Worldwide Satellite Magazine – January 2019

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Authors

Robert Bell

Kfir Benjamin

Andrew Bond

Alan Crisp

Dr. Mark Dickinson

Chris Forrester

Eric V. Holtzclaw

David Logsdon

Catherine Melquist

Jassem Nasser

Anthony Penderis

John Priday

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InfoBeam

Comtech EF Data enhances portfolio

Comtech EF Data Corp. a subsidiary within Comtech Telecommunications Corp.'s (Nasdaq: CMTL) Commercial Solutions segment, has set a new industry performance record for General Packet Radio Services (GPRS) Tunneling Protocol (GTP) acceleration, enabling faster downloads and enhanced Quality of Experience (QoE) in LTE and 5G networks.

As the mobile industry is preparing for the introduction of 5G, Comtech EF Data has enhanced their award-winning satellite modem and optimization portfolio to support demanding mobile applications and services.

The November 2018 *Ericsson Mobility Report* highlights that there are now 25 LTE-Advanced networks in the world supporting Gigabit download speeds.

The report also states that with the introduction of 5G, user demand for mobile data services are expected to increase at a 31 percent CAGR until 2024.

Comtech EF Data states they are the primary satellite modem vendor that develops and manufactures an end-to-end portfolio of optimizers and modems in-house to accommodate high throughput in LTE and 5G networks over satellite.

The latest test of the Comtech EF Data ***FX Series*** WAN Optimization solutions demonstrated 700 Mbps of throughput for a single IPv6 TCP session in an LTE environment.

When paired with Comtech EF Data's lineup of satellite modems or the ***Heights™ Networking Platform***, the FX Series provides acceleration to maximize the throughput and usage of the link to the modem's current capacity.

When coupled with Comtech EF Data's **HX Series Load Balancing** product, the total throughput can reach up to 5 Gbps, well within the performance goal established by the International Telecommunication Union (ITU) for 5G networks.

In North America, a major satellite operator is already rolling out the solution in support of 3 Gbps to a single site while supporting hundreds of thousands of concurrent accelerated TCP sessions.

Richard Swardh, SVP, Mobile Network Operators for Comtech EF Data, said the company is recognized as the performance leader in satellite backhaul infrastructure equipment. With the latest additions to the firm's portfolio, Comtech EF Data is again demonstrating the company's commitment to supporting the most demanding mobile applications and services.

Richard added that customers can be assured that by investing in the firm's technology today, they have a solution that will grow and scale in line with ever-increasing demands for higher speeds as 5G is being deployed worldwide.

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Acquisition: Bradford Space and DSI

Deep Space Industries (DSI) has been acquired by Bradford Space, a U.S.-owned company with facilities in the Netherlands and Sweden — the announcement was made on January 1, 2019, and has been confirmed by a Bradford director, Mr. Ian Fichtenbaum — terms of the acquisition were not disclosed.

A group of entrepreneurs and space advocates founded DSI in 2012 with a goal of developing technologies for prospecting and eventually extracting space resources, such as water and ice, from asteroids. It proposed carrying out those missions using small spacecraft the company planned to develop.

More recently, DSI pivoted toward smallsats in general, including the production of a propulsion system called Comet that used water as propellant. The company promoted Comet on that smallsat's ability to provide performance approaching that of traditional monopropellant systems such as hydrazine, but with a non-toxic propellant that was less expensive and safer to handle.

Bradford Space has its own green propulsion systems for spacecraft, courtesy of the firm's 2017 acquisition of ECAPS, a Swedish company that developed high-performance, non-toxic, satellite propulsion systems. Fifteen spacecraft are using those ECAPS thrusters, including three launched on December 3, 2018, on a SpaceX Falcon 9. That launch also carried four satellites using Comet thrusters from DSI.

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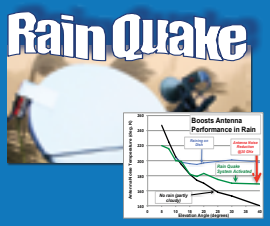

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Australian launch infrastructure development initiated

NewSpace company Southern Launch will begin developing the infrastructure to deploy smallsats from the Eyre Peninsula in South Australia.

The **Whalers Way Orbital Launch Complex** in South Australia will be capable of launching rockets such as **Rocket Lab**'s ***Electron***, pictured here.

Southern Launch CEO *Lloyd Damp* said that after an 18 month search for the perfect spot, the company found a site at Whalers Way on the Eyre Peninsula for their new launch pad.

"*We looked at sites from Western Australia to Victoria that were suitable for a southern launch and provided the right safety for people and the environment and South Australia met all the criteria*," said Damp. "*In addition to offering the ability to launch rockets into a polar or sun synchronous orbit, we also needed to have access to major infrastructure like ports and airports.*"

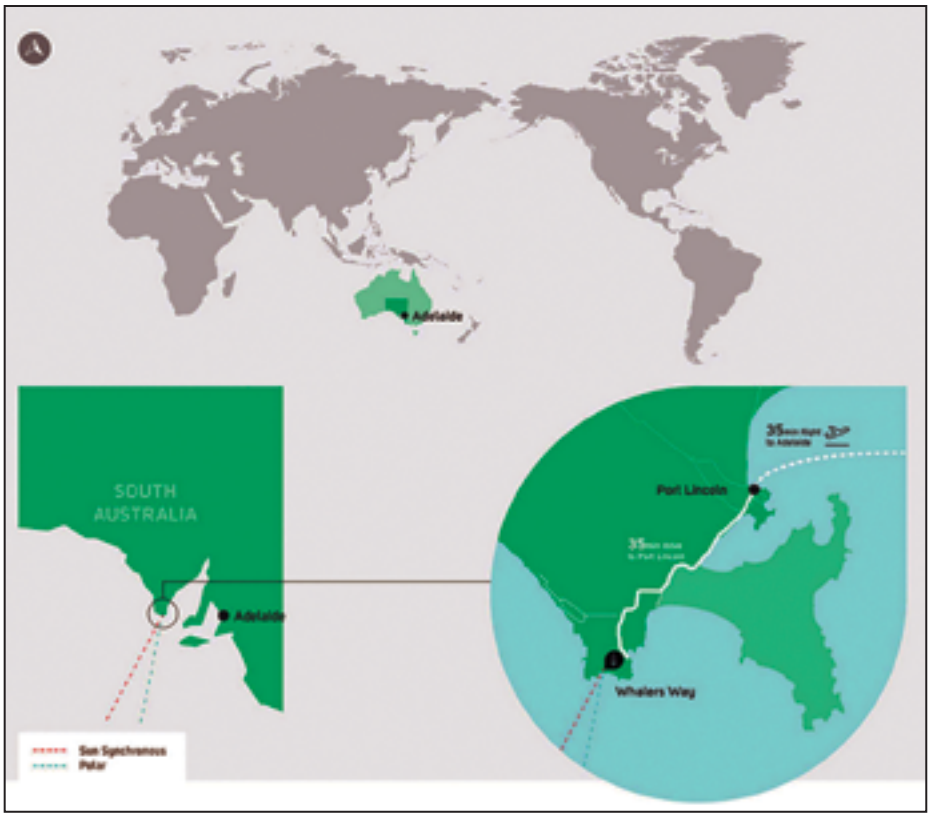
Called the Whalers Way Orbital Launch Complex, the 1190 hectare site sits at the bottom of Eyre Peninsula, about a 35 minutes drive from the regional center of Port Lincoln. The complex is 300 km. Northwest of Adelaide and 500 km. South of Woomera, the historic rocket launch site that is restricted to military use.

Damp said the startup was in discussions with domestic and international rocket manufacturers to begin designing and developing the necessary infrastructure at its site for launch vehicles and would begin construction early in 2019 with the aim of being operable by the end of the year.

"*Both here and overseas I realized a lot of new companies were developing small rockets, but there weren't many places to launch these rockets from and Australia has this really unique geography*," Damp said.

Southern Launch will target rockets with payloads between 50 kg. and 400 kg., such as the aforementioned Rocket Lab's Electron, that carry smallsats into polar or sun synchronous orbits to service internet of Things (IoT) applications for operations such as monitoring agricultural land.

"*There has been a huge shift in the space ecosystem from the old-space equatorial orbits for large telecoms and TV satellites to the NewSpace polar orbits for IoT*," Damp said. "*Satellites in a north-south orbit mean you need a smaller number of inexpensive satellites to observe the entire globe.*"



Southern Launch is working with the South Australian government, the **Australian Space Agency** and other regulators to work through the regulations and assessments needed to launch from the site.

Rockets launched at the site will fly 500 km. South over the Great Australian Bight before reaching orbit.

Italian Space Company Sitael Australia's general manager, ***Mark Ramsey***, said the firm, which established an office in Adelaide in 2018, would use the complex for its satellites.

"*This will allow us to offer satellite customers the ability to launch out of Australia to these new orbits*," Ramsey said.

The site announcement came at the same time that South Australian startup **Fleet Space Technologies** launched its fourth smallsat from different international sites.

The Adelaide-based IoT company's second ***Centauri*** smallsat was successfully launched aboard **SpaceX**'s ***Falcon 9 SSO-A*** mission from Vandenberg Air Force Base in California last year.

Fleet sent ***Centauri I*** aboard **Indian Space Research Organization**'s ***PSLV-C43*** mission on November 29, 2018, and launched experimental satellites ***Proxima I*** and ***II*** aboard Rocket Lab's ***It's Business Time*** manifest on November 11, 2018.

Fleet Space co-founder and CEO ***Flavia Tata Nardini*** said both Proxima satellites and Centauri I were successfully completing their duties and the second Centauri satellite was expected to start transmitting data in the next few weeks.

"*We're thrilled to showcase Fleet Space Technologies' capabilities to the world by launching our very own constellation of nanosatellites within a matter of weeks. It is incredible to work with industry heavyweights such as SpaceX, ISRO and Rocket Lab to help make our vision of building the global digital nervous system a reality*," Nardini said. "*There's no time to rest, we're onwards and upwards to provide our customers with global connectivity to solve the world's future challenges from space.*"

The launch news came a day before Australia's space industry met at the **6th South Australia Space Forum** in Adelaide to discuss the future of the industry and get an update from the newly-established Australian Space Agency.

Story by *Jim Plouffe* of ***The Lead*** infosite.

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Galileo's global system update

Having completed all necessary qualification testing, ESA has received the green light to upgrade the global infrastructure running Europe's Galileo satellite navigation system.

The resulting migration, set to start in February, will incorporate new elements into the world-spanning system and boost the robustness of Galileo services delivered from the 26 satellites on orbit.

Authorization for this upgrade — formally known as ***Galileo System Build 1.5.1*** — has been given by the ***Galileo Security Accreditation Board***, made up of European Union Member States.

This important milestone marks the climax of a system qualification campaign that took more than a year to execute: more than 150 system tests summing up to a total of 409 tests runs across Europe in the various Galileo operational centers.

This work was performed by the ESA Galileo project team in tight collaboration with the WP1x system support team led by **Thales Alenia Space** in Italy.

"*This marks the first update for Galileo's operational infrastructure since it entered service,*" said ESA Galileo system test and verification manager ***Edward Breeuwer***. "*Galileo Initial Services began in December 2016 then last year we passed control of the system to our partner organisation, the European Global Navigation Satellite System Agency, or GSA.*

"*This, therefore, marks a major step, but migration to the upgraded system should in principle be entirely transparent to Galileo users. We achieve this by taking advantage of the redundant elements of the Galileo system, taking them offline to update them while their operational counterparts continue to run.*"

The constellation in orbit is only one element of the overall satellite navigation system. At the same time as satellites were being built, tested and launched, ESA was putting in place a global ground segment, extending to some of the world's loneliest places.

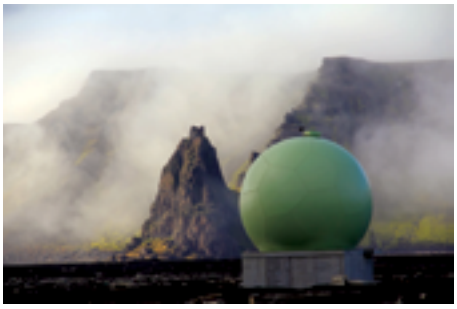
The ground segment is essential to keeping Galileo services running reliably. It identifies and generates corrections for any tiny drifts in the onboard atomic clocks delivering meter-scale positioning, or in the positioning of the satellites themselves.

Establishing Galileo's ground segment was among the most complex development ever undertaken by ESA, with the requirement to fulfill strict levels of performance, security and safety.

A major driver of this latest update was the growth of the Galileo constellation, which increased by 12 satellites through a trio of ***Ariane 5*** launches in the last three years to become Europe's largest.

The updated ground system incorporates a sixth telemetry, tracking and control station in Papeete, used to oversee Galileo satellite platforms, as well as an expansion of the number of antennas at the sites of uplink stations at Kourou in French Guiana; Reunion Island in the Indian Ocean and Noumea in French Polynesia — serving to upload navigation message corrections to the satellites for rebroadcast to users.

Artistic rendition of Galileo satellites on orbit.



The ground station on Jan Mayen Island. Photo is courtesy of ESA/Fermin Alvarez Lopez.

