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WHITE PAPER

Low-Latency Microwave Links

ACHIEVING LATENCY ADVANTAGES WITH WIRELESS OVER FIBER

Introduction

Recently, there has been much interest in implementing ultra low-latency networks. Such interest mainly stems from requirements for the electronic trading community to process financial transactions with as little delays as possible. Many of these communications links are often dedicated communication lines with high capacity, of the order of 100 Mbps to 1 Gbps.

Copper or fiber landlines are conventional means to achieve such dedicated lines, but landlines are not the best means if one's primary objective is to achieve the lowest latency possible. Consider the following facts:
The speed of electromagnetic (EM) waves determines the latency in getting information from Point A to Point B. The fastest possible EM wave speed is achieved in vacuum, about 187,000 miles/second, or alternatively speaking, it takes 5.3 microseconds for EM waves to traverse one mile of distance. EM waves slow down in traversing through any physical medium, including air. The following is a comparison between air and solid media like fiber or copper:

- Microwave links via air is almost as fast as vacuum – 99.97% compared to the speed in vacuum.
- EM wave speed through fiber is about 62% of that in vacuum.
- EM wave speed through copper is about 66% of that in vacuum.

So, in general, microwave links can cut down on the latency by 30 to 40%.

In addition, in trying to cover a long distance, fiber lines may have to take zig-zag lines or resort to severe detours due to obstructions, buildings, terrains, and right-of-way issues. In comparison, microwave links can be achieved in a relatively straight line between two end points using repeater sites. This practical issue makes microwave links even more attractive for low latency link that may sometime span a long distance.

Against this backdrop, the rest of the task falls on the equipment designers to minimize the delays that information packets experience while being processed through electronic circuitry. Propagation delays are already in the microsecond ranges, so the objective should be to make equipment delays no more than a few microseconds for long-haul applications. For short hops, equipment delays should be a fraction of a microsecond.

In general, there are two types of microwave links that should be considered.

E-Band Gigabit Links

The primary advantage is that there is plenty of BW available at E-Band (70/80 GHz) and thus achieving gigabit/second speed is relatively easier with low-order RF modulation techniques (more robust than high-order modulations). For ultra low-latency application, simpler electronics and software running at OSI Layer 1 will greatly reduce the latency. E-Band end-to-end latency can be below 100 nanoseconds, a negligible fraction of the propagation delay. In addition, getting regulatory licenses for PTP links is very easy, quick, and cost-effective.

The disadvantage is that E-band links are for shorter hops only due to weather-related limits put on maximum link distances at E-Band. E-Bands may be best used for regional communication links.