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SATELLITE Markets & Research

Industry Trends, News Analysis, Market Intelligence and Opportunities

Is 2021 the Year Smallsat IoT Takes Off?

by Hub Urlings

Will 2021 be the year that a new generation of smallsat Internet of Things (IoT) networks take off?

Last January SpaceX's Transporter-1 rideshare mission launched 133 smallsats in a sun-synchronous orbit (SSO).
(image coutesy of SpaceX)

Smallsats offer ubiquitous low-cost and low power connectivity for the global IoT industry. If it is up to some of the new operators, it sure will be, as the launch activities in the first quarter of 2021 demonstrate.

When the SpaceX Transporter-1 rideshare mission shot up in January 2021 to put 133 smallsats into a sun-synchronous orbit (SSO) this January, four of the most noticeable small satellite IoT systems were on board.

The launcher carried eight Kepler satellites, 36 so-called "space bees" from Swarm, five AstroCast satellites, and the Hiber 4 satellite. With that, it certainly looks like satellite IoT has moved into the new exciting phase: the Constellation Phase, where the commercial services are becoming available to end-users.

In March a second launch by Soyuz-2 that carried smallsats for 3 IoT operators: Hiber and Kepler were again on board carrying the Hiber Three satellite and Kepler 6 and 7, and UK-based Lacuna launched its 5th smallsat.

The day after that Rocketlab from Mahia Launch Complex on New Zealand's North Island, launched the 7th small satellite for the Australian-based Myriota as well as the Centuari 3, the 5th satellite of Fleet Space Technologies.

With all these launches several satellite IoT constellations are starting to get the shape, and a new type of network emerges, the Low Power Global Area Networks (LPGAN) that operate smallsat-based infrastructures in

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What's Inside

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EDITORIAL

The Rise of Non-GEO Constellations

This month's issue focuses on smallsats, cubesats, nanosatellites and microsatellites that are coming into the market this year. These small satellites are being launched in Low Earth Orbit (LEO) in a time when LEO constellations with somewhat larger satellties are ramping up. It's amazing that two years ago, there are only about 3,000 satellite in space in various orbits. Meanwhile, over a thousand satellites have been launched since (a 30% percent increase) with many thousand more being planned (up to 40,000 in the next decade according to some estimates).

This explosive growth will have many implications for the industry and Hub Urlings' cover story on the smallsats IoT asks some of the key questions. It really is a game-changer for the industry.

Another article in this issue which will have important implications to most of you is Martin Jarrold's regular column on the GVF's conference plans for the rest of the year. It looks like CABSAT will be a "Live, in-person" event as their ad on page 34 says and the GVF Satellite Summit usually held a CABSAT will be coming back as a live event. Having been part of this event for many years, I can't wait to get back on the trade show circuit again. So we hope to see you in Dubai next month!

Virgil Labrador

Editor-in-Chief

Satellite Executive BRIEFING

Industry Trends, News Analysis, Market Intelligence and Opportunities

EDITORIAL

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Smallsat IoT...

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Low Earth Orbit (LEO). Officially Low Earth Orbit (LEO) is between 350 and 1400 km, but most small-sat IoT systems are between 500 and 600 km above the earth.

From that position, LPGAN networks will be connecting all kinds of sensors via small low-power satellite terminals, and send their data back to the dashboards on customers' screens. LPGANS provide global coverage, and they come with prices that are a magnitude below current satellite IoT price levels.

Smallsat IoT in LEO

LEO satellites are visible only for a limited period. You can see that by watching the ISS (https://spotthestation.nasa.gov/) or Iridium (https://www.satflare.com/track.asp?q=iridium#MAP) passing in the night sky. In a couple of minutes, the satellite comes up at your horizon, crosses over you, and is gone again. A fundamental principle of small-sats is that the only time the ground terminal can send its data messages up to the satellite is when it is insight. The small-sat will receive the data message, accept it and store it. Then when it passes over a ground station, it will send the message back to earth, and the ground station will deliver it to the final destination, usually the customer data dashboard. The more often a satellite comes over (e.g. with multiple satellites in the constellation) the more messages can be sent and delivered each day.

At the end of 2018 the so-called Small-sat Express, with rockets from SpaceX and the Indian Polar Satellite Launch Vehicle (PSLV), launched the first batch of Pathfinders for the IoT small satellites to test them in space. It took two years for these Pathfinder satellites to get settled and validated.

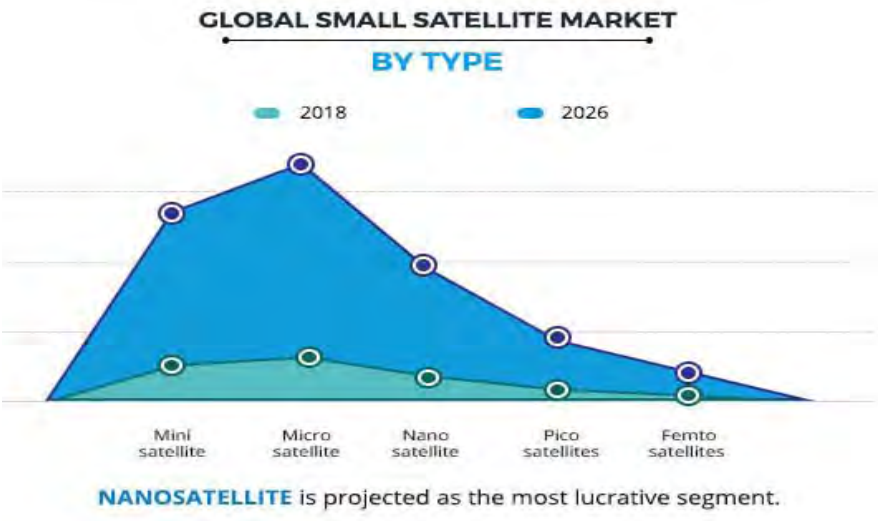
Now in 2021, we are seeing that satellite IoT has completed the research phase, and with the experience of the last two years under the belt, a better and much-improved generation of IoT satellites being launched.

The list of smallsat IoT start-ups around the world is extensive and diverse. It includes AstroCast (Switzerland), Fleet (Australia), Kepler (Canada), Kineis (France), Lacuna (UK), Myriota (Australia), Swarm (USA), XingYun (China), and Hiber (Netherlands). They have all entered the first round of the smallsat IoT race over the last year. But now it looks that a couple of these players are moving significantly ahead of the pack by launching their (minimum but growing) constellations, and are ready to build out their commercial network and services.

In this article, we'll have a closer look at the leading LPGAN players moving into their commercial phase, and the IoT services they can provide.

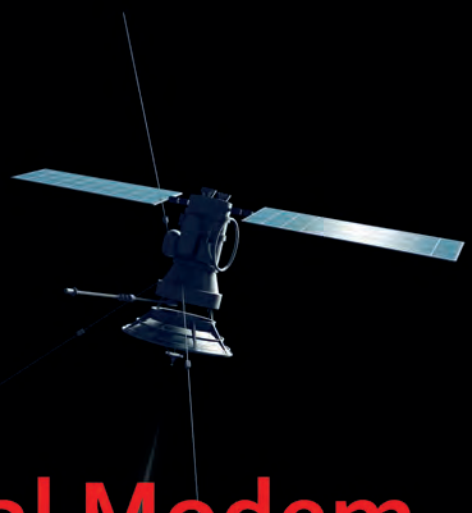
We also look at some other aspects of this exciting new phase:

- What does it mean to have dozens, hundreds, and in the future even thousands of satellites circling our globe in low earth orbits? How can we track those large number of satellites and keep them physically apart? Not to mention, what we will do when we cannot keep them apart? And what can we and should we do with the potential space debris.
- The legal domain also plays an important role in small-



Based on type, the nanosatellite segment is anticipated to grow at the fastest rate according to Allied Market Research. This is attributed to its beneficial features such as small size and low mass owing to which numerous satellites can be launched simultaneously from a single vehicle launcher.

WORK MICROWAVE



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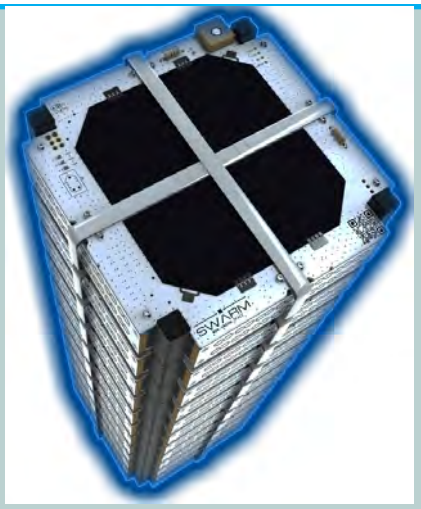
An overview of the smallsat IoT networks that launched their second generation smallsats in the first quarter of 2021 with SpaceX, Soyuz, and Rocketlab.

Swarm launched 36 next-generation satellites into their low earth orbit constellation which already had 36 “space bees” in space, doubling the size of their previous network to 72. With the Swarm network being live for commercial services they can now start serving customers.

Swarm will continue to launch more VHF-based satellites over the coming months and plan to complete their full 150 satellite commercial constellation by the end of 2021.

The more satellites in space, the more satellites will pass over a given location on earth every day, and the higher the service level that Swarm can provide.

http://swarm.space



With the launch of 8 new Gen1 satellites on SpaceX Transporter-1 and 2 more on the Soyuz-2 Kepler has expanded its active constellation to 15 satellites in total.

Once fully operational within the Kepler constellation, the Ku-band-based small-sats will significantly increase the capacity of Kepler’s global data service.

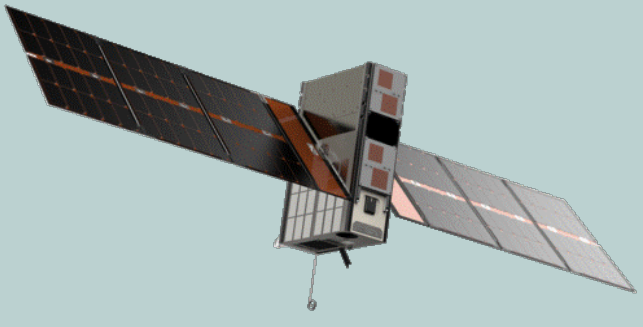
Kepler has a hybrid service that already is offering store and forward service for large files, and they are looking forward to the launch of their satellite IoT service.

http://kepler.space

With 5 satellites in space and two more launching in 2021, South Australia-based Fleet Space is building a constellation of 140 small satellites in Low Earth Orbit.

Australia’s particular connectivity challenges have been a major driver in creating new connectivity technologies like nano-sat digital beamforming.

Fleet launched its first four satellites in November 2018 when Proxima 1&2 and Centauri 1&2 were launched in three weeks. With the recent launch of Centauri-3 on Rocketlab, Fleet is continuing its work on launching the next batch of its second-generation satellites in 2021.

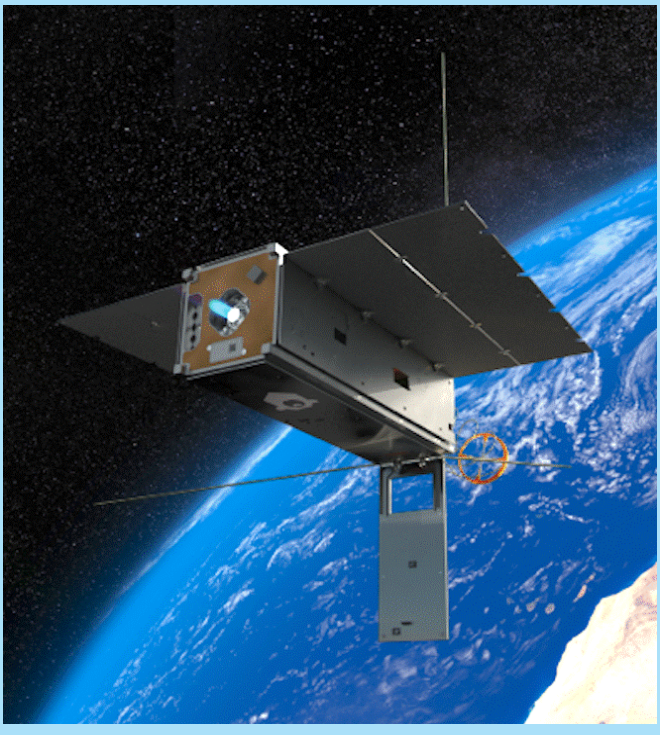


The fourth operator to launch their smallsats on board the SpaceX rideshare and Soyuz-2 is Hiber. The Hiber Three and Hiber Four satellites operate in UHF and are the first of the in-house build, second-generation 3U Hiber satellites.