Additional receivers have been added to the Galileo sensor stations to ensure full redundancy: their small antennas check the accuracy and signal quality of individual satellites in real time, and work together to pinpoint the current satellite orbits.

And the two Galileo control centers at the heart of this global ground segment — Fucino in Italy focused on Galileo navigation payloads and Oberpfaffenhofen in Germany on the satellites hosting them — will be made fully redundant of one another, each one able to perform all the functions of the other at a moment's notice ensuring the required business continuity.

Operation of the individual Galileo satellites from the control centers will be further streamlined, with automation of key housekeeping tasks.

The system build connects two brand new ***Galileo Security Monitoring Centers***, one in Paris and, in the near future, one in Madrid currently under construction, to the core Galileo infrastructure.

These two sites check on security issues related to Galileo services, and are used for controlling access to the Public Regulated Service, the single most accurate and secure class of Galileo signal, restricted to governmental users.

Similarly, the new System Build is able to connect to the Galileo Service Centre in Madrid, the portal for the Galileo user community and to the Galileo's ***Search-and-Rescue Return Link*** service, overseen by French space agency **CNES** from Toulouse, France.

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USAF's GPS III satellite launched

On Sunday, December 23rd at 5:51 a.m. PST, *SpaceX* launched the U.S.A.F.'s first Global Positioning System III space vehicle from Space Launch Complex 40 at Cape Canaveral Air Force Station, Florida. *Launch photo is courtesy of SpaceX.*

The Lockheed Martin-built satellite, known as "*Vespucci*" in honor of *Amerigo Vespucci*, the Italian explorer for whom the Americas were named, was carried to orbit aboard a SpaceX ***Falcon 9 Evolved Expendable Launch Vehicle***, after previous launch attempts on December 18, 20 and 22 were thwarted by weather or technical issues.

GPS III's "Vespucci" separated from its upper stage at 10:47 a.m. EST (15:47 UTC, 7:49 a.m. Pacific), approximately two hours after launch. Engineers and operators at Lockheed Martin's Waterton facility will now begin on-orbit checkout and tests which are estimated to complete in six months. Operational use is expected to begin in about a year.

Vespucci will be vectored to augment the current GPS constellation comprised of 31 operational spacecraft. GPS satellites operate in medium Earth orbit at an altitude of approximately 20,200 km (12,550 miles) in six planes.

Each satellite circles the Earth twice per day. GPS provides the "Gold Standard" of position, navigation, and timing services for billions of users worldwide. GPS III, the newest generation of GPS satellites. It brings new capabilities to users, including three times greater accuracy, and up to eight times improved anti-jamming capabilities.

The GPS III Vespucci team is led by the ***Space and Missile Systems Center (SMC)'s Global Positioning Systems Directorate***, located at **Los Angeles Air Force Base** in El Segundo, California. ***Lockheed Martin Space Systems Corporation*** is the prime satellite vehicle contractor.

USAF 2nd Space Ops engaged in satellite C&C

The launch was led by Space and Missile Systems Center's ***Launch Enterprise Directorate***, and was on the SpaceX Falcon 9 launch vehicle at Cape Canaveral AFS.

U.S. Air Force Space Command's 50th Space Wing and ***2nd Space Operations Squadron*** operate the GPS constellation from Schriever AFB, Colorado.

SMC is the U.S. Air Force's center of acquisition excellence for acquiring and developing military space systems. Its portfolio includes the GPS, military satellite communications, defense meteorological satellites, space launch and range systems, satellite control networks, space based infrared systems and space situational awareness capabilities.

As the U.S. enters a new era with the declaration of space as a warfighting domain, SMC is undergoing re-architecting as part of "SMC 2.0" efforts which will manage other significant U.S. acquisition agility initiatives that seek to build new partnerships with industry, allies, and DOD partners, in order to drive innovation within the space enterprise and speed the delivery of new capabilities to warfighters.

Lt. General *John F. Thompson*, Commander of the Space and Missile Systems Center and Air Force program executive officer for Space, said that launch is always a monumental event, and especially so as this is the first GPS satellite of its generation launched on SpaceX's first National Security Space mission. As more GPS III satellites join the constellation, it will bring better service at a lower cost to a technology that is now fully woven into the fabric of any modern civilization.

He added that this launch keeps GPS the gold standard for positioning, navigation, and timing information, giving assured access when and where it matters. This event was a capstone, but it doesn't mean we're done. The USAF is going to run a series of procedures for checkout and test to ensure everything on Vespucci functions as it was designed."

Colonel ***Steve Whitney***, director of the GPS Directorate, stated that this launch could not have succeeded without the teamwork of dedicated professionals. This launch is the beginning of the GPS III era, bringing greater capabilities for the nation's military and civilian users worldwide.

Colonel ***Robert Bongiovi***, SMC Launch Enterprise director, added that the first GPS III launch marks a significant milestone for the GPS constellation as well as SMC's partnership with SpaceX. This launch demonstrated the successful teamwork and cooperation among all mission partners to deliver the capabilities the nation's warfighter demands.

In support of the U.S. Air Force, *The Aerospace Corporation* (Aerospace) performed a complete independent verification of SpaceX's Falcon 9 rocket and the Global Positioning System (GPS) Block III-2 satellite.

This successful launch marks two major milestones for a national security space mission — the first newly certified rocket for the U.S. Air Force in 20 years — and delivery of the first national security satellite that will provide the next-generation of position, navigation, and timing (PNT) services.

"We have worked with SpaceX over the past six years to ensure the mission success of their first national security launch," said Steve Isakowitz, Aerospace President and CEO. "As demonstrated in this launch, Aerospace has pioneered the process for future entrants to compete and succeed in national security launches."

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Artistic rendition of the GPS III satellite. Image is courtesy of Lockheed Martin.

Aerospace worked extensively with the U.S. Air Force and SpaceX on the Block 5 design to meet the government's high standards for reliability to ensure mission success for national security satellites critical to our country's defense. The team has supported more than 60 SpaceX civil and commercial launches, collaboratively developing new certification and mission assurance processes. These efforts included rigorous qualification and acceptance review for systems, including propulsion, avionics, structures, ground systems, and safety systems.

"*Working with SpaceX over the last several years has provided our team with a great opportunity to develop agile mission assurance processes*," said ***Randy Kendall,*** the VP of Launch Program Operations. "*We're looking at every aspect of our mission assurance process to improve efficiency, effectiveness, and responsiveness. We're also using new technologies such as cloud computing, machine learning, and artificial intelligence to dramatically reduce our analysis timelines by a factor of 10 or more and to help our engineers identify data trends that may not be visible.*"

SpaceX has won six competitive Evolved Expendable Launch Vehicle (EELV) launch services for the Air Force, including four more GPS satellites scheduled to be launched in the next three years. These launch service awards represent the reintroduction of competition to the EELV program and provide highly critical assured access to space for national security payloads.

Aerospace has facilitated the opportunity for new entrants to work with the government and industry to bring new launch providers to serve the U.S. government's needs.

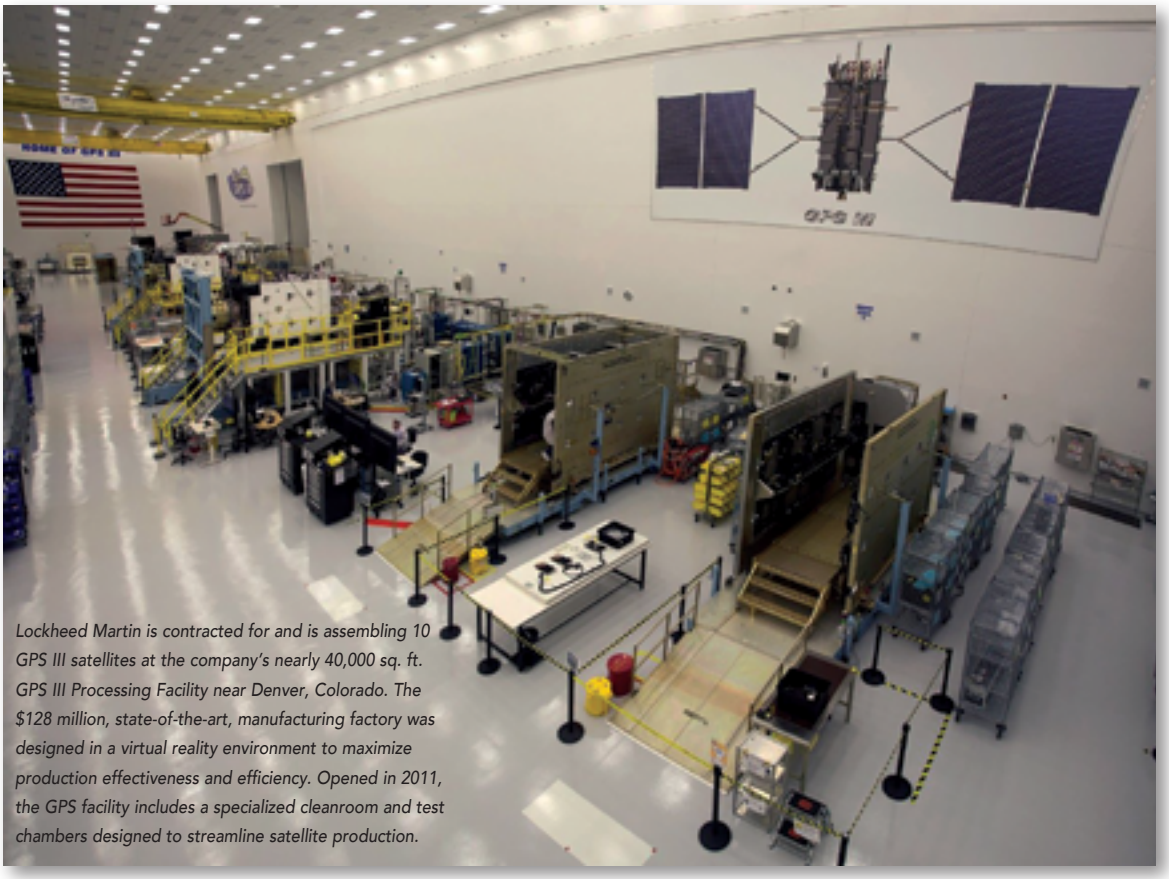
The GPS III series boasts numerous upgrades over previous GPS models in anti-jamming capabilities; more military and civilian signals that are more accurate and powerful; specialized signals, such as for aviation services; and a signal that can be used with other satellite navigation systems, such as the European Union's Galileo system.

Lockheed Martin added that this GPS III satellite has already began "*talking*" with engineers and operators from ground control.

GPS III Space Vehicle 01 (**GPS III SV01**) is receiving and responding to commands from Lockheed Martin's Launch and Checkout Center at the company's Denver facility. Air Force and company engineers declared satellite control signal acquisition and rocket booster separation about 119 minutes after GPS III SV01's launch.

GPS III SV01 is the first of an entirely new, next generation GPS satellite designed to modernize the GPS constellation. GPS III has three times better accuracy and up to eight times improved anti-jamming capabilities. Spacecraft life will extend to 15 years, 25 percent longer than any of the GPS satellites on orbit today.

GPS III's new L1C civil signal will also make it the first GPS satellite broadcasting a compatible signal with other international global navigation satellite systems, like Europe's ***Galileo***, improving connectivity for civilian users.



Lockheed Martin is contracted for and is assembling 10 GPS III satellites at the company's nearly 40,000 sq. ft. GPS III Processing Facility near Denver, Colorado. The $128 million, state-of-the-art, manufacturing factory was designed in a virtual reality environment to maximize production effectiveness and efficiency. Opened in 2011, the GPS facility includes a specialized cleanroom and test chambers designed to streamline satellite production.

Once declared operational, GPS III SV01 is expected to take its place in today's 31 satellite strong GPS constellation, which provides positioning, navigation and timing services to more than four billion civil, commercial and military users.

"*In the coming days, GPS III SV01 will use its liquid apogee engines to climb into its operational orbit about 12,550 miles above the Earth. We will then send it commands to deploy its solar arrays and antennas, and begin on-orbit checkout and tests, including extensive signals testing with*

our advanced navigation payload provided by Harris Corporation," said ***Johnathon Caldwell***, Lockheed Martin's Vice President for Navigation Systems.

U.S. Air Force and Lockheed Martin engineers are controlling GPS III SV01's launch and checkout test using elements of the ***GPS Next Generation Operational Control System*** (**OCX**) Block 0. Satellite control and operations are expected to shift to the Air Force's current Operational Control Segment when GPS III Contingency Operations upgrades are fully implemented later this year.

Caldwell added the company is excited to begin on orbit test and demonstrate the satellite's capabilities. By this time next year, Lockheed Martin also expects to have a second GPS III on orbit and users should be receiving signals from this first satellite.

Lockheed Martin developed GPS III and manufactured GPS III SV01 at its advanced $128-million GPS III Processing Facility near Denver.

In September 2017, the Air Force declared the satellite "Available for Launch" (AFL) and had the company place it into storage.

Last summer the Air Force "called up" the satellite for launch and Lockheed Martin delivered it to Florida on August 20. On December 8, GPS III SV01 completed pre-launch processing, fueling and encapsulation at **Astrotech Space Operations**.

