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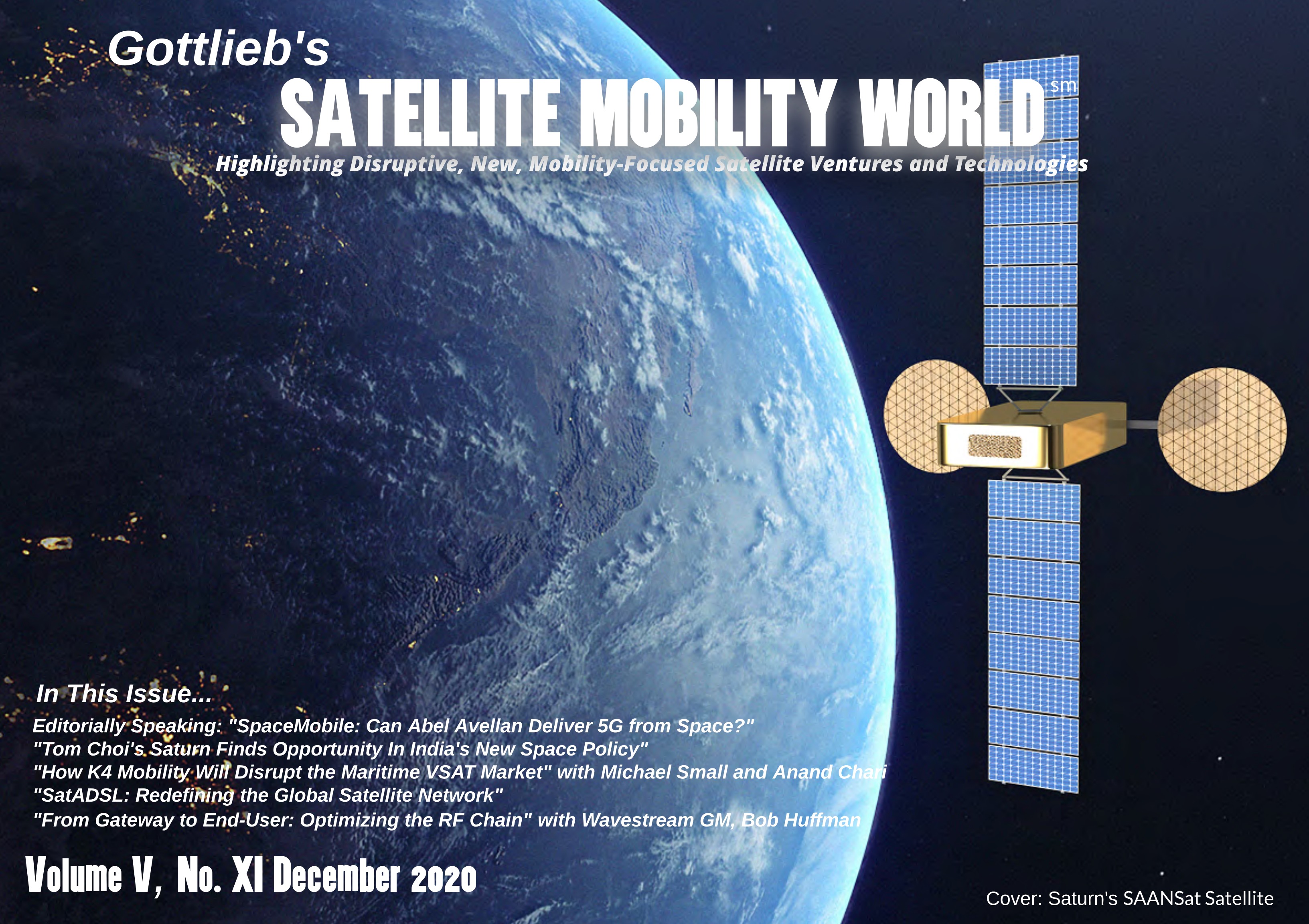
SATELLITE MOBILITY WORLD[sm]

Highlighting Disruptive, New, Mobility-Focused Satellite Ventures and Technologies



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Cover: Saturn's SAANSat Satellite

An Interview with Bob Huffman General Manager at Wavesteam, Gilat's Wholly Owned Subsidiary

From Gateway to End-User: Optimizing the RF Chain

In the highly competitive satellite services market, the difference between profit and loss may depend on how efficiently they convert Hertz to Bits per Second (BPS). Today, operators, as well as integrators sell managed services, giving rising importance to the technologies that enable high-efficiency Hz to BPS conversion.