The new generation Hiber satellites are a new innovative model that is utilizing high-performance green propulsion technology.

This will allow Hiber ground engineers to adjust the satellite's orbit. This ensures that Hiber Three and Four, and its future descendants, avoid collisions and, importantly, de-orbit themselves at the end-of-life. This makes Hiber one of the most sustainable small-sat constellation operators in the world, setting a new standard for responsible small-sat operations.

http://hiber.global



With the latest launch of five satellites, AstroCast the Swiss-based Satellite IoT operator, has officially gone live offering commercial two-way communications to customers.

The new generation satellites operate in L-band, a proven Sat-IoT frequency, and have 100 times more communication speed and onboard storage.

AstroCast plans to have 20 satellites up at the end of 2021 that will allow them to have a high service level in terms of messages per day.

http://astrocast.com.

sat IoT. Spectrum wars are already underway between terrestrial and space-based operators to get access to the best frequency bands. And then there is a mountain of licensing work, to get access to all the countries in the world, each with their own rules and regulators. Not so much a fight, but operation licenses might be the key differentiator between sat-iot networks.

- And, who is going to pay all for all this? Who is going to provide the funding for all that Low Orbit infrastructure? And who are the customers of these new small-sat IoT networks, and are they eager for their global low-cost services?

Welcome to the Constellation Era

The relations between the number of satellites and the service level that can be offered.

Low Earth Orbit mechanics have an impact on customer service levels. Even with only one satellite in LEO, LPGAN networks can provide IoT connectivity starting with a once-per-day service. When the constellations grow and the number of satellites and ground stations goes up. Later with the full constellations in place they can go up to once-per-hour, and increasing to once-per-15-minutes, and offer a similar service level as in terrestrial cellular networks with 100 data messages a day.

How do we get all these small satellites into orbit?

More than 500 start-ups are working to develop a smallsat launcher. After all, these small satellites only have to go up to 500 or 600 km. You can reach that orbit by launching from a plane as some systems like Virgin and Dawn Aerospace are aiming for.

At the moment of writing, nearly all small launcher start-ups are still in the development phase, while we see that the big boys like PSLV, SpaceX, and Soyuz are providing rideshare missions that can bring up more than 100 satellites with one launch. We see smaller launchers and start-ups enter the market, however. Newcomer RocketLab is starting to show a solid track record as well,

so the availability of launches around the world is increasing for the LPGAN operators. And no, we will not go into the development of smallsat launchers in Europe here. We keep that for another time!

Another important development in the launch market is the availability of transport vehicles to place the small-sats in the proper orbit. Onboard the SpaceX Transporter 1 in January was an additional rocket stage: D-orbit, that can bring satellites, after they are released from the main launch rocket, exactly into the orbit they need to be. As the launchers mainly go to sun-synchronous orbits (SSO), D-Orbit can help to spread the constellation in other orbits around the globe.

RocketLab took this one step further and integrated the so-called Kick Stage a powerful extra stage on Rocket Lab's Electron launch vehicle, designed to circularize the orbits of smallsats, taking them exactly where they need to go

Welcome to the LEO Sphere

Space is increasingly becoming a new commercial exploitation zone. Established commercial satellite operators such as SES, Thuraya, Asiasat, Inmarsat continue to grow their space "real estate" in Geostationary orbit and Medium Earth Orbit but now are also looking at Low Earth Orbit (LEO) systems. Existing LEO operators like Iridium and Globalstar are already there.

With at least 10 smallsat IoT providers planning constellations of dozens to hundreds of satellites each, there will most likely be to 1000 small-sats for IoT alone in the LEO sphere within the next few years.

Add to that the growing number of earth observation satellites, scientific and governmental satellites and we see that the whole LEO sphere becomes rather populated, mainly by commercial small-sats.

And then we did not even take into account the vast numbers of satellites required by broadband constellations like OneWeb, Amazon's Kuiper project, or SpaceX.

Some speak of the industrialization of the LEO sphere.

How to Manage all these Small Satellites?

To manage these LEO constellations we need a large number of ground stations. Where most of the pathfinder satellites were in polar orbit, we could do with ground stations at the very north or very south.

A leading ground-station provider here is Norway-based KSAT (http://www.ksat.no) with stations close to the North and South Pole. But with the growth of the constellations, and to increase the service level at all locations on the world we need other orbits and more ground stations.

How can we track and distinguish all these satellites? Traditionally the US Air Force tracked all satellites, but nowadays also commercial parties like LeoLabs (http://leolabs.space) are offering tracking services to satellite operators, regulators, and insurance companies.

To do this Leolabs operates a network of ground-based phased array radars to tracking thousands of objects in LEO, switching from one object to the next every millisecond. Have a look at what is happening in the LEO sphere at https://platform.leolabs.space/visualization

What about Space Debris?

The number of objects in LEO orbit is steadily increasing, and good tracking does help to keep sight of what is happening. But good tracking is not enough as, with exception of Hiber, the current IoT small-sats do not have propulsion and just drift around the earth, and are unable to do anything even when the radar warns there might be a collision.

This situation leads to discussions in the industry and their governing bodies on Space Traffic Management (STM) and Space Environment Management (SEM). Governments, space agencies, and insurance companies are starting to revamp global policies as the public and professional con-cern for space debris, and potential impact or damages, increases, and propulsion may soon be mandated. Recently FCC advised on having propulsion on board that can help to avoid collisions and also help to de-orbit the small-sat in a managed way.

What about Radio Regulations, Spectrum, and Interference?

With the growing number of constellations, can we separate them in terms of radio frequencies? Not only in space, but some of them are also in terrestrial frequency bands. Who will handle the interference? The ITU? National Telecom Authorities? Regulations regarding the use of different frequency bands are a patchwork build-up in the last 50 years. Increasingly we see the

spectrum wars where one type of network (cellular) operators try, to conquer spectrum from other networks (e.g. C-band spectrum from satellite operators).

New satellite IoT networks have to comply with the regulatory framework they are in and try to do that with a wide range of strategies: apply and reserve your own global frequency band (e.g. in UHF), move to an "open" frequency band like VHF and UHF ISM band, use a "readily available" frequency (e.g. in KU-band).

On a national level, the situation is also challenging. Individual satellite IoT operators will have to manage the agreements necessary to operate in all the individual countries around the world, all with their respective Radio Spectrum Management and licenses.

What will LPGAN networks bring to the market?

LPGAN services are typically store-and-forward messaging services, used to send small data packages from sensors back to the dashboards at the customer side. The message size is fairly limited. Subject to the specific service the message will be around 20-120 bytes, large enough to contain the data input coming from sensors.

The new satellite IoT systems can send data regularly depending on the size of their constellation. This can range from once per day when you have to say one or two satellites, once-per-hour if you have about 12 satellites, and later - when you have a couple of dozen satellites - to once-per-15 minute, equal to 100 messages per day as also used in terrestrial IoT networks.

The name Low Power Global Area Network (LPGAN) is derived from the three main promises fact that small-sat IoT systems have for their customers when it comes to sensor data messaging services: a) They provide global coverage b) For low-cost IoT and c) With Low power IoT devices.

LPGAN Offering a New Type of Service for New Product-market Combinations

Existing satellite IoT services from Iridium or Inmarsat provide near real-time connectivity providing critical communication for niche markets like maritime (e.g. for the Global Maritime Distress and Safety System), government, or trucking and logistics market tracking trucks, trailers, heavy machinery or cargo as they move around the world. Connectivity pricing and engineering costs are relatively expensive, which limits the market, but for the niche markets, these costs are justified by the fact this is critical communication.

Many applications in the market however are non-critical and do not require the high service quality as provided by the existing operators, and could do with one or several messages a day. Think of applications to monitor water-levels, air quality, weather data, ground humidity, etc.

That is where LPGAN comes in providing a new type of global IoT connectivity with a low-cost store and forward service, using low-power devices for their transmissions. These features open up new product and market combinations, in particular for monitoring applications and wide area telemetry.

As such the service looks very similar to terrestrial Low Power Wide Area Networks (LPWAN) such as Lora, Sigfox, and NB-IoT that are currently the carriers of the IoT disruption. The one big difference that LPGAN offers is that their services are deployed on a global basis.

From the niche markets served by existing satellite IoT operators, the introduction of LPGAN will allow the satellite IoT market to expand to a lot of other markets segment and customers.

LPGAN with its global connectivity will bring the benefits of IoT, which we know from terrestrial networks to the whole earth. Streamlined corporate operations, more efficient resource utilization, lower costs, better logistics and supply chain management, improved security benefits will now become available on a truly global scale.

Who is Going to Benefit from this New Generation of Small IoT Satellites and their Services?

The whole market from the existing niche markets like government, logistics, and maritime, as well as service providers, NGOs, and – not forgetting - producers and manufacturers in the developing and emerging world will benefit from low-cost IoT connectivity. Satellite IoT will develop from a rather expensive service for niches like the maritime, government, and trucking market, to a low-cost service that in the end will be able to serve the 500 million farmers around the world helping them to improve their yields and bringing their crops to the market in an accountable and efficient way.

Most promising is also the big wide area telemetry market in particular in the public sector. Think of applications like public infrastructure monitoring,

climate measurements, weather stations, water management, soil management, natural disaster management, healthcare, and wellbeing (monitoring Covid, Ebola, Zika, measles, etc.). The call for more government investments in these areas is getting stronger and stronger. But the necessary data-gathering infrastructure is not yet in place. An example is C02 emissions levels. Although there are international agreements to bring those down, there is no proper measurement infrastructure in place. Instead of being measured Co2 emissions, at least at a national level, are estimated.

To build up the infrastructure our smart society needs also outside cellular coverage, to monitor air pollution, groundwater levels, local weather conditions, climate change, nutrient content in agricultural areas, LPGAN will play an important role. Together with the new generation of sensors, the increased power of data analytics, and the lower prices of electronic components and circuits, the low-cost connectivity of LPGAN will be the main driver for the development of global sensor networks in the private but mainly also in the public sector. Organizations in the public sectors can benefit very much from new possibilities for wide-area telemetry, and for that will be an important new satellite IoT market.

While the price point and product availability will initially be a brake on the global rollout of the LPGAN, it is expected within the next two years both these issues will have become academic. Communications that allow to globally improve quality of life and have detailed knowledge for health, trade, and wellbeing will become essential to industries, governments, and people.

Satellite IoT, up to the Third Round

With the satellite IoT networks in space, the development of the market becomes another story. With LPGAN systems operational, the efforts will have to move to the marketing and distribution of satellite IoT equipment. Many satellite IoT operators need large volumes of subscriptions to pay back the investments for their satellite IoT constellations. Who is going to sell and install all these units with customers? New models for sales, distribution, installation, and maintenance of satellite IoT units are necessary.

Not to speak of the many potential new customers that are not aware yet of the possibilities that IoT can bring to their organizations, which includes governments and industrials (mining, fishing, energy) as well as farmers and NGOs. The satellite IoT value chain is very fragmented consisting of sensor manufacturers, satellite IoT connectivity providers (which one out of the many systems?), data marketplaces and data analytics companies, dashboard visualization companies.

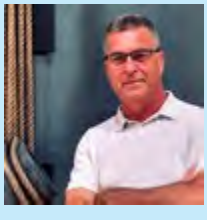
After launching and validating the technical part of their networks in round two, satellite IoT operators now face a new challenge, something we will come back to in a follow-up article.

Conclusion

With the launches of IoT small-sats with SpaceX, Soyuz-2, and Rocketlab in the first quarter, the year 2021 made a good start. It looks that 2021 will become the year where small satellite-based IoT networks come to the market with their low-cost and low-power-based solutions for IoT. With so many IoT small-sats in space, the establishment of Low Power Global Area Networks is a main technological achievement that ushers in a new era for the global IoT sector – one where data from devices is accessible anywhere on the planet securely and affordably.