GPS III SV01 is the first of 10 GPS III satellites originally ordered by the Air Force. GPS III SV03-08 are now in various stages of assembly and test. In August, the Air Force declared the second GPS III "AFL" and, in November, called GPS III SV02 up for a 2019 launch.

In September, the Air Force selected Lockheed Martin for the GPS III Follow On (GPS IIIF) program, an estimated $7.2 billion opportunity to build up to 22 additional GPS IIIF satellites with additional capabilities.

GPS IIIF builds off Lockheed Martin's existing modular GPS III, which was designed to evolve with new technology and changing mission needs. On September 26, the Air Force awarded Lockheed Martin a $1.4 billion contract for support to start up the program and to contract the 11th and 12th GPS III satellite.

For civil users, GPS III significantly increases accuracy for critical national infrastructure and commercial applications, including transportation, banking, emergency services, and agriculture.

For military users, GPS plays a critical role in every warfighting domain, including precision- guided munitions, manned and unmanned aircraft navigation, handheld applications, land and sea navigation, and military logistical support.

InfoBeam

Space history written by China

On January 3, the Chang'e-4 lunar rover shaped space and Chinese history by successfully completing the first-ever soft landing on the far side of the Moon — close-up images of the previously unexplored region of the Moon were then captured by the rover and relayed to Earth.

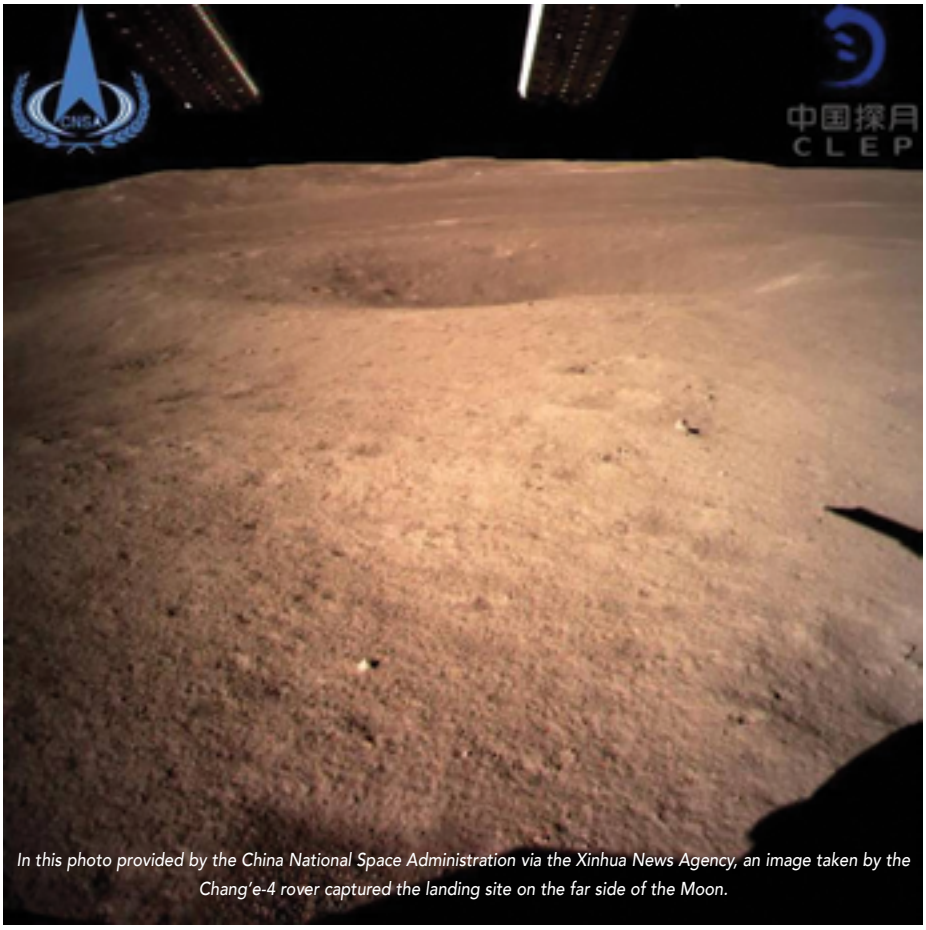
Named after a Chinese moon goddess, and comprised of a lander and a rover, the touchdown occurred at the pre-selected landing area at 177.6 degrees east longitude and 45.5 degrees south latitude on the far side of the Moon at 10:26 a.m. (Beijing time), this according to the *China National Space Administration* (CNSA).

NASA congratulated Chinese scientists on this success, which is actually the fourth lunar probe launched by the nation. The robotic spacecraft is carrying instruments to analyze the unexplored region's geology and will conduct biological experiments. The first-ever soft landing is a major milestone in space exploration because, unlike previous Moon missions that have landed on the Earth-facing side, this is the first time any craft has landed on the unexplored and rugged far side of the Moon. The *China Daily* infosite posted that this successful landing formally inaugurated the world's first expedition to the far side that never faces the Earth and is expected to fulfill scientists' long-held aspiration to closely observe the enormous region.

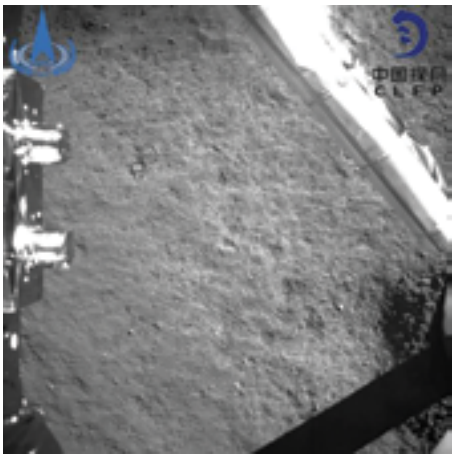
The probe was launched by a Long March-3B carrier rocket on December 8, 2018, from the Xichang Satellite Launch Centre in Sichuan Province and landed on the Von Karman crater in the South Pole-Aitken basin and then sent back a picture of the landing site that was captured by one of the monitor cameras on the probe's lander, marking the world's first image taken on the Moon's far side.

The picture shows the place where Chang'e-4's rover will be traveling to roam and survey. Tidal forces on Earth slow the Moon's rotation to the point where the same side always faces Earth. The other side, most of which is never visible from Earth, is the far side of the Moon.

Direct communication with the far side of the Moon, however, is not possible, which is one of the many challenges for the Chang'e-4 lunar probe mission — China launched a relay satellite, named Queqiao, in May, to establish a communication link between the Earth and Chang'e-4 lunar probe.



In this photo provided by the China National Space Administration via the Xinhua News Agency, an image taken by the Chang'e-4 rover captured the landing site on the far side of the Moon.



In this photo provided by the China National Space Administration via the Xinhua News Agency, an image taken by the Chang'e-4 rover captured the landing site on the far side of the Moon.

Chang'e-4 includes two main components include the main lander that weighs approximately 2,400 pounds and a 300 pound rover. By comparison, NASA's Opportunity rover on Mars weighs about 400 pounds and the Curiosity rover on that planet is much larger, weighing 2,000 pounds.

The spacecraft is largely a clone of Chang'e-3, which landed on the Moon in 2013. Named after the goddess of the Moon in Chinese legends, the first Chang'e spacecraft was launched in 2007 to verify China's lunar probe technology, obtain lunar images and perform scientific surveys.

Then the Chang'e-2 followed in 2010 to capture high definition images of the Moon and to investigate landing conditions for the Chang'e 3, which landed on the Moon in 2013. Chang'e-3 released the first Chinese lunar rover, Yutu, on the Moon where the vehicle worked for 1,000 days.

Chang'e-4, this fourth lunar probe launched by China since this program was initiated in 2004, has four scientific payloads that were developed by scientists from the Netherlands, Germany, Sweden and Saudi Arabia. Chang'e-4 is the fourth lunar probe launched by China since the country's lunar program was opened in 2004. The scientific tasks of the Chang'e-4 mission include low-frequency radio astronomical observation, surveying the terrain and landforms, detecting the mineral composition and shallow lunar surface structure, and measuring the neutron radiation and neutral atoms to study the environment on the far side of the Moon, according to CNSA.

InfoBeam

ORBCOMM's OG1 is gone...

On December 22, 2018, one of ORBCOMM's first generation satellites — the OG1 — came apart in orbit.

The CEO of the company, *Marc Eisenberg*, has said that the firm is investigating the reason behind the loss of the satellite with the breakup resulting in producing some 34 trackable objects.

However, according to the company, their OG2 satellites handle the majority of the company's comms obligations, managing approximately 90 percent of all communication services.

According to the company, ORBCOMM OG2 is the world's first and only commercial satellite network that is 100 percent dedicated to M2M and uses LEO satellites to provide M2M comms to and from in the most remote areas of the world.

Each satellite's VHF frequency furthers signal propagation and message delivery is unaffected by bad weather. In addition, the optimized message size is ideal for M2M applications.

Each OG2 satellite offers as much as six times the data access and up to twice the transmission rate of the OG1 satellite.

Each OG2 satellite is the equivalent of six OG1 satellites, providing faster message delivery, larger message sizes and better coverage at higher latitudes, while significantly increasing network capacity.

ORBCOMM's proven ground infrastructure enables worldwide M2M satellite messaging.

The company's 16 Gateway Earth Stations in 13 countries track and establish two-way satellite communications, while the firm's Gateway Control Centers process the data and provide the interconnection to terrestrial communications networks.

ORBCOMM's Network Control Center in Sterling, Virginia, serves as the focal point for managing their satellite constellation and ensures reliable message delivery.

InfoBeam

GomX-4 smallsat completes mission

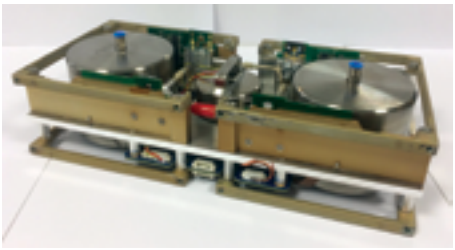
The GomX-4B — ESA's largest, small cubesat yet flown — has completed its mission for the Agency, testing out new miniaturized technologies including: inter-satellite link communication with its GomX-4A twin, a hyperspectral imager, star tracker and butane-based propulsion system.

ESA is making use of the standardized 10 cm. cubesats for testing new technologies in space. GomX-4B was ESA's first six-unit cubesat, double the size of its predecessor GomX-3, built for ESA by **GomSpace** in Aalborg, Denmark, who is also the builder of GomX-4A for the **Danish Ministry of Defence**. The cubesat pair was launched in February of 2018 from Jiuquan, China.

GomX-4B used its butane cold gas propulsion system to maneuver away from its twin, flying up to 4,500 km. away in a fixed geometry — a limit set by Earth's curvature and representative of planned smallsat constellation spacing — to test inter-satellite radio links allowing the rapid transfer of data from Earth between satellites and back to Earth again.

Supplied by the Swedish branch of GomSpace, the propulsion system allows the cubesat to adjust its orbital speed in a controlled manner by a total of 10 m/s — a speed equivalent to a kicked football.

In another first, GomX-4B acquired the first hyperspectral images of Earth from a cubesat. **Cosine Research** in the Netherlands and their partners constructed the hand-sized ***HyperScout*** imager for ESA. This divides up the light it receives into many narrow, adjacent wavelengths, gathering a wealth of environmental data.



GomX-4B's cold-gas thruster system takes up two half-cubesat units at one side of the nanosatellite, with two spherical titanium tanks filled with liquid butane. It has four 1 mN thrusters, typically to be fired in pairs while keeping one set in reserve.
Photo is courtesy of Nanospace.

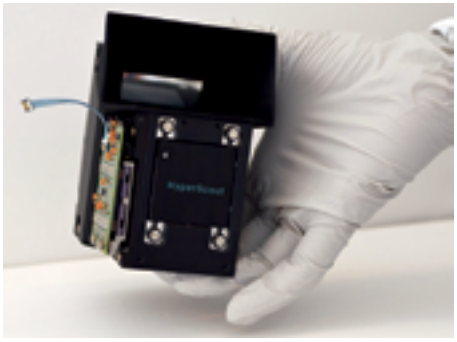
The mission also proved that hyperspectral image processing can be performed aboard, to reduce the amount of data needing to be transmitted down to Earth.

High-quality image acquisition requires good pointing accuracy and stability, so GomX-4B also trialed a miniaturized star tracker developed by Dutch cubesat manufacturer **ISIS** to orient itself by its surrounding starfield, turning itself using fast-spinning reaction wheels.

A final experimental payload gathered data on how orbital radiation affects computer memories.

The large amount of flight data returned by the mission is being analyzed as a source of lessons learned to guide the development of follow-on smallsat missions, starting with GomX-5 whose 12 unit design begins next month at GomSpace.

An artistic rendition of the GomX-4 smallsat pair. Image is courtesy of GomSpace.



Observing in 45 visible and near-infrared spectral bands, the HyperScout hyperspectral imager was launched in February 2018, aboard ESA's cereal box-sized GomX-4B smallsat. HyperScout has been developed by cosine Research in the Netherlands.
Photo is courtesy of the company.

