gateway selection process. A linux kernel level module has been implemented that associates each connection with a certain gateway by using advanced policy routing mechanisms.

One of the main features of our architecture is that the mobile clients are not required to be modified at all. All the intelligence resides in the access network. An AP advertise itself as a next hop node to its clients and assigns a unique IP address, and does network address translation and forwards the traffic to appropriate gateways.

In case of a AP (or gateway) failure, the new path can be setup within seconds which depends on the network parameters configured by the system administrator. Having multiple gateways provides also robust Internet connection against gateway failures.

As future work, we are planning to focus on capacity and range enhancement, location awareness, QoS and fairness, path setup optimization and security.

Figure 1: The hardware system and the network architecture