Market researchers tell us that based on this there will be a strong expansion from the current market (millions) served by Inmarsat, Iridium, and Globalstar up to the market with tens of millions of sat-iot units serving customers in all kind of vertical markets.

To make this happen, the next phase is mainly a commercial challenge. With the technical infrastructure in LEO, now the commercial infrastructure becomes a priority. The establishment of end-to-end IoT solutions and value chains required to build up the large forecasted subscriber base for satellite IoT requires a more earthly skillset. Let's see how this develops.



Hub Urlings was one of the pioneers of Satellite M2M as Product Manager Inmarsat-C at the famous KPN Station 12. Now, 25 years later he is again involved in the development of a new generation of smallsat based Sat-IoT services as ESA Innovation Manager at Hiber.global. To meet the complexity of the sat-IoT value chain he developed the SatIoT lab.eu as an education and co-creation platform for global sat-IoT applications. He can be reached at urlings@m2sat.com

FEATURE

Space Tourism: Fueling Commercial Demand Across Space Market Verticals

by Omkar Nikam

Image courtesy of Pitchbook.com

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The dream of today is the reality of tomorrow, and space tourism is a classic example of how the human race is unlocking the full potential of its capabilities to learn and explore outer space. A decade ago, space tourism consisted of a handful of companies, with Space Adventures at the forefront of this emerging market. One of the early triggering factors of the space tourism investment was the joint success of Roscosmos State Corporation for Space Activities (Roscomos) and Space Adventures. In the early 21st century both Space Adventures and Roscomos achieved success in short tourist flight to the International Space Station (ISS). And these commercial movements developed huge interest among the investors, which also ultimately led to the rise of companies like the Virgin Galactic. With the acceleration in research, development, and commercialization of space technology, space tourism is becoming a strong commercial pillar of the space industry.

With respect to the recent developments, there are only handful number of government and private players in the market; with the Russian government showcasing consistent interest in developing space tourism capabilities. In January 2021, Glavkosmos, the commercial arm of Roscosmos, has announced that it will be selling four seats on Soyuz MS spacecraft with an aim for launch in 2022 and 2023, respectively. This complete commercial landscape of space tourism is currently concentrated in the low-earth orbit (LEO). Along with LEO tourism, Richard Branson's Virgin Galactic is gearing up to commercialize the suborbital tourism vertical. The company has already registered more than 600 customers (USD 225,000 per ticket) for its SpaceShipTwo suborbital flight. Though the company's plans are consistently delayed over the decade, the rising demand for space tourism will present the opportunity to accelerate its operations for the first suborbital flight carrying a group of passengers. While many challenges and opportunities lie ahead of this sector, the rapid innovation pace is increasing the sphere of opportunity for private players in this domain. To receive more insights on how space tourism will benefit and trigger commercial demand across key space and satellite market verticals, let's dissect each of the following points:

Launchers and Satellites

New Space technologies have fueled innovation in the satellite sector. With satellite communications at the forefront of unlocking the commercial sphere

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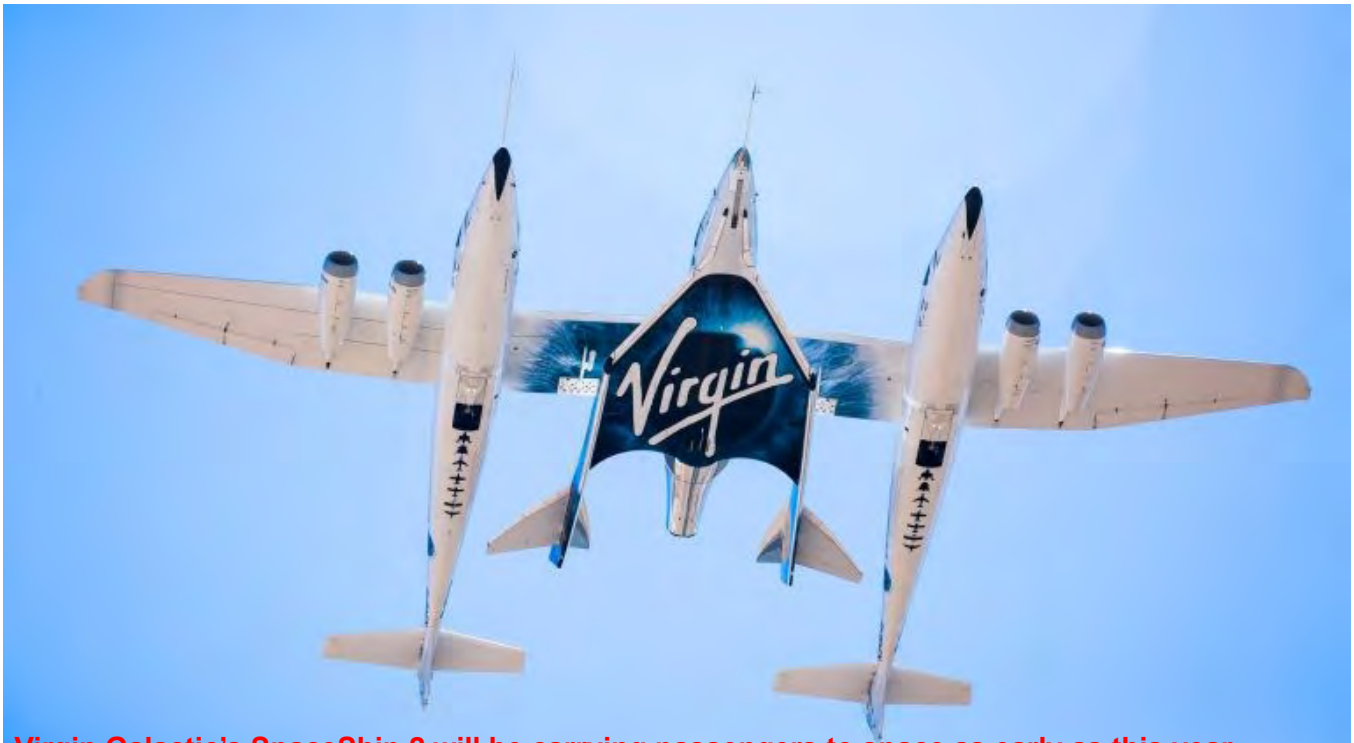


Virgin Galactic's SpaceShip 2 will be carrying passengers to space as early as this year

of the communications market. Lesser the satellite's weight, lower will be the launch cost; ultimately decreasing the end-user data prices. This is one of the huge technological innovation that satellite industry has seen till date. And with the emerging LEO and medium-earth orbit (MEO) satellite constellations, the launch segment has started evolving at a much rapid pace. Considering the contribution of space tourism, heavy launchers will be soon entering the market (and the demand is rising), ultimately launching multiple satellites and tourists at a much lower cost. SpaceX is one of the companies that has created a competitive ecosystem in the launch segment with its reusable rocket technology. Though SpaceX's Falcon Heavy launcher is currently carrying astronauts to the International Space Station (ISS), it's Starship will be carrying a group of passengers to the space.

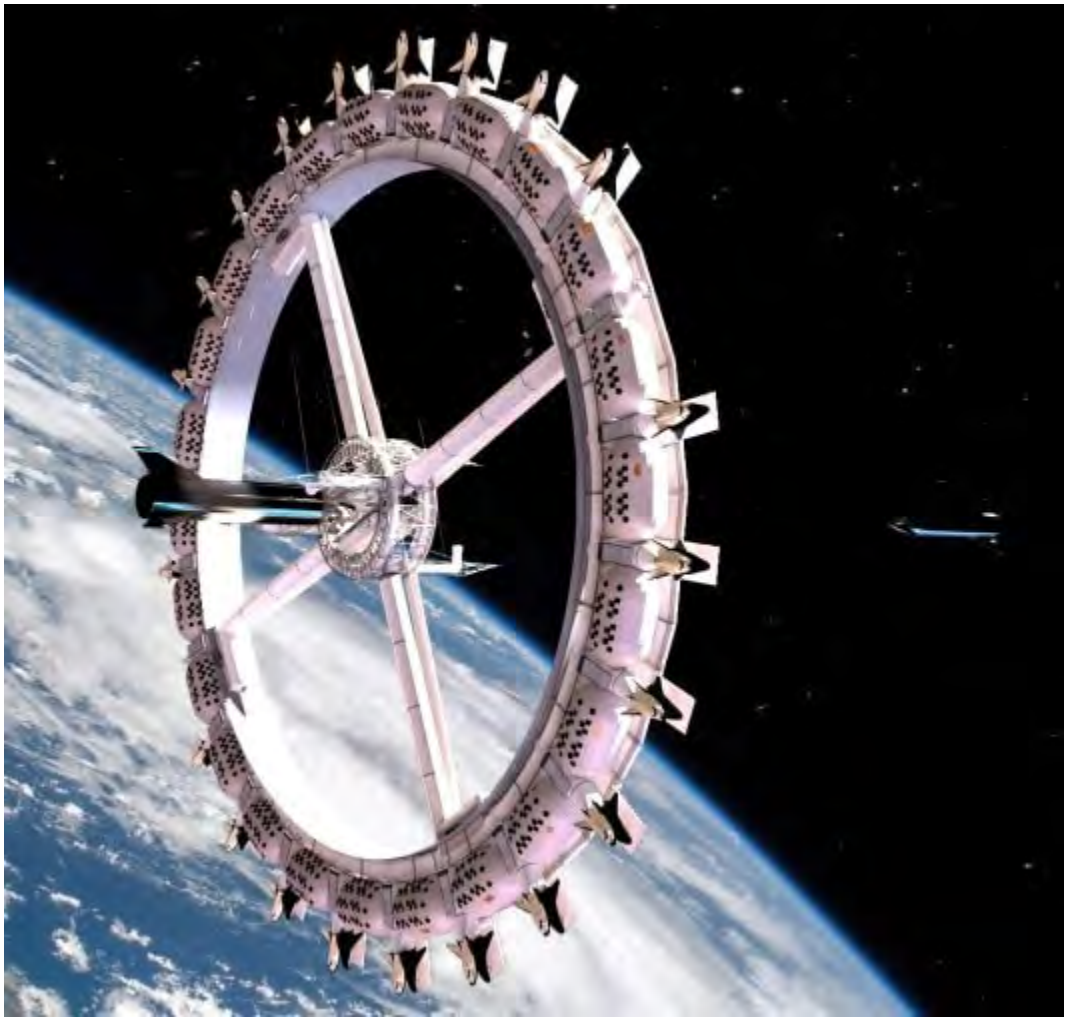
Infrastructure Management

Extreme environment architecture and design have always been a crucial part of the space industry, but over the years, it has received little or no media limelight. Space tourism is increasing the demand for space architecture and design to carefully curate and build the future commercial space station in LEO and habitats on the moon. Axiom Space, a US-based private aerospace manufacturer and orbital spaceflight services company, is planning to build a private space station orbiting 250 miles above earth. Recently, Axiom Space also received USD 130 million funding for its existing work on private space station. Similarly, Orion Span's Aurora Space Station and Bigelow Aerospace's Next-generation Commercial Space Station, are some of the emerging companies that will be soon reshaping the commercial aspects of the space station. These future commercial space station will be slowly opening the space hospitality market to host tourists; ultimately making infrastructure management crucial for space tourism sector.

Research & Development

The demand for more private space stations is not triggered by the upstream space market, but by the downstream terrestrial industries. Genetics, medicine, meteorology, and many more are the key fields of research triggering the demand for private space station. Till now ISS has recorded more than 100 companies sending their respective payload for research purposes in space. The hospitality in-

frastructure initiated due to space tourism, will also be acting as a live research laboratory for research and development purposes. Axiom Space is one of the companies aiming to host research experiments in its private space station laboratory.



Artist's concept of the planned space hotel scheduled for launched in 2027.
(image courtesy of Gateway Foundation)

Media and Entertainment

Media and entertainment industry will be soon embracing the new change of ecosystem to participate and produce content in space. Tom Cruise has officially declared that he will be travelling to ISS along with the Director Doug Liman to direct the first ever movie shot in space. Both Cruise and Liman will be travelling to ISS, as a part of SpaceX Axiom Space-1 mission. Media and entertainment industry have been an integral part of satellite broadcasting industry for decades. With the ongoing development in the space tourism, once again this industry is set engage in providing significant commercial opportunities for private space station and spaceflight companies.

