

Worldwide Satellite Magazine — October 2017

SatMagazine

Focus on Africa

Smallsat Futures

Antenna Array

The Forrester Report

The Coming of Age of Smallsats

"Go for Launch!"

NEPTUNE-1 Test Launch Prep

InfoBeam

*The launch of Japan's Michibiki No. 3 satellite
by JAXA and Mitsubishi Heavy Industries.*

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Michibiki No. 3 Launched by Japan

After a week's delay, Japan successfully launched the third of the nation's new quasi-zenith satellites on August 19, 2017.

This satellite is one of an entire constellation being placed into orbit to improve the accuracy of available global positioning data. The launch, overseen by the Japan Aerospace Exploration Agency (JAXA), came a week later than scheduled after the rocket that was to carry the satellite developed technical issues, causing the originally planned launch to be aborted. The new satellite system will improve positioning data for a range of applications, including for smartphones and vehicle navigation systems, and will improve emergency service personnel's ability to locate people in disasters.

JAXA and Mitsubishi Heavy Industries Ltd. launched the Michibiki No. 3 satellite, which is the third in a planned constellation of four GPS satellites, on an H-2A rocket from the Tanegashima Space Center in Kagoshima Prefecture, southwestern Japan. The planned launch on August 12 was postponed due to concerns over a possible helium leak. The gas is used to move valves in the first-stage rocket's engine, according to the constructor Mitsubishi Heavy. The problem was resolved through the replacement of a related component, the company said.

The newly launched satellite will work with the first and second Michibiki satellites and complement the existing U.S. satellite network that Japan and many other countries depend on. Once in its final position, this third satellite will slot into a geostationary orbit — the Japanese government is scheduled to launch the final satellite for their constellation in October.



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Australia Moves to Establish a National Space Agency

The heads of the world's major space agencies have praised Australia's decision to finally establish a national agency of their own.

The Australian Government used the opening of the International Astronautical Congress (IAC) in Adelaide, South Australia, to announce a national space agency would be established by the nation.

This announcement follows months of lobbying by the Space Industry Association of Australia and the South Australian Government. Details of how the agency will be set up are yet to be announced.

The IAC congress was attended by the heads of the world's largest space agencies, all of whom praised Australia's decision.

NASA Acting Administrator Robert Lightfoot stated that the new agency would provide an excellent opportunity to increase the collaboration with Australia. *"From a NASA perspective, we've had a great partnership with Australia for a long time and I look forward to seeing which areas Australia decides to focus on," he said. "I think that will be their challenge but there's enough room for them to participate in what we're doing. It's a global endeavor — we're all here for that reason — and I think Australia not being a part of that (until now) is a little bit strange."*

European Space Agency Director General Jan Woerner said having a national agency provided a good access point for space interactions with other nations. *"We welcome this very much," he said. "There are two aspects to this: One is the national development and capacity building so you have a voice in your own country but at the same time you have a voice to the outer*



Heads of space agencies, from left, NASA Acting Administrator Robert Lightfoot, Russian Federal Space Agency Head (Roscosmos) Igor Komarov, European Space Agency Director General Jan Woerner, China National Space Administration (CNSA) Secretary General Tian Yulong and Japan Aerospace Exploration Agency (JAXA) President Naoki Okumura at the International Astronautical Congress in South Australia.

world. At the beginning of the '60s, Australia was an associate member of the European Launch and Development Organisation (ELDO), so we are really happy we can continue our strong cooperation."

Japan Aerospace Exploration Agency (JAXA) President Naoki Okumura said his agency was already working with Australia on Earth Observation satellite activities, but the new agency would lead to even closer ties. *"In the future, we would like to work more closely with Australia in order to become an innovation center and strengthen our relationship," he said.*

Canadian Space Agency (CSA) President Sylvain Laporte said establishing a national space program was not without its challenges. *"There's a ton of opportunities and things you can do, but there's always limited resources," he said. "Putting in place a sound governance system that will allow the space agency to make the right decisions, to prioritize what it should do and to make sure it can make the best pitch possible to politicians to secure as much funding as is required*

for this country to invest in space I think would be a good first step."

Until now, Australia was one of the only OECD countries without a national space agency.

More than 4,200 delegates were registered for the congress, the world's biggest space meeting of the year, making it the largest conference ever staged in South Australia and an ideal opportunity to show off the \$397 million Adelaide Convention Centre redevelopment.



Photo is courtesy of the Adelaide Convention Center.

Space Industry Association of Australia Chair Michael Davis said the SIAA was thrilled with the announcement and expected the agency would be a collaboration between government and industry.



"What a start to this congress," he said. "The aim is to deliver clear economic benefit to the Australian economy and of course, to re-enforce our status as a participant of long-standing in the development of outer space. We will soon take our place at the table of space agencies as major initiatives and cooperative projects are considered and developed. We have the capacity, the science, the skills, the research and development environment, the culture, the industry nous. Now we have the standing of the Australian Space Agency."

South Australian Premier Jay Weatherill said the week presented an opportunity for the state to send a bold message to the world. *"We are ready to put ourselves in the service of this nation by becoming a key part of a national space agency," he told the congress. "We are also sending a clear message to the world that we want to work with you — as our state logo suggests — as an open door to opportunity."*

The SIAA launched a White Paper in March calling on the Australian Government to establish a national space agency.

Last month Weatherill and ACT Chief Minister Andrew Barr signed a Memorandum of Understanding to work together towards the creation of a Canberra-based space agency with a prominent presence in Adelaide.

The State Government has also announced a space industry center was being established in Adelaide as part and increased Defence Industries Minister Martin Hamilton-Smith's portfolio will include space.

This report was authored by *Andrew Spence*,
The Lead South Australia (theleadsouthaustralia.com.au).

Rocket Lab, Spire and Planet Add Excitement to Upcoming Second Test Flight

From two different continents these companies will combine their expertise—one with their rocket and the others with their satellites.

Rocket Lab has announced the company will fly payloads for Planet and Spire aboard its upcoming second test flight, 'Still Testing,' from Launch Complex 1 on the Mahia Peninsula, New Zealand.

Rocket Lab's Electron orbital launch vehicle will carry two Earth-imaging Dove satellites for Planet and two Lemur-2 satellites from Spire for weather mapping and ship traffic tracking.

The flight is the second of three in Rocket Lab's Electron test program and follows the successful inaugural Electron test flight that was carried out on May 25, 2017.

Peter Beck, Founder and CEO of Rocket Lab, said that carrying a test payload marks a significant milestone for the Electron program, enabling Rocket Lab to gather crucial data and test systems for the deployment stage of a mission.

He added that Rocket Lab is thrilled with Electron's performance in the first test flight and now they're eager to test the next crucial step — payload deployment.

No major changes to the launch vehicle hardware have been required and the focus is on the six Electron vehicles currently in production. While they're still very much operating in a test phase and can likely expect a few scrubs during the second test flight attempt, they're incredibly excited about carrying Planet and Spire payloads on Electron.



The data these companies gather has an increasingly significant role to play in how they understand the planet and better manage it.

Mike Safyan, Senior Director of Launch at Planet, said that their companies have long shared an ethos of dreaming big and executing on that vision, so it's only fitting that Planet is among the first payloads to fly on a Rocket Lab Electron. The Electron will be a game changer in a traditionally difficult launch market. They are excited to quite literally be riding the leading edge with Rocket Lab.

Planet's largest-ever network of 190 satellites collects more imagery daily than any other commercial provider, creating a completely new information feed about the world.

With this comprehensive and empirical dataset, Planet uses machine learning-driven analytics to create unique insights that deliver crucial market intelligence for businesses, governments, and NGOs.

Peter Platzer, CEO of Spire added that the ability to iterate quickly and execute on an incredibly high level is core to the success of both Rocket Lab and Spire. 'Still Testing' is a culmination of that work into a single event, and they're proud to be onboard for this inaugural deployment attempt.

Spire, the world's first commercial weather satellite constellation, adds two satellites to an existing constellation of Lemur-2 satellites that covers every location on Earth over 100 times per day.

The multi-sensor satellites gather global atmospheric measurements for advanced weather warnings and predictions and track global ship traffic for multiple commercial and government applications.

The Electron vehicle for the 'Still Testing' flight is expected to be trucked to Rocket Lab's Launch Complex 1 on the Mahia Peninsula, New Zealand, in October of 2017 with a launch window to open in the following weeks once the vehicle checks have been completed.

rocketlabusa.com/

www.planet.com/

spire.com/

Thales Alenia Space Has a SMILE for the ESA

Thales Alenia Space has recently been awarded one of three competitive studies funded by the European Space Agency (ESA) to lead the design definition of the Payload Module (PLM) for SMILE (Solar Wind Magnetospheric Ionospheric Link Explorer).

SMILE is a joint science mission between ESA and the Chinese Academy of Sciences, which aims to investigate the interaction between Earth's protective shield — the magnetosphere — and the supersonic solar wind. The SMILE satellite consists of a platform, provided by the Chinese Academy of Sciences, and a fully independent Payload Module, provided by ESA.

The PLM hosts the four customer furnished science instruments* from Canada, the UK and China, the PLM Control and Mass Memory Unit, the PLM Power Distribution Unit and the X-band communication system used to downlink all science data.

During the study phase, Thales Alenia Space in the UK will work with the ESA team to define and optimize the Payload Module, including the structural and thermal solution, definition of the supporting PLM equipment, accommodation of the four science instruments and the delivery of all science data to the ground.

With a planned launch in 2021 from French Guiana, the two ton satellite will enter a Highly Elliptic Orbit (HEO) with an apogee of around 120,000 km over the Earth's North Pole. Following a competitive evaluation prior to PDR (Preliminary Design Review), one of the competing designs will be down-selected for the SMILE mission.

If successful, Thales Alenia Space in the UK will procure the equipment, assemble, integrate and test the Payload Module in the UK's future National Satellite Testing Facility.

This world class facility, due to open in 2020, has been awarded funding by the UK Government's flagship Industrial Strategy Challenge Fund to boost the UK's space capabilities for the design and build of more complex space instruments and technologically advanced satellites.

Ben Olivier, the CEO of Thales Alenia Space in the UK, noted that the company is proud to team with ESA experts and to contribute to the SMILE mission, which expects to make an important contribution to our understanding of space weather and, in particular, the physical processes taking place during the continuous interaction between the solar wind and the magnetosphere.

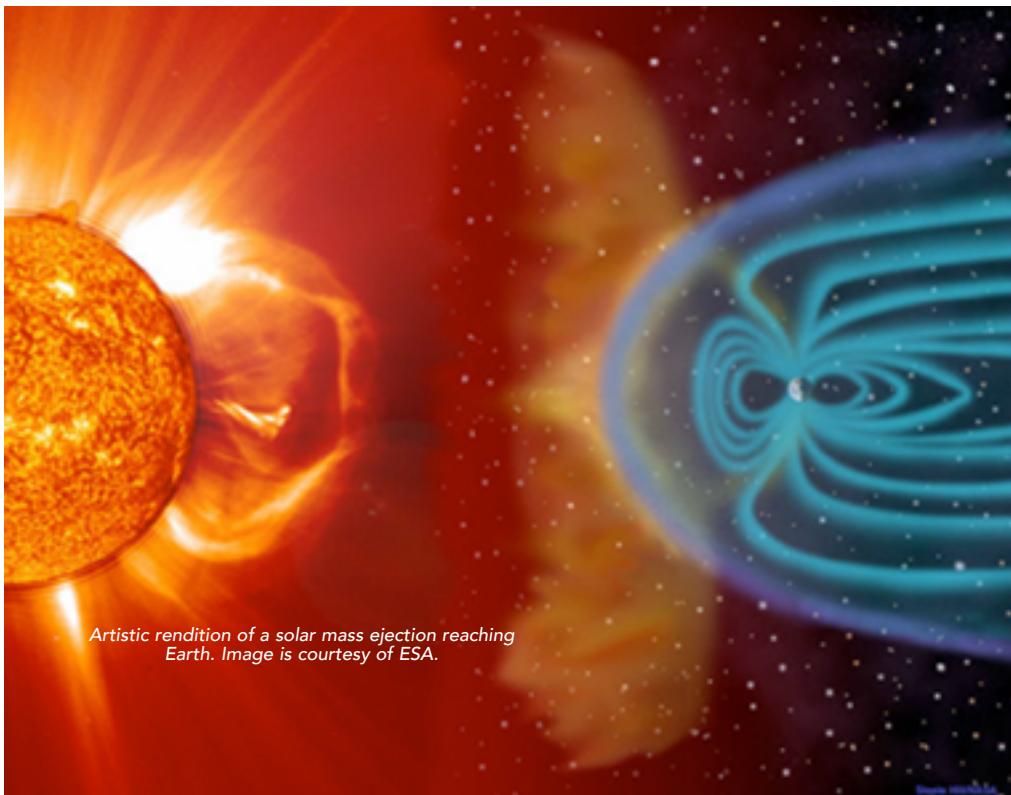
Olivier added that this contract reflects Thales Alenia Space's strategy of growing its European footprint and is fully in line with market trends and growth dynamics. For Thales Alenia Space, this is a significant milestone in the recognition of the company's capability as a Prime contractor in the UK for major space missions.

