Record 180 km Hybrid Diversity IP Microwave Link

Link between Honduras and Belize Crosses Water and Land

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Last year I wrote about the world's longest all-IP microwave link, stretching 193 km over the Atlantic Ocean in Honduras. Aviat Networks and Telecomunicaciones y Sistemas S.A. (TELSSA) designed and implemented this link together. This year, Aviat Networks and TELLSA again worked together to build another link and achieve another record—an Eclipse microwave link between Honduras and Belize that crosses 75 km of the Atlantic Ocean and 105 km of rugged terrain for a total path length of 180 km. This is a new world record for a hybrid diversity microwave link!

After the success of implementing the 193km link over water, Aviat Networks and TELSSA were eager to meet the challenge to connect Honduras and the neighboring nation of Belize using a single microwave link. Aviat Networks network engineers and TELSSA engineers were able to use their extensive knowledge of local propagation conditions, thorough understanding of long path design principles and precise installation practices to successfully implement this 180km microwave link.

Long Path Design Considerations

As outlined in the article last year for the longest all-IP hop, a deep understanding of path design considerations and experience in microwave transmission path design are necessary to successfully complete a long path design. Key considerations involved:

- The effect of antenna diameter on highly refractive paths
- Precise alignment of the antennas to mitigate the effect of refractivity
- Optimum RF and space diversity spacing to counter elevated divergent dielectric layers
- Deterministic prediction of the variations of atmospheric conditions
- Multi-path propagation delay

Figure 1. Survey view from Belize toward Honduras, at 1000 m AMSL.

With these considerations in mind, the design staff was able to engineer a microwave path to deliver fiber-optic level error performance over difficult terrain and climatic conditions unique to the Honduras-Belize coastline. Using their long path design experience, Aviat Networks design engineers were able to specify a 99.9995 percent path reliability equating to just 32 seconds of accumulated outage per year.

Understanding Local Propagation Conditions

By understanding the behavior of the local atmospheric conditions, a microwave link can be designed that will perform as required regardless of the temporal, seasonal, and climatic variations along the path. In Central America, with its coastal warm days and nights, standard propagation is considered prevalent, because the troposphere in this region is "assumed" thermodynamically unstable and in a state of constant turbulent mixing.

However, above 1.3 km average mean sea level (AMSL), in this part of Honduras and Belize (Figure 1), erratic propagation is observed with RSL (receive signal level) values varying widely and as low as -90 dBm. Without

understanding of such erratic propagation conditions, a microwave link designed for standard propagation would experience outages and long-term degradation.

The Path Design

Aviat Networks designed a 40 Mbit/s IP link at 6 GHz for the 180km distance between Honduras and Belize featuring a small path inclination (3.25-mr). Because of the long distance, a three-antenna Hybrid Diversity RF arrangement was specified. This hybrid arrangement was selected over Space Diversity to provide the maximum RF improvement factor, and the three-dish arrangement—instead of four dishes—further helped to optimize tower loading and minimize cost.

To span this enormous distance, sufficient site elevation was required to prevent diffraction or blockage. In this design, Site A in Honduras is at 1600 meters AMSL and Site B in Belize is at 1000 meters AMSL.

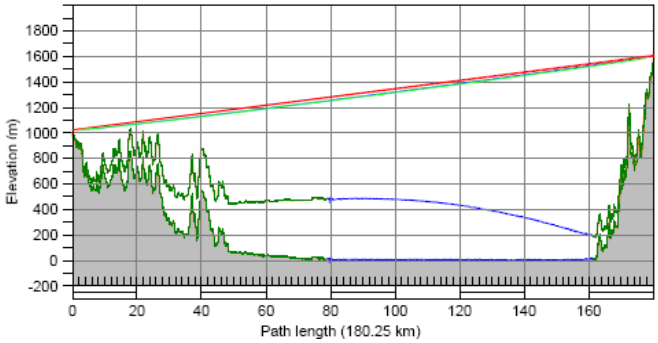

Figure 2. Microwave Path Profile showing antenna centerlines and path clearance over effective Earth's curvature.

Hybrid Diversity has improved RF performance over Space Diversity as it adds 1+1 Frequency Diversity. However, because Hybrid Diversity requires two pairs of frequencies, it is rarely implemented because spectrum may not be available. In this case, in Honduras, a second pair of frequencies was available, so the engineers selected Hybrid Diversity, which delivers the maximum RF improvement factor possible against multi-path fade outage, especially for a long path.

Three-dish Hybrid Diversity was selected because of the space-limited mountaintop deployment, and four dishes would have given little or no performance improvement over a three-dish design. For this link, the three antennas were deployed in an atypical arrangement: the lower site was chosen as the one-antenna site (Figure 3) to accommodate some logistical constraints. Normally, the lower elevation site gets two antennas to minimize the effect of wind loading in mountainous paths.

Figure 3. Frequency Diversity single antenna during installation at the lower site, Site B (1000 m AMSL), in Belize.

During commissioning, the Elevated Atmospheric Boundary Layers (ABLs) effects, visible in real-time through Aviat Networks' PCR (Paperless Chart Recorder), would be optimally neutralized with precise antenna spacing, RF separation, RF assignment and up-tilt.

Installation

An experienced crew helped ensure that a complete field survey was properly performed, followed by a careful and exact installation and precise alignment of the antennas.

Results

The microwave link has being monitored using Aviat Networks' unique PCR software, which records real-time, up to one second, RSL behavior.

According to the PCR analysis (Figure 5) shown below, not a single SES or path-down activity was perceived during 72 hours even though the RSL shows wild fluctuations around 50 dB—proper signal decorrelation is key to this clean performance.

Figure 4. Frequency/Space Diversity in Honduras (1600 m AMSL) toward Site B. Note: The two antennas behind overlook a 193 km IP link over the Atlantic Ocean.

The wild fluctuations PCR recorded contradict the common wisdom that would assume an absence of violent atmospheric multipath at around 1500 m above sea level in Central America.

At 180 km, this Eclipse link is probably the longest all-packet microwave Hybrid Diversity path in the world and demonstrates that making challenging paths work well takes experience, superior product performance and quality, careful path design and precise antenna alignment.

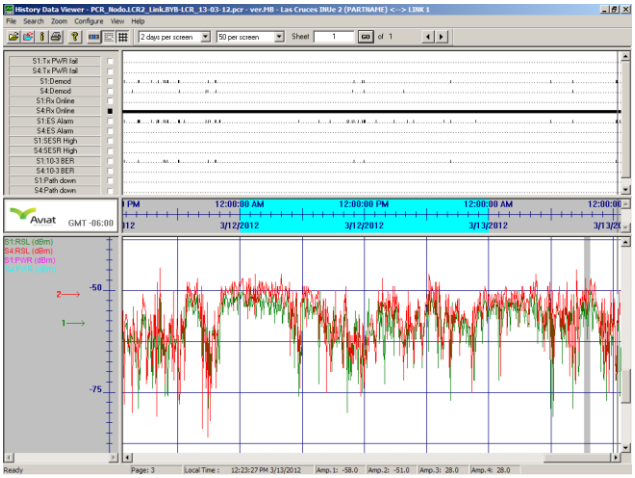

Figure 5. PCR output over 72 hours showing RSL fluctuations but zero Rx alarms.