Future Scope

Space tourism vertical can also be an opportunity for several companies and agencies to increase their investment outlook in the space technology segment. For example, the rise of SpaceX's Dragon, a reusable cargo spacecraft, has made USA less dependent on the Soyuz for the ISS activities. Therefore, Russia's developing interest in space tourism can be considered as a strategic move to revamp its launch business and increase commercial investments in the launch segment. This model of amplifying the business on the existing capabilities can be a potential opportunity to monetize and invest in the development of new space technologies. The future of space tourism looks promising, yet the execution of the plans laid out for actual launch by several agencies and companies, will accordingly shape the future investment landscape of this sector.

Conclusion

Space tourism companies are consistently progressing towards achieving their ambitious goals, and the current technologies are making it possible

to shape commercial plans. According to NSR's latest space tourism forecast, this industry will generate revenues worth USD 7.9 billion by 2030. Considering the investment landscape, space tourism is on the verge to become one of the strong commercial space market verticals in the coming decade. The significant rise in demand for moon and mars missions is also paving way for private commercial space stations to build and host experiment of the government and private organizations/companies. Though several challenges are presented to execute these ambitious plans, space tourism is simultaneously helping several space and satellite market verticals to participate, innovate and experiment on new technologies. In the coming years, it is evident that the space tourism market will also be the hotbed of opportunities for investors and companies aiming to build habitats on the moon and mars.

Omkar Nikam is an independent space and satellite consultant based in Strasbourg, France. He has eight years of experience in technology and business consulting. He is also the EMEA correspondent for Satellite Markets & Research, USA. Omkar specializes in market research, analysis, and consulting services for several space and satellite market verticals. He can be reached at: www.oknikam.eu

FEATURE

Prospects in the CubeSat Market

by Mayank Halmare

CubeSats are miniaturized cubical-shaped small satellites measuring 10x10x10 cm^3 - approximately the dimension of the popular Rubik's cube and weighs around 1 kg. A CubeSat can be used as a single unit (1 U) or in clusters of several units or U's (1U, 2U, 3U, 6U, 12U, and others).

CubeSats have revolutionized the space market by proving an efficient solution for the economical launches into space and in conducting various technology demonstrations, scientific researches, Earth exploration, and other missions. Moreover, these satellites are exceedingly used by commercial businesses, government, military, and non-profit organizations as they are quite simple to design, develop, and launch as compared with the traditional satellites.

According to Allied Market Research, the global CubeSat market was valued at US$ 184.11 million in 2020, and is estimated to grow at a CAGR of 15.1% during the forecast period (2020-2027).

CubeSat Industry Dynamics

CubeSats are a type of nanosatellites, defined by the CubeSat Design Specification (CSD), unofficially known as the CubeSat standard. These satellites are much smaller in size and lower in weight as compared to the conventional satellite. Making small satellites as per the CubeSat standards results in cutting down costs associated with the research and technical development stages. Moreover, the time required to build and position one CubeSat in the orbit takes less than 8 months, which is substantially lesser than the traditional or large satellites. Attributed to these benefits, the demand for CubeSat is increasing significantly especially for commercial applications such as agriculture, forestry, energy, media & entertainment, civil engineering, traffic monitoring, and archaeology. For instance, ESA launched a CubeSat GomX-3 built by GomSpace in October 2015. Since its launch, the GomX-3's unique helical antenna has identified lots of signals transmitted from aircraft, which helped to build a comprehensive map of worldwide air travel traffic.

Moreover, CubeSats are being used increasingly for earth observation, owing to their low cost and short development cycle. CubeSat systems equipped with different spectral, radiometric, and spatial sensors have been launched over the years for optical Earth observation and related services. For instance, Planet Labs Inc. launched Flock-4e'1 to Flock-4e'9, constellations in 2020. Moreover, Hera-1 by Hera Systems (2019), Tianyan-02 by ADA Space (2019), and NAPA-1 by Royal Thai Air Force (2020) were launched to collect and analyze Earth's resources.

In addition, the use of CubeSat is significantly growing in non-profit organizations, such as universities or colleges, which design and develop CubeSats for research or experimentation pur-

poses. Governments and space organizations across the globe are supporting these CubeSat launches aimed at the enhancement of research applications undertaken by research institutions. For instance, the National Aeronautics and Space Administration (NASA) has announced CubeSat launch Initiative through which NASA provides CubeSat developers a low-cost pathway for small satellite payloads developed by non-profit organizations by accommodating them in NASA's upcoming launches.

Some of the prominent players that offer geospatial technologies for defense and security applications are Planet Labs Inc., GomSpace, AAC Clyde Space, Endurosat, Tyvak Nano-Satellite Systems, Inc., Surrey Satellite Technology Limited, and others. The companies operating in this market are focusing on partnership and agreement strategies to improve their market share. For instance, in July 2020, GomSpace and ESA signed a contract for the implementation of Juventas CubeSat in support of the Hera mission. Moreover, in September 2020, AAC Clyde Space, SAAB AB, and ORBCOMM Inc. entered into a partnership to develop the next generation of space-based VHF Data Exchange System (VDES) system.

Stringent government regulations are a major challenge for the growth of the CubeSat market. The legal issues pertaining to the restrictions on data collection, location privacy, intellectual property rights, and use & storage of geospatial information and data limit the scope of the CubeSat market. For instance, the transmission of radio signals to or from a CubeSat involves

regulatory approval in the U.S. Regardless of orbit or the ultimate destination, the necessity to obtain a license applies to all CubeSats that transmit signals. Besides, the procedures and measures required for obtaining the license are spread between numerous rules & regulations issued by the domestic regulatory bodies and are also subjected to further regulations made mandatory by the international agreements. The timeline for obtaining the satellite and Earth station licenses are usually significantly time-consuming than the development cycle for a CubeSat project. These factors can affect the project duration. Apart from regulations, the small size of CubeSats limits the accommodation of the volume of propulsion, payload, and other subsystems, thereby posing a challenge for CubeSat manufacturers.

Key Trends

Advanced technologies, such as artificial intelligence, big data, and machine learning, have emerged as the main trends in the earth observatory sector. These technologies play a vital role in the effective analysis of satellite data. The capability of AI is leveraged by the key players to allow systems to derive insights and make the right decisions using raw data sets with negligible human contribution. For instance, the European Satellite Association (ESA) is planning to launch a CubeSat, which is equipped with onboard artificial intelligence to improve the efficiency of sending Earth observation data back to Earth. Moreover, the machine learning algorithm provides more accurate insights to analyze the satellite imagery of any resolution. For instance, in October 27th, 2020, Google and the National Oceanic and Atmospheric Administration (NOAA) linked up to cooperatively steer machine learning and artificial intelligence driven pilot projects that will allow the advancement of the agency's weather predicting, environmental monitoring, and climate research capabilities.

Moreover, the companies operating in the CubeSat ecosystem are coming up with advanced subsystems for the efficient working of CubeSats. For instance,

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The wide coverage areas of Yamal satellites enable communication services delivery to different parts of the world for the purposes of Oil & Gas, Government, Aviation, Maritime, Education and Emergency segments. Yamal Satellite Capacity is successfully used for communication links and data transmission, TV distribution, occasional use, trunking, backhaul, inflight and maritime connectivity.

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GAZPROM SPACE SYSTEMS

GomSpace is providing solar panels for CubeSats. The energy collected from the solar panels that are exposed to direct solar radiation is the source of power for CubeSats. The batteries are installed together with the solar panels to collect the energy, which can be used while the satellite repeatedly passes through the shadow of the Earth.

"...CubeSats have revolutionized the space market by proving an efficient solution for the economical launches into space and in conducting various technology demonstrations, scientific researches, Earth exploration, and other missions..."

COVID-19 Impact

The COVID-19 crisis is creating uncertainty in the market, slowing down the supply chain, falling business confidence, and increasing panic among the customer segments. Governments of different regions have already announced total lockdown and temporarily shutdown of industries, which adversely affected the overall production and sales. As the COVID-19 pandemic has swept the world, many industries are struggling to stay afloat, including the satellite industry. The companies involved with space are reacting differently to the new situation.

Digitalization is on the rise across the globe, and satellite data and signals play an increasingly crucial role in the effective functioning of societies and their economic growth. The space sector has witnessed considerable growth over the years and has resulted in increased levels of start-ups participating in the market. Moreover, owing to the COVID-19 crisis, this trend is anticipated to slow down the business activities of small & medium-sized firms that constitute the majority of commercial players in the space sector. If the high costs to enter the sector are considered, the detrimental economic impacts caused due to the pandemic may lead to more industry concentration and might result in the elimination of smaller firms.

The COVID-19 crisis has prompted CubeSat operators across the globe to abandon mission operations centers.

However, as the demand for crisis monitoring has increased significantly, the players in the CubeSat ecosystem are establishing remote operations access for smooth functioning. For instance, University of California, Los Angeles (UCLA), which is operating twin Electron Losses and Fields Investigation (ELFIN) CubeSat, has established the remote operating access for the satellite.

Despite the negative impact of COVID-19, the CubeSat industry managed to perform moderately and several CubeSats were launched in 2020 such as DeMi, TechEdSat-10, Gundam, TDO-2, Flock-4e, Flock-4v constellations, and SpaceBee. This steady growth in CubeSat missions can be attributed to the low cost but efficient operations of the CubeSats and the rising participation of private players in the market. Moreover, CubeSats continued to offer an effective solution for academic study across the world. For instance, Quetzal-1 was launched in April 2020 for educational training missions. The space sector, like all others, has been impacted by the spread of the pandemic and the consequent slowdown of the global economy, but the CubeSats market has managed to tackle the negative impacts of the pandemic, owing to the increase in capabilities of the cost-effective small satellites over the years. With the initiation of vaccination around the globe, the COVID-19 pandemic is anticipated to be eliminated gradually over the years, and the space sector is expected to attain a considerable leap in the near future.

Mayank Halmare is a seasoned professional with more than 3 years of experience in Market Research, and Business Consulting. He has worked on various successful consultation projects with well-known brands in Aerospace and Defense industry such as Sierra Nevada Corporation, Airbus, Planet Labs Inc., and others. His expertise has helped clients across the globe to formulate successful business strategies which contributes significantly in growth of the company. For more information on research on the Cubesat Market go to: ***https://www.alliedmarket-research.com/cubesat-market-A09399***

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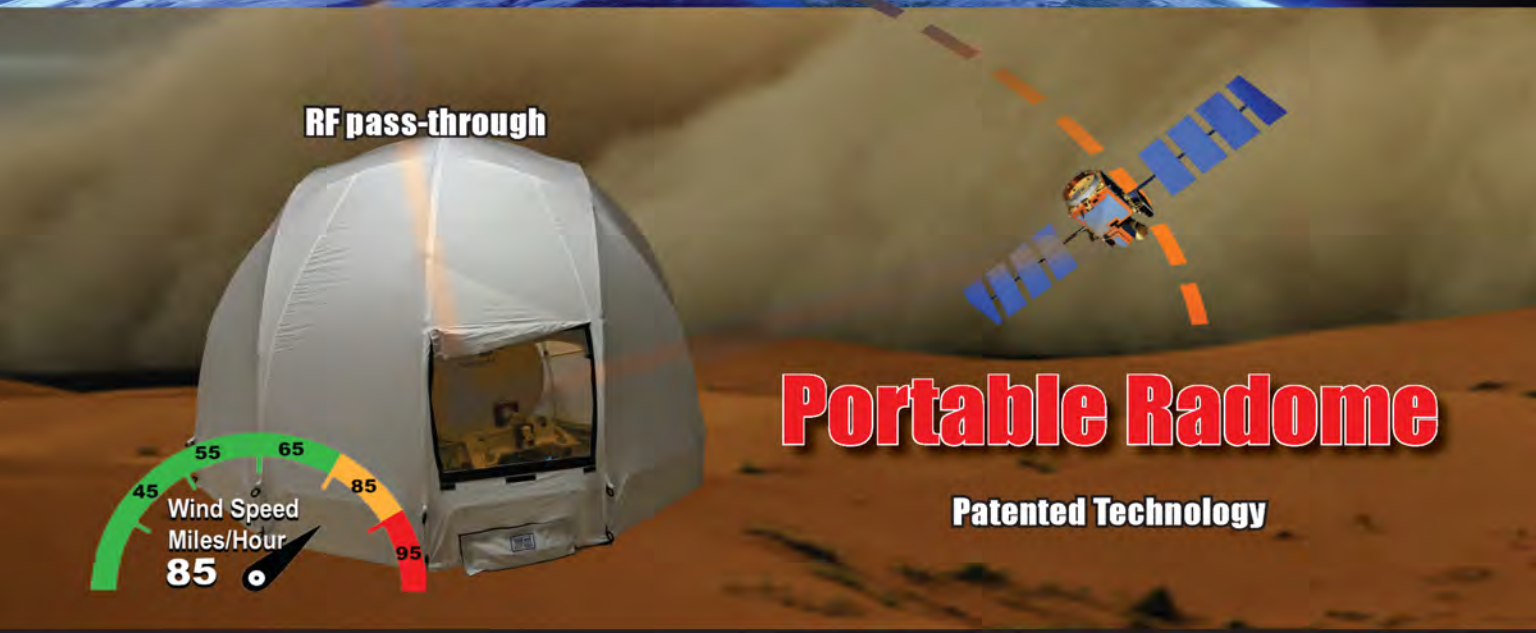

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Bart Van Poucke, VP-Product Management ST Engineering iDirect

Satellite Executive Briefing Editor-in-Chief Virgil Labrador spoke with Bart Van Poucke, Vice-President of Product Management, ST Engineering iDirect, who explained the features and benefits of ST Engineering iDirect's newly-launched Mx-DMA Multi-Resolution Coding (MRC) technology. Excerpts of the interview follows:

You have recently built upon your award-winning Mx-DMA® HRC technology with Mx-DMA MRC. What are the key features of MRC technology and what benefits would these provide your current and potential customers?