The SMILE design definition phase is Thales Alenia Space's first opportunity to work directly, as a Prime contractor in the UK, with the engineering teams of the ESA Science Directorate and also demonstrates the confidence and trust placed in Thales Alenia Space in the UK and its teams of highly skilled engineers.

www.thalesgroup.com/en/global/activities/space

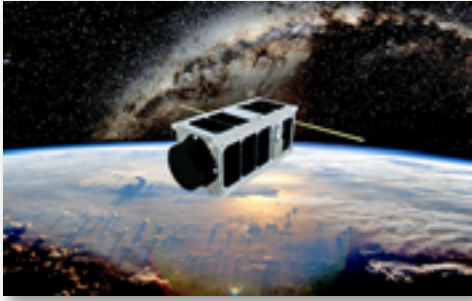
www.esa.int/

**The four SMILE instruments are CFI provided by ESA Member or Participating States (Ultra Violet Imager (UVI) and Soft X-ray Imager (SXI)), and CAS (Magnetometer (MAG) and Light Ion Analyser (LIA)).*



Artistic rendition of a solar mass ejection reaching Earth. Image is courtesy of ESA.

Italian Space Company SITAEL Signs On Australian Firm Inovor for Smallsats



The largest privately-owned space company in Italy has signed on to manufacture smallsats in Adelaide.

A letter of intent has been signed between Italian company **SITAEL** and startup **Inovor Technologies** to jointly establish a multi-million dollar company in South Australia to design and manufacture smallsats and ground station applications. South Australian company Inovor Technologies designs and integrates small satellites, including its InoSat smallsat, a turnkey surveillance pod to protect satellites from space junk.

The InoSat is a less-expensive alternative to directing space traffic and can also be used to study climate change, natural disasters and general agriculture on Earth.

Inovor chief executive Matthew Tetlow said partnering with SITAEL would his company's capabilities to manufacture space hardware in Adelaide as well as expand the firm's product range to larger, more capable spacecraft. South Australia has established itself as a hub for space industry research and hosts a number of space primes such as Boeing, BAE systems and Lockheed Martin.

The state launched its South Australian Space Industry Centre before welcoming the world's space leaders to the International Astronautical Congress this week.

This agreement was the result of an MOU signed by South Australia and the Agenzia Spaziale Italiana (ASI) last October to pursue joint research and development, academic exchange and industry collaboration in the space sector.

South Australian Minister for Defence and Space Industries Martin Hamilton-Smith said South Australia led the way in the development of Australia's space economy now that Australia had agreed to establish a national space agency.

*News reporting by Jim Plouffle,
The Lead South Australia.*

Carried to the Cape: EchoStar-105/SES-11 Satellite



Artistic rendition of the EchoStar-105/SES-11 satellite. Image is courtesy of Airbus.

EchoStar Corp., SES and Airbus Defence and Space have shipped the EchoStar-105/SES-11 spacecraft from the Airbus facilities in Toulouse, France, to Cape Canaveral, Florida, for the forthcoming launch by SpaceX this October.

The first satellite that EchoStar has constructed with manufacturer Airbus, EchoStar-105/SES-11 will be launched by SpaceX on a flight-proven Falcon 9 rocket from Launch Complex 39A at Kennedy Space Center, Florida.

EchoStar-105/SES-11, a high-powered hybrid Ku- and C-band

communications satellite, is a dual-mission satellite for U.S.-based operator EchoStar and Luxembourg-based operator SES.

EchoStar-105/SES-11 provides EchoStar with 24 Ku-band transponders of 36 MHz, marketed as EchoStar 105 — SES is provided with a C-band payload of 24 transponders, marketed under the name SES-11.

EchoStar-105/SES-11 replaces Ku-band capacity for AMC-15 and C-band capacity for AMC-18 at the SES well-established 105 degrees West orbital slot.

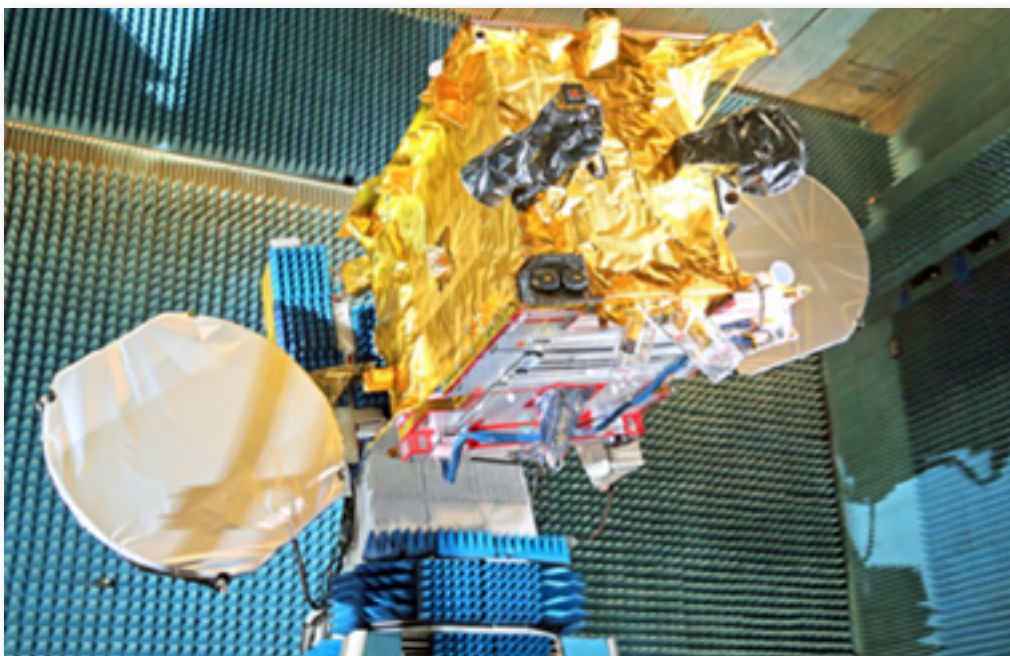
EchoStar-105 was tailored to meet the Ku-band capacity needs of EchoStar's enterprise, media and broadcast, and U.S. government service provider customers, offering coverage of the 50 U.S. states and expanded reach to the Gulf of Mexico and the Caribbean.

SES-11, designed to accelerate the development of the SES U.S. prime video neighborhood and optimized for digital television delivery, joins SES-1 and SES-3 at the center of SES's robust North American orbital arc, which reaches more than a hundred million TV homes.

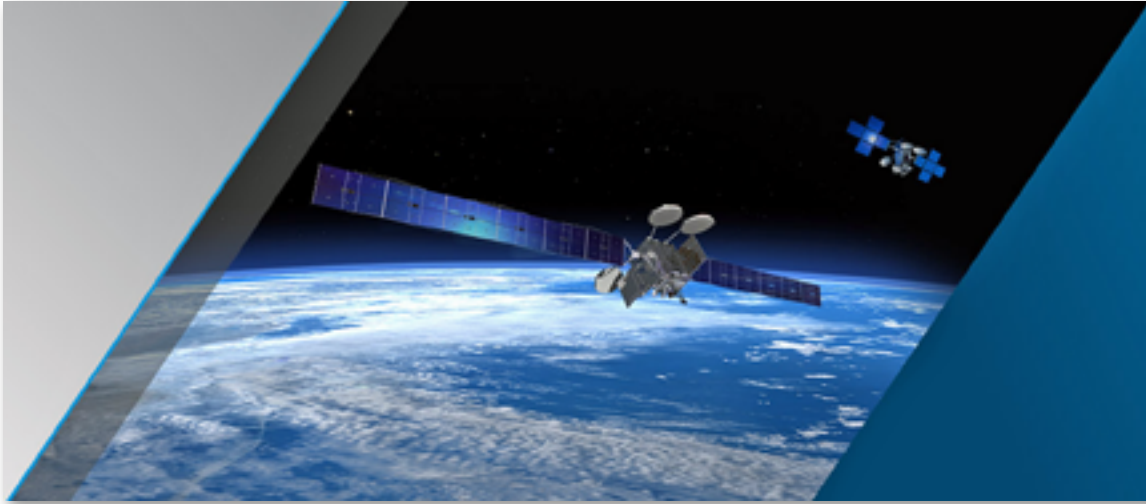
The satellite also replaces the AMC-18's C-band capacity, which SES offers over North America, including Hawaii, Mexico and the Caribbean, empowering businesses and governments to capture new opportunities and expand their reach.

EchoStar 105/SES-11 is the 47th satellite based on the highly reliable Airbus Eurostar E3000 platform and will have a launch mass of 5,200 kg and spacecraft power of 12 kW.

www.echostar.com/



ViaSat and Boeing Start Work on Two ViaSat-3 Class Satellites



ViaSat Inc. has completed the Critical Design Review (CDR) milestones for their ViaSat-3 class spacecraft.

The payload CDR was successfully completed last week, and when combined with the successful bus CDR that was conducted with Boeing in mid-August, both companies are now moving forward with building, integrating and testing the first two satellites.

According to the company, the ViaSat-3 class of Ka-band satellites is expected to provide unprecedented capabilities in terms of service, speed and flexibility.

The first two satellites will focus on the Americas and on Europe, Middle East and Africa (EMEA), respectively, with a third satellite planned for the Asia Pacific region, completing ViaSat's global service coverage.

Each ViaSat-3 class satellite is expected to deliver more than 1-Terabit per second of network capacity, and to leverage high levels of flexibility to dynamically direct capacity to where customers are located.

The ViaSat-3 payload is being designed and manufactured by ViaSat at its Tempe, Arizona, facility while Boeing is building the all-electric propulsion 702 satellite platform at their factory in El Segundo, California.

Boeing will deliver the payload module structure to ViaSat's satellite integration facility in Tempe where the payload will be installed and tested.

Following completion of payload testing, ViaSat will send the completed payload module back to Boeing, where it will be mated to the spacecraft and tested to ensure readiness for launch and the space environment once on orbit.

Mark Dankberg, chairman and CEO, ViaSat, stated that the ViaSat-3 class satellite platform enables high-speed, high-quality, affordable internet on a global scale. The company is still on a path to achieve the target bandwidth and the flexibility to dynamically allocate capacity to the most attractive and engaged geographic markets.

He added that completing the CDR process for both the payload and bus programs brings this very unique broadband resource another step closer to launch.

Paul Rusnock, chairman and CEO, Boeing Satellite Systems International, noted that completing the bus CDR validates that the satellite meets all necessary requirements

for production to begin. ViaSat-3 is the largest satellite in both size and power that Boeing is building and one of the largest satellites in the industry.