The GomX missions are funded primarily by Denmark in the 'Fly' element of ***ESA's General Support Technology Program*** to develop and prove leading edge space technologies.

ESA has a trio of Technology cubesats from Belgium planned to fly during the new year: Qarman to gather atmospheric reentry data, Simba to monitor Earth's radiation budget and Picasso to monitor the troposphere and stratosphere.

Roger Walker, who oversees ESA's Technology cubesats, said that this multi-faceted mission has performed extremely well in flight. What its results demonstrate is that European cubesats are now ready for operational deployment, as the first generation of cubesat constellations in LEO for a variety of applications.

He added that the post-flight review has declared ESA's in-orbit demonstration mission a success, but in fact GomX-4B's story is far from over.

Walker also noted that GomSpace, the manufacturer of the satellite, continues to operate the smallsat, while GomSpace's subsidiary in Luxembourg will be in charge of mission exploitation. In spite of all the orbital maneuvering, GomX-4B still has a lot of fuel. Of the original 130 grams of butane, only 13 grams were consumed during the mission.

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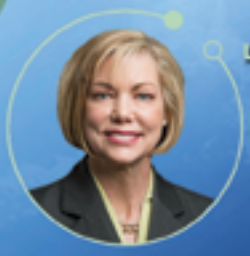

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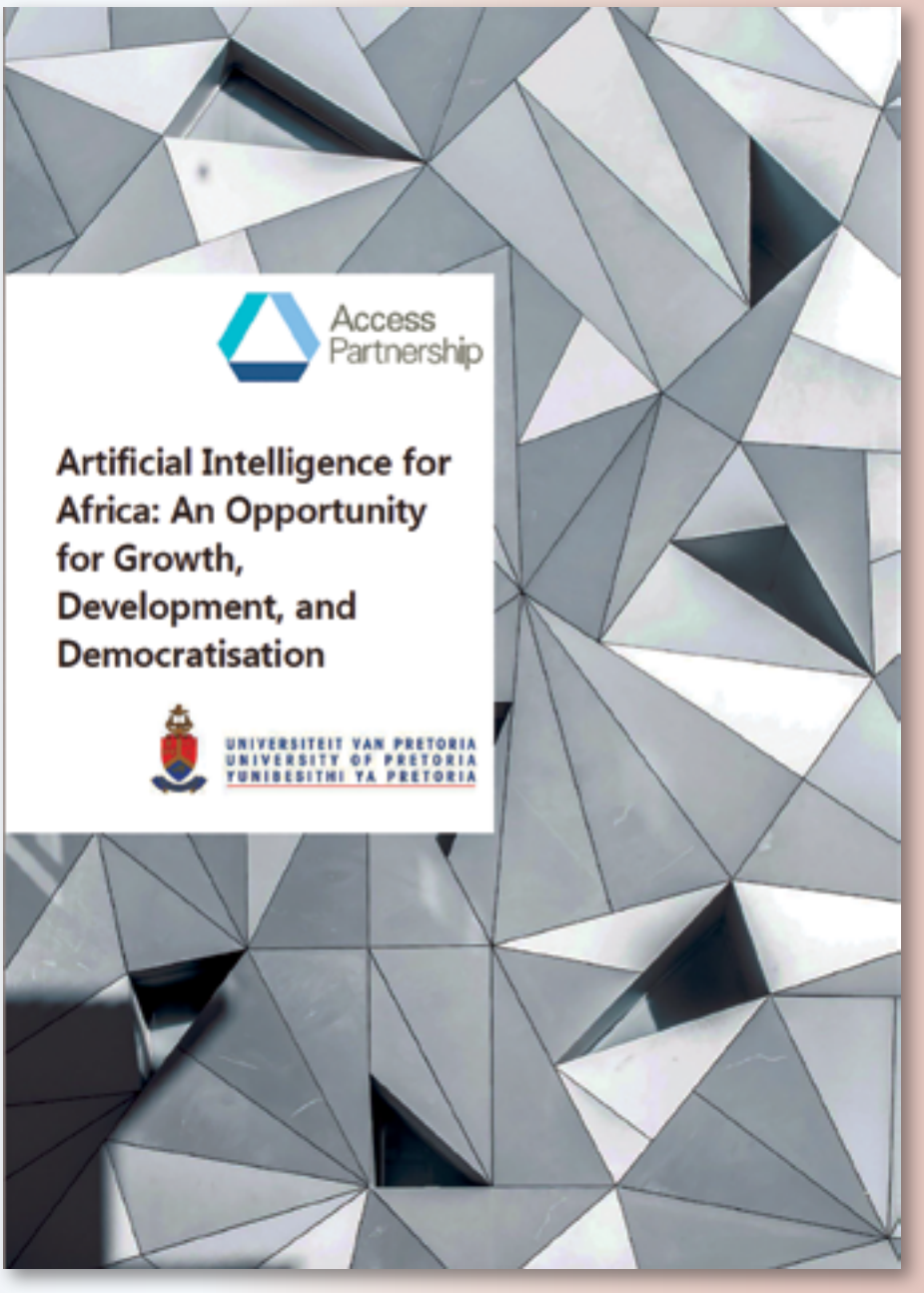
AI FOR AFRICA

An opportunity for growth, development and democratization

The rapidly developing set of Artificial Intelligence (AI) technologies has the potential to solve some of the most pressing challenges that impact Sub-Saharan Africa and drive growth and development in core sectors:

- *Agriculture will be done more efficiently and effectively, raising yields.*
- *Healthcare will be better tailored, higher quality, and more accessible, improving outcomes.*
- *Public services will be more efficient and more responsive to citizens, enhancing impact.*
- *Financial services will be more secure and reach more citizens who need them, expanding access.*



Forward thinking policy-makers, innovative startups, global technology partners, civil society groups, and international global stakeholders are already mobilizing to promote the growth of a vibrant AI ecosystem in Africa.

However, there remain structural challenges that can hamper the development of a healthy AI ecosystem in Africa:

- *Education systems will need to adapt quickly, and new frameworks need to be created for workers and citizens to develop the skills they need to thrive.*
- *Broadband coverage will need to expand rapidly — specifically in rural areas — in order for all citizens and businesses to reap the benefits.*
- *Ethical implications regarding the fair, secure, and inclusive use of AI applications also must be addressed through collaboration and engagement to ensure AI systems earn trust.*
- *Ensuring a deeper, broader, and more accessible pool of data is available will also be key to enable researchers, developers, and users to drive AI.*

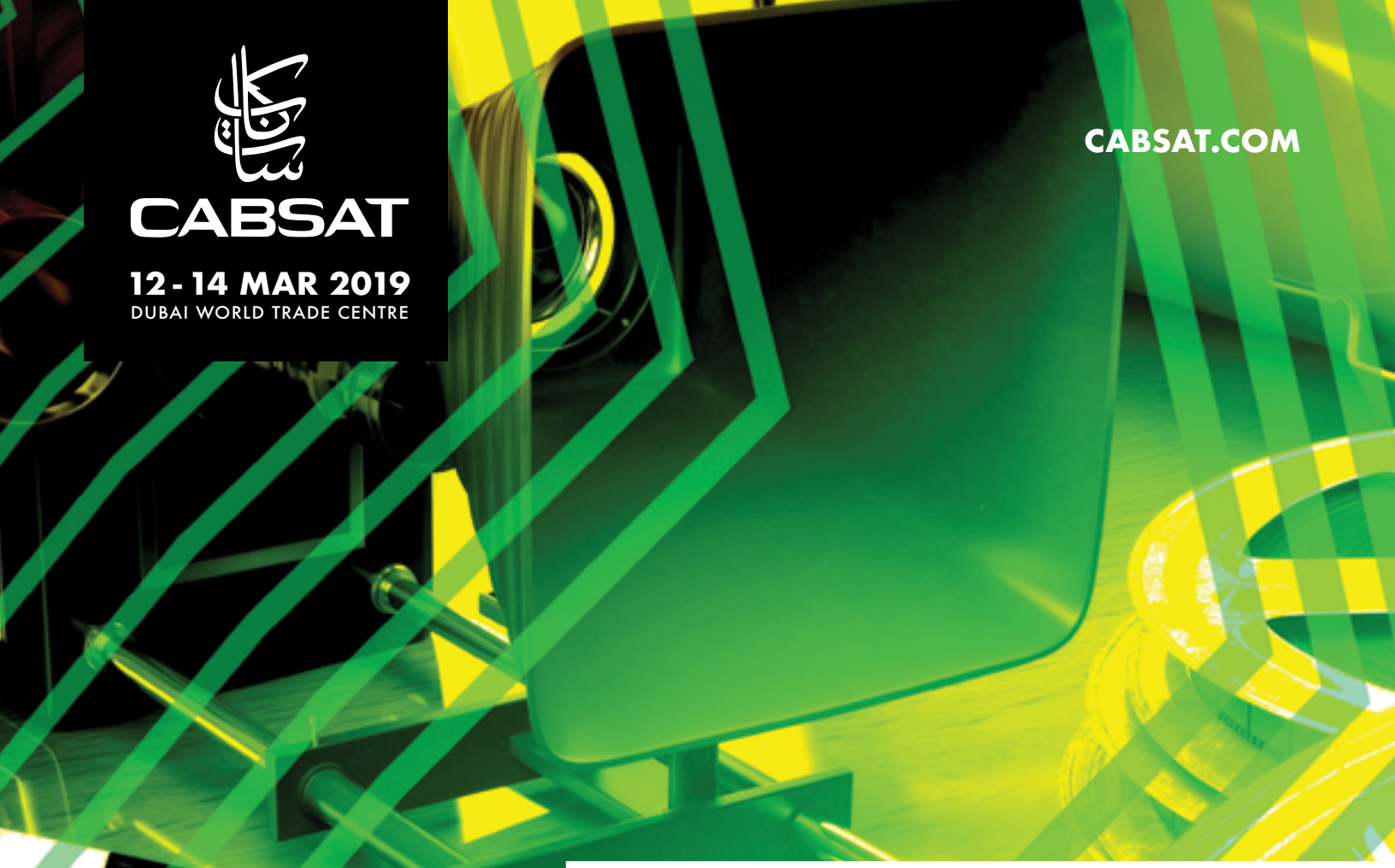
As with other transformative and revolutionary technologies, there are challenges inherent in the development of AI.

Governments can embrace these challenges and benefit from AI by creating clear roadmaps to guide the adoption of this technology.

They should recalibrate their laws and legal frameworks to support data-driven technologies and innovation-driven growth; strengthen the supporting infrastructure for development; and set the tone of a collaborative approach that allows all stakeholders to share their expertise, insights, and build trust.

With the correct mix of policies, Africa and its citizens can reap the benefits of the transformations in the years to come.

Download an informative whitepaper to learn more about the opportunities and challenges for AI in Africa.



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*Source: Saudi General Entertainment Authority (GEA) Announcement – Feb 2018

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Drastic Shake-Up Needed...

...for the South African space industry

By Anthony Penderis, Editor, African Association of Remote Sensing of the Environment

The South African Space Industry is in need of a drastic shake-up otherwise the country will miss out on the Fourth Industrial Revolution now driving economies worldwide.

The cause could rest with the nation's lack of funding and the fact the country's space industry is not operating in a coordinated manner. This is the message that ***Department of Trade and Industry*** (**DTI**) and the ***South African Council of Space Affairs*** (**SACSA**) received loudly and clearly at an October workshop in Cape Town to test the space fraternity's response to the organizations' *Space Industry Development Framework* and draft Space Legislation.

However, it seems that SACSA — whose mandate is to advise the DTI on space legislation and related matters — was well aware of the space industry's precarious position, hence the study and preparation of the new space legislation.

Ms. Nomfuneko Majaja, Chief Director of South Africa's Department of Trade and Industry

"*We regard the space industry as one the strategic sectors in our country and an essential enabler to the digital economy and a driving force to Fourth Industrial Revolution worldwide,*" said Ms. ***Nomfuneko Majaja*** the DTI's Chief Director.

