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STRATEGIES TO MITIGATE WEATHER IMPACT ON LEO KA-BAND LINK AVAILABILITY FOR GSAAS OPERATORS

Abstract

The increasing congestion of lower frequency bands and the growing amount of data generated in space are becoming a significant problem for communications between spacecrafts and Earth. For this reason, satellite operators are moving to higher frequencies, for instance having remote sensing satellites adopting Ka-band (space-to-Earth: 25.5-27 GHz). This frequency segment ensures a larger contiguous available bandwidth, higher data-rates, and therefore higher throughput with a single satellite pass.

Operating in Ka-band has however a major drawback: increased attenuation with respect to traditional S/X bands. This translates into a significant challenge as it can greatly affect the quality and availability of communication links in case of adverse weather conditions. When designing a ground station network to offer Ground-Segment-as-a-Service (GSaaS), the installation site must be selected carefully because weather-related attenuation varies with the location. Further complexity is added by the nature of Low Earth Orbit (LEO) satellite operations: orbital characteristics and varying azimuth and elevation angles with respect to a ground station can also affect signal quality.

Leveraging Leaf Space's in-house-developed software Leaf Link Availability Calculator, link availabilities predictions can be made for signal reception from LEO. A trade-off analysis can be performed to outline the best solution to comply with operators' requirements, also exploiting site diversity to minimize unavailability windows. The software functionality is displayed by identifying the most suitable locations for a Ka-band expansion of an existing multi-mission ground station network.

To validate Leaf Link Availability Calculator, a large set of scenarios is compared with commercially available software confirming estimated weather-caused service outages. Different locations are analyzed and average annual link availability can be obtained for each site. The paper additionally introduces the possibility to enhance and complete the initial validation by mapping predictions against data observed after the effective deployment of Ka-band stations.

Furthermore, different strategies are explored to counteract weather-caused windows of unavailability. This is done by comparing a "traditional" satellite passes booking system vis-à-vis an automatic scheduling system. This comparison highlights the possibility for a scheduler algorithm to identify link availability based on short-term weather forecasts, and automatically re-schedule satellite passes to avoid disruptions.

Finally, with a fine-tuned technical solution to identify optimal sites, the theory must face operational reality: the 25.5-27.0 GHz band has been allocated internationally to the deployment of 5G. Ground operators will need to address regulatory barriers and coexistence requirements that currently have satellite activities on the losing end of the spectrum.