Paul additionally stated that this will be a highly-capable and advanced spacecraft — with greater than 25kW of power at end of life, and an ability to take full advantage of the efficiency of its all-electric propulsion.

www.viasat.com/

www.boeing.com/

Phasor and OmniAccess Sign ESA Agreement

Phasor reached an agreement with OmniAccess to become that firm's commercial launch partner in the super yacht and related maritime broadband services markets.

Phasor and OmniAccess will engage in Beta trials early in 2018, with additional partners and, following the success of these field tests, Phasor will introduce its initial products to the commercial maritime broadband services market.

Phasor has been conducting extended trials of this equipment over the last two months and has consistently demonstrated highly reliable, broadband duplex satellite links, including unparalleled return-link speeds of greater than 24Mbps connectivity from a single 71cm equivalent aperture, using an Intelsat EPIC® HTS, all while mounted on a moving platform.

Phasor's very low profile, electronically steerable antenna (ESA) provides high-bandwidth services in a more reliable, robust and failure-tolerant way.

The antenna is solid-state, with no moving parts, so satellite signals are tracked electronically.

The ESA can be flat or conformal in design and can be fitted more seamlessly to moving vehicles, including an aircraft fuselage, a cruise ship or a high speed train.

The same technology is very well suited to support traditional fixed satellite networks (FSS), High Throughput Satellites (HTS), and Non-Geosynchronous (NGSO) satellite networks.

Moreover, the antenna's modular architecture allows the system to be scaled to virtually any use-case requirement, fixed or mobile.

David Helfgott, the CEO of Phasor explained that over the past several quarters, Phasor has made great strides forward and are now at the stage to prepare full Field/Beta testing.

He noted that with OmniAccess, Phasor aims to provide the best technical solution to the super yacht market; one that is very low profile (2-inches high), bandwidth efficient, aesthetically attractive, and scalable to accommodate a range of connectivity requirements.

Bertrand Hartman, CEO of OmniAccess added that his company is delighted that all are now one important step closer to making this radical new product available to clients in the very near future.

The Phasor Maritime Quantum Aperture™ offers a unique combination of low profile and high performance, while offering unprecedented scalability and many other advanced features. It has the potential to become a real game-changer, particularly when used to provide demanding ultra-high bandwidth services such as those provided by OmniAccess.

www.phasorsolutions.com/

www.omniaccess.com/

SpacePath Has Tango Wave Tech

The Uplink Amplifiers and Sub-Systems from Tango Wave are now Incorporated into SpacePath Communications

SpacePath Communications has acquired the satellite amplifier portfolio of Californian-based Tango Wave Inc. ('Tango Wave').

According to the company, Tango Wave's uplink amplifiers and sub-systems are among the most advanced on the market today, with small, lightweight, high efficiency designs offering superlative performance. With immediate effect, all Tango Wave development and production will be transferred to SpacePath Communications ('SpacePath') in the UK.

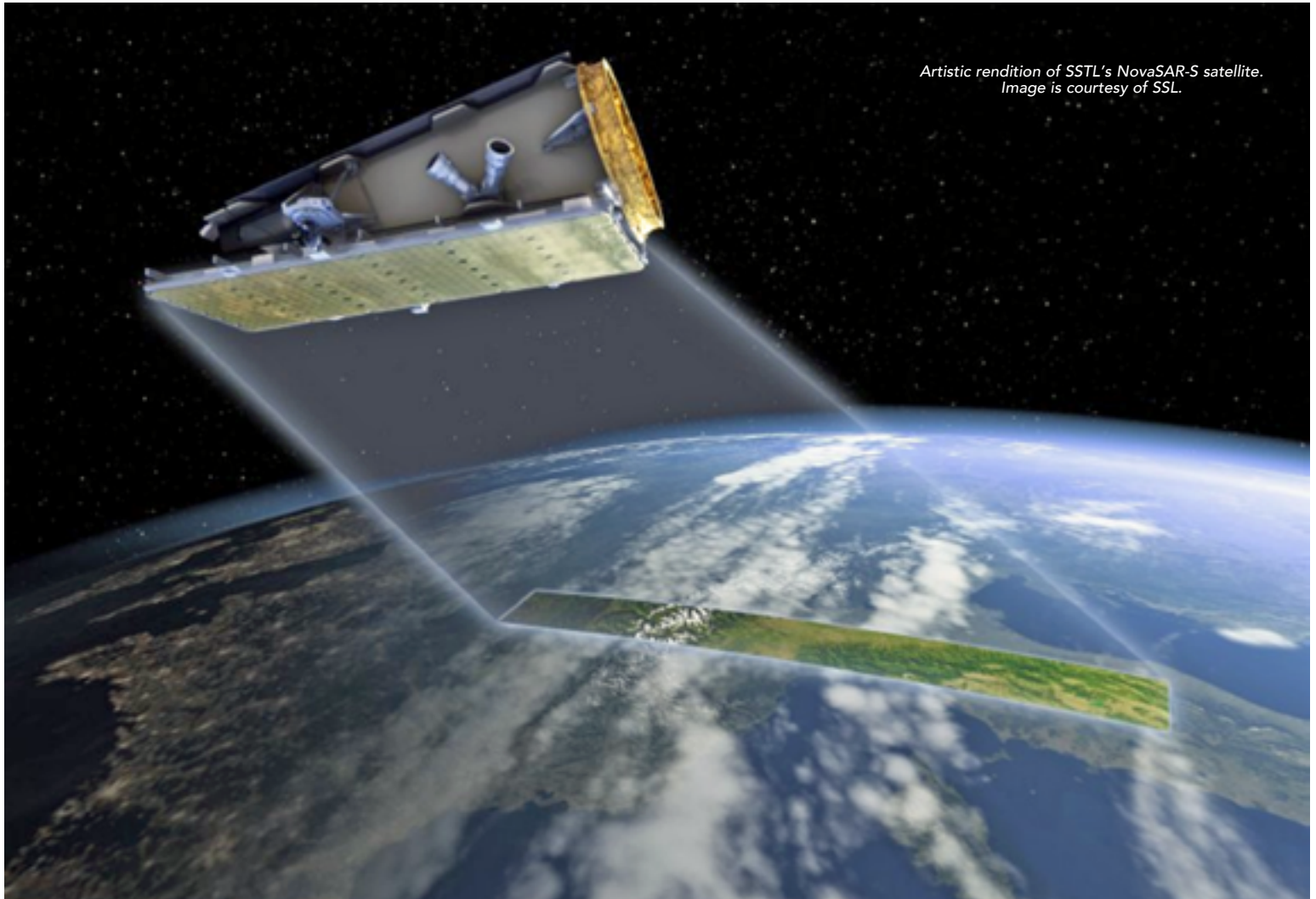
Among the new products soon to be available from SpacePath will be high power 1,250W Ku-band and 1,500W DBS amplifiers and systems which are ideal replacements for legacy klystron amplifier technology. Among other new additions will be Ka-band amplifiers with power levels up to 550W. These designs are the smallest and lightest on the market today which is essential to minimize losses when mounting in the antenna hub.

With the trend toward the development of amplifiers to support new uplink frequencies, the Tango Wave acquisition will also add high power Q- and V-band products, ready for the next generation of satellites.

Newton Burnet, managing director, SpacePath Communications, said this acquisition allows SpacePath to provide customers with the widest array of indoor and outdoor amplifier and subsystem designs, covering all frequencies and powers.

www.space-path.com/

Australia's Big Country, Big Sky, Big Ideas and SSTL's Small NovaSAR-S Satellite Deal



Artistic rendition of SSTL's NovaSAR-S satellite.
Image is courtesy of SSL.

Surrey Satellite Technology Limited (SSTL) signed an agreement in Adelaide during the International Astronautical Congress to provide Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) a 10 percent share of the tasking and data acquisition capabilities from NovaSAR-S, a first-in-class small radar satellite due for launch later this year.

NovaSAR-S is a technology demonstration mission designed to complement much larger, complex radar satellites with a smaller, lighter and more cost effective platform that delivers Earth Observation Synthetic Aperture

Radar imagery day and night, and through cloud cover.

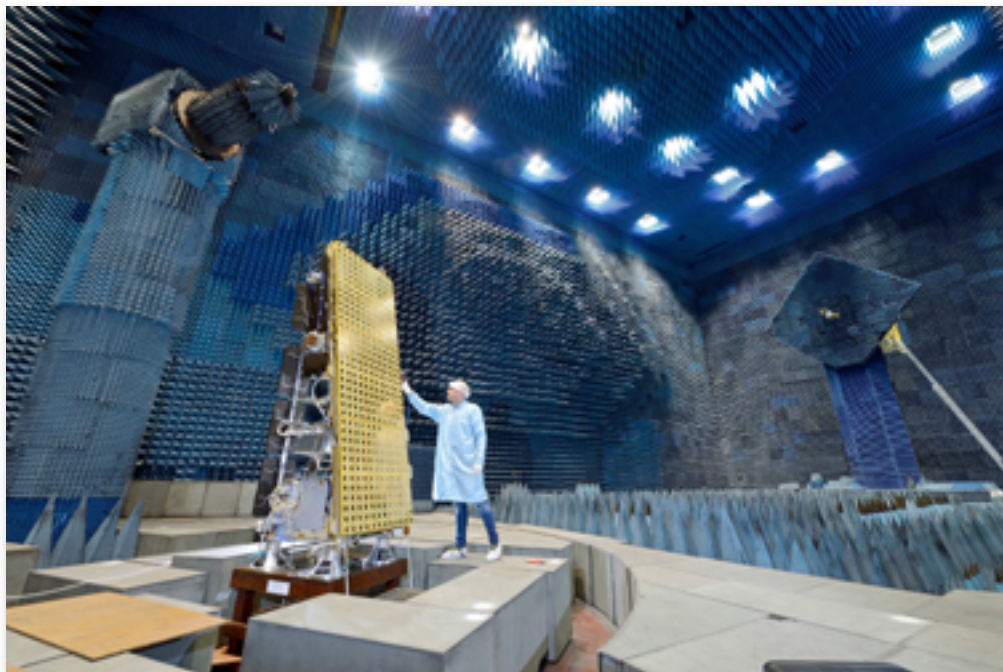
Managing the energy use on board the small SAR platform has been made possible by using a new, highly efficient S-band solid-state amplifier technology and flying an innovative S-band SAR payload developed by Airbus UK in Portsmouth

Speaking at the IAC in Adelaide, Luis Gomes, SSTL's Commercial Director said that they are delighted to be here in Adelaide for the IAC, and to see the Australian government's "Big Country, Big Sky, Big Ideas" slogan underpinned by today's announcement of their

partnership with CSIRO on the NovaSAR-S mission.

She added that they anticipate that CSIRO will greatly enhance Australia's sovereign Earth Observation (EO) capability with the addition of SAR data, particularly for this continent which has a tropical climate and a large coastline territory.

Gomes also confirmed that further data shares on the mission are available, commenting that with the launch of the satellite due later this year, they have a number of discussions open with potential partners on the mission but they also welcome new partners looking



*NovaSAR-S in the anechoic chamber for EMC testing (electromagnetic compatibility) and SAR payload testing. The chamber is part of the Triton test facility at Airbus Defence and Space in Portsmouth. The EMC test campaign demonstrates the compatibility of the spacecraft with the launch vehicle and confirms that all the systems and equipment on the spacecraft can operate at the same time without interference.
Photo is courtesy of Airbus Defence and Space.*

to take a data and tasking share in NovaSAR-S.

The agreement gives CSIRO tasking priorities and the ability to access the raw data directly from the satellite, and a license to use and

share the data with other Australian companies and organizations over an initial seven year period.

Dr. Dave Williams, Executive Director of Digital, National Facilities and Collections at CSIRO, said the deal represented a significant investment in Australia's space capability. He commented that the aim is to manage the NovaSAR satellite as a natural extension of the significant role CSIRO already plays in managing a range of National Facilities, on behalf of the Australian community of scientists and for the benefit of the nation.