She added, "*Apart from its obvious advantages in communication, it is also clear that space technology now finds application in just about every sector of governance in the domains of Energy, Agriculture, Forestry, Maritime, Mining, Mapping, Urban and Rural Development, Transportation, Intelligence and Disaster Management.*

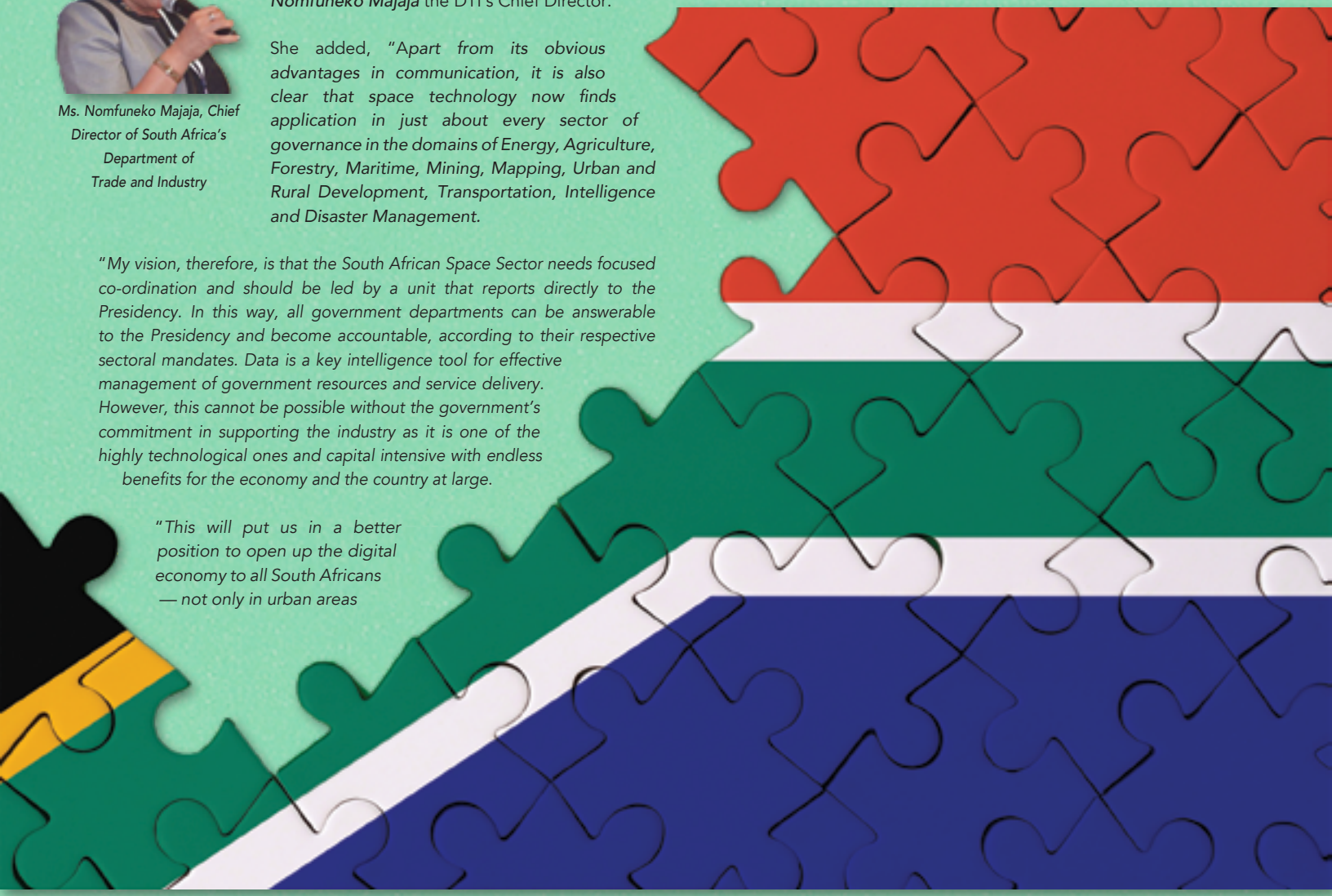
"*My vision, therefore, is that the South African Space Sector needs focused co-ordination and should be led by a unit that reports directly to the Presidency. In this way, all government departments can be answerable to the Presidency and become accountable, according to their respective sectoral mandates. Data is a key intelligence tool for effective management of government resources and service delivery. However, this cannot be possible without the government's commitment in supporting the industry as it is one of the highly technological ones and capital intensive with endless benefits for the economy and the country at large.*

"*This will put us in a better position to open up the digital economy to all South Africans — not only in urban areas but also in far flung rural areas, where terrestrial infrastructure is not possible. It will improve service delivery and can help to reduce the inequalities we still experience in our country,*" said Ms. Majaja.

Some of the most important recommendations contained in the Space Industry Development Framework report presented at the workshop can be summarized as follows:

The South African socio-economy cannot become more equal without access to space-based communications and space-enabled data;

1. *Space technology can very quickly reduce costs for government (data and communications) and can increase earnings in the short, medium and long term — especially through profit and exports. This can also enable intelligent decision making;*
2. *Access to satellite generated data, and the information derived from this in real- time, can improve the performance for every*



single government department and speed up service delivery without exception from Social Services to Agriculture;

3. *It can provide access for remote and deprived communities to most needed specialized health, advanced education and other services they currently have no access to;*
4. *Space enabled data can also assist SMME's in assessing networks which could open endless opportunities in the field of consumer application;*
5. *Services related to Spaceports, including launch services and potentially space tourism will facilitate infrastructure development, related jobs and potentially, a tourism offering, however this is seen as long-term developments;*
6. *Industry should operate in a coordinated fashion of clustering their activities;*
7. *Broadening participation should be the cornerstone of all space development for inclusive growth.*

The report also highlighted the fact that buy-in of space data via commercial satellite operators is extremely costly and does not meet all South African needs; that the *South African National Space Agency* (SANSA) compared to 24 national space agencies worldwide has to operate on the third lowest annual budget of only $9.5 million dollars (2017); and that South Africa has slipped back from being the leading African space nation now to sharing the number one spot with Algeria, both with a total of six satellites in space.

The *Algerian Space Agency* (ASAL) operated on a budget of $360 million dollars last year.

The workshop titled '*Building a Development Framework for the South African Space Sector*' was organized by the S*outh African Department of Trade and Industry* at the *Cape Peninsula University of Technology* (CPUT) on October 15, 2018.

This was a two-pronged workshop with the objective of presenting the *Draft Space Industry Development Framework* compiled by **Blueprint Holdings (PTY) Ltd.** as well as SACSA's draft Space Legislation to the country's space stakeholders for comments.

The draft Space Legislation is to be introduced in Parliament by September of 2019 by Ms. Majaja, the DTI's Chief Director.

More information on these events can be requested from **josie@blueprintgroup.co.za** or **nmajaja@thedti.gov.za**.

This report was compiled by Anthony Penderis, Newsletter Editor: African Association of Remote Sensing of the Environment (AARSE)

BUDGET & POLITICAL COMMITMENT- REVIEW

Agency (country/region)	Budget (in millions of US $)	Year
NASA (USA)	19,500	2018
ESA (Europe)	6,496	2018
Roscosmos (Russia)	3,272	2016
CNSA (China)	3,000	2017
CNES (France)	2,600	2017
DLR (Germany)	2,500	2017
JAXA (Japan)	2,030	2016
ASI (Italy)	1,800	2016
ISRO (India)	1,600	2018
UKSA (UK)	529	2017
CSA (Canada)	489	2017
KARI (South Korea)	366	2016
ASA (Algeria)	360	2017
SSAU (Ukraine)	250	2016
CoNAE (Argentina)	180	2016
ISA and ISRC (Iran)	139	2015
INTA (Spain)	135	2015
NSO (Netherlands)	110	2017
SNSA (Sweden)	100	2015
AEB (Brazil)	100	2015
SUPARCO (Pakistan)	82	2015
SANSA (South Africa)	9.5	2017
SSO (Switzerland)	10	2017
AEM (Mexico)	8.34	2016
Total All Agencies	43,400	

Case Study Countries					
	Algeria	Brazil	Germany	India	South Africa
Main Agency	Algerian Space Agency ASAL	Brazilian Space Agency (AEB)	German Aerospace Centre (DLR)	Indian Space Research Organisation (ISRO)	South African National Space Agency (SANSA)
Satellite Capabilities	Yes	Yes	Yes	Yes	Yes
Number of Satellites [1]	6	7 (3 retired)	43	49	6
Launch Capabilities	No	Yes	Yes (ESA)	Yes	No
Agency Budget (Annual USD)[2]	$360M	$100M	$2,500M	$1,400M	$9.5M
Gross Domestic Expenditure on R&D (GERD)[4]	0.07%	1.17%	2.9%	0.63%	0.72%

Source: International Space Agencies, 2018

This comparison of 23 national space agency budgets worldwide clearly shows that South Africa is third lowest. Algeria scores the highest amongst African countries with an annual budget of $360 million compared to $9.5 million for South Africa during 2017. This graph was presented by Blueprint Holdings (PTY) Ltd at the Draft Space Industry Development Framework workshop on October 15, 2018. Source: International Space Agencies 2018

The Forrester Report

The 2019 picture for European DTH satellite broadcasting — two financial views

By Chris Forrester, Senior Contributing Columnist

In his first column of 2019, Chris examines the end of year guidance for Europe's two satellite giants — SES and Eutelsat — and the impact of a potentially positive C-band frequency reallocation decision by the FCC that is expected in June.

A Tough Road Ahead

A comprehensive report from equity analysts at **Deutsche Bank** makes for tough reading for investors and the market in general for **Eutelsat** in 2019. The warning is blunt and stated that the bank expects 2019 to see Eutelsat suffer a de-rating and the firm advises clients to 'sell' their Eutelsat shares.

However, another bank reports that Eutelsat's recent contract renewals have delivered better terms on leases in Russia and the Mideast — here are two views on Eutelsat's trading for this new year.

Deutsche Bank states that in 2019 Eutelsat will suffer the "*raft of downgrades which plagued SES in 2016-17*" and which will arrive during 2019. The firm suggests that Eutelsat's lack of diversification away from the GEO widebeam business will reveal itself in 2019 with a worsening gap in free cash flow growth versus **SES**.

"*We think Eutelsat will miss its guidance for a return to growth in the fiscal year ending June 30 and be forced to cut its medium term outlook. We expect a -0.2 percent revenue result this fiscal year, worsening to -0.5 percent over the next two years, with FCF also falling. Based on the telco ex growth period of 2009-11; this should be 14-15 percent.*"

Eutelsat will only be a minor beneficiary of any C-band capacity restructuring from their modest North American capacity on its '***Eutelsat Americas***' satellites.

The bank's rationale for this opinion: "*Relative to SES, Eutelsat is more exposed to video distribution and lacks the positive areas (video services and O3B/MEO boost to networks). Eutelsat has not invested in video services or built the HD+ direct-to-consumer platform in Germany. Video distribution faces a structural decline due to fiberization of fixed networks (i.e., migration of digital TV transportation layer to all-IP networks). In its 1Q/19 result call, Eutelsat noted that it lost the U.S. government contract due to 'the package of technology' provided by the winning contractor who is using his own capacity, and 'it has nothing to do with the price.' We suspect SES won the contract with its MEO/GEO bundling solution, which Eutelsat was unable to provide.*"

Not helping matters is a downgrade by ratings agency **Standard & Poor's**, which recently gave Eutelsat a BBB- rating (the rating previously was BBB).

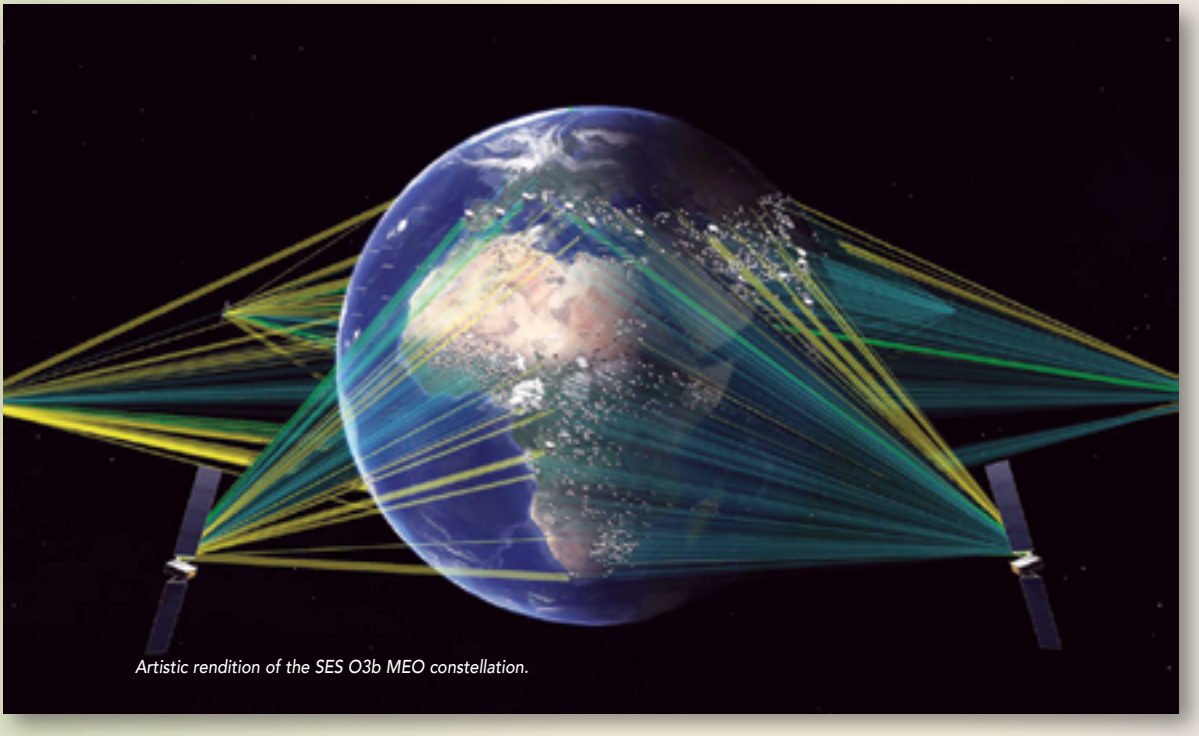
However, an alternate view comes from investment bank **Exane/BNPP**, which had the benefit of two senior staffers from Eutelsat at its mid-cap conference event in Paris at the end of November in 2018.

