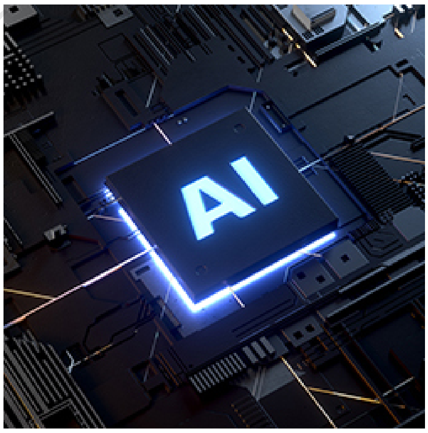
www.pipelinepub.com
Volume 21, Issue 1

Using AI to Minimise Outages on HTS Networks

By: John Yates

Not for distribution or reproduction.

It is well documented that the satcom industry is undergoing a major transformation. The technology is becoming accessible to all and is increasingly being adopted by fresh industries and new customers. As reliable communication systems have become widely available, more data is being shared than ever before. In light of this, High Throughput Satellites (HTS) are an increasingly popular choice for satellite operators because they deliver more than twenty times the data capacity of traditional satellites at a fraction of the cost per bit. To achieve such impressive rates of data transfer, HTS operate at higher frequency bands than conventional satellites.



The challenge associated with utilizing higher frequency bands such as the Ka-, and Q/V-bands, is their susceptibility to attenuation caused by rain fade. Weather is hugely influential on HTS network performance, and when you add to the mix that HTS ground segments comprise tens, if not hundreds, of gateways, managing these networks effectively is a complex undertaking. For service efficiency, it is critical that networks are designed and adapted to manage the impact of weather events. This is one area of satcom where AI is already playing a critical role.

Managing Complex HTS Networks

The primary advantage of HTS systems lies in the use of spot beams to enable frequency re-use, which allows more efficient use of the available spectrum and, combined with the use of the higher frequency bands, for greater network capacity. However, as mentioned, these higher frequencies are also prone to greater atmospheric attenuation, particularly due to rain fade. While this issue also affects Ku-band to a lesser degree, it becomes much more pronounced in frequencies at the higher end of the spectrum, such as Ka-band, Q-band, and V-band, as used by HTS and even more advanced

© Pipeline Publishing, L.L.C. All Rights Reserved.

Very High Throughput Satellite (VHTS) networks.

Rain fade occurs when moisture is in the atmosphere, which absorbs and scatters radio waves, leading to signal degradation. The higher the frequency, the more susceptible the signal is to attenuation. As a result, in regions prone to rainfall or variable weather conditions, network operators must contend with mitigating frequent signal degradation to avoid intermittent outages or reduced network performance. This susceptibility to weather interference presents a significant challenge for HTS network operators, which is exacerbated by the vast number of gateways involved. Operators will typically mitigate interference from precipitation by switching to an alternate gateway. However, such switching can take several minutes and there is always the risk that the alternate gateway may itself go on to experience adverse weather conditions and degredation.

For seamless network operation, these gateways need to be managed effectively so that any instances of weather-related attenuation do not impact the customer. There are two aspects to achieving this and to maximising network and service availability. First, networks need to be designed in such a way as to ensure that gateways are sited in locations least affected by local weather conditions. Second, network operators need the ability to switch to an alternative gateway before the impact of weather is felt by the customer. With the use of AI, combined with the scalable power of cloud computing, operators can design and operate complex multi-gateway Ka-band and Q/V-band satellite networks much more effectively.

AI-Enhanced Network Design

HTS networks require a large number of gateways to support the network capacity and to achieve adequate coverage so are more complex to design than traditional satellite networks. It’s critical that the networks are designed to be cost-effective in terms of how many gateways are employed, while at the same time meeting service availability requirements. This is a delicate balance to achieve. Operators need to determine how many gateways and diversity gateways are needed, work out where gateways should be located for best availability, and determine both the optimum gain for each gateway antenna and the optimum link budget/fade margin. This is where AI can really make a

difference. Using AI in this way enables operators to not only select the gateway locations with the best link availability, but also to group the gateways in a way that minimizes the number of sites that are likely to be affected by the same weather system concurrently. However, designing multi-gateway networks to provide the most cost-effective and optimized network configuration is only half the battle. Managing these complex networks effectively is another major challenge.

Not for distribution or reproduction.

Proactive Network Operation Enabled by AI

Once a HTS network is operational, real-time monitoring and proactive management are integral to maintain performance. For a seamless service, operators need to switch traffic to an alternative gateway before an outage occurs. And to do that, they need to be able to accurately predict an outage a number of hours before it happens so they have time to synchronise and seamlessly switch traffic between gateways. Additionally, network operators need to know with a high level of certainty that the diversity gateway to which the traffic will be switched isn’t also impacted or about to be impacted by a weather event.

AI is already making this kind of network management possible. It can be used to process historical

© Pipeline Publishing, L.L.C. All Rights Reserved.

weather data together with real-time data collected from the network to predict outages ahead of occurrence, as well as to predict weather at diversity gateways. These AI generated predictive analytics enable network operators to proactively take corrective actions, before performance is impacted, by manually or automatically rerouting traffic through an unaffected gateway. This approach minimizes service interruptions, maintaining quality of service while also optimizing network efficiency.

Looking Ahead

As the need for high throughput services increases, operators will undoubtedly continue to turn to multi-gateway HTS networks to meet demand. And as more satellites are launched, including non-geostationary satellite constellations and multi-orbit networks with inter-satellite links operating across LEO/MEO and GEO, the complexity of managing the ground stations for these networks is only going to increase. Already AI is proving to be an indispensable tool in overcoming the challenges associated with operating at high frequencies and ensuring that HTS networks remain resilient, efficient, and dependable. Indeed, we're only just beginning to see what's possible in terms of AI capabilities.

AI technology is constantly advancing and there's every reason to expect it will take on an even more prominent role in satcom in the not-too-distant future. AI enables automation, improving cost and operational efficiency, as well as scalability, both of which are critical factors for the long-term success of satcom. Over time it will also likely help operators optimize network operations by detecting potentially hidden issues and dynamically adjusting resources in real time to make ground segments fully autonomous.

HTS networks constitute a significant leap forward in satellite communications, and AI is the key to unlocking their full potential, transforming the way these networks are both designed and operated to ensure optimal service reliability and efficiency.

Not for distribution or reproduction.

© Pipeline Publishing, L.L.C. All Rights Reserved.