He added that because they'll be able to direct the satellite's activity, it provides significant opportunities to support a wide range of existing research, further develop Australia's Earth Observation data analytics expertise, and create new opportunities in the field of remote sensing.



*The NovaSAR-S structure in the Assembly, Integration and Test Hall. The spacecraft's structure is made from aluminium and carbon fiber panels, manufactured at the Composites Facility in Bordon.
Photo is courtesy of Airbus Defence and Space.*

These new opportunities hold potential for building stronger research partnerships between the government, universities and the wider space industry in Australia.

The ability to image through clouds and at night using SAR technology provides additional and enhanced EO applications and opportunities in disaster monitoring, agricultural monitoring and forestry assessment which requires imaging on a regular basis regardless of cloud cover.

NovaSAR-S is also equipped with a wide >400 km swath maritime mode for ship detection across oceans and flies an Automatic Identification System to provide additional data for shipping, Coast Guard and customs authorities.

The UK Government provided £21 million to assist in the development and launch of NovaSAR-S and will also benefit from access to the SAR data, significantly boosting the UK's sovereign Earth Observation capabilities for applications such as ship detection and identification, oil spill detection, forestry monitoring and disaster monitoring, particularly flood detection and assessment.

www.sstl.co.uk/

www.csiro.au/

**[www.sstl.co.uk/Missions/
NovaSAR-S/NovaSAR-S/NovaSAR-
S-Small-satellite-Synthetic-
Aperture-Rada](http://www.sstl.co.uk/Missions/NovaSAR-S/NovaSAR-S/NovaSAR-S-Small-satellite-Synthetic-Aperture-Rada)**

Focus on Africa

A Conversation with Sean McCormick of Globalstar

Sean McCormick, the Botswana-based Chief Executive Officer for Africa at Globalstar, shares the satellite solutions that are assisting African industry to improve their operations and security as well as helping farmers and animal conservationists better protect livestock and wildlife.

What industry sectors are seeing the most growth in demand for Globalstar's solutions in Africa?

Sean McCormick

One sector experiencing fast growth in Africa is the fleet management sector. This is because cross-border goods transport is growing and is an important part of African economic development. At the same time, there is an increasing desire among transport companies for better, more far-reaching security and effective ways to mitigate theft.

The vast expanses of Africa have many areas with limited, or no, cell coverage yet logistics companies increasingly require continuous, uninterrupted tracking as goods transit between towns and countries. There is now a clearer understanding of the disadvantages of GSM-only communications and the benefits of using satellite communications or a hybrid approach.

With GSM, roaming charges are another big issue. As one network hands off to another, and sometimes crossing national boundaries, the costs can soon mount up. Data roaming is expensive, prohibitively so for many African businesses. Globalstar is helping to raise awareness that satellite technology is really an important consideration for ubiquitous reach, is affordable and is also a useful complement to GSM.



Globalstar has seen, and continues to forecast, a lot of growth in the farming sector. African livestock roam free, with no fences. However, livestock theft is a serious day-to-day problem.

The risk to herds can be exacerbated by the threat of predators. Farmers and ranchers are now embracing satellite technology as they see the value of using animal collars with satellite trackers integrated with geo-fencing and mapping software as a means of knowing where their stock are located.

There are other sector seeing growth as well — construction, oil and gas, mining, trucking, financial services — these are all set to see more demand for smart SATCOMs.



scientific engines for seismic measurement, as well as monitoring vehicles used to transport personnel.

VMD customized these deployments by adding a one-touch SOS button onto the vehicles' dashboards. If the driver or any passenger is in danger, requires emergency medical help or if the intervention of security forces is needed, a single button press alerts security teams and first responders can instantly know the precise location where help is needed. This level of always-on connectivity is an essential security measure in the remote regions in which oil operations take place.

Globalstar is probably best known for SPOT safety devices for consumers. What is the recreational market potential in Africa?

Sean McCormick

The tourism and recreation market is very important. Many adventures, such as safari, include traveling far off the grid. The hospitality industry is quite aware of the need to safeguard tourists and staff, including adventure travelers.

Africa hosts some of the world's most extreme sporting events and races, such as the annual Marathon Des Sables across the Sahara Desert, which SPOT has supported for the last three years. Also, SPOT has been recently appointed the "Official Tracking Partner" of the ABSA Cape Epic event series, known as "The Tour De France of Mountain-biking". In March 2017, more than 1,300 athletes on mountain bikes took on 691km of South African coastline with almost 80 percent of the race route being outside of cellular coverage.

Organizers had used a GSM based solution in the past — now, starting in 2018, they will rely on SPOT satellite communications for the first time. Moreover, through Globalstar's technology, the company is helping race organizers meet their requirement to demonstrate to authorities that adequate safety precautions exist to protect participants, officials, support staff and spectators.

Sean, would you share details of how Globalstar solutions are helping to protect African wildlife?

Sean McCormick

Globalstar's technology is being used in many places in Africa to track and monitor elephants, rhinos and big cats. For example, Globalstar-connected tracking is used in South Africa where rhinoceros poaching is a major issue. Recently, some 300 rhinos were relocated to safety at a protected national park in Botswana and now are continuously being tracked by conservationists using Globalstar's satellite network. Another instance finds a SPOT Trace painlessly inserted in a rhino's horn to track the animal while giving away no tell-tale visual signs to potential poachers.

Additionally, satellite solutions in support of e-government operations implemented in Africa in recent years are likely to continue to gain traction, and SATCOMs are widely used by NGO (non-governmental organization) and relief agencies.

Oil and gas is a key growth sector in Africa, where are you seeing satellite technology being used in this sector?

Sean McCormick

Companies in the oil and gas industry have been particularly progressive in how they have put satellite-enabled tracking to work. Early on, they embraced the Internet of Things (IoT) as an effective way to optimize the remote management of oil and gas pipelines, even reducing or eliminating the need to send a crew to an inhospitable location. Globalstar has announced several African deployments where we are helping companies better support their oil and gas exploration and production customers.

Early in 2016, a Tunisian civil works contractor, Kilani Enterprise for Public Works, deployed Integrated Vehicle Monitoring System (iMVS), developed by Globalstar's Tunisia-based partner VMD, to track their fleet of 4x4 vehicles, with the goal of achieving better fleet security.

The system also helps monitor driver behavior. iMVS gives Kilani Enterprise the precise location of their fleet while transmitting engine data, which indicates driver performance, such as sudden braking or unexpected acceleration.

Kilani Enterprise was already familiar with the usefulness of satellite communications because the company has been using Globalstar's SPOT handheld devices since 2013 as their only means of safeguarding staff who are carrying out operations in southern Tunisia's vast desert.

A Ukrainian oil services company, in another example, also uses this system to help their exploration and production customers monitor vehicle fleets and safeguard staff in the same region. The devices monitor vehicles used for transporting heavy engineering equipment, including

SPOT is even playing a role in helping to reduce illegal poaching. Security staff on game reserves are using SPOT to help co-ordinate their anti-poaching operations more rapidly than previously possible. If a crew member on patrol suspects an act of poaching, he or she can alert the team who can then track the crews via SPOT as they carry out their investigations.

Rangers often carry a two-way radio for basic communications. However, whenever the team needs to rendezvous in the bush, or if a team member gets lost, searching thick unmarked terrain for the crew member, who might be alone and/or in danger, can take hours or days without knowing their accurate GPS location.

With one touch of SPOT's SOS button, GPS co-ordinates are transmitted to rescue teams who then instantly know the precise location where their help is needed. If the crew is in pursuit of a poacher, fellow members in the anti-poaching unit can keep close watch over their movements via SPOT's Google Maps interface.

In another animal tracking deployment, SPOT Trace has been used to simultaneously track lions and neighboring farm cattle. In Botswana, there are no fences in wildlife reserves and people live among the animals. In these areas, keeping farm cattle safe from wild predators is the highest priority. With the help of a German research institution, villagers are using SPOT Trace as an early warning system to alert farmers and the local community when lions are getting too close to cattle, or the village.

How do you see the market for SATCOMs in Africa developing in the next few years?

Sean McCormick

I have been working with Globalstar for a decade, ever since the launch of the latest generation satellites, and there has been dramatic growth in Africa. SATCOM technology usage is advancing and is definitely on an upward curve. The prediction is for continued growth in satellite enabled tracking deployments across industry sectors and throughout the African continent.

In anticipation of continued growing demand in Africa for Globalstar solutions, the company is increasing our reach to better support African customers and are well poised to help accelerate market development. New specialist and regional Value Added Resellers (VARs) are being signed up, many of whom are actively developing new products. Globalstar is also working with Value Added Manufacturers (VAMs) on cost-effective, white label offerings.

Africa remains a young market in many ways. There is a lot of education going on currently in African industry. People are increasingly aware they need reliable, uninterrupted satellite-enabled coverage when tracking valuable assets, whether a digger, tractor or a farm animal.



Globalstar's SPOT GEN 3 and SPOT Trace products.

Globalstar is also fielding more inquiries from organizations that are interested in using SPOT as the basis of a lone worker solution. Essential workers often carry out their duties in extremely isolated locations, where they are the only person around for miles and miles. Game rangers, security staff, oil and gas crews and other remote workers can stay connected with colleagues, family and first responders with SPOT. More people are aware that SPOT is a valuable lifeline, giving protection to users as well as peace of mind for their colleagues and families.

Now, with Globalstar's Botswana Teleport live and performing at full steam, the company is succeeding in spreading the word that affordable solutions based on satellite technology can help diverse organizations across the African continent operate more efficiently and with greater security.

<https://africa.globalstar.com/en/>

Sean McCormick has more than 20 years' experience in the telecommunication industry in Africa. Sean's deep market expertise, operational experience and commercial skills have helped him to build several successful telecoms businesses in Africa, all of which continue to grow and expand.

His achievements include setting up one of Botswana's largest wireless ISPs, Botswana Broadband Internet. Sean has overall responsibility for Globalstar Africa operations. A key leader in successfully establishing Globalstar's Botswana gateway, Sean is committed to helping African businesses benefit from Globalstar satellite solutions.



Small satellites today have been a subject matter of great interest, and some intrigue. Their rapid growth rate, and ability to tag team with fellow spacecraft to take over workloads previously done by more expensive and elegant satellites, are at the root of current attention.

The question on everyone's mind is — "what does the future of this market hold?"

Mass Commoditization, Commercialization and a Tale of Three Industries

To gain better understanding of how the smallsat market might potentially develop, simply look at the "aisle path lighting" and other guide posts that are already out there. Fundamental bellwethers are no longer hidden from thoughtful observers.

Smallsats are rapidly becoming commodities. Today's small satellite market is behaving much like the mobile wireless and computing markets did when they were on the cusp of commoditization, commercialization, miniaturization, and falling price points characteristic of movement from "elite" to "commodity."

This shift happened within a few short years as smaller satellites <500 Kg (and specifically those under 150 Kg) continue to improve performance and increase life cycle. A recent analysis showed similarity of movement in the smallsat market to the mobile wireless and computing markets by comparing adoption and commoditization patterns through 20 years of research in patterning market and systems behavior. (See *New Space Journal*, Rhemann, M.K., 2017. *How Understanding Disruptions in the Mobile Wireless Computing Market Can Help Us Anticipate and Create a Healthier Smallsat Market*. *New Space*, 5(1), pp.27-32.)

Significant cost reduction has created new uses. Price points of fully loaded costs for launch and satellite continue to drop to 1/10th and, in some cases, 1/20th of last decade's cost structures. Their relative value proposition will continue to rise profoundly as long as they remain cost competitive.

Satellite Use is changing. The late 1990's U.S. ITAR crack down on the satellite industry forced a divergent market, and supply chain differentiation, in the satellite and telecommunications industries. Both developed separate markets, industry associations, and followings based on ITAR impact. Follow-on rapid democratization of mobile telecommunications in Asia, South America, Africa, and the Middle East, had a strongly non-traditional effect by creating droves of new mobile users willing to skip dominant market

models and leap-frog directly into next-generation communications.

