Mexican Radio

Cellular extension using Multi-hop unlicensed 802.11 radios.

A remote educational facility in a mountainous region of Mexico was having issue in receiving stable cellular services. At best, by standing in a specific room corner, sometimes a cell call could be completed. However, adding a remote cell site for an educational facility in a mountainous region of Baja California was going to be a very expensive proposition. System requirements called for an E1 circuit to assure sufficient bandwidth for voice traffic at the mobile cell tower location. The geography of the region makes it very expensive (and difficult) to install a multi-hop microwave link capable of reaching the desired location. Also there would have been considerable delays due to the microwave radio's licensing requirements. So the private microwave plan would have to be scrapped, and the end-user needed a better alternative.

The end-user had previously installed a multi-hop run of 802.11A radios for Internet access. The 3 hop 802.11A system was sufficient for data but posed issues for adding an E1 connection for the Cellular Base Station. The end-user was referred to Engage Communication and asked if they could BackHaul the Cellular Base Station's E1 over their 802.11A system. The 802.11A radios did offer several advantages for the end-user. The radios were much less expensive than an equivalent private microwave link, the 802.11A radios do not need to be licensed so there would be minimal delay in installing the voice services and since a 802.11 link was already working, the local support personnel were intimately familiar with the equipment. So, in summary, the 802.11 radios would be much less expensive to install and also less costly in recurring costs, such as maintenance and management.

Advantages to multi-hop 802.11 radios:

- ***Lower cost radio equipment.***
- ***Easier, quicker installation.***
- ***No licensing delay.***

It, however, quickly became apparent that there would be technical issues in attempting to use the 802.11 technology, over this distance, to carry an E1 circuit. Basically the 802.11 radio is a half-duplex radio. This means the only one direction, transmit or receive, can transport Ethernet packets at a time. For data packets, this is not usually an issue, but when supporting full duplex real time latency sensitive voice circuits that are in turn supporting mobile voice access, this becomes a problem. The half-duplex characteristic adds latency to the Ethernet packets being delivered. For data, the packet delays are transparent and easily handled by the application. But adding latency to a voice circuit that is

supporting a mobile access location is not acceptable. The circuit synchronization becomes untenable and calls will fail or fall off due to conflicts in the transmission paths being used.

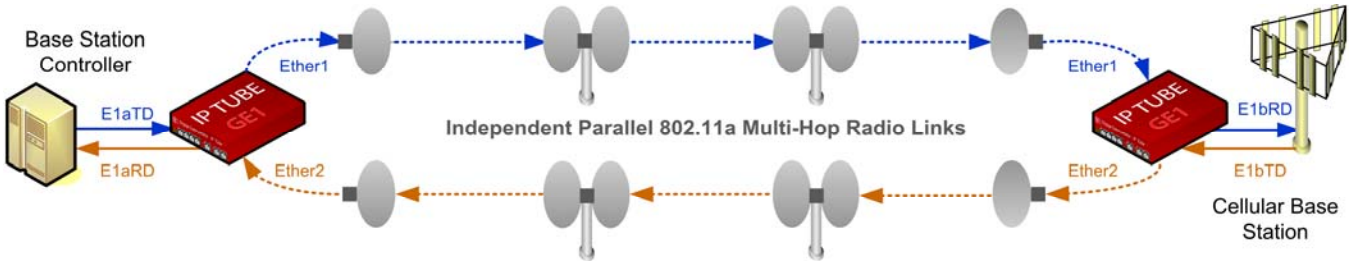
Engage Communication was familiar with transporting voice over 802.11 radios. Their engineers realized that to use half-duplex configuration for transporting an E1, the system would have to be designed with the capability for separate transmit and receive communication paths. To make this solution work, it would be necessary to add an E1 to Ethernet converter that was capable of directing packets to independent Ethernet interfaces. Specifically, the 802.11 multi-hop system would have to be doubled to add separate transmit and receive links for the connection. This would require that the E1 to IP conversion interface would have to support separate Ethernet connections that maintained timing over independent, parallel radio hops. The desired solution was one in which the transmit IP traffic and the receive IP traffic would be carried as separate communication links, utilizing individual radio hops. Engage manufactures such a product and responded to the end-user with a proposal to complete the tower backhaul circuit. Engage involved system integrator, JH, who was familiar with the Engage equipment and using 802.11 radios for voice.

Issues with multi-hop 802.11 radios:

- ***Packet size and latency delays affect cellular services***
- ***Half-duplex transmission requires independent transmit and receive links***

The Engage E1 to Ethernet conversion product, the IP•Tube, would make installing 2 parallel radio links possible. The Engage product not only converts the E1 to Ethernet, it also is capable of directing specific packets to one of several Ethernet interfaces. The Engage product could take the downstream packets over one Ethernet interface, and return the upstream packets over a second, completely independent Ethernet connection. With this approach, even considering the half-duplex characteristic of the 802.11 radios, the connection would maintain the timing and synchronization requirements for cellular voice traffic. And equally important, the capital equipments costs would still be significantly less than the private microwave approach.

The Engage Communication IP•Tube product is designed to provide conversion from an E1 serial communication interface to a standard Ethernet interface. Additionally, the IP•Tube provides separate Ethernet connections permitting transmit and receive IP traffic to be maintained and synchronized.



By interfacing the Engage Communication IP•Tube to the remote E1 backhaul connection of the Cellular Base Stations and then utilizing the Engage products at the central switching Base Station Controller location, a complete two-way communication link was installed. The separate 802.11 links are able to independently carry two-way voice traffic, supporting the E1 for the mobile access. The Engage IP•Tube conversion products are able to maintain timing and no-loss data connectivity over the parallel radio hops providing service for any remote cellular voice customer.

Additionally, the Engage products offer a proprietary ‘lossless’ data protocol. This interface assures data packet receipt and the highest possible data throughput for any remote backhaul connection. The Engage Communication IP•Tube can also be equipped with data compression to further increase data capacity for an existing connection and assuring maximum bandwidth utilization.

The complete dual radio link was installed and made ready in less than 30 days. The multi-hop 802.11 radio links are robust and offer maximum data integrity. The voice services, as well as the data services, now available at the remote educational site, are of a quality equivalent to any services provided within a metro service area. In fact, the system has worked so well, a second E1 backhaul link has been installed to add even more voice circuits. But maybe best of all, the entire installation was completed at a fraction of the cost of the individual microwave solution first considered. A fraction of the microwave radio cost, even without considering the additional expenses for installation, maintenance and support. The Engage Communication E1 IP•Tube solution was the best choice in terms of cost, time and most of all, performance.