The banks stated, "*The [conference] feedback was that investors left with much more buoyant [opinions] than the last two months of share price action. Recent contract renewals in Video broadcasting have seen price increases in Russia and the Middle East, with price stability in Europe. The ramp-up of Konnect Africa is progressing, Congo opened this week and more countries are to open shortly. Ten distributors have been signed; another 20 are in the pipeline. The Dec 3rd distribution agreement with [Spain's] MasMovil also underpins our Fixed Broadband estimates.*

"*Management reaffirmed that it expects broadly stable organic revenue growth in FY19, a return to growth in FY20 and 'significant' growth thereafter. Capex efficiency continues to improve. The return to growth in Video in H219 and the ramp-up of the African broadband project look to be the next main catalysts for the stock," adds the bank's note to clients.*"

Also helping is the favorable decision by the French government to reduce Eutelsat's tax rate.

"*More specifically, pre-tax income generated on GEO satellites located at orbital slots not owned by Eutelsat (various slots over Africa, Russia, MENA in our view) will not be taxable in France. We estimate that Eutelsat's tax rate will fall from 32 percent to 26 percent from FY19 onwards. This would produce a 9 percent positive accretion to consensus EPS and should help increase cons EFCF by 6 percent in our view. I call this the Macron tailwind and in fairness why shouldn't*



Artistic rendition of the SES O3b MEO constellation.

Eutelsat be allowed to an equal tax rate to Inmarsat and SES in which to compete? This negotiated cut with the French tax man comes on top of the ordinary corporate income tax cut and the stock has yet to bake in this potential upside," said the bank's note.

Additionally, the bank expects — over the longer term — to see Eutelsat gain efficiencies through lower CAPEX expenditure and stable revenues in terms of video income.

Gareth Hollis from Exane/BNPP said that Eutelsat is the most shorted stock of all the media names working with the bank and has lagged the purer C-band -led stories (for **Intelsat** and SES) in terms of share price performance and multiple expansion, where Intelsat has returned 659 percent and SES 57 percent share price uplifts in the year to date.

Fighting the Tide

Deutsche Bank's end-of-year report on the media sector included an examination of SES's prospects for 2019. The bank's equity analysts praised SES for the company's diversification away from their legacy wide-beam geostationary business and stated that its investments and formation of new business units (notably playout division **RR Media/ *MX1*** and **O3b/MEO** launches) are starting to pay off.

"*[Its] C-band potential windfall will continue to underpin SES stock and ex-band valuation is not overly demanding at 9.6 percent free cash flow yield at normalized CAPEX, if you strip out C-band at consensus valuation of 8p/sh euros for 200 Mhz (source: Zone Finance). But with ~70 percent of earnings and FCF coming from the video business where we still see consensus downgrades to come, Fixed Satellite Services are still a sub-sector to avoid and SES 'hold' (peer Eutelsat is our sell),*" said analyst ***Laurie Davison*** at the bank.

He goes on to say that SES's investments in O3B/MEO and video services (MX-1 and ***HD+*** platform in Germany) are far from proven winners, but the evidence is growing that these can offset some of the accelerating declines in the video distribution (down 6 percent in 3Q18).

He noted the company's video exposure is more weighted to the most advanced video platforms who have cut capacity earliest — this will not go away; indeed, it will get worse as CDN bandwidth pricing continues to fall, speeding the transition of new and existing channels to IP distribution. But 3Q results showed upgrades in its networks business could offset some of the downgrades in video outlook. SES cut video guidance to the lower end of its target range, but raised Networks to upper end. The bank added that it estimates the C-band auction in the U.S. could generate gross proceeds of $11-20bn for 200 MHz spectrum and SES is inline for a 40 percent share.

"*Net proceeds are far less certain; but with a 50 percent retention ratio; this would equate to 2 to 4 billion euros for SES; worth 4 to 9p/sh euros. We revise our valuation from 100 to 200 Mhz and from 4 to 8p/sh euros and Target Price rises from 14.5 to 18.5 euros (Target Price basis: 8 percent FCF yield at normalized CAPEX and add 8.5p/sh euros C-band potential proceeds). However, while there will be enough news flow with the final FCC order published end 1Q or 2Q, the final judgment on proceeds may not be resolved for a further 3 years from then. The actual amount allowed to be retained by SES and Intelsat remains highly uncertain.*"

As the industry moves from the new year into the springtime, it will obtain a better idea as to how 2019 is likely to pan out. Perhaps more worrying is the November 29, 2018, news that **AT&T's DirecTV** division will not be ordering any more satellites for their U.S. DTH customers. AT&T CEO ***Randall Stephenson*** said that DirecTV would be concentrating on building out fiber and OTT services for their customers. "*We're kind of done,*" he told analysts during that November presentation and earnings call when referring to DTH growth.

As of this writing, there's no sign that the likes of **Sky** or **Canal Plus** (Europe's two major DTH payTV providers) are following AT&T's lead. However, the consequences could be challenging for SES and Eutelsat's video divisions if DTH is not just in its '*mature*' stage, but in decline.

Senior Columnist and Contributing Editor Chris Forrester is a well-known broadcasting 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 1998 he 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.

From Asset Management to Asset Intelligence... in Oil & Gas

By Paul Scardino, Senior Vice President, Speedcast, and Senior Columnist

After a robust 2017, the oil and gas (O&G) market has entered a period of turmoil. According to Deloitte's *John England*, writing in a recent *Wall Street Journal* article, the U.S. has come into its own as an energy producer and the nation's shale cost reductions have been dramatic as well as sustainable.

In a time of turmoil, he notes, the low-cost producer will be the long-term winner and the digital revolution can mean the difference between thriving, surviving or floundering. The proliferation of increasingly affordable digital technology is unleashing innovations across the O&G business, affecting everything from how companies develop fields and move product all the way to the back office.

Where digital is in demand, so is connectivity. The research firm **NSR** forecasts that the O&G business will spend a billion dollars per year on satellite connectivity in 2027, up from $700 million in 2017. Increasingly, the demand is not just for a robust flow of bits — it is for the ability to turn that flow into value for the company.

Every Form of Connectivity

Upstream operations in oil and gas demand just about every form of connectivity known. That bit-flow supports efficient production, safety, site security and remote connection to the enterprise. It permits a small number of experts at headquarters to oversee the trickiest part of operations across multiple sites and it supports the morale and retention of crew members with internet access and video content.

One requirement is for backhaul to the rest of the world from remote sites. Depending on the location, that may be provided by cellular, microwave, fiber or satellite — or several technologies in combination, supporting different applications and backing each other up in case of failure. Onsite, people and devices connect over private WiFi and cellular networks deployed across the site as well as mesh radio networks for voice, data and IoT.

All this is complex enough to integrate and manage. **Speedcast**'s preferred solution is a converged Internet Protocol architecture that optimized performance and ensures interoperability of communication services. All communications between disparate systems or between onsite and offsite locations is ultimately turned into IP traffic routed over the local LAN, with its routers, switches, accelerators and firewalls.

In a typical installation, we architect the overall system, integrate the equipment onsite and provide terminals, radio masts and towers, antenna/RF systems, as well as push-to-talk radios, phones and laptops ruggedized for upstream operation.

Managing Assets

The technology implementation onsite, however, is only a small part of the greater value.

With the improvement in the market, companies are laser-focused on obtaining the most from their assets and avoiding expensive mistakes that will come to haunt them in the next downturn. That means reaching production targets even as the aging of oil and gas fields requires greater operating expenditure — which, in turn, means making smart decisions about capital and operating budgets in order to manage assets well at minimum cost.

Getting there takes a level of sophistication at the leading edge of what's possible. Today's smart organizations are going beyond basic connectivity to systems that enable:

- *Integrity management for physical assets so that they remain available.*
- *Production management that ensures optimum exploitation of those assets.*
- *Staff equipped with collaboration-enabling technology to delivery operational efficiency.*
- *Maximum use of the full value of all data feeds from the field, in all its forms.*
- *Analytical capacity to allow this wealth of information to support informed decision-making.*
- *Data visualization that supports the agile management-control of all operations in real time.*

Each of these capabilities exists in some form or other — usually in silos within the organization that limit the benefits it can deliver. Those

silos are formed around legacy IT systems that have evolved to meet individual challenges: asset tracking, drilling and production metrics, infrastructure monitoring and surveillance, to name a few. Each can offer only a limited view of the business and, at worst, they can actively discourage big-picture thinking because of their tight focus.

Asset Intelligence

The leading companies in oil and gas want more and they are asking their communications service providers to deliver it.

They want to connect and integrate the specialist software products and business workflows across operations, maintenance, condition assessment, integrity management, staff training, data analysis and visualization. They want it to add up to more than asset management – they want asset intelligence.

Example

A company's senior management faces requests from maintenance engineers who need the OK to proceed with a proposed schedule, and from the investment department that wants to start work on a brownfield project, and from the integrity management team that wants to change operating parameters to extend the life of an asset, even though it will have some negative impact on current productivity. Today, management has to approach those decisions separately and effectively use intuition to assess what impact they might, together, have across the organization. Withdrawing or directing funding on any of these projects will have an impact on the organization's assets, but what it will be is hard to forecast. Asset intelligence provides a more rigorous way to put a common monetary value on a range of processes or requirements and to make valid comparisons among them. It empowers management to make decisions that enable technical and engineering staff to meet their objectives instead of winding up at cross purposes. Few organizations have all of the systems available, nor do they necessarily need them to achieve asset intelligence. But leading companies are already focusing on the top right corner of the graphic, where predictive and financial analytics offer the greatest potential.

The Road to Intelligence

Asset intelligence is complicated and implementing it could be a nightmare. How can we in the services business help our customers to gain its benefits without disappearing down the rabbit hole of complexity and cost?

Based on Speedcom's experience, there are three essentials to help customers achieve the results they require.

First, conduct a gap analysis. On one side are the existing sensors and systems in the field, the enterprise IT systems and established business processes. On the other side of the gap are the decision-support capabilities the company needs. From the conducted gap analysis, develop a detailed roadmap that reveals how the gaps will be filled, integration achieved and selected objectives delivered.

Secondly, think dashboards — taking data from many different sources, find visual, easily understood and actionable ways to interpret and present that data to management. This will become increasingly critical as IoT technologies cause the flow of data to become a flood of information.

Third, rather than investing in huge, new systems, build a light framework over the top of existing platforms that provide:

- *Reliability analysis based on all the lifetime data in asset integrity, maintenance management and other related systems.*
- *Predictive analytics to support informed, evidence-based decision-making.*
- *A data visualization dashboard to present benchmarking and performance against chosen metrics across all assets*
- *A task-based graphical user interface that shows a continuously updated and re-prioritized set of tasks.*

The day is long past when being a communications service provider could be just about moving signals or bits for a living. Satellite service providers have a great advantage over their competitors when it comes to serving O&G customers.

www.speedcast.com

Paul Scardino is the Senior Vice President, Speedcast. He holds an MBA in Management (with Distinction) from Hofstra University in New York and a BSEE from Polytechnic Institute of NYU. Mr. Scardino is also a PMI certified PMP, a Six Sigma Green Belt and holds an ITIL Foundation Certification. He serves on the board as Northeast Chapter President of SSPI, director of Long Island Software & Technology Network (LISTnet) and senior advisor of the TIA.

An NSR Analysis:

The growing involvement in SATCOM M2M and IoT

By Alan Crisp, Senior Analyst, NSR Hong Kong

M2M and IoT is exhibiting growth across the globe as more and more things are becoming automated, more devices are connecting to the internet and connected things are contributing a greater proportion than ever to increased economic output across a huge range of industries — from agriculture, to transport to energy, and many, many more.

While ~99 percent of things are and will, in general, be connected via terrestrial means, there remains a small and valuable niche that satellite can serve. This ***M2M via IoT via satellite*** niche will derive a disproportionate share of revenues, given the high value verticals which satellite serves.

In NSR's recently publish report ***M2M and IoT via Satellite, 9th Edition***, NSR expects more than 10 million in-service units by 2027. While traditional M2M operators exhibit strong growth, this technology surge will start to accelerate from 2022 as smallsat constellations designed for M2M and IoT are fully developed and will contribute to user demand. This growth is due, in part, to end-users becoming increasingly accustomed to always-on connectivity. Having 24 hours visibility into assets and things is the expectation with mandatory across industries.

Agribusiness demands high resolution data on performance of crops and data optimization to increase yield through precision agriculture. Land vehicles, ships and aircraft demand a plethora of readings to investigate performance and to handle maintenance issues. Consequently, M2M and IoT are forming some of the strongest growth components of operators revenues in recent years. **Iridium,** for instance has seen a year-over-year increase of subscribers of 26 percent in Q3 2018, and **Orbcomm** has, likewise, witnessed a 21 percent subscriber increase in the year prior to Q2 2018. NSR expects this growth to continue over the coming decade, and even accelerate in the years after 2021.