Meanwhile, on a global basis, "millennials" began to seek micro-banking apps and network ubiquity. As of 2016, 4.7 billion people have a mobile internet connection¹. Multi-billion dollar investments in infrastructure for emerging nations, such as fiber and cable installations and rampant build outs of 3G/4G/ LTE mobile wireless networks in South America, has reduced some dependencies on traditional satellite providers.

Mobile Wireless, Computing, and Small Satellites have increasing synergies. As mentioned, the smallsat industry is showing signs of becoming a commodity industry, much like computing and mobile wireless device industries, with similar demand curves. Additionally, commoditization will continue to impact load balancing between networks and devices, much like was seen in the 1990's when debates emerged over intelligent networks versus the smart devices.

Some terrestrial services are becoming "substitute" products for satellite as continued network convergence and ubiquity unfolds globally. As 2020 approaches, smallsats promise to play multiple roles in load distribution by providing and moving data across converged systems as network ubiquity and convergence continue to unfold.

A Story of Underlying Demand

Recent analysis indicates future smallsat demand is driven by broadband and underlying mobile wireless demand, constituting nearly 80 percent of the future market when measuring underlying demand, investment dollars, and anticipated future payloads. The other 20 percent of the market will consist of 17 percent imaging and 3 percent AIS and other low data rate functions. Near insatiable demands for data communications will inexorably gravitate toward lowest cost points for moving global traffic, which could well become smallsats.

"Where is this pent-up demand coming from?" The short answer is "Everywhere!"... cars, TVs, toasters, and the Prada trousers you just tried on at the boutique. In the future, these trends continue as mobile video (for automobiles, advertising, mobile conferencing) becomes 69 percent of mobile traffic by 2025, followed by social networking, with 16 percent anticipated market share, with the remainder being apps, web browsing and other traffic.

The global telecommunications market looks much like it did in the 1990's with bandwidth bottlenecks occurring everywhere. Mobile video, data feeds from autonomous

vehicles and the emerging IoT are on target to constitute 10,000X data traffic growth, growing by an order of magnitude every five years as all move into the 2020's.

Global economic growth in 2016 was roughly 3 percent, with escalated growth coming from emerging economies. The drive to expand global GDP through reaching the "other 3 billion people" has redefined future use for satellites as they continue to become more economical, and as the world seeks economic growth through connectivity. A 10 percent increase in broadband penetration can equate to a 1 percent increase in GDP.

However, in order to get growth, a new crop of consumers is needed. As the U.S. and industrialized nations become increasingly saturated markets for broadband and mobile services, consumer growth for companies such as Samsung, Facebook, Coca Cola, and Google will be achieved by linking electronically with new and younger populations of consumers globally². In many emerging nations, broadband communications is considered "infrastructure" and included as part of government planning functions.

Architectures are Shape Shifting

Movement toward architecture ubiquity is driven primarily by broadband and other communications where future architectures deliver 3G/4G/ LTE, and future 5G/6G, by reaching between terrestrial domains to space to be further connected and enabled by LEO, MEO, and GEO architectures. The SES acquisition of O3B is symbolic of this architectural direction. SES's acquisition of O3B, and Intelsat's and OneWeb's collaborations on LEO/GEO partnership, portend dramatic changes in future meshed architectures that will span from terrestrial mobile wireless, multi-G networks, and LEO and GEO constellations.

These new partnerships are resulting in expanded lower cost network offerings, such as O3B's 2013 wireless trials with Huawei to deliver mobile 3G voice, data, and video. This large scale "architecture shift" is likely to continue, as is a move to "design your own" as cost/technological barriers fall and improvement scales up through new investment and volume. In fact, convergence and small satellite inclusion is a theme in meshed architecture planning by the 5G planning organization (5G-PPP). The broad sweep of next-generation mobile wireless systems throughout Asia has created a more utilitarian view of small satellites, seeing them more as node extenders for wireless networks.

It is easier to gain a glimpse of future architectures by appreciating past lessons on how mobile phones/networks incorporated WiFi, WiMAX, NFC and IP routing to other networks, by interconnection with external "faucets" for bandwidth, whether cellular, cable, or satellite. Software compression, miniaturization of antennae, and advanced software applications continue to improve speed and reduce latency. Meshed ground architectures and small cell networks have become rapidly configurable and can utilize

mixes of regulated and unregulated spectrum. Antenna manufacturers such as Kymeta are leading the way for low-latency miniaturization of reception technologies.

Reliable, Agile, Low-Cost Launch Becomes More Competitive Toward 2022

Shorter satellite life cycle demand and rapid replenishment will continue to drive, reliable, agile launch, as cost pressures ensue for subsequent-generation replenishment of constellations. Due to the overall volume and launch intensity required for shorter-life smallsats, the market is fundamentally shifting to a meshed architecture approach to providing communications services. It is anticipated, based on forward trends analysis, that underlying unit costs (based on demand) will likely force increased price competitiveness in launch beyond 2022, thereby changing the competitive landscape.

The Future of the Market

Overall, the market bodes well for both smallsats and small launch. Though failure is certainly possible for some constellations, lower price points, rapid innovation and replacement, commercialization, and miniaturization, create an energized environment for ongoing technology infusion and cost reduction.

Taking OneWeb as an example, with a price tag of less than \$3.5 billion, it is still a relative bargain. It is instructive to recall that in the year 2000, SBC Communications was involved in a \$6 billion dollar effort merely to bring broadband to a handful of U.S. states. Even if large constellations ultimately fail, the next iteration is likely to succeed. As we've learned from terrestrial networks, price competition and M&A activity, as unit prices go down economies of scale, must occur.

Market models that own both satellite and launch will likely reap more competitive advantages as future cost pressures ensue. Further, the business model behind the business model could be staggering: Broadband by satellite (if done efficiently) could, in the future, allow some VOIP models to one day replace carrier grade mobile telecom as we know it today, depending on many factors such as capital markets, global recessionary tendencies, and geopolitical factors. **Whatever happens, it is going to be exciting!**

Footnotes

¹GSMA, 2016

²SEC Filings Facebook, Samsung, Coca Cola, and comparison/benchmark companies, Future market value; valuation models; World Bank growth trends; IMF emerging market data

Maureen Rhemann is the Sr. Executive and Strategist with the Reperi Analysis Center (RAC) and its research arm, Trends Digest™, specializing in disruptive trends, applied R&D, M&A, and predictive algorithm development for private client in space, mobile wireless, telecommunications, and computing. Maureen has been an analyst and strategist for 25 years working with Fortune 500 C-suite executives, senior public sector executives, and has served as the author, engagement lead or P.I. on more than 120 studies. ou can reach Maureen at maureen@trendsdigest.com

Innovation: Replacing a Dish Antenna With an Antenna Array

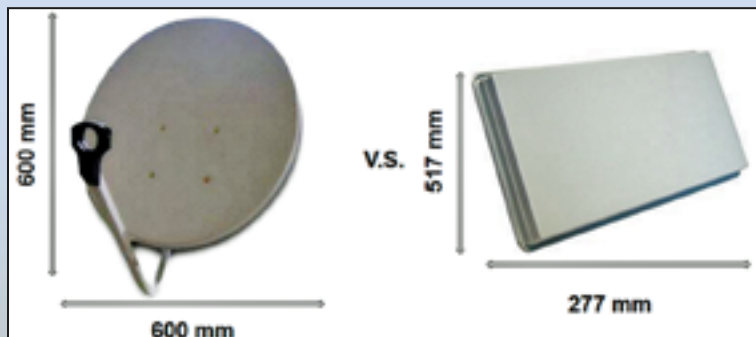
by Dmitrii Shubin, Shubin Satellites

The idea of replacing satellite dishes with flat antenna arrays (FAA) is not a novel idea.

However, there are only a few companies who have been successful in the implementation of this technology.

First, it is important to understand why FAA is a focus of research in consumer electronics. The answer is that there are several advantages of FAA over satellite dishes.

FAA has smaller dimensions than a satellite dish. For example, a 0.6 meter dish may have the same gain value as a 0.517x0.277 meter analog, which is up to twice as small. Moreover, FAA has no external LNB converter — the LNB is placed on the back side of the array. Plus, the weight of a 0.6 meter satellite dish is about 7 kg. With the same gain value, flat analog may be up to three times lighter.

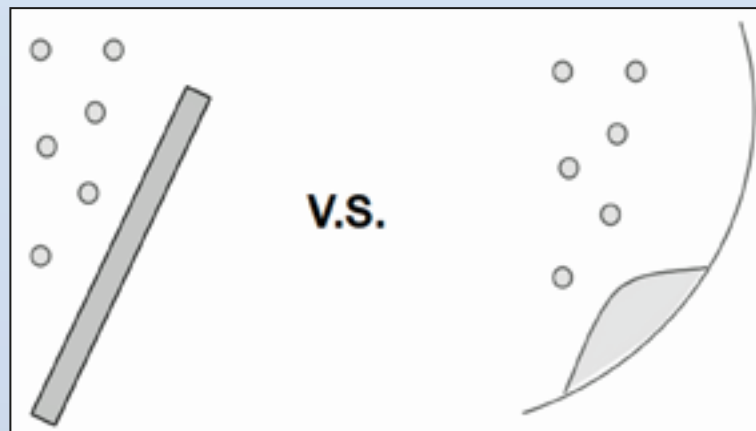


Small size, low weight and a much more attractive look allow customers to place their antennas on a balcony or patio, with the unit being much less noticeable than a dish. Also, the lighter weight allows customers to save



money by handling the installation by themselves.

In colder regions, snow sticks to the dish cavity surface during the winter. This interferes with the antenna beam and damages the quality of the incoming video stream.

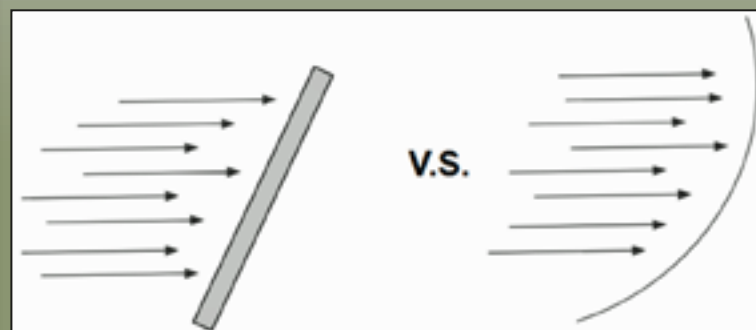


The flat surface of FAA prevents any build up of snow, which makes the unit the ideal technology for northern areas.

In addition to size and weight, ease of installation and better adaption to cold weather, FAA has undeniable economic advantages. Due to its much smaller dimensions (517x 277 meters versus 600x600 meters), FAA is twice as inexpensive in terms of storage, transportation and packing logistics.



Additionally, the flat ergonomic design and small size decreases the effect of the wind as much as 6.5 times. The lower weight substantially cuts costs for the manufacturing of the parts required for fixing the unit, should such



become necessary. For mobile satellite TV purposes, the low weight of the antenna structure compared to the 0.6 meter satellite dish may also cut costs for a motorized orientation system. There are two main and important reasons why FAA has not yet replaced satellite dishes.

The first is the complexity of providing double-polarization for FAA, which means the customer may get access to only half the number of TV channels, and that makes this system less attractive to consumers. Also, the polarization problem has not yet been adapted to accommodate the trend toward multi-TV receivers, when access to different channels needs to be available for simultaneous display on different, independent screens. As of this writing, SelfSat and Satgear are the only two companies who have solved that problem.

The second reason is the price. The price of FAA is still too high for the mass market. For example, SelfSat's H30D1 or Satgear's Flat 440 Portable cost about \$80.00 in the European Union. In contrast, a 0.6 meter dish can be purchased for approximately \$38.00. As a result, the market is wide open for companies who are ready to solve these two problems.