Wavestream is a well-known leader in this technology, providing hardware, software and specialized expertise designed to optimize the entire satellite link's efficiency - gateway to end user.

To help better understand how our operator and integrator readers can maximize the return on their satellite capacity investments, we asked Wavestream General Manager, Bob Huffman, to visit with us.

SMW: What is the significance of providing more Bits per Second per Hertz (BPS/Hz) through a satellite network? Why is this an important topic?

Bob Huffman (BH): Satellite communications is becoming increasingly more integrated into fixed and mobile broadband solutions for people across the globe. The cost of launching satellites has plummeted by 95% since the Space Shuttle era, which has enabled launching more payloads than ever into Low Earth Orbit (LEO). While satellites cover more land, sea, and air than terrestrial bandwidth, the cost of satellite bandwidth is still inherently higher.

The challenge that satellite operators face is closing a business model that involves the massive costs associated with building the satellite infrastructure of thousands of satellites, hundreds of gateways, and potentially millions of end-user terminals. The business model must consider the number of users, how much data they consume, and how to serve them using a limited frequency band.

For satellite to be remotely competitive with terrestrial bandwidth, MHz capacity must be converted to MBPS at the highest possible efficiency. We measure this as Bits per Second per Hertz, or BPS/Hz.

SMW: Who benefits from increasing the BPS/Hz?

(BH): Satellite operators selling managed services and integrators purchasing MHz both benefit from a high MHz to MBPS conversion rate. Network integrators and bandwidth resellers also benefit, allowing them to stack more value-add services on top of the core throughput.

Therefore, it stands to reason that operators want to cram as many BPS per Hz as possible. Increasing the throughput from 1 BPS/Hz to 2 BPS/Hz effectively doubles the data throughput and doubles the revenue potential.

"For satellite to be remotely competitive with terrestrial bandwidth, MHz capacity must be converted to Mbs at the highest possible efficiency. We measure this as Bits per Second per Hertz, or BPS/Hz."

SMW: What are the technical challenges associated with increasing the number of BPS/Hz in a satellite transmission?

(BH): The main difference between a satellite communication link versus transmission over cable, fiber, or a terrestrial wireless link is that the Signal-to-Noise ratio (SNR) of the satellite link is typically much lower. Because the satellite is so far away, the signal is much weaker, but the background noise is similar. Consequently, much of the challenge involves increasing ground terminal's output power while simultaneously improving the quality of the signal.

Signal quality is evaluated as follows:

- Distortion: just like your home stereo or home theater amplifier, if you try to drive too much power through the system, the output gets distorted. And just as distortion makes it harder to recognize the music or understand a soundtrack, it also makes it difficult to recognize the transmitted signal information.
- Gain Flatness: Again, using the home stereo analogy, if your stereo has poor high-frequency performance or poor bass performance, you will miss hearing some of the instruments or some of the notes. If the RF chain's frequency response is not flat, the receiver may occasionally miss a bit of information. The further the frequency response is from perfectly flat, the greater the probability of an error.

- Phase noise: This is a measure of timing jitter in the transmission of the signal. The more jitter, the greater the possibility that the receiver misinterprets a bit of information in the transmission. The higher the frequency of the transmission, the more difficult it is to maintain low phase noise. Achieving a given level of phase noise on Ka-band satellite transmissions (around 30 GHz) is much more difficult than doing the same for cellular transmissions (around 2 GHz).

Because traditional satellite transmissions carried relatively few BPS/Hz, they operated at relatively low SNRs. While this low SNR transmission requires lower signal power, the quality of the signal will be lower as well.

As one tries to increase the BPS/Hz of the transmission, not only does the transmission power need to be increased, but the RF chain's distortion, gain flatness, and phase noise must be simultaneously improved.

All of this means that the more BPS/Hz in a given satellite link, the higher quality the RF electronics must be throughout the chain – at the Gateway, the Satellite, and End User Terminal.

SMW: Are there different challenges depending on whether the satellite is in a Geostationary Satellite Orbit (GSO) versus non-GSO?

BH: LEO satellites require a wide dynamic range to account for pointing at a satellite near the horizon (lots of atmosphere to travel through, potentially lower antenna gain at lower look angles, etc.). The dynamic range variation is so large that the power cannot be managed exclusively by the modem.

The modem has a maximum signal strength and some minimum signal due to its noise floor, analogous to the background 'hiss' in a stereo.

If the dynamic range of the signal is very large (as in a LEO constellation), turning the output of the modem down too far may result in burying the signal into the "hiss" of its output. In this situation, the Solid-State Power Block Upconverter 's (SSPB) Uplink Power Control (UPC) should be implemented.

However, this implementation poses challenges for the SSPB. The performance of attenuators or variable-gain amplifiers that implement the power control must retain a very flat frequency response over full gain control range.

An additional challenge is developing a robust, low-latency datalink with the uplinking modem and synchronizing UPC information between the SSPB and the modem.

SMW: How do your products maximize the efficiency of the RF chain and preserve the signal quality to maximize the BPS/Hz?

BH: Our proprietary Spatial Power Combining allows us to produce compact, lightweight RF power amplifiers with low power consumption and low distortion - levels necessary for the more complex modulations schemes that can encode more BPS/Hz onto a signal.

Wavestream also designs and produces SSPBs that have exceptionally low phase noise – required for successfully transmitting complex modulations, and we have developed very sophisticated Uplink Power Control with gain control elements resulting in minimal impact on gain flatness over 30dB in power control range.

SMW: Where are your products deployed (i.e., in the hub and modern infrastructure, in the satellite, or both)?

BH: Wavestream builds SSPBs, upconverters, down-converters, Low-Noise Amplifiers (LNAs) & Low-Noise Block Down-converters (LNBs), and hybrid units that combine the uplink and downlink active components in a transceiver package.

Our SSPBs are currently used in LEO Gateway terminals today, and many End User Terminals in ground and airborne applications. To date, we've shipped more than 40,000 units worldwide, with more than 5,000 of those installed on commercial and military aircraft.

SMW: Can you give us a real-life example of how a Wavestream solution has maximized the BPS/Hz in a satellite link?

BH: Wavestream implemented its high-power, low-distortion amplifier engine into our PowerStream 160 Ka SSPB unit, which also has very low phase noise and sophisticated UPC capabilities, for the Gateway terminals used in a global LEO constellation. This unit can carry 8 GBPS of throughput over just 2 GHz of Ka bandwidth. That means that single feeder terminal at a landing site can carry up to 16 GBPS using both polarizations.

SMW: What satellite-related markets are the best fit for Wavestream products?

BH: Our products fit best in satellite constellations optimized from Gateway to Satellite to end-user Terminals such as High Throughput Satellites (HTS), Very-High Throughput Satellite (VHTS) constellations, and any application where high link efficiency impacts a project's economic viability.

SMW: Can you tell us about any new products in the pipeline?

BH: 2021 is a big year for Wavestream in terms of R&D. We will be announcing several new products and technologies throughout the year that will benefit all our customers.

In support of several LEO constellations, at least two new Gateway-class products will come to market, focusing on maximizing the BPS/Hz of a satellite system.

Additionally, around Q3 we will be announcing a new modular RF architecture and several new products that come from this architecture.

It's a product line allows us to quickly build a new product in a fraction of the time it typically takes to design an SSPB product from scratch. We will also be announcing several new products in both airborne and ground/mobile markets that allow customers to connect to multiple satellite constellations.

SMW: How do you see the industry changing in the next five years and will Wavestream accommodate those changes?

BH: As tough as 2020 has been for everyone, we believe the SATCOM industry is poised for a decade of rapid growth across the board.

As these new LEO constellations come online, everything will change for our industry, including Satcom's fundamental economics.

The bandwidth will be less expensive, but the Gateways and End User Terminals will be more complicated, and the business model will change – operators will sell data throughput (MBPS), not bandwidth (MHz).

Satellite backhaul will become increasingly important as 5G wireless networks are built and expanded over the next decade.

During these service expansions, Wavestream will work diligently with satellite operators and network integrators, and resellers and, in doing so, will help them maximize the enormous investment in their new networks. ★

About Bob Huffman:

Bob Huffman joined Gilat's senior leadership team in 2014 as the General Manager of Wavestream, Gilat's subsidiary, with a track record of 26 successful years of experience in the defense industry.

Prior to joining Wavestream, Bob was the Vice President of Engineering and then President for 10 years at L3 communications Interstate Electronics Corporation.

Following, he was the President of L3's Advance Technologies Sector with 6 different companies reporting to him. As General Manager, Bob strives to further develop and grow