The successful introduction of Mx-DMA in 2014 enabled us to answer the MF-TDMA versus SCPC dilemma that many of our customers faced, and this was a milestone for the market. Now, with the added dimensions and scalability of MRC we are unlocking tremendous flexibility and scale so our customers can deliver a broader range of service levels at a lower cost structure without compromise.

The introduction of Mx-DMA MRC answers the market's call for unprecedented service agility and extends the availability of Mx-DMA to very large networks, expanding the applicability and use of the technology to include a full spectrum of use cases.

Mx-DMA scales in MHz independent of the number of terminals so customers can be served with a single return link for the majority of their use cases, minimizing operational complexity and maximizing statistic multiplexing. Mx-DMA MRC delivers these benefits by maintaining the industry-leading spectral efficiency of Mx-DMA HRC while drastically improving the agility, scalability and fill efficiency. Designing an Mx-DMA MRC link does not require precise knowledge of the traffic and terminal mix as the link self-optimizes in real time. Moreover, the high efficiency enables bandwidth savings, higher throughput, better network availabilityand substantial terminal cost savings.

Bart Van Poucke

What impact will Mx-DMA MRC technology have on overall Quality of Experience and its ability to serve many different markets and applications?

Through Mx-DMA MRC, customers can experience SCPC-like performance at very high throughput. For example, if you are uploading picture to Facebook, this won't result in a big impact on the capacity requirement because MRC's agility means that a wide carrier would only be assigned when needed and can then shift back to smaller, more agile carriers. Mx-DMA functionality uses real-time demand, link condition reports, optimization performance metrics and QoS profiles to maintain optimal bandwidth utilization at all times.

What markets and applications will Mx-DMA MRC serve?

Service providers can now cover a myriad of use cases in a single return link, from cruise ships and large enterprise customers to SCADA and broadband access, sharing satellite capacity more efficiently over a group of satellite terminals and applications achieving the lowest Total Cost of Ownership (TCO).

Succesful busines models are based on fitting smaller customers with high value customers where the smaller cutomers are not burdening the high value customers. Both networks have very different service requirements, and very different link budgets. Before introduction of Mx-DMA MRC, given the requirements of both services, Mx-DMA HRC for mobile backhaul and MF-TDMA for enterprise were the designated return technologies and would operate in separate static return capacity. Mx-DMA MRC is suited to both types of services, allowing both services to share one chunk of return capacity, improving efficiency and statistical multiplexing.

How has the initial reaction been to MRC technology from your customers? Can you share some results of trials or beta tests that you have done or initial implementation of the technology?

Initial reaction to Mx-DMA MRC has been extremely positive and we have had great feedback from the market already in terms of results. One of our earliest adopters, Ningbo BIRDSAT, a Chinese service provider that serves coastal fishing vessels, has told us that they have noted a significant increase in bandwidth efficiency. In turn, this has helped to decrease the cost per satellite transponder, and the service quality has also been further improved enabling it to provide even better services to its customers. The return channel efficiency is superior and there is no packet loss. It has also allowed them to be more flexible in their service offering and to prioritize different services for different users. They are already planning to deploy new satellite networks in the coming months that are based on Mx-DMA MRC technology.

How integral is Research and Development (R&D) to ST Engineering iDirect and the development of Mx-DMA MRC?

Our R&D team is integral to our progress and the instigator for our innovations. We are an R&D driven company and innovation has always been in our DNA. With Mx-DMA MRC, we have built upon previous innovation and we've also drawn upon our experiences with our large installed base and large networks. Our previous work constantly informs us on our future work. With MRC we quite literally took a big leap forward. We took the best of what we had in Mx-DMA and then added a further dimension pushing the limits of efficiency in a shared bandwidth network yet again!

I think it's important to note that, as a forward-thinking team we are fully aware that the focus of innovation varies over time. Things change. But it's very important that we employ cross-layer thinking in what we do which will lay the foundation for future innovations in new ground capabilities that are needed to keep pace with the developments in New Space across our industry.

To read or download a pdf of a TECHBrief on Mx-DMA MRC click here

Mission Microwave Continues Growth and Moves to New State-of-the-art Manufacturing Facility

Cypress, Calif., April 5, 2021– Mission Microwave Technologies LLC, a manufacturer of highly efficient Solid State Power Amplifiers (SSPAs) and Block Upconverters (BUCs) has moved from their original offices in Santa Fe Springs to a larger facility in Cypress, California.

Mission Microwave manufactures X, Ku and Ka-band solid state amplifiers and frequency converters to support the leading manufacturers of satellite uplink terminals. The company started in 2014 in Santa Fe Springs and in 2016 and 2018 doubled their footprint in that facility to approximately 15,000 square feet. The new Mission Microwave facility at 6060 Phyllis Drive in Cypress, CA again doubles the size of the company's California headquarters and manufacturing facilities to accommodate dramatic growth in the company's Ku and Ka-band amplifier production.

"Our customers and employees have contributed the energy and enthusiasm that have made our growth possible "said Mission Microwave's President and CEO, Francis Auricchio. "Our new office and manufacturing center brings some well-deserved improvements in efficiency and workflow for our employees. The expanded manufacturing and development facilities will continue our customers' confidence in our capability to support their increasing demand for our products."

Mission Microwave's new 31,000 sq. ft. facility in Cypress, Orange County, California, about 25 miles from Los Angeles.

The new facility of over 31,000 square feet is equipped with ten temperature controlled test equipment suites capable of automated production testing up to 40 GHz for high power amplifiers, up to 750 watts. The facility has enhanced power distribution and HVAC systems to accommodate the growing volume of deliveries of Mission products that each undergo proprietary burn-in, tuning and testing processes.

The new floorplan layout supports the reliable manufacturing of Mission's well-known products such as the Cube, Dart, Stinger, Javelin, and Titan BUCs used on tactical SATCOM terminals throughout the DOD and critical commercial telecommunications networks. Improvements to the production and testing lines also enhance Mission Microwave's growing airborne product business including Ku and Ka-band BUCs and transceivers for UAV's and for DO-160 qualified terminal partners.

Mission Microwave brings revolutionary design for RF (Radio Frequency) and microwave electronics, supporting ground-based, airborne, and space-based applications. Using the latest in semiconductor technology, Mission Microwave's focus is to minimize the size, weight, and power (SWaP) for these critical applications, while providing its customers with the best possible reliability. Mission Microwave sets the new standard for design, performance, and reliability.

For more information go to: www.missionmicrowave.com

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Retrofiting ACU 7200 with *sat-nms* ACU2-19V2

by Michael Ulbricht

The SatService Antenna Control Unit sat-nms ACU2-19V2 provides an excellent field replacement for the discontinued ACU 7200 from GD Satcom. Compatible with the SatService sat-nms MNC and the Calian Mon-A-Co monitor and control systems, the sat-nms ACU2-19V2 has a web-based user interface along with other standardized interfaces making it simple to integrate into existing SATCOM antenna monitor and control infrastructure. With improved SatService specific firmware capabilities and its effective user interface the sat-nms ACU21-19V provides an excellent means of cost-effectively upgrading antenna systems.

SatService has in the meantime delivered 400 sat-nms ACUs in different configurations, both for new installations or as upgrades of existing satcom antennas. The antenna diameter of these antennas ranges from 1,8m to 32m. The track record of ACU upgrades covers almost all worldwide antenna manufacturers like for example ASC, Andrew, Vertex, GD Satcom, Scientific Atlanta, ViaSat, NEC, Siemens, TIW and Patriot. Ask SatService if you have another type and we can do it for you.

SatService *sat-nms*

The Requirement

SatService was approached by customers who asked for an alternative when the production of the Vertex 7200 ACU was discontinued. A typical system installed at the customer site is a 7150-drive cabinet located outside close to the antenna mount, several cables routed from this drive cabinet to the 7200 ACU which is installed indoors in a 19” rack. If an ACU 7200 fails and no spare parts are available but the complete outdoor system is still in good working condition, the teleport operator may not want to spend the money for a complete exchange of all the indoor and outdoor equipment.

The Idea

SatService has a proven antenna tracking design which is very well established and accepted in the market for more than 10 years. Until now SatService concentrated more on complete outdoor solutions (sat-nms ACU2-ODU-AC) which are

directly installed at the satellite ground station antennas and required, beside the mains voltage, only a LAN interconnection to the building. But this is all only packaging around the sat-nms ACU2-ODM core module which includes all the intelligence and software algorithms.

Based on this experience the idea was born to develop a 19" 1RU drawer which is hardware compatible with the 7200 ACU. The goal is that the integrator will find all matching and compatible connectors, so that they can easily exchange units.

The Solution

The sat-nms ACU2-19V2 19" 1RU rackmount unit presented on the next pages is the result of these development activities. It includes the complete functionality of an antenna tracking controller with all the hardware interfaces necessary to exchange it against a 7200 ACU drawer.

To be even more universal the sat-nms ACU2-19V2 provides three different angular encoder interfaces:

- analogue resolver
- optical encoder with SSI interface
- analogue DC interface for potentiometer

The front panel design is typical of the sat-nms products which allow management of the controller from the front panel LED display as well as keyboard and display. Nevertheless, the most common method of access for standard operations would be through its browser-based user interface or via the established monitor and control system. Equivalent functionality can be obtained through any of the interfaces selected above. Especially the set-up of the antenna controller and tracking system but also the daily operation is performed via the web browser GUI which is also presented on the next pages.

At the rear panel the sat-nms ACU2-19V2 provides a set of connectors which matches to the ones of the 7200 ACU. See Figure 2.

- J6 PL Encoder (interface to polarization angular encoder, either resolver or SSI interface)
- J7 EL Encoder (interface to elevation angular encoder)
- J8 AZ Encoder (interface to azimuth angular encoder)
- J9 LAN Remote (Ethernet interface for Web GUI and SNMP, and to sat-nms LBRX beacon RX)
- J10 Drive Interface
- J11 Digital Inputs
- J14 RS232 (not used)
- J16 RS422
- J17 RS422
- J21 Analog in (interface to other vendors beacon receiver)
- TB1 Alarm
- J5 PL2 Encoder (for 4th axis option)
- TB1-2 LP/CP SW (for 4th axis option)

Both analogue resolver and/or optical encoder with SSI interface can be connected to the sat-nms ACU2-19V2. This has to be defined at the time of order, as the necessary daughter cards will be installed accordingly.