The Shubin Satellites team has developed an alternative to the Selfsat and Satgear models — the specifications of this new configuration are listed to the right above:

Parameter	Selfsat H30D	Satgear's Flat 440 Portable	New configuration
Surface Area	143209 sq. mm (517x277 mm)	193600 sq. mm (440 x 440 mm)	117425 sq. mm (427 x 275 mm)
Thickness	58 mm	10 mm	40 mm
Gain at 12.75 GHz	33.7 dBi	34.8 dBi	33.7 dBi
Self-cost (with single LNB)	~ 55\$	~ 55\$	~20\$
Weight (with package)	2.7 Kg	4.7 Kg	~2 Kg

For additional information, the email contact is **shubin.satellites@gmail.com** or via **LinkedIn** at **Dmitrii Shubin**

Dmitrii Shubin studied at the Peter the Great Polytechnical University, Department of the Radio and Telecommunication Systems, and obtained a bachelor degree and then in the Department of Innovative Entrepreneurship, earning a Masters degree. He is an independent researcher in the fields of radio and telecommunications, RF systems and signal processing. Dmitrii has worked on spectral density enhancement for satellite communication television systems. From 2014, Dmitrii worked on scientific and applied activities in antenna systems for smallsat platforms as well as consumer electronics.

The Forrester Report: Bedazzled by Bezels and Pixels

IP means the end of 'conventional' TV

by Chris Forrester, Senior Contributor

The typical news from the two giant European technology shows in September — Internationale Funkausstellung (IFA) in Berlin and Amsterdam's IBC — told it all and usually included IP and/or UHD/HDR somewhere in the headline. VR and 360-degree capture and display were also far from ignored. As usual, IBC's Hall 1 was dominated by the world's satellite operators.



The important German Home Electronics Market Index (HEMIX) delivered up excellent news for IFA, saying that Consumer electronics sales in Germany saw a 2.4 percent YoY rise in sales to nearly 12.5 billion euros (\$14.8 billion). Entertainment

electronics and telecommunications were up 9.1 percent and 4.6 percent, respectively. TV sets noted a 3.1 percent growth in value with sales of almost 2 billion euros (\$2.4 billion) and were up 3.4 percent by volume to 3.4 million units. The conversion from DVB-T to DVBT2 HD broadcasting led to the sale of 3.4 million STBs (up 172 percent), costing 349 million euros (\$412 million, up 255 percent). IFA also commemorated 50 years of color TV in Berlin, which made its first transmission on August 25, 1967.

Meanwhile, both shows were awash with the latest examples of high-end TV products, whether LG's wonderful OLED devices, or Samsung's Quantum Dot (QD/QLED) ranges, or the rival UHD offerings from Sony, Panasonic, Hisense and Vizio. Add in Dolby Vision and Atmos and there's another suite of confusing claims for the viewer to weigh. Incidentally, Samsung said that in the 'premium' price ranges (\$1,500 and up), they hold the Number 1 position, globally. Samsung, quoted by Large Display Monitor, said that while these TVs account for only 5 percent of the volume of the market, they account for 20 percent of the revenue and 40 percent of the profits.

According to Samsung's own statistics, Samsung TVs maintained their first place standing in the over-\$1,500 global premium TV market in the second quarter of 2017, with more than 40 percent of market share by sales volume in all the major global markets, except China, where it was number one but with around 30 percent market share. Samsung's market share remained above 40 percent in North America and Europe, the major battlegrounds of the global TV market. Samsung TV also recorded approximately 50 percent market share in Central and South America, and a higher percentage than all other competitors combined in the Middle East, CIS, African and Korean markets.



Of course, adding further to the complex decision-making process for buyers, are to go flat or curved, bezel or bezel-less, or so-called 'super narrow' bezels. Consumers have never been so bedazzled by bezels. However, there was one dominant message: UHD is here to stay, so while bezels might be important in the sales literature, it is pixels that actually matter, and the minimum 10 bit and 12 bit (and more) for High Dynamic Range. There was also considerable show chatter about 8K coming along soon.

Of course, there was plenty of debate about broadcasting standards to help jolly the conferences along. But, read these words from Sotiris Salamouris, CTO of Olympic Broadcasting Services, and already supervising the build-out of the 30,000 square meters broadcast center at PyeongChang, South Korea, in readiness for this winter's Winter Olympics. As well as managing the challenges of getting signals down and around the mountains, or along the narrow valleys of the region, he also has to cope with 4K/HDR, and 8K.

By the way, planning in detail for the 2020 Tokyo Olympics is underway. "For us, 8K is an interesting element!" admitted Salamouris. With our long-standing partner [Japan's public broadcaster] NHK we are also creating an 8K platform from PyeongChang. We have worked with NHK in a very strong partnership on 8K since the London games, which means that with London, Sochi, Rio, and now from Korea it will be the fourth Games that we have covered in 8K in some form. Today's 8K productions are advancing and becoming more and more sophisticated, and the whole setup becomes much closer to the 'normal' HD production. There is still much to be done. The biggest change for Korea in 8K and that of Rio is the introduction of HDR and the BT 2020 wider color gamut. It really is the 'Full Monty' in terms of 8K. The only thing missing if you really want to get to the final frontier is higher frame rates. Our colleagues from NHK are working on this, of course.



"For PyeongChang, we also have a quite complex 4K operation but we will, in general, down-convert the 8K images because camera positions are sometimes precious. Our 4K coverage comprises two key elements: we will produce 4K/HDR but with standard dynamic range availability to satisfy the needs of the majority of our broadcasters. This is because the number of HDR-equipped TV sets is still modest, but we are also supplying the down-converted from 8K to 4K with HDR for those who want it."

Salamouris predicts that the constant discussion over HDR, as well as 4K and 8K, could soon end. "Our industry has been moving from standard definition to high-def, and now to 4K and with 8K in front of us. But I would hope that we also accept that there's another revolution and that is in IP-based technologies which is happening in parallel, and that includes live capture. We have also to be aware that distribution is no longer just to TV sets, but to other devices including OTT delivery. I'd like to see these elements coming together and to be seamless for the viewer, and irrelevant. Perhaps by 2022 or 2024 we will no longer be talking of 4K or 8K but instead talking of excellent quality because my device will support it, and then perhaps medium quality because I have not yet bought the latest display, and then a good quality but visible on hand-held devices. We must be able to mix and match the images to suit the devices. We are still in a transition period but moving towards this situation."

"We know that pretty much every set sold today is 4K. But the traditional broadcasters, and our clients, are struggling to adopt 4K. They have legacy issues and technologies still to change, but they are changing and the adoption of IP technologies is key. But it also a 'chicken and egg' situation, with complaints that there's not enough content for the devices out there, and also the distribution chains are not quite ready. The problems are being solved, but it costs money, and amortizing these investments, and there are threats and competition from the OTT providers who do not have these legacy issues. In other words, the whole picture is extremely dynamic. But jump forward a few years and we will not be talking about image resolution."

Bill Baggelaar (SVP/Technology, Sony Pictures Entertainment) also majored on the topic. Baggelaar is passionate about UHD and, in particular, the visible difference High Dynamic Range (HDR) can make to a production. "We look at UHD right across the board, on all of our productions. Not all of our broadcast clients want us to finish a show in UHD/HDR but as far as episodic TV is concerned the technology is extremely important," he said.



"It is also important to remember that a first transmission, perhaps of a show like *The Blacklist* [on NBC], might not be required in 4K/HDR but ancillary sales [to Netflix] might require the improved quality. I don't want to just focus on *The Blacklist* but you don't want a situation where you have a wonderful hit show where Season 5 is in UHD with HDR but not Seasons 1-4! It was the same with *Breaking Bad* [for AMC], where the series was shot on 35mm film, so we had the opportunity to go back and remaster all of the episodes in UHD. The entire series just looks wonderful on a 4K set."

He admitted there was a cost impact on workflow for UHD. "But I want to make it clear that we see HDR as a growing area, and there are benefits all around, not least from Netflix and Amazon in terms of ancillary sales. Of course, all of our Theatrical titles are created with streaming and Blu-ray disc, and now UHD Blu-Ray in mind. For TV, I know that HDR is going to be increasingly important wherever we think there will be future demand. It might not be needed for today's broadcast outlet, but down the line it has to be available."

Baggelaar, not unnaturally, didn't want to suggest that movies and high-end drama were not important in driving consumers into the stores to buy HDR-equipped TV displays. "Consumers do that for sport," he admitted. "But we add to the drive, the demand, for 4K. On the broadcasting side it is a fact that the networks love the benefits, and would transmit if they could. They just need to figure out how to do it in a reliable and cost-effective way. Then you'll see an HDR avalanche happen."

Brian Sullivan, until two years ago the CEO at Sky Deutschland (and previously 14 years with BSkyB's Customer Group), is now heading up Fox Network's Digital Consumer Group. Sullivan joked that he'd like to announce a Hologram service at IBC, but said the USA's adoption of Ultra-HD was getting close and much closer than people realize. "All of the major studios are shooting in 4K/UHD and we have been for a couple of years now. Sports, in many cases, is already in 4K. The financial models are becoming clearer. The high costs of a few years ago are now less. But there's still a big difference, and that is to compare UHD with HD. Yes, of course, it is better, but the move to HD coincided with a massive shift to flat-screen digital TV sets, and the demise of the Cathode Ray Tube. For the consumer sector you do not have that same shift from flat screen to flat screen, and this means a slower TV replacement cycle."



Sullivan also brought the debate back to basics. "All this technology is wonderful. But it is always about the content. Nobody cares about the challenges and headaches we have had. They just want to access our programming, and we are one of the Big Five content factories in the world. With consumers expecting to dig deeper and faster into our content, we have to get that technology and architecture right. But it is all about the content. Nobody ever bought a service because of the neat user interface! What we are doing is a real game-changer."

Senior Contributor Chris Forrester is a well-known broadcast journalist and industry consultant. He reports on all aspects of broadcasting with special emphasis on content, the business of television and emerging applications. He founded Rapid TV News and has edited Interspace and its successor, Inside Satellite TV since 1996. He also files for Advanced-Television.com. In November of 1998, Chris was appointed an Associate (professor) of the prestigious Adham Center for Television Journalism, part of the American University in Cairo (AUC), in recognition of his extensive coverage of the Arab media market.

The Coming of Age of Smallsats

A BIS Research Report



Imagine flocks of small satellites (smallsats), hundreds in number, orbiting around Earth right now... satellites that are the size of a youngster's play action figures.

Almost two decades ago, smallsats were merely ideas on a paper. Then these tiny spacecraft began to take shape, thanks to California Polytechnic State University (Cal Poly) and Stanford University, institutes of higher learning that developed the specifications for what are now known as CubeSats, intended for space research and exploration.

For the past two years or so, the smallsat market has been moving along an accelerated growth path, with a record number of them having been launched during the first half of 2017. The global smallsat market is expecting tremendous growth, with the market estimated to reach \$6.35 billion by 2021, according to BIS Research.

The market will grow at a CAGR of 37.91 percent during the time period from 2017 to 2021. The next five years will

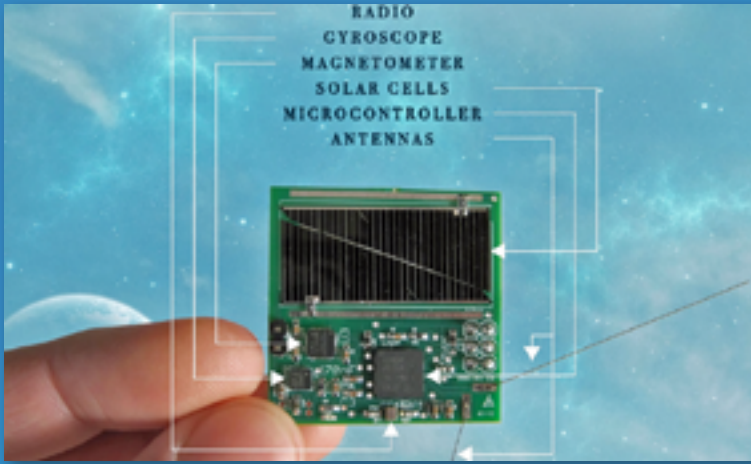
witness a steep rise in the number of launches of smallsats as the world accelerates the application of smallsat technology solutions to various programs and products.