Due to this growth, there are significant levels of investment at present and that funding is increasing their involvement in M2M and IoT. Companies such as **Thinxtra** have developed products that combine *Low Power Wide Area* networks with satellite being used for backhaul connectivity, which is an increasing trend in the agriculture space to connect livestock. For instance, Orbcomm has also partnered with John Deere for agriculture connectivity, and Iridium with **Appareo**. While there is incremental investment made in M2M and IoT made by the traditional M2M satellite operators, which include Orbcomm, **Globalstar**, **Thuraya**, Iridium and **Inmarsat**, there are two main new technologies that will shift the needle in favor of increasing investment in SATCOM M2M and IoT — smallsat constellations and 5G technologies.

Smallsats

Traditionally, M2M/IoT services have been offered on VSATs or via MSS services, such as Iridium and Inmarsat. These systems are highly reliable and are relied upon by millions for critical M2M demands, and have higher priced airtime and hardware costs to match.

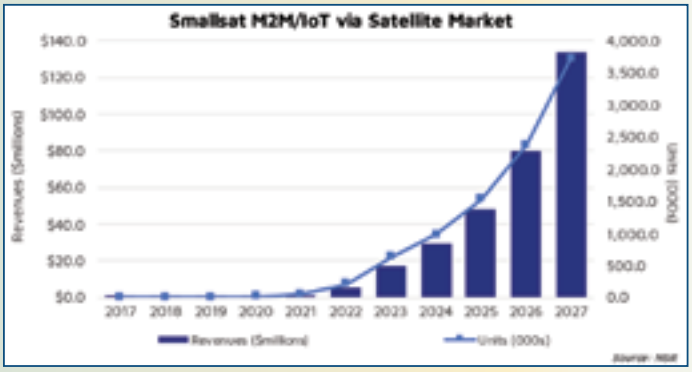
A plethora of new smallsat constellations have been proposed to offer services to a portion of the billions of new internet connected devices over the coming years. Such proposed constellations are intending to offer prices from $1 per month to a few dollars per year, depending on the end-users data requirements — typically 1 data packet per day at these prices. Due to the significantly lower price offered by these services, new markets are expected to open up to satellite, such as

life jackets with embedded satellite connectivity, or other traditionally unconnected objects.

NSR is tracking more than 15 smallsat constellations aiming to enter the market, including companies such as **Fleet Space**, **Kepler Communications** and **Hiber**. New terminal form factors will be developed to function with these new constellations for low cost (under $50) and system-on-a-chip systems for significantly less cost to integrate with a wide range of products, which will drive much more significant adoption (outside of those areas with terrestrial network coverage).

Because of the potentially huge addressable market, investments into smallsat constellations continue to be announced. In the past year, **Myriota** has raised $15 million, **Astrocast** $4 million and the aforementioned Kepler Communications $21 million, as well as many other firms. However, because of these significantly lower prices, millions of IoT devices will be required to turn a profit on each constellation.

NSR expects only 3.7 million connected devices to come online via smallsats over the coming decade and competition will be extremely fierce between the 15+ constellations on orbit for this purpose, with most companies either merging or never actually launching.



However, existing funding available for most IoT smallsat constellations will not be enough to support operations over the short term, with additional funding required to fully launch their spacecraft. Kepler Communications, for instance, estimates that its constellation will cost $50 million. This is more pronounced due to the extremely high latency during the early to mid-launch of the constellations (greater than 12 hours), which is a tough sell to end-users for most applications.

The number of satellites is key for launch CAPEX; Kepler Communications capital expenditure is higher compared to Hiber and Astrocast due to the greater number of satellites planned — this design and manufacturing costs will absorb the majority share of capital expenses, followed by the constellation launch costs.

5G

5G is often defined as a network of networks. One of the main targets of this transition is providing a uniform network involving many technologies, including satellite as a critical component. 5G network implementation is finally coming online after years of planning where in the U.S., for instance, all big four operators have started building out 5G networks and where **Verizon** has launched its own proprietary '5G' home internet service.

The introduction of 5G will also spur development and growth potential within the satellite M2M/IoT ecosystem. While 5G has been traditionally seen as being a competitor in the terrestrial space, the technology opens up the opportunity for satellite to seamlessly integrate with ground networks. The consolidation of technologies will provide a way for satellite to be integrated from a platform operational perspective. This includes leveraging *Network Functions Virtualization* (NFV) and *Software Defined Networking* (SDN). With this simpler integration between terrestrial and satellite networks, new growth potentials for M2M/IoT will be provided, specifically in terms of backhauling IoT data from terrestrial networks. This is especially true for intermodal units and fleets.

Many further deployments are expected when the benefits of 5G connectivity for IoT devices become fully realized. **Hispasat** is already performing tests on the design of hybrid networks between satellite and 5G in Barcelona, Spain, where the aim is to validate satellite network ubiquity for extending the range of 5G services to areas with poor or no connectivity. The initiative could set the stage for widespread collaboration with M2M/IoT operators and systems integrators, significantly increasing satcom involvement in the process.

Challenges

While smallsats have their own challenges as noted in this article, traditional M2M SATCOM players will also have their own set of challenges and those are different in nature to those of the smallsat players. With airtime pricing declining, a greater proportion of revenues will be driven by service providers, systems integrators and other value-added services including software, databases and big data analysis. Consequently, it will be increasingly important for satellite operators to enter into these parts of the value chain and to reach customers directly.

However, it will be important not to compete directly with service providers. Iridium has managed to balance this challenge by directly serving only large customers, including the *U.S. Department of Defense* (DoD). Inmarsat is also in the process of becoming more of a managed service provider to large customers to capture this greater revenue, and Orbcomm has, in recent years, made a string of acquisitions, including **Blue Tree Systems**, **inthinc**, and **Skygistics** in order to achieve this.

More broadly, smallsat constellations will need to develop their distribution channels to have an impact on the greater market. To achieve this in part, MoUs have been established between these newcomers and existing operators for increased distribution through the sale of dual-mode solutions through existing distribution channels as well as the potential co-development of M2M technology and services. This indicates there will not be a significant overlap between MSS and smallsat M2M markets, with these solutions already being complementary in nature. These MoUs include Astrocast signing an MoU with Thuraya, and a similar agreement between Iridium and Hiber.

Bottom Line

With a large addressable market, M2M and IoT via satellite has a long way to go in terms of demand growth — involvement in SATCOM M2M and IoT will continue to surge. However, the new technologies, most notably smallsats and 5G, including dual mode connectivity, will see the greatest investment levels over the coming years and will attract new customers into the SATCOM IoT ecosystem. By pairing these technologies with lower cost solutions, and by providing customers with easy to use solutions, the result will be opportunities for the greatest obtainable growth, well beyond the traditional demand drivers of the land transport and energy markets.

www.nsr.com/research/m2m-and-iot-via-satellite-9th-edition/

Alan Crisp is a senior analyst at NSR Hong Kong and a member of the research and consulting firm's Fixed Satellite Services Group. He is the co-author of NSR's annual M2M and IoT via Satellite Report.

A THURAYA PERSPECTIVE...

The implementations and implications of IoT and satellite M2M

By Jassem Nasser, Chief Strategy Officer

It's a buzzword and all the rage today. It's a technology trend that's pegged to change our way of life and propel us into a smarter future. You've heard of it and are probably using elements of it in your daily life. We're talking about The *Internet of Things* or — IoT.

While aspects of IoT and *Machine-to-Machine* (M2M) connectivity have been around prior to the 1960s, these technologies only gained traction in the new millennium. Today, it's widely acknowledged that IoT affordably and reliably increases operational efficiency, and can support artificial intelligence (AI) frameworks.

IoT and M2M systems render automated data exchange between equipment and intuitively solve problems based on collected information. They are integral to wide-scale projects across multiple points and to unmanned missions in remote regions. Consequently, widespread IoT implementation requires that our world be fully and truly connected.

Enter Satellite M2M

In order to actualize a fully connected and wireless world, we have to depend on satellite technology as it is the only option for optimized coverage across land, sea and air. That's why IoT backed by satellite networks — or *satellite M2M* — is increasingly relevant, as it ensures uninterrupted communications in inaccessible areas that lie outside the range of terrestrial coverage.

Although satellite M2M capabilities are slightly delayed in contrast to the available IoT technologies today, as all move toward global connectivity, there is an increasing reliance on the participation of SATCOM operators. Satellite M2M is especially integral to large-scale IoT operations for sectors such as government, energy, agriculture and maritime.

Varied Implementations and Influences

IoT has already started to effectively alter the way we do things around the world, on both a micro and macro level. Let's examine IoT's different implementations and influences:

Business and Industries

The private sector is often the first to engage in disruptive technology in hopes of digital transformation. By 2018, most *Multi-National Corporations* (MNCs) will have sizeable revenues set aside for IoT projects. According to forecasts, suppliers of IoT components are expected to have annual revenues exceeding $470 billion[1].

IoT helps companies lay out smarter business models and to focus on developing new and improved products. Operationally, the technology harbors a remarkable impact for every industry — consider that sensors and actuators can easily be utilized on everything from pipeline monitoring to predictive maintenance on aircraft. IoT also has a huge potential to develop agtech and edtech, changing the way industrial and small-scale farming works, and how educational institutions interact with students.

Public Policy and Economies

In 2010, China took the step to include an IoT roadmap in their annual budget. Since then, many countries have followed suit — for example, between 2011 and 2015, the *U.S. Government* (USG) spent as much as $35 billion on IoT solutions[2]. In its most important public usage, smart government initiatives rely on satellite M2M to provide real-time surveillance and data exchange for border security, resource and habitat protection, and ISR, SAR and disaster relief missions. In the pursuit of '*smart cities*,' IoT also changes how governments can monitor and bring solutions to urban spaces, traffic, banking, utilities, healthcare, and retail.

As a technology that's adaptive to myriad applications, IoT can powerfully impact developed nations as well as meet the sustainable development goals in emerging economies. IoT in developing countries can be used to accelerate human welfare needs.

For example, satellite M2M can give remote villages more access to electricity, help conserve groundwater and optimize the harvesting of solar and wind energy. IoT has also brought a noticeable change in cold-chain logistics for the delivery of vaccines and enables telemedical solutions that are used to contain epidemics and treat remote patients.

Citizens and Community

From a consumer perspective, IoT improves everyday life and convenience. As mentioned, the implemented

technology can provide better access to water, electricity, and healthcare.

In more advanced communities, connected devices and wearables are used to monitor real-time health or provide home automation solutions via cloud computing. Expeditionists and mountaineers can also use satellite connectivity for real-time weather information as well as other vital stats.

Gradually, as more detailed information becomes available, individuals will have the ability to make more informed choices or opt for practical solutions. IoT helps citizens choose to live more eco-friendly lives or can empower drivers to ease traffic flow and parking congestions.

When it comes to working for societal change, the data gathered from IoT and satellite M2M sources can enable citizens to work together for more tangible communal goals.

Critically Contemplating IoT Choices

A new technology that has the potential to bring change also poses rampant consequences. A connected world inevitably gives rise to increased opportunities for wide-scale security breaches. Moreover, while IoT sensors are affordable, it's set-up isn't simple. Often, the backend integration for satellite M2M systems, especially in industrial settings, is highly complex; there's still a shortage of system integrators who can develop and maintain such equipment.

Additionally, IoT has to be understood and used for specific needs depending on the context. For example, a developing country has to focus on different requirements than a developed one — decisions have to be considered before rolling out a nation-wide IoT strategy.

Some questions to consider are: *Where is it most required*? *How will the data be used*? *What is the role of telecoms and SATCOMs in managing the data output of the systems they enable*? The world today is still in the early stages of knowing how to handle big data. As IoT use increases, the scenario wherein dominant tech leaders prescribe decisions to those who are new to such solutions isn't that far-fetched.

Meeting Smarter Technology with Smarter Decisions

Any technology is a tool in the hands of those who use it. Ultimately, IoT's ability for effective change depends on decision-makers.

Realistically speaking, it may take a few decades (if not less) for the world — including network providers and OEMs — to understand how to handle this technology. However, this will happen. IoT and satellite M2M are no different than when the world gained access to electricity or the internet — the benefits were realized and a way was found for worldwide implementation — life cannot now be imagined without such technologies. For now, we — as a community — have to realize the value enabled by this technology and work together to use it for a better world.

www.thuraya.com

References

[1]*Forbes*

[2]*Business Insider*

As Chief Strategy Officer, Jassem Nasser leads the strategy and business development division which includes Corporate Strategy, M&A and investigating new ventures outside the company's core MSS business. Jassem also manages Thuraya's Corporate Affairs including Regulatory, Spectrum Management and Development.

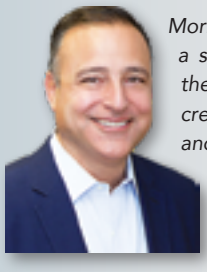
Jassem has more than 19 years of experience in the satellite industry including roles of providing strategic direction, as well as overseeing spectrum and frequency management. His engineering background has been applied to a business environment specializing in satellite communications and other radio communication systems. Jassem has been involved in setting up and managing a start-up satellite organization and seeing the company through its various stages of development by devising strategic direction and priorities, identifying and selection of strategic options.

Jassem graduated with first class honors from Khalifa University of the UAE with a bachelor's degree in Communications Engineering.

An MSUA Conversation With…..