The Hardware

The key module within the 1RU 19" unit is the sat-nms ACU2-ODM module. This is the module which provides all the hardware interfaces to the drive system (frequency inverters are most common, but could be also servo or DC motor drivers), the antenna limit switches, and axis encoders, etc. In the case of this special sat-nms ACU2-19V2 19" drawer a printed circuit board (PCB) was designed which transfers all the interfaces at its rear panel in the right way to be compatible to the ACU 7200. In addition to that the unit also provides an ethernet interface via which the customer has full access to the integrated web server for operational purposes and remote interfaces like SNMP and http protocol for M&C.

sat-nms front panel

Independent from the development of the sat-nms ACU2-19V2 version also the core sat-nms ACU-ODM module was upgraded with a new more powerful processor to cover the requirement for more CPU power and firmware capability. The result is the new core module sat-nms

sat-nms rear panel

ACU2-ODM, in which the 2 expresses the next generation. This will also be delivered in future in all other SatService antenna controller configurations.

The Firmware

As already explained, the sat-nms ACU2-19V2 is from the interfaces point of view hardware compatible to the ACU 7200, whereas the firmware including tracking- and adaptive models-algorithm is SatService's complete own development and implementation.

The sat-nms ACU is implemented on a modern firmware architecture and has a proven track-record of performance in a variety of satellite networks over several years. The firmware design allows for continued product and algorithm improvements and will be constantly supported and also maintained. Just recently SatService performed a significant update of the firmware, and in case of the 4th axis interface also the hardware. This led to a significant expansion of functionality, like for example:

- Orbit prediction based on TLE two-line elements data
- and Intelsat I11 data
- TLE and I11 editor and file manager
- polarization prediction, which is especially helpful for inclined orbit satellites
- NTP time synchronization
- jack screw protection mode
- sat-nms LBRX beacon receiver direct control
- space for 200 targets
- Tracking improved with "initial pointing mode" based on model, TLE or I11
- "4th axis" functionality can be covered as option

The Matching Beacon Receivers

All sat-nms ACU tracking systems are designed to interface also to any other vendors beacon receiver via the universal 0 to 10V ADC interface. But the more sophisticated solution would be to use our sat-nms LBRX, which no longer makes a 0 to 10V calibration necessary. The beacon receiver sat-nms LBRX transfers via UDP packets the exact beacon level information (for example -67.23dBm) to the sat-nms ACU2-19V2 and its internal tracking algorithm via its ethernet interface.

Multiple configurations of the sat-nms LBRX beacon receiver are available; small DIN rail mounted version, the sat-nms LBRX19 with 4 L-band inputs, the sat-nms LBRX19-81 with 8 L-band inputs (which allows for example C/Ku multifeed operation) and the beacon receivers which provide inputs at the direct receive frequency in C-band, X, Ku and Ka-band, so for example sat-nms KuBRX19.

Interfacing an Existing DTR Beacon Receiver

An RS232 interface with its serial protocol to the DTR beacon receiver is not implemented. But you certainly can continue to use the DTR if you switch to the analog (0…10 VDC) output. This is working fine and runs without any problems. But as already described you can avoid the DC output interface if you take a SatService beacon receiver, so then all devices communicate via the network.

The installation/integration workflow of the retrofit:

Our goal was to make the retrofit procedure from a 7200 ACU to a sat-nms ACU2-19V2 as easy as possible. Here is a short description of the tasks involved.

1. Stop step track at the 7200
2. Readout and write down azimuth, elevation and polarization values presented at the 7200 ACU
3. Switch off the circuit breakers in the 7150-drive cabinet, so that the antenna cannot move
4. Disconnect the cables from the ACU 7200
5. Remove ACU 7200 from the 19" rack

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TECHNICAL DATA

- Hardware compatible replacement of GD 7200 ACU with ***sat-nms*** ACU19V2
- State-of- the-art beacon receiver ***sat-nms*** LBRX in C-, X-, Ku-, Ka- & L- Band
- Time & space saving installation
- Fully remote controlled by ***sat-nms*** M&C if required
- German engineering

FURTHER UPGRADES

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- Further ACU replacement units on request
- More high performance solutions e.g. optical links, frontend processor, M&C software are available

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the 19" rack

6. Slide in the sat-nms ACU2-19V2

7. Connect the three resolver cables to the sat-nms ACU2-19V2

8. Connect Ethernet to your local LAN

9. Connect mains voltage cable to sat-nms ACU2-19V2

10. Switch on the sat-nms ACU2-19V2

11. Configure the IP address so that it matches to your IP subnet with @CHIPTOOL Software installed on a PC

12. Navigate with your web browser to this IP address and you will see the web interface of our sat-nms ACU2-19V2.

13. In the "setup" page you calibrate azimuth, elevation and polarization to the values which you wrote down from the old ACU 7200 under point 2

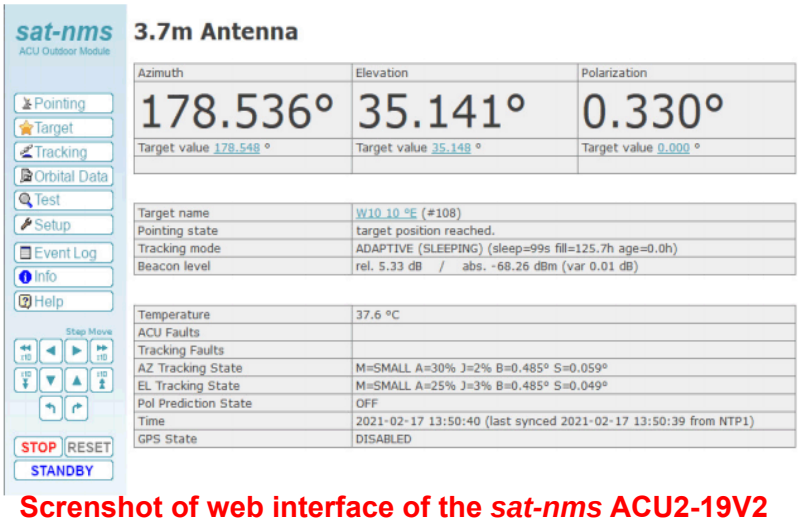
14. Then switch on each axis circuit breaker step by step at the 7150-drive cabinet and test motorization in each axis via the sat-nms ACU2-19V2 main "pointing" page.

15. Check the drive direction of each axis and if necessary, change it in the set-up page. We recommend not to move all three axes at the same time, do it step-by-step

16. Test limit switches in each axis, so that you are sure these are operational and working

17. Now the new antenna controller is operational and you can move all three axes

18. You can make yourself familiar with the operation of the sat-nms ACU2-19V2 and its tracking modes by using the handbook either in electronic or printed form.



Screnshot of web interface of the *sat-nms* ACU2-19V2

19. SatService is always available to provide assistance. SatService can also provide training for the operator, or system integrator.

In summary, these are very easy steps to be performed and can be completed easily in 2 hours.

Support

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Support can be reached by e-mail at: support-satnms@satservicegmbh.de

Our Sales team can be reached by e-mail at sales@satservicegmbh.de or by phone at +49 7738 99791 20.

Michael Ulbricht is the Managing Director of **SatService GmbH**, he can be reached at mu@satservicegmbh.de

To read or download a pdf of the full version of the White Paper on "Retrofit of ACU 7200 with *sat-nms* ACU2-19V2" at:
https://satservicegmbh.de/tl_files/doc/application-notes/ACU2-19V2-WhitePaper-2021-03-24.pdf

In The Land of Virtual

by Robert Bell

The pandemic has made those of us lucky enough to still have jobs wince at the word "virtual." We take part in virtual meetings and virtual cocktail hours. We attend virtual conferences, receive virtual medical care and see virtual versions of our adult children and young grandchildren. It is virtually impossible to escape from our screened-in lives. On the other hand, I have to point out that we are very short on gratitude when it comes to appreciating all that virtualization has allowed us to preserve.

In the satellite communications business, virtualization is about much more than faces on screens, as I discovered in editing a new WTA report, The Virtual Teleport, sponsored by a leader in the technology, Kratos.

What is Virtualization?

Virtualization describes the transition of computer applications from dedicated hardware to software that runs on commodity servers. The most common examples are email and internet applications, which used to run on dedicated hardware and use only a fraction of its processing and storage capacity. In a virtualized environment, multiple applications can share the same physical machine, increasing efficiency and conserving resources.

It's not a new idea. The first computer supporting virtualization was a mainframe developed by IBM for scientific use in 1968. Upgraded and commercialized in 1970, it became VM/370 OS, which ran one of the most popular mainframes in IBM history, the System/370. But it was the evolution of the internet that brought virtualization into its own, because website hosting companies needed a flexible, reliable way to divide up their server capacity among thousands or millions of users.

Playing Catch Up

Terrestrial IT and telecom have been in the virtualization game for decades – the latest iteration being cloud computing. But it has only recently begun to catch on with teleport and satellite operators. There are many reasons for it from sunk investment and proprietary standards to a long industry tradition of operating closed-loop systems.

But this reality is changing as satellite and teleport operators learn the virtues of virtualization. The degree of virtualization varies among operators, but there is general agreement that the trend will pick up steam in the coming years. There is simply too much to gain and too much to lose by maintaining the status quo, especially as the industry vies for new customers in an increasingly competitive environment and seeks to integrate more closely with the broader terrestrial communications grid.

From a report based on interviews with executives in teleport, satellite and technology companies, I offer a few key insights.

The Applications

One of the most basic kinds of virtualization in teleports is automation in the network operations center or NOC, the nerve center of a facility or multiple facilities. The ability to monitor performance across widely dispersed assets enhances network reliability by allowing operators to spot trends that could presage a costly service outage and address the issue preemptively.

Once key elements of the network and traffic riding on it have been virtualized, it creates opportunities for a higher level of operation. Called service orchestration, it aligns the applications, data and

infrastructure with business requirements. It defines policies and service levels to guide operations and then automates workflows, provisioning, and change management.

One area ripe for virtualization is radio frequency (RF) signal processing and distribution. The key to virtualizing these functions is the conversion of analog RF signals to digital (typically IP) signals as close to the antenna as possible. Once those signals are digitized, subsequent functions can be orchestrated from miles away using software. Whole new architectures are being built based on the ability to digitize RF signals.

Many if not most operators are integrating cloud-based computing into their processes. It gives satellite and ground segment operators the option to buy capacity on a pay-for-use basis, which allows processing to be spun up when needed and spun down just as easily, turning fixed capex for computing into a variable operating expense.

Growth Opportunities

Virtualization is providing growth opportunities across the industry. It facilitates expansion into new geographic markets by reducing the infrastructure costs involved. Integrating a new antenna into a network – once a costly and time-consuming endeavor, when most functions were hardware-based – now can be done in a day or two.

A related advantage is that, through virtualization, ground network operators are able to scale up quickly as dictated by demand. When a network is built out with hardware, the entire infrastructure investment must be made up front, even if initial demand requires only 25 percent of capacity. With virtualization, the processing elements of the network can be built out in software as demand dictates.

Moreover, virtualization enables better service in key markets such as maritime, where satellite services have long dominated. In effect, customers in these markets have come to expect OSS/BSS integration that allows them monitor network performance.

Virtualization enables the integration of satellite with the operational support systems and business support systems of terrestrial networks, from wired telecom to mobile network operators, creating opportunities that previously were unavailable to satellite operators. Increasingly, teleport operators must provide more than satcom, because customers expect a complete solution with integrated, multi-layered communication technology.

At the extreme end of virtualization strategies are the companies offering ground segment as a service or GSaaS. Of course, ground segment cannot be entirely virtual. Somewhere, there are antennas, RF chains, HPAs, modems and the rest of the teleport infrastructure. The difference is in the business model. GSAAS companies consciously limit their hardware investments by using other companies' resources whenever possible. There may be operating agreements with third-party teleport operators to dedicate an antenna to their services, or collocation deals that put the GSAAS operator's antenna at a third-party teleport. Where traditional teleport operators have unused capacity, GSAAS operators become customers.

The GSAAS companies' special sauce is the ability to manage this far-flung network of earth stations to meet their customers' needs. That is where clever software and virtualization play a critical role eliminating the standing IT army that traditionally would be required to monitor, control, maintain and operate a large ground network.