Smallsats have been widely used in academia for various spatial research purposes for many years and are now being demonstrated as viable tools for weather forecasts, Earth imaging, and so on. Smallsats are proving to be a boon for space exploration as well as for the communication sectors as these spacecraft are efficient and cost-effective.

On June 23 this year, 30 smallsats were successfully launched by the Indian Space Research Organisation (ISRO) into Low Earth Orbit (LEO). This payload included six satellites from the company Breakthrough Starshot called "Sprites." Each Sprite is just a 4gm flake of a circuit board that is 3.5cm on a side, comprised of solar panels, computers, sensors and communications equipment.



Artistic rendition of CubeSats in orbit. Photo is courtesy of NASA.



*The Sprites carry solar panels, computers, sensors and radios.
Photo is courtesy of Breakthrough Starshot.*

These satellites are the smallest to have orbited around Earth. The Breakthrough Starshot project, backed by the most famous cosmologist of our time, Stephen Hawking, aims to send a fleet of these small spacecraft to the closest star system, Alpha Centauri, which is located about 4.37 light years away from Earth.

Several established companies, as well as startups in the aerospace industry, are looking forward to developing their own small-sized launch vehicles that will be targeted to launching CubeSats into LEO.

One such example is Fleet Space Technology, based in Australia and founded in 2015. This company is vying to solve the demand of connectivity for the ever-increasing number of Internet of Things (IoT) devices finding their way to market. As the firm states on their infosite, *"Our mission is to Connect Everything, using cutting-edge communications and space technologies to maximize the resource efficiency of human civilization and enable the next industrial revolution with our free, ubiquitous connectivity platform."*

These small spacecraft are evolving rapidly, thanks to the formidable advancements in technologies for satellite subsystems, such as 3D printed electronic satellite equipment, onboard internet system, agriculture management and natural resource identification as well as electronic and propulsion systems.

The extensive demand for smallsats has also been noted in the defense and security segments for use in various applications such as intelligence, surveillance, reconnaissance, and navigation — the North American and European regions currently lead this market.

Kestrel Eye, an electro-optical smallest developed by the U.S. Army Space and Missile Defense Command, was launched by SpaceX in August and was developed by relay orbital reconnaissance imagery directly to warfighters on the ground, rather than through ground stations that are based in the U.S. The U.S. Army states that at a price of approximately \$2 million each, more smallsats with military capabilities can be readily launched more rapidly, as opposed to the more conventional satellites.



Artistic rendition of the U.S. Army's Kestrel Eye smallsat.

According to the analysts at BIS Research, *"Among applications of smallsats, the communication segment is expected to foster a high growth rate of 46.61 percent in the market, owing to an increasing number of small satellite constellation systems for varied applications. Companies are building large clusters of smallsats, primarily to facilitate communication services for mobile connectivity and access to the internet."*



The estimate is that by 2050, nine billion people will inhabit the Earth. As a result, the pressures on the agricultural industry will increase, along with the crucial need for water sufficiency.

IoT is poised to play a major role in monitoring the processes involved in these areas, such as production, processing, shipping, security, and more. The functionality of IoT will be facilitated by smallsats, as that market segment requires low bandwidth and will be far more efficient in covering wide areas from their LEO orbits when compared to the use of WiFi on the ground.

Numerous countries are investing huge amounts of their resources as they tackle space-based solutions for research and development — now, even less developed countries such as Nigeria and Bangladesh are successfully launching their own smallsats. The comparatively low price for the development and launch of smallsats also provides a cost-effective platform for training and research.

The increasing need for satellite miniaturization and the enhanced capabilities of electronic technology have boosted the demand for smallsats across the globe. The demand for smallsat constellations continues to grow and the industry is facing various challenges in meeting this rising demand to develop safe, low-cost and small payload spacecraft to launch for orbits far beyond LEO, as well as designs being considered for these spacecraft to assist in cleaning up dangerous space debris.

Countries are increasing their interests in smallsats and are expected to create a pool of lucrative opportunities for new as well as existing actors in this market. According to BIS Research, the nanosatellite market reported a revenue of \$127.20 million in 2016. Over the coming years, the government will emerge as the highest revenue generating end-user segment by 2021, accounting for 24 percent of the overall market share in 2015.

The need for instant connectivity and efficient GPS for various purposes has set the smallsat market on a stride toward even greater utilization. The commercial end-user market is estimated to register the highest growth in the smallsat market, owing to the development of new and diverse satellite applications that will address communication, remote sensing, Earth Observation, and navigation for use by commercial industries such as IT & telecommunication, agriculture, mining, and oil & gas, according to BIS Research.

North America has always been at the forefront of technology developments — and that statement also applies to smallsat technology. The U.S. government's budget for the space industry accounted for 13.8 percent of the global market and that percentage is expected to increase over the coming years.

The U.S. employs the transformational developments created by NASA and American entrepreneurs — all are highly motivated by their desire to explore space through the deployment of cost effective small satellite constellations. Increases in investment and research activities by the government, as well as the companies in developing enhanced satellite subsystems, such as solar electric propulsion system, laser communication system, and more, is expected to foster the high growth of the North American smallsat market over the next five years.

The space industry is driven by the demand for increased connectivity for smart devices, Internet of Things (IoT), increased data analytics, and migration to streaming broadband. Governments and the companies in the global space industry are investing in new space infrastructure, especially in smallsats.

Companies are also focusing on developing efficient subsystems to decrease the size and complexity of their space ventures, thereby facilitating the use of smallsats. This environment is driven by a staggering number of startup companies who are venturing into the market and succeeding in providing highly useful satellite applications, such as broadband communications, remote imaging, navigation, and much more.

In the last 50 years, 38 pico satellites, 680 nano satellites and 860 microsatellites have been launched, worldwide. An estimated number of more than 3,600 small satellites, including nano, micro, and pico, are expected to be launched over the next ten years.

The advanced concepts of a connected world and interstellar missions have become far more viable with the advent of smallsats.

bisresearch.com/industry-report/global-small-launch-vehicle-market-2026.html

"Go For Launch!"

Spotlight on EXOS Aerospace Systems and Technologies

by David Mitchell, Co-Founder and President, and,
John Quinn, Co-Founder and Chief Operating Officer, EXOS Aerospace

EXOS is working through the process of completing a launch license with the FAA for the firm's new SARGE Rocket — a launch date is planned for on December 9, 2017, from Space Port America in New Mexico.

What Does EXOS Bring to the Scene?

The company has more than 12 years building hundreds of rocket engines as well as designing, building and flying reusable rockets and landing them within a few meters of the launch site itself. This experience brings reliability in engine and rocket performance.

The EXOS team has built lunar landers for NASA, developed rocket engines which have been used in manned flight and has won more than \$1 million in prizes for rocket and guidance designs through the Northrop Grumman Lunar Lander Challenge as well as the X-Prize Cup competition, which is funded by NASA. EXOS engineers are also known for their rapid prototyping system which reduces design and product evolution by years and saves their clients' capital.

The EXOS team designed, built, flew, and landed the first reusable rocket on September 16, 2010 — five years before Blue Origin accomplished a similar landing.



This experience allows EXOS to jump ahead of competitors with less experience, and to provide safe, lower cost services to clients.

SARGE is a suborbital rocket and represents stage one of the company's mid-term plan. Phase two will include development of orbital rockets by 2020. With sub-orbital rockets, there are many opportunities to help clients who need to find a less expensive way to get agricultural, biological, medical, and other zero G experiments into space. There are also affordable ways to pre-test payloads and get them ready for a later flight to the ISS.

EXOS can assist clients in the following areas:

Payload integration

EXOS' payload integration methods are the most efficient on the market, which allows the company to launch payloads and then promptly provide data to clients during microgravity time.

Tie Down Test: 08.17.17



SARGE rocket being tested.

(NASA has asked EXOS engineers for advice on how to speed up payload integration.)

Access to data in real-time

Clients may access their experimental data during the actual launch through EXOS' live streaming data option, providing live interaction with experiments during zero G time.

Access to payload in minutes

EXOS' state-of-the-art retrieval system allows clients to access their payload in minutes because the rocket flies back to the launch point.

Saving Time and money

Time and money is saved on Research & Development expense for International Space Station or any other flight preparations. When EXOS flies micro G pretests or validation experiments, clients save time and money. Due to EXOS re-usable launch vehicles, waiting periods for payloads are much shorter, and the cost is greatly reduced.

The possibility of being able to do micro G testing a few months from now (rather than years) for biomedical and pharmaceutical research, fluid and fundamental physics, materials science, aerospace engineering, or on space exploration hardware, has not existed before — now this can be accomplished through EXOS. View the "SARGE Rocket Payload Users Guide" for technical details at **www.EXOSAero.com** and prepare to enter the realm of rapid experiment validation that supports tests and retests in months rather than years.

Companies that need R&D results for "public release" before the next annual earnings report can now allow EXOS to get them there.

Rapid Prototyping

NASA has requested EXOS Engineers to do Rapid Prototype training. The Rapid Prototyping Edge (RPE) can help companies launch into a rapid R&D program that can support and hasten their revenue growth. EXOS is known for its micro G R&D program and can provide a Rapid Prototyping Edge for companies.

Helping Educational Institutions

EXOS Aerospace Systems & Technologies, Inc., can help Universities, High Schools, even Elementary Schools have access to, and the ability to navigate through the complex world of federal, state and industry grant programs in the areas of biomedical and pharmaceutical research, fluid and fundamental physics, material science, aerospace engineering, space hardware or any other field.

Testing Space Manufacturing Systems

EXOS can help companies test their manufacturing theories in microgravity and vacuum environments for a fraction of the assumed cost.

EXOS C.O.O., John Quinn, recently conducted an interview with the Rising Tide publication in Ft. Worth, Texas.

"We can serve payloads that were previously not feasible to experiment with in space because we bring those payloads directly back to the launch area about 20 minutes after launch. This opens up a whole new level of discovery in space for research and manufacturing.

"We're completing all the final tests on the SARGE platform and this technology demonstration represents the team's commitment to overcoming all the obstacles along the way. We built a vehicle that delivers on our goal to make space more accessible and we will share the thrill of making that happen with the whole world in the last quarter of the year as we fly to space from Spaceport America.

EXOS is planning for monthly launches starting in 2017 and is now accepting Launch License requests for the 2017 and 2018 calendar years. Additionally, the company is positioning themselves to provide launch services weekly starting in 2018 and beyond.

Future Plans

EXOS' mid-term plans include going orbital by 2020. At that time, EXOS plans to be the "truck" hauling commercial, government and military smallsats into space. The smallsat market is estimated to be a \$2.52 billion market by 2020.

Watch the skies on December 9, 2017, as the first SARGE rocket from EXOS burns a trail in to space and the company places their claim in commercial space race real estate.

For more information on EXOS, please contact us through our website, **www.exosaero.com** or call us at **844-AT-WARP3**.

David Mitchell is an entrepreneur, national Radio Show Host ("The Word on Investing"), and Businessman/Pastor. He is the Founder and Owner of E.G. Hall Oil Company in the Permian Basin of Texas; TRADEway, an SEC Registered Investment Advisory Company and Investment Educational Company; and Co-founder and President of EXOS Aerospace. He is Sr. Pastor of Park Meadows Church in Corsicana, Texas.

John Quinn is an Electrical Engineer, Stock Trader and Entrepreneur. He spent 14 and a half years in service to the nation in the U.S. Navy on Trident Submarines. He spent 21 years working in Engineering and Management in the power plant industry. He is now an entrepreneur and stock trader as well as the is Founder and C.E.O. of Martin Systems and Technologies, which creates products for the U.S. military, and co-founder and C.O.O. of EXOS Aerospace.