Morris Shawn, President, Roadpost

By Catherine Melquist, President, Mobile Satellite Users Association (MSUA)



Morris Shawn is the President and CEO of Roadpost Inc., a satellite communications provider. Since founding the company in 1991, he has been responsible for creating new business through emerging technologies, and overseeing the company's strategic direction, key partnerships and product development. As Roadpost's President and CEO, Morris's key mandate is to drive the company's leadership in world-class satellite and remote communications solutions, exemplified by its development of the GeoPro remote workforce safety and communications solution, and its appointment as master Canadian distributor of the DeLorme inReach. He has helped grow Roadpost into Canada's clear mobile satellite leader; indeed, Roadpost is among the top Iridium service providers on a global basis.

Morris's telecom industry expertise spans almost a quarter century. Earlier in his career, he held Marketing and Strategic Planning positions with Bell Mobility, where he played an integral role in many of the company's distribution development, product roadmap and long-term strategic planning initiatives. Morris holds an MBA from the University of Chicago and received his bachelor's degree from the Wharton School of the University of Pennsylvania.

Catherine Melquist (CM): *Morris, thank you for taking time for a Mobility News interview. I thoroughly enjoyed our recent catch up and I believe fellow MSUA members and Mobility News readers will enjoy learning about Roadpost and your perspectives on the satellite mobility business. Let's start by focusing on Roadpost. What is the mission and focus of Roadpost and how would you describe the business you oversee today?*

Morris Shawn (MS): Roadpost is focused on the land mobile segment of the MSS space, with a full range of Iridium, Inmarsat and Globalstar telephony, broadband and personal tracking solutions. We serve close to 45,000 subscribers under our Roadpost and BlueCosmo brands. Our fastest growing business is GeoPro, which is a cloud-based platform that helps enterprise customers manage their employee duty of care. GeoPro supports functions like tracking, check-in scheduling and management, and SOS alerting through a number of different satellite devices and mobile apps.

CM: *What geographic and vertical markets does Roadpost prioritize and do you see new markets emerging?*

MS: Our business is split fairly evenly between the U.S. and Canada. The Canadian market has been flat recently given depressed natural resource prices, and so we've seen more growth in the U.S. both organically and through our acquisitions of BlueCosmo and Satellite Phones Direct.

Our key verticals are the usual suspects that operate in remote areas, including government ministries, oil and gas, and utilities. We also are seeing a growing business continuity application amongst enterprises that are not traditional MSS users, driven by the increasing frequency of extreme weather events. And lower priced devices such as IsatPhone and especially personal tracking devices including SPOT and inReach have spurred an emerging consumer market.

CM: *As change is always in motion and we're amidst a sea of change in the satellite industry, how do you see things evolving on the distribution side of the land mobile business?*

MS: We will clearly see more consolidation among service providers and resellers. Resellers in particular are one layer too far removed from the network operators and therefore have a higher cost of sales, which will be increasingly tough to sustain in the low growth handset and telephony market. That distribution layer is going to get disintermediated, except for those companies with highly specialized solutions or integration capabilities in, for example, the IoT space.

CM: *What about on the customer side? How do you think today's users experience satellite communications?*

MS: If we're talking about legacy products and solutions, too many land mobile users today don't experience satellite communications. Terminal and usage costs are very high and so MSS is relegated to emergency use only, sort of an insurance product that people buy because they have to but hope they don't have to use.

This seems crazy given the explosive growth in penetration and usage that we've seen in the mobile phone world, which suggests that land mobile usage would explode if the affordability was there. In fact, that's exactly what we've started to see with many IoT applications and the emerging personal tracking segment.

CM: *As MSUA focuses on satellite mobility innovation and market development, what do you believe to be the most important product innovations emerging in the industry and why?*

MS: Iridium's launch of its NEXT constellation is obviously a huge industry milestone, and Certus will bring lots of new terminals and services. The initial Certus 350 products aren't really targeting our land mobile markets, but that will change once we see more portable and cost-effective lower bandwidth terminals and services in a couple of years. Where we don't see much innovation is on handsets, where the functionality and expectations gap between satellite phones and what's available on the mobile side keeps growing.

At the other end of the bandwidth spectrum, the personal tracking market is another area where we expect more innovation. We see additional high-volume markets and opportunities for low-priced, low-bandwidth devices, and Roadpost certainly intends to participate.

CM*: Do you believe the innovations will help simplify the sale of satellite connectivity or add additional complexity?*

MS: That's a great question. The industry traditionally has a very strong technical orientation in how it presents itself and its products to the marketplace. There is not enough focus on what some marketers call the "whole product", which is the core product itself surrounded by the layers that make it so much more valuable to the customer.

For example, Roadpost was intimately involved with the inReach, having participated in its initial development and later as master Canadian distributor until Garmin acquired DeLorme. It's a great example of a whole product that is more than a device; it's easy to activate, the monthly service plans offer lots of value and are the same no matter who you buy the device from, you can manage your subscription online, and it

has a mobile app and online portal and even product ambassadors that are super focused on the inReach's core outdoor adventure market.

Of course, "whole product" for a low-priced, consumer-oriented device is different than for a more specialized solution sale, where the whole product may extend beyond satellite and into a solution that spans connectivity technologies, but the concept is the same even if the ingredients aren't. In the end, it's not the products themselves that will determine customer engagement, it will be what the distributors, VARs and VAMs build around those products, and how easy they make it for customers to integrate those products into their business workflows.

CM: *What about your existing markets and users. Does the promise of new broadband LEO systems and low-cost next gen terminals complicate purchase decisions that need to be made today?*

MS: Not yet — while there has been much industry chatter around OneWeb and the other new LEOs, at the customer level these programs and products still seem undefined and distant. Customers who do dig in find these systems may not offer the expected mobility and portability and are instead targeting more fixed and transportable applications.

CM: *We used to talk a lot about the market convergence of MSS and FSS spawning the new "mobility" market. Today, it seems there's an even larger convergence occurring between satellite and wireless services with some service providers positioning themselves as being both satellite and cellular capable. Do you see this dynamic taking place and are users expecting service providers to be able to support multiple wireless technologies?*

MS: Yes, we certainly see that in some of our markets. One example is GeoPro, our work alone safety platform. Although we started with satellite devices, we now have customers that use the platform to monitor workers across technologies. A big box retailer might have an overnight maintenance worker who needs WiFi-enabled indoor location functionality on a cellular device, as well as transport truck drivers who are traversing areas outside of mobile coverage, and therefore need a satellite device. That customer wants to manage their duty of care on a single platform, regardless of the specific employee's connectivity and functionality requirements. What we're not seeing much of, at least in our space, is demand for actual devices that are dual-mode, as opposed to platforms.

CM: *Does this dynamic and other industry trends present any new or unique challenges?*

MS: Yes. All of us that sell MSS need to educate ourselves and think outside of the satellite box if we want to identify new opportunities and grow our businesses. First, we need to understand and articulate how our pieces fit within the larger operating, business process and network contexts for our customers. And second, we must recognize how customers' smartphone and online experiences have influenced expectations of satellite products and service providers – ease of provisioning and deployment, simplicity of use, always-on connectivity and self-serve account management and support.

CM: *Morris, you've worked in the satellite industry for many years. How did you get involved in satellite and what's your career path been?*

MS: I worked for Bell Cellular in the early days of that industry and left to become a specialty dealer of theirs. We had phone rental booths at airports, like a car rental counter. We started renting GSM phones to outbound overseas travelers, and when Iridium first launched with their idea that this would be a phone for the global business traveler, it was a natural product extension. We all know how that turned out, but we stuck with Iridium through their relaunch and repositioning, and as our original business faded into oblivion, we went all-in on MSS. Ironically, things are now coming full circle, and GeoPro in particular is bringing us back into the cellular space.

CM

Is there a particular aspect of the business you find most engaging?

MS

I really enjoy the product roadmap and strategic planning pieces, and I'm definitely a numbers guy. Structuring and negotiating our acquisitions of BlueCosmo and Satellite Phones Direct has been a new and engaging challenge for me. And I'm fortunate to have an awesome management and front-line team at Roadpost that can both contribute to our strategy and make it happen at the operational level. They know from experience what makes my eyes glaze over, and usually save me from it.

www.msua.org
www.roadpost.com

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President of the Mobile Satellite Users Association, Catherine spearheads the group's mission to promote mobility market development and mobility innovation. With more than 25 corporate and small business members representing all levels of the satellite value chain as well as end-users, MSUA collaborates with conference organizers around the world to facilitate panels and keynote speakers that decipher mobility market dynamics including: growth opportunities, strategic partnership, barriers to progress, application aspirations, adjacent market influences and more.

Catherine Melquist is a strategic marketer with more than two decades of experience developing marketing and public relations strategies for global companies in the satellite and space-based market.

Catherine is the principal strategist at CAM & Company, a boutique marketing practice offering a cost-effective, ready-to-go alternative to resourcing an in-house marketing team or contracting with a traditional marketing firm. Ideal for start-ups, companies in transition, or established businesses looking to augment their staff, CAM & Co helps companies navigate the market to achieve brand awareness, strategic outreach and revenue success. CAM & Co employs a carefully selected network of professionals with satellite and aerospace expertise and shape-shifts them into teams to meet the unique needs of each client.

An ETL Systems Focus...

Satellite implementation in MENA

By Andrew Bond, Sales and Marketing Director, ETL Systems

Satellite technology is undoubtedly helping to improve lives across Middle East & North Africa (MENA). Thanks to technology such as High Throughput Satellite and a great deal of investment into the region, we are beginning to see otherwise isolated communities benefit from connectivity which can often be life-changing. However, with vast expanses of areas lacking in other infrastructure, challenges still remain if we want to see the entire region connected.

Driving Adoption

Satellite adoption in MENA is being driven by a number of requirements that include:

1. *Satellite TV*
2. *Internet connectivity*
3. *Cellular backhaul*
4. *Monitoring environmental issues*

Satellite TV

In many areas of the world, there is talk of cord-cutting, with consumers moving away from satellite TV in favor of *Over-The-Top* (OTT) services, such as Netflix or Amazon Video. In MENA, however, satellite TV remains the most popular method of consuming content.

According to a report by Eutelsat earlier this year, 94 percent of homes in MENA receive their TV reception via satellite and this trend has been growing steadily over recent years. While there is increased interest in *subscription video on demand* (SVOD) services, in many parts of the region, they are either not available or consumers don't have the means to sign up for those services.

In some areas there are other factors that affect TV consumption — this is where companies such as **Azuri Technologies** enter the market, providing solar powered satellite TVs to tens of thousands of households across Africa. The majority of these households would otherwise not have TV at all, so this is a real game-changer for many.

Internet Connectivity

Providing broadband across MENA is a considerable challenge. At the same time, that connectivity provides a vital life line to many rural communities. In those really isolated communities, broadband provision has the potential to drastically improve quality of life, reduce poverty and create job opportunities as well as enabling education.

One of the biggest challenges with broadband in this region is the high cost of access, which is just not feasible for many of the poorer communities. Simultaneously, the landscape and vast areas of rural communities means that building the infrastructure is often not feasible.

Cellular Backhaul

Mobile connectivity has been another massive challenge in MENA, leaving the region far behind when compared to the rest of the globe. However, that is starting to shift and rapid growth of smartphone adoption in the region has been witnessed. According to **Frost & Sullivan**, mobile penetration is around 63 percent for MENA, although in the Arab states this remains quite low at only 45 percent. While consumer interest and adoption is increasing, there remain some fundamental challenges when it comes to cost and infrastructure barriers.

Satellite is starting to play a role in enabling that mobile traffic and greatly reduce the infrastructure barriers.

Monitoring Environmental Issues

Another area where satellite can have a massive impact is with the monitoring of environmental issues. The vast expanse of country makes it difficult to track weather patterns, water resources and other similar activities. Satellite is enabling these types of issues to be better tracked and that can lead to the much needed resources being delivered to badly affected areas far more quickly.

Growing Interest in MENA

The increasing appetite for connectivity across the region is bringing interest and innovative ideas to the fore — certainly not surprising is that a number of satellite launches have already occurred and many are also planned for this region in the not-too-distant future.

Ethiopia is the latest to announce plans to launch a national satellite, with the nation's first due to launch this year to track environmental issues, which is currently managed through the use of foreign owned satellites, with those services offered at either no cost at low resolution, or for a fee for high resolution imagery. By launching its own satellite, Ethiopia hopes to carry out this effort far more cost effectively. Over the coming year, massive launches of nanosats across the region are expected, as operators move to cash in on the demand for affordable data services. This includes a planned 200 smallsats by the close of 2020 from Australian company, **Sky and Space Global** (SAS). These smallsats will be key in bringing a new level of connectivity across the region, especially for those as yet unconnected or poorly connected rural areas.

Key Considerations

While satellite will be extremely crucial over the coming year for MENA, there remain some important considerations. One key factor is weather extremes. As the need for improved communications in the region increases, satellite will become more and more important. The increased use of HTS, in particular with Ka-band transmission, requires that certain technical issues be considered.

One key issue is potentially adverse — rapidly changing weather conditions. The rain fade effect on Ka-band can render a satellite link useless, so the requirement for backup