Whether or not satellite and terrestrial telecommunications infrastructure ultimately merge into one, as many experts envision or hope, the pull of virtualization will only grow stronger in the years ahead. Companies that balk, or even hesitate, risk being left behind.

Robert Bell is Executive Director of the World Teleport Association, which conducts research into the teleport and satellite industry and offers a Teleport Certification program to service providers. The Virtual Teleport is available for free to members and for sale to non-members at https://www.worldteleport.org/store/viewproduct.aspx?id=17787849 He can be reached at: rbell@worldteleport.org

10,000 Viewers & Counting; Dubai, Singapore, DC Calling

by Martin Jarrold

After the most recent webinar in the GVF-Satellite Evolution Group (SEG) series, 'Satellite Networks Solutions: Development & Evolution of Capability & Performance', attracted 328 registrations from 70 countries, we received the following comment from an audience member in the Czech Republic, "Thanks to GVF for this unique webinar series." This was just one of many complimentary responses received over the 11-months since the series started. In another example of responses to the series we have people dialling-in all around the clock. Over the Zoom Chat function at the start of 'Satellite Networks Solutions' we received this message – "Hello, this is Timor-Leste. It is 12AM here."

By May 2020 pandemic lockdowns and travel restrictions had come to necessitate that the satellite community gather only virtually. Meeting industry colleagues, partners, and customers had to be online, and in response GVF forged a new, regular and frequent series of connections in the Zoom ecosphere. The 'Satellite Networks Solutions' event brought the total of our webinar viewers to over 10,000 located in at least 141 countries.

GVF greatly appreciates the support of the diverse range of global audience members who have been joining us on Zoom since May last year. As at the date of writing the series has featured 24 broadcasts, including programs for third party virtual conference organizers and in association with satellite industry companies. A visit to https://gvf.org/webinars/ will reveal the complete video archive as well as details of future online events which will build on the success achieved so far.

This April and May will see us working with one of our members, Intelsat, to produce a series of three events focusing on Africa and EMENA, further information about which is available on the GVF website web pages, as above.

Reflecting the demand for coverage of more current satellite industry topics, and requests for further opportunities to sponsor events, the webinar series will continue for the forseeable future. In parallel, GVF will be contributing to the satellite industry 's in-person events which are now on the horizon. First in GVF's calendar will be CABSAT 2021 which, billed as "Live, In Person", brings the return of the SATEXPO Summit. GVF is a Knowledge Partner for the Summit and will host live moderated panel sessions during 24 & 25 May.

Three GVF-hosted SATEXPO panels are in preparation to provide GVF members, who are also exhibiting at the show, with the opportunity to have their representative serve as a panel member. Please note that the conference organizers are currently planning for the Summit to be an in-person event and the panel population is still subject to invitee acceptances.

The three panels will be themed across the market verticals Enterprise, Maritime, and Broadcast, as follows: 'Reach, Reliable, Robust: The Essential "Rs" in Enterprise'; 'Satellite and Maritime IoT and Cloud: The Digitalisation Imperative'; and 'OTT Killing the Satellite Video Star?', the latter title being with apologies to the British band, The Buggles. Their video of the synth-pop music track 'Video Killed the Radio Star' was the first to feature on the MTV channel in the United States in 1981.

- 'Reach, Reliable, Robust: The Essential "Rs" in Enterprise'… The rationale: Global or regional, metro, rural or remote, successful enterprise operations are built within an increasingly digitised global economy via networks that must be easily planned, deployed, operated and grown to meet the demands of scalability. Businesses with mul-

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tiple sites must have connection irrespective of physical location and corporate networks must have reach and reliability, and be robust. Supporting this, satellite is key in bringing broadband services to enable secure private networking, cloud connectivity, and internet access. It provides enterprise with access to information and productivity tools, increasingly based in software-defined wide area networking (SD-WAN) intelligence to maximise bandwidth utilisation and applications performance. Extended provision of uniform levels of access to business critical applications across all company sites necessitates that organsations look to the latest innovations, such as expansion of MEO, deployments of LEO, and roll-out of satellite-supported 5G networks. This session will examine satellite's vital role in enterprise, identifying the continuing opportunities for it to grow the enterprise environment.

• 'Satellite and Maritime IoT and Cloud: The Digitalisation Imperative'… The rationale: Digitalisation, a transition evolving across the maritime sector and bringing wider fundamental change to the way shipping businesses operate is accelerating, enabled by deployment of broadband connectivity over Earth Stations in Motion (ESIMs) and high-throughput satellite fleets and constellations unlocking access to cloud and IoT services. One narrow example of the impact of satellite broadband connectivity at sea is the enabling of easier troubleshooting of faults in a ship's onboard IT network, reducing the need for shipping companies to send IT staff to visit individual vessels to locally install new applications software or otherwise maintain onboard digital infrastructure.

With data and software hosted on the Web, digitisation processes are being implemented remotely, simplifying deployment, reducing costs, effecting consistency across fleets, and continual incremental upgrades. Adding to the digitising momentum has been the impact of Covid-19 which has increasingly necessitated that disparate elements of the geographically spread maritime industry work closely, yet remotely, to preserve supply chains through collaborative online platforms, video conferencing and remote data monitoring.

The month of May marks the return of CABSAT 2021 as a "Live, In Person" event, which includes the SATEXPO Summit. GVF is a Knowledge Partner for the Summit and will host live moderated panel sessions from 24 and 25 May.

Deployment of latest generation of satellite communication systems is also the solution to earlier obstacles to IoT adoption – the inability to get data off ships in real-time. Cloud and IoT technologies, complemented by satellite broadband, are connecting an increasing number of control and sensor devices to enable real-time data telemetry covering fleet management, systems performance computing, cybersecurity applications, and more in terms of analytics, facilitation of informed insights and decision-making, cost savings, and demonstration of compliance with emissions regulations. The satellite digitalisation imperative is now a fixed feature of an industry that, pandemic-19 or not, constitutes the vital fabric of international commerce. This panel will explore how the digitalisation of martime communications is being enabled by satellite communications and the many benefits accruing to the maritime industry as a result of satellite-enabled digitalisation.

- 'OTT Killing the Satellite Video Star?'… The rationale: Satellite has been the infrastructure sustaining media broadcast for decades and video has propelled growth in the satellite industry across those decades, either in direct-to-home (DTH) or video distribution to head-ends. The growth of non-linear video-on-demand (VOD) viewing, "over-the-top" (OTT) via inexpensive high-bandwidth broadband connections, was supposed to signal the demise of broadcast video. Has this proven true? Apparently, not.

"...OTT via satellite offers video platforms the cost benefit of multicasting and the ubiquitous coverage and high quality and reliability of satellite..."

Satellite operators are still signing and renewing contracts with major content broadcasters and satellite transponders for broadcast are still being launched. In light of the increasing popularity of terrestrrial OTT, one can reasonably ask, "why"? The answer lies in satellite's core value point-to-multipoint multicast economics that are based on a constant bandwidth cost regardless of the number of viewers within the same footprint. In short, satellite remains a highly cost-effective way to reach large numbers of people in an increasingly OTT world.

If satellite broadcast is not dead, then what role will satellites play as OTT proliferates? Benefitting the satellite proposition is the typical inconsistency of broadband networks, a factor applying even in countries with advanced telecoms infrastructures. Beyond urban concentrations coverage, reliability and speed can be a patchwork and not good enough to meet high levels of network demand for high definition formats. User experience expectation for HD, UHD and 4K services reinforces the satellite technology differentiator of being able to provide crystal-clear viewing without bandwidth limitations.

Consumption of higher quality video provides illustration of ummatched cost and efficiency advantages with satellite multicasting because when streaming such heavy content via unicast, with increasing concurrent views costs grow linearly. Thus, customer migration to UHD is of prime importance for satcom business as it leverages this economic advantage as well as its compression standards and advanced modulation schemes. OTT via satellite offers video platforms the cost benefit of multicasting and the ubiquitous coverage and high quality and reliability of satellite. This panel will explore how and why satellites will play a role as video is increasingly distributed over-the-top.

Looking further to the horizon, GVF will also contrribute panel content to both ConnecTechAsia 2021, 14-16 July, and SATELLITE 2021, 26-29 July. Details of these programs will feature in future columns here.

Meanwhile, wherever you are while reading these words… Keep well, stay safe.

Martin Jarrold is Vice-President of International Program Development of GVF. He can be reached at: martin.jarold@gvf.org


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Redwire to go Public with Merger with SPAC

Jacksonville, Fla., March 25, 2021--Redwire, a provider of mission-critical space solutions and high reliability components for the next generation space economy, and Genesis Park Acquisition Corp. (NYSE: GNPK), a publicly traded Special Purpose Acquisition Company (SPAC), announced that they have entered into a definitive merger agreement that will result in Redwire becoming a publicly traded company.

The transaction is expected to be completed by the end of the second quarter of 2021, and at that time, Genesis Park Acquisition Corp. will change its name to Redwire and the company will trade on the NYSE.

Redwire provides critical space infrastructure technology and services and is uniquely positioned to deliver critical solutions to meet the growing needs of national security, civil, and commercialcustomers for a full spectrum of activity in space. The company is differentiated from its peers because it offers both rich flight heritage, with more than 50 years of space flight experience and more than 150 missions flown, and unmatched innovations in space infrastructure, including over 100 patents and applications. Its infrastructure and services enable nearly every space mission, and Redwire sees increasing opportunities as decreasing launch costs continue to enable exponential growth in deployed space infrastructure.

Redwire is the leading developer of on-orbit servicing, assembly and manufacturing ("OSAM") capabilities, a transformational technology deploying 3D printing that enables customers to build satellites and other spacecraft in space, solving the size and other limitations posed by launch dynamics. Through the launch of raw materials into orbit, in-space manufacturing of component parts through 3D printing and other methods, and robotic assembly of highly functional objects, Redwire's OSAM technology enables lower cost deployment and higher power capabilities. The advantages of Redwire's in-space manufacturing will allow its customers to efficiently create more advanced products in space with greater performance characteristics than terrestrial based manufacturing methods, driving increased investment in space infrastructure from adjacent markets and the commercialization of space.

"Space-based capabilities and services are improving lives on Earth every day, and Redwire is an invaluable mission partner, providing technology that has been at the forefront of space infrastructure from the beginning. Today, the influx of private capital, new public sector space initiatives and decreased launch costs are driving tremendous growth in the space industry, which is projected to exceed $2 trillion by 2040," said Peter Cannito, Chairman and CEO of Redwire. "With our extensive space flight heritage and deeply innovative capabilities, we are accelerating humanity's expansion into space by delivering reliable, economical and sustainable infrastructure for future generations. As we enter this second golden age of space, Redwire is supplying the picks and shovels that enable nearly every space mission, supporting initiatives to help us better understand our planet, transform our space security infrastructure, and move humanity deeper into our solar system. We are thrilled to enter into this business combination with Genesis Park. With their extensive aerospace, operational and financial expertise and strong industry relationships, we are confident that Genesis Park is the right partner to propel Redwire's growth in the public market."

"We intended to find a profitable partner with strong management, powerful intellectual property and impressive organic growth. Redwire achieves that vision by transforming the future of space infrastructure and services at a time when the space industry is on the brink of exponential growth. Redwire is a proven, solidly profitable player in the space community and the undisputed leader in on-orbit 3D printing, servicing, assembly, and manufacturing. We also believe there is significant opportunity to accelerate growth through strategic combinations in the fragmented space landscape. Redwire has established itself as a first-mover consolidator and an acquirer of choice, and we believe its position will be further improved as a public company," said Paul Hobby, CEO and Director of Genesis Park. "We are very excited about Redwire's growth potential and we look forward to partnering with Peter and his team as they help usher in this new era of space exploration."

"As an innovative space infrastructure leader, Redwire is set to power a new age of space travel, exploration and commerce," said Kirk Konert, Partner at AE Industrial Partners. "With this transaction, Redwire will have even greater opportunities to drive growth and value by delivering tailored, responsive solutions for its growing customer base across the public and private sectors."