Interorbital Preps for NEPTUNE Test Launch

and eleven smallsats will go along for the ride...

by Randa Milliron, Co-Founder and President, Interorbital Systems

In the High Desert of California, the nation's proving ground (and airspace) for advanced space launch vehicles, and the HQ for many of the companies of New Space, Interorbital Systems (IOS) engineers are hard at work preparing for a critical milestone in the development of the company's NEPTUNE Rocket series.

The Interorbital team is nearing completion of its N1 GTV (NEPTUNE 1 Guided Test Vehicle) rocket which incorporates a high-efficiency CPM 2.0 filament-wound tank assembly, its new rocket engine gimbaling systems, its new CPM Controller, and a new in-house developed guidance system. The finless single CPM (Common Propulsion Module) launch vehicle will be used in an upcoming Q4 2017 low-altitude flight test.

Eleven commercial and educational CubeSat and TubeSat payloads are manifested on this flight. The rocket — a CPM 2.0/ N1 — is composed of four identical tanks containing the rocket's storable propellants and pressurant gas. This regulated pressure-fed configuration was selected to increase engine performance, while at the same time reducing costs and manufacturing time.

During the test flight, the rocket will simulate an orbital launch trajectory by using the main rocket engine's throttling

capability to vary the thrust-to-weight ratio, thus simulating the actual conditions that will be experienced during an orbital launch.

After the rocket passes through the transonic phase and Max Q, the engine will gradually throttle down, slowing the rocket until it begins to hover. At that point, the rocket engine will shut down and the rocket will be allowed to fall. At a safe altitude, a parachute will deploy for vehicle and payload recovery.

Following the test of the N1 GTV launch vehicle, the IOS team will construct an orbital version of the N1, which consists of a single CPM 2.0 and two liquid upper-stages. It will be capable of placing a 14 pound (6.4 kg) payload into a 192 mi (310 km) polar orbit — perfect for the dedicated launch of the new 3U-CubeSat plus 1U propulsion system assemblies now trending in the smallsat industry.

As the N1 launch vehicle is 36 feet (11 meters) in length, and weighs only 5,400 lbs. (2449 kg), this will be the smallest orbital launch vehicle in the world. The NEPTUNE 1 is also the world's lowest-cost orbital launch vehicle, with a base price of \$250,000 (academic price) per launch to a circular polar orbit at 310 km. The same single Common Propulsion



Interorbital's NEPTUNE-1 rocket.

Module that powers the N1 can be bundled into groups of three, five, or eight to meet increased lift requirements for payloads weighing up to 500kgs (1,100-lbs).

What's Launching?

Interorbital offers the lowest-cost launch opportunities in the world for suborbital, orbital, and interplanetary missions. IOS will be testing its own guidance and control systems with the upcoming launch and will also provide the platform for demonstrating and flight-testing these significant science applications and breakthrough technologies:

Wayfinder II Mission

Wayfinder II is a 3U CubeSat designed and integrated by Boreal Space, NASA Ames Research Park, Moffett Field, California. The overarching mission of Wayfinder II is to raise the Technology Readiness Level (TRL) of technologies that are key to space science, exploration, and commerce. Boreal Space has created a unique hosted payload architecture that will house and flight-test the following four high-profile payloads aboard its Wayfinder II:

1. Spacelink Secure UHF radio

The Spacelink Secure radio, developed in collaboration with Space Inventor of Aalborg, Denmark, is a fully redundant UHF transceiver operating in the UHF band refined as a hardware pair with a ground station source for Internet of Things (IoT) connectivity experiments — AES/GCM Encryption addresses IoT security concerns. Spacelink is the first in a series of highly capable radios that are expanding into S- and X-band frequencies. These radios are low-power, lightweight solutions for CubeSat applications; the Spacelink radios are destined to be an enabling technology for various Use Cases including connected cars, oil and gas industry, agriculture, etc.

2. SHARK Payload provided by the Stanford University Extreme Environments Laboratory (XLAB) — <http://xlab.stanford.edu>

Stanford University's XLAB is focused on the development of micro- and nano-systems for operation within extreme harsh environments. Researchers in Stanford's XLab are investigating the synthesis of temperature tolerant, chemically resistant, and radiation-hardened wide bandgap semiconductor thin films and nanostructures. These new material sets serve as a platform for the realization of sensor, actuator and electronic components that can operate and collect data under the most hostile conditions. More specifically, smart and adaptable structures for extreme environments are enabled through the technology developed in the XLAB; research efforts support a variety of applications including deep space systems, hypersonic aircraft, combustion monitoring, and subsurface monitoring.

With respect to Wayfinder II, the Extreme Environments Lab has created a hosted payload known as SHARK—1. The Principle Investigator for this effort is Karen Dowling, a Ph.D. candidate at Stanford. The purpose of this experiment is to test AlGaN (Gallium Nitride) sensors and others to measure magnetic fields, temperature, and radiation in orbital and suborbital levels. Mitigation to susceptibility to extreme environments is an important area of research for LEO applications and beyond.

3. Graphene Experiment supplied by the Centre for Advanced 2D Materials, National University of Singapore — Graphene Experiment provided by NUS and Wayfinder II



This is a 3U CubeSat Structure with experimental housing — The Centre for Advanced Two-Dimensional Materials (CA2DM) of the National University of Singapore (NUS)

has partnered with US-based Boreal Space to test the properties of graphene material after it has been launched into the stratosphere.

During this launch, the graphene material will be subjected to rapid acceleration, vibration, acoustic shock, strong pressure, and a wide range in temperature fluctuations. The research team will retrieve the graphene material and will be testing its properties to see if it was able to resist the various challenges imposed by the launch environment. Technologies that push the limits in graphene research by demonstrating electro-magnetic shielding; efficient solar power generation; and excellent thermal protection.

Graphene, which is one of the crystalline forms of carbon, is a relatively recent discovery in 2004. Since then, a torrent of data has been uncovered by the academic community and industry on its advantages, including ultra-thinness, mechanical strength, heat conduction and electronic properties.

In this collaboration, a team led by Professor Barbaros Özyilmaz, head of graphene research at the NUS CA2DM, prepared the graphene material by coating a substrate with a single layer of graphene. This is about 0.5 nanometers thick, which is more than 200,000 times thinner than a strand of hair.

"Graphene is the lightest thin film in nature and 1 gram can cover 2,300 square meters of area. This extreme low mass density is perfect for space applications such as sails for spacecraft."



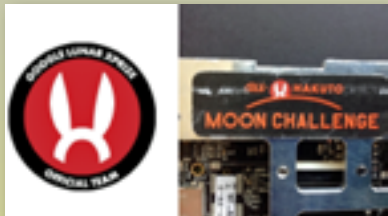
However, efficient space sails require high optical reflectivity so they can be accelerated by sun rays or lasers beams. Being one atom thin, graphene is mostly transparent. Nevertheless, state of the art nanotechnology can make graphene highly reflective by deposition of light atomically thin metal films on its surface keeping its mass still low enough. The Center for Advanced 2D Materials is currently developing such graphene sails and other devices based on 2D materials for space exploration," said Professor Antonio Castro Neto, Director of the NUS CA2DM.

"Space is the final frontier for graphene research. If this research collaboration is able to demonstrate that graphene maintains its various properties and features after the launch into stratosphere, this will open new opportunities for incorporating graphene into numerous technologies suitable for outer space and aerospace missions."

Concurring, Ms Barbara Plante, President of Boreal Space, said, *"We are dedicated to expediting access to space, and we believe that graphene plays an important role in that path, with structures and batteries for on-orbit space platforms. This launch is in support of such future uses in space."*

Interorbital's suborbital launch opportunity offers materials scientists the ability to collect real-world Graphene flight research data that is extremely relevant to a program like the highly anticipated Breakthrough Starshot.

4. Robotics Payload provided by Google Lunar X PRIZE Team Hakuto, ispace, inc.

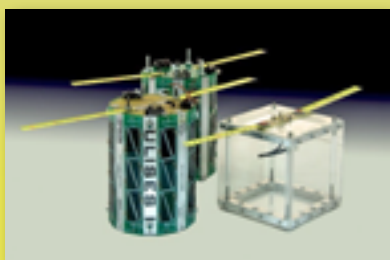


Boreal Space will host a robotics experiment provided by TEAM HAKUTO, [https://team-](https://team-hakuto.jp/en/)

[hakuto.jp/en/](https://team-hakuto.jp/en/). Team Hakuto is a contender for the Google Lunar X PRIZE. Their mission is to privately develop a spacecraft to land on the Moon and then be able to move their robotic payload more than 500 meters plus then send high resolution images to Earth (HD, 360 degree images called "Mooncasts.") They are Google Lunar X PRIZE contenders, one of five teams racing to the finish line.

Mexican Space Collective

One of three Mexican smallsats scheduled to fly on IOS' suborbital launch includes Juan Diaz Infante's Project ULISES I TubeSat Arts/Music satellite. The other satellites are from



UNAM and University of Zacatecas. At press time, following the recent 7.1 Mexican earthquake, IOS is awaiting word on their launch participation status.



IOS NEPTUNE-1 being prepared for launch.

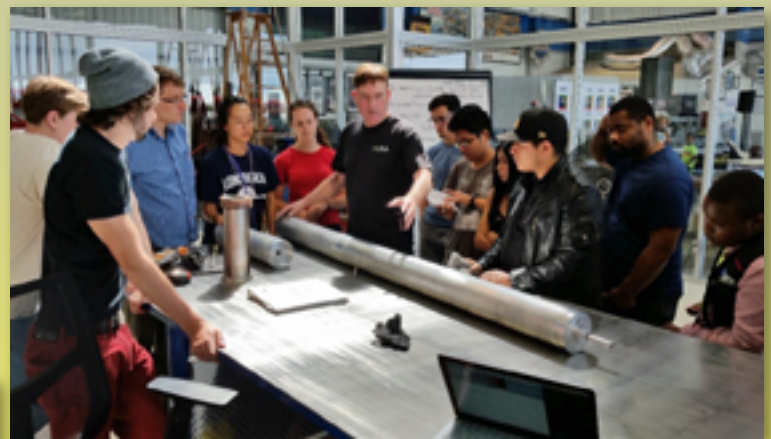
Google Lunar X PRIZE Team SYNERGY MOON Payload

Interorbital Systems, launch provider and member of the Google Lunar X PRIZE Team SYNERGY MOON, will fly its own team's electronics and communication package. This is identical to the one slated to be carried by its lunar rover on the surface of the Moon on the suborbital launch of the CPM 2.0 GTV. The flight will test the comms unit's behavior under the stresses of launch.

The NEPTUNE rocket test article that will carry all payloads listed in this article is also being tested on this launch for use as the main structural and propulsion component for SYNERGY MOON's LUNA Moon Rocket, which it will fly in its bid to win the Google Lunar X PRIZE. Interorbital will use its NEPTUNE 3 (N3) LUNA, a 3-module, 4-stage NEPTUNE Rocket variant to carry the GLXP payload to the Lunar surface.

Interorbital's Compton Rocket Academy

Interorbital has begun a series of rocket-building classes held weekly at Tomorrow's Aeronautical Museum at the Compton/Woodley Airport. Each class is an exercise in workforce development with structured engineering and hands-on skills training organized and taught by Roderick Milliron who developed the curriculum with IOS partner and educator Randa Milliron. Students learn by doing as they participate in the build of an Interorbital Neutrino bi-propellant liquid rocket kit.



Interorbital's President/CTO/Co-Founder Roderick Milliron instructs students from the Compton School District's FLARE (Future Leaders of Advanced Rocket Engineering); Cal Tech; UCLA; USC; Cal State Long Beach; UC Irvine; Cal Poly Pomona; Tuskegee University and UC San Diego in the black arts of liquid rocket propulsion

www.interorbital.com

