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Satellite's Role in Underpinning Mobile and Wireless Networks

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Mobile connectivity and wireless networks are critical in today's world, driving innovation, connecting people globally, and enabling essential services and applications. With the drive toward ubiquitous connectivity, the proliferation of IoT devices, and with the rollout of 5G networks and 6G in the horizon, there is increasing pressure on terrestrial infrastructure to meet user demands for high speed, seamless and universal coverage. Yet just as satellite is not the best solution to meet all user's connectivity needs, terrestrial networks are unable to provide connectivity in every area around the globe. As the demands on mobile and wireless networks grow, so too does the need for innovative solutions that ensure performance and reliability.



Satellite technology offers unique advantages such as wide-area coverage, and the ability to reach underserved regions and areas where terrestrial towers cannot be constructed such as offshore and in inhospitable regions. Satellite technology is, however, not only critical in providing connectivity to those areas lacking in terrestrial networks or where terrestrial networks have failed following a disaster. It also enables telco operators to expand their coverage, enables Direct-to-Device connectivity, provides 5G backhaul, can be used to help telcos manage an unexpected surge in demand, and additionally plays a key role in providing data for IoT systems. And as we move towards the 6G age and a future network of networks, satellite networks will unquestionably be instrumental in the new landscape.

An Industry Transforming

It's well known that the satellite industry is going through a period of transformation, and this change is future proofing satellite's role as an integral component in the mobile and wireless industry moving forward. Both the ground segment and space segment are evolving rapidly in line with technological developments, and to better meet consumer needs. LEO mega constellations are reshaping the industry, and there's also a shift toward multi-orbit networks operating across LEO, MEO and GEO, which altogether is enabling the industry to better meet user's needs.

The costs associated with developing and launching satellites have reduced significantly over recent years, leading to a shift in market dynamics. In a relatively short space of time, the industry has moved from having a small number of satellite operators providing the bulk of the world's satellite services, to the current landscape which sees many new players having entered the playing field, offering services that were not previously available. Satellite connectivity is more accessible and more effective than ever before, yet it cannot meet the needs of consumers single handedly. It's becoming increasingly apparent that satellite operators and telco providers need to work together in order to meet the worlds connectivity needs.

Adapting to a New Landscape

However, integrating satellite capabilities into mobile and wireless networks isn't without its challenges. The emergence of multi-orbit constellations, a shift toward software-defined satellites, and the transition to cloud-based architectures are reshaping how the satellite industry can support terrestrial networks. These advancements are enabling greater flexibility and scalability but also require the industry to adopt new approaches to ensure seamless interoperability and efficient spectrum use.

One of the most pressing challenges facing both the satellite and mobile industries is spectrum efficiency. RF spectrum is a finite resource, and its efficient utilization is crucial to ensuring uninterrupted service. If satellites and terrestrial networks operate within the same frequency bands, there is a risk of overlap and therefore interference. This overlap between terrestrial and satellite spectrum usage underscores the need for innovative strategies to efficiently manage the spectrum.

Advanced signal processing techniques, dynamic spectrum allocation, and interference mitigation strategies including robust testing mechanisms to ensure RF equipment is operating optimally are just a few ways the satellite industry is helping to optimize spectrum use. By working collaboratively with the mobile and wireless sectors and the International Telecommunication Union, satellite operators and service providers can help ensure that spectrum is used efficiently to support the growing demands of connected devices and high-bandwidth applications.

6G and Beyond

Building on 5G which is essentially a ground-based wireless system, next to come is 6G which will see the creation of a new combined network that will make use of satellites, drones, high-altitude platforms (HAPs), and base stations to create a seamless communication infrastructure: the Space Air-Ground Integrated Network (SAGIN). It's anticipated that sixth-generation wireless connectivity will provide significantly higher capacity alongside microsecond latency.

In 6G SAGIN, it's anticipated that connections will dynamically route through the most optimal part of the network, enabling low latency and high throughput. For example, satellites can provide backhaul support to ground-based stations, ensuring the various components of space, aerial, and ground networks work cohesively. This integration will give 6G networks unprecedented efficiency, speed, scalability and flexibility,

Industry specifications for 6G enabled network products are currently being developed, and it looks like the 6G SAGIN network may well be rolled out around 2030. As for 7th generation and 8th generation connectivity, what they may bring remains to be seen, but if each generation takes around a decade to arrive, that puts 7G in the 2040s and 8G sometime in the 2050s, or perhaps sooner considering how technological development accelerates over time.

Building Resilient, Reliable Networks

In a world where connectivity underpins everything from business operations to consumer applications and public safety, network reliability is paramount. Satellites add an critical layer of resilience to mobile and wireless networks, ensuring continued service during infrastructure failures or other disruptions, as well as demand surges.

To enhance reliability, the satellite industry is leveraging technologies like AI for predictive maintenance, cloud-based network management for greater flexibility, and advanced analytics to optimize performance. These efforts not only improve service delivery but also help mitigate the risk of downtime, which can have significant financial and reputational consequences.

As satellite networks grow more complex, it's paramount that antennas and RF equipment is functioning as it should be, so that systems are optimized. And for this, it's critical that satellite operators and service providers carry out regular testing, calibrating, and validating of antennas and RF equipment, in their operational environments. This helps ensure that antennas and equipment perform as expected, and that performance is maintained over time. Not only does this approach minimize the risk of interference and downtime so that the industry can provide a seamless, resilient, high-quality service, but it also enables cost efficiency, helping to improve return on investment. Recent innovations in portable testing solutions, using a drone-based approach, allow accurate, comprehensive assessments to be conducted whenever and wherever they're needed, allowing operators to verify that equipment functioning as expected throughout its lifecycle.

A Collaborative Future

Satellites have long played a critical role in providing connectivity in areas where terrestrial networks are lacking, such as in remote or underserved areas where terrestrial infrastructure is impractical or cost prohibitive. And now, the transformation that the industry is going through is cementing its position as being integral in meeting the world's connectivity needs, providing 5G backhaul, enabling IoT connectivity, and supporting terrestrial communication networks, both currently and in the future.

As the lines between satellite and terrestrial networks blur, collaboration between these sectors will be key to unlocking the full potential of mobile and wireless connectivity. By combining their respective strengths, these industries can deliver innovative solutions that address the connectivity challenges of today and tomorrow.

Whether it's enhancing network resilience or expanding coverage to the most remote corners of the globe, the satellite industry has a vital role to play in shaping the future wireless communications. By embracing new technologies and fostering partnerships, the industry is helping to create a world where seamless, reliable connectivity is available to all.