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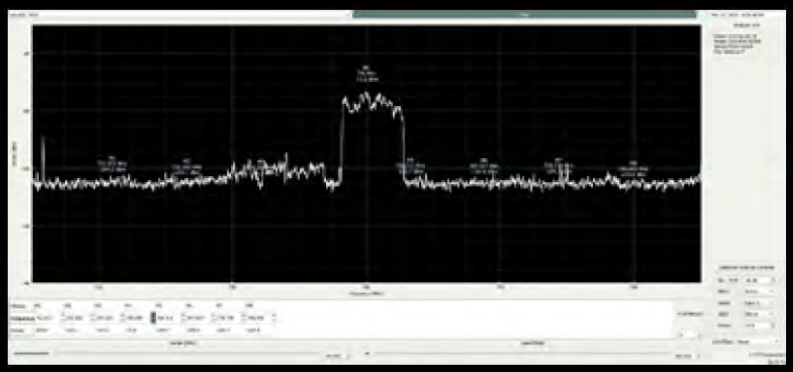

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Inmarsat Appoints Two Key Marketing Executives

London, UK, March 25, 2021--Inmarsat announced the appointments of Barry French as Chief Marketing and Communications Officer (CMCO) and Jat Brainch as Chief Commercial and Product Officer (CCPO).

Barry French

French, formerly Chief Marketing Officer at Nokia, will report to the CEO. His role will be to sharpen customer focus, drive customer engagement and revenue generation to the next level, ensure Inmarsat is an effective and engaged participant in key policy discussions, and further enhance employee engagement. Under his leadership, Inmarsat will be bringing together its marketing, communications and government affairs functions into a single executive level organisation.

Jat Brainch

French joined Nokia in 2006 as Head of Communications, prior to which he was Vice President of Corporate Communications at United Airlines and Director of Corporate Communications at Dell.

Brainch, previously Senior Vice President of Group Commercial Management at Inmarsat, will also be reporting to the CEO. Brainch will be responsible for Inmarsat's evolving commercial and product strategy and roadmap and to ensuring that the company continues to lead the industry in advanced, customer-centric products and services that are designed specifically for mobility and Government users.

Prior to joining Inmarsat in 2019, Brainch worked across a range of complex, international businesses and has a proven track record of delivering sustainable growth. Jat has held senior roles in telecoms and technology brands, including Logica Group PLC (now part of CGI), Telefonica Europe PLC and T-Mobile (UK) Ltd.

Vikas Grover Joins Avanti as CTO

London, UK, March 23, 2021 - Avanti Communications Group announced the appointment of Vikas Grover as its new Chief Technology Officer. Grover was recently the founding Chief Information Officer at OneWeb, where he led Global Networks, IT Platforms and Security. Grover will succeed Scott Richardson in the role, who will be leaving the company.

Before OneWeb, he was the CIO and EVP Technology Planning at Vodafone India. Vikas brings a rich cross-industry experience from his stint at KPMG (Atos).

Avanti CEO Kyle Whitehill, "I am delighted to welcome Vikas to Avanti. Vikas is an accomplished Leader in the Telecoms field with a background including Mobile and Satellite organisations. He is also a highly regarded people leader and I have no doubt he will make an excellent addition to Avanti

Vikas Grover

and our Executive Committee.

SAIC Appoints David Ray to Lead Space Business Unit

Reston, Va., March 9, 2021--Science Applications International Corp. (SAIC) announced the appointment of David Ray as senior vice president, Space Business Unit, reporting to Michael LaRouche, president of SAIC's National Security and Space sector. In his new role, Ray will manage SAIC's newly formed Space Business Unit, which combines the company's civilian, defense and intelligence space operations under one organization.

Ray brings extensive space and leadership experience to SAIC and its US$ 1.3 billion space business. He has worked with prominent space organizations such as the National Reconnaissance Office, NASA, and the U.S. Space Force. Most recently, Ray served as president, Government and Defense, at Flir Systems, where he led all aspects of the company's government and defense business, including mergers and acquisitions. Prior to that, Ray held leadership positions with Raytheon Intelligence, Information, and Services; Raytheon Space and Airborne Systems; Raytheon Missile Systems; and Booz Allen Hamilton.

Satellite On Track to Provide Broadband Access to Over 100 million People by 2029

Paris, France, March 31, 2021--In its first ever report on Universal Broadband Access, Euroconsult forecasts that the global market for satellite broadband is expected to triple with service revenues reaching US $12.7 billion by 2029. With 46 percent of the world's population still unconnected, satellite broadband remains key to bringing essential services to sparsely populated regions where extending terrestrial networks is not economically feasible.

Significant progress has been made to expand access and adoption of broadband services as demonstrated by the growth in internet users, which doubled between 2010 and 2020, to just over 4 billion users worldwide in 2020. The Covid-19 crisis has highlighted the importance of universal broadband access and accelerated efforts towards bridging the divide between those with high-speed broadband access and those without connectivity.

"Organizations such as the Broadband Commission for Sustainable Development set targets to encourage governments to invest in programs that contribute to bridging the digital divide," said Dimitri Buchs, Senior Consultant at Euroconsult. "Overall, the broadband ecosystem will be central to building the post COVID-19 world, notably by making sure universal equitable access to broadband services is part of the new normal. We have a long way to go to achieve this, but satellite will be key to reaching many who are currently unserved or underserved."

There are three categories of satellite solutions that address the Universal Broadband market. They include: consumer broadband, Wi-Fi hotspots, and cellular backhaul. Consumer broadband is currently the dominant option in advanced economies while Wi-Fi hotspots are most frequently used in less developed regions, notably due to the lower cost of services and the ability to share costs among a large number of users.

The Euroconsult research found that in 2020, 43 million people were connected to broadband via satellite, roughly one percent of the world's connected population. This number is expected to grow to 110 million in 2029, with Latin America adding roughly 20 million users and Sub-Saharan Africa adding 16 million.

The growth, in part, will be driven by an influx of new lower cost capacity with LEO constellations, such as Starlink, Amazon Kuiper, OneWeb and Telesat Lightspeed and several Very High Throughput (VHTS) GEO satellites coming into service. This will be key to the development of the Universal Broadband Access market as all three segments have relatively high price sensitivity.

The improved economics enabled by lower capacity pricing are expected to drive higher data rate service to existing satellite broadband users, while also unlocking new opportunities in rural and remote regions as well as in areas just outside of urban centers that have less than adequate service. HTS systems are, for example, required for the use of satellites to support 5G network deployments.

"The Universal Broadband Access market offers significant growth opportunities to the satcom industry whose revenues have been on a downward trend since 2014," said Dimitri Buchs. "During this period, this market has been one of the few bright spots for satellite operators, with revenues increasing every year."

The Satellite Markets 20 Index™

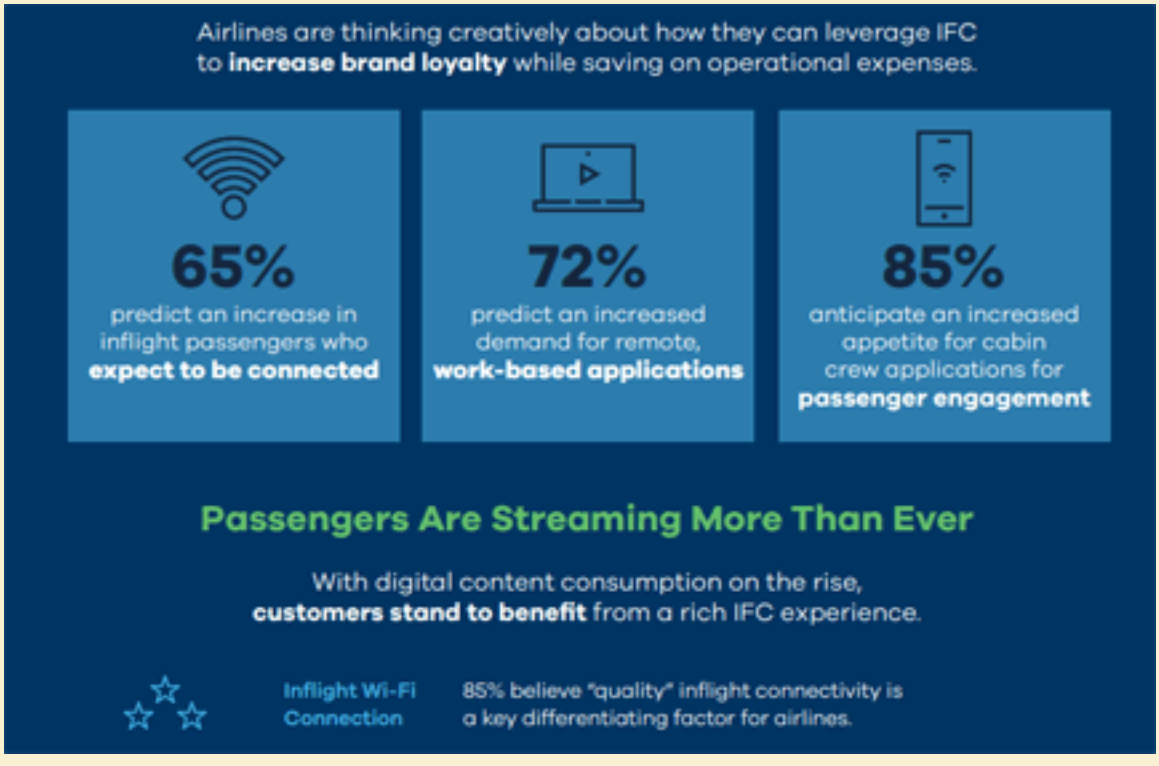
Company Name	Symbol	Price Apr 5	52-wk Range		Price Change Last Month	Price Change From Jan 15
Satellite Operators						
Thaicom Public Company Limited	THCOM.BK	9.20	2.40	11.40	2%	1%
Eutelsat Communications S.A.	ETL.PA	10.47	7.98	10.88	4%	11%
APT Satellite Holdings Limited	1045.HK	2.40	1.70	2.89	12%	14%
Echostar	SATS	24.24	19.75	35.33	-9%	-1%
SES S.A.	SES.F	6.92	4.88	8.55	2%	-9%
Satellite Manufacturers						
The Boeing Company	BA	255.17	113.89	278.57	14%	20%
Maxar Technologies	MAXR	37.92	8.65	58.75	-12%	-24%
Lockheed Martin Corporation	LMT	378.97	319.81	417.62	11%	7%
OHB SE	OHB.DE	35.5	30.55	49.85	1%	-20%
Honeywell International Inc.	HON	219.19	117.11	221.01	6%	6%
Equipment Manufacturers						
C-Com Satellite Systems Inc.	CMI.V	3.99	1.70	4.48	-1%	48%
Comtech Telecommunications Corp.	CMTL	25.86	12.96	30.40	-8%	16%
KVH Industries Inc.	KVHI	13.43	7.38	15.29	1%	11%
ViaSat Inc.	VSAT	50.45	29.82	61.35	2%	39%
Gilat Satellite Networks Ltd.	GILT	10.61	4.80	22.69	-7%	45%
Service Providers						
DISH Network Corporation	DISH	37.43	20.41	39.24	11%	15%
Globalstar Inc.	GSAT	1.29	0.28	2.98	-9%	45%
Orbcomm Inc.	ORBC	7.81	2.04	9.25	14%	-8%
Sirius XM Holdings Inc.	SIRI	6.34	4.82	8.14	8%	8%
RigNet Inc.	RNET	9.17	0.77	11.19	3%	37%

The Satellite Markets 20 Index™ is a composite of 20 publicly-traded satellite companies worldwide with five companies representing each major market segment of the industry: satellite operators; satellite manufacturers; equipment manufacturers; and service providers. The base data for the Satellite Markets Index is January 2, 2008 - the first day of operation for Satellite Markets and Research. The Index equals 1,000. The Satellite Markets Index™ provides an investment benchmark to gauge the overall health of the satellite industry.

INDEX	Index Value March 5, 2021	2-Month Percentage Change January 15,2021	1-Year Percentage Change Jan. 2, 2020
Satellite Markets 20 Index™	2,609.45	4%	5%
S & P 500	4,073.94	6%	7%

ADVERTISERS' INDEX

VITAL STATS



Intelsat recently conducted an Inflight Connectivity (IFC) survey asking airlines, service providers, and Original Equipment Manufacturers (OEMs) what they believe the future of IFC will look like. The survey aimed to gain an understanding of how inflight internet demand and service requirements have changed in light of the pandemic.

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To learn more about the **Summit II** high power systems, visit **advantechwireless.com/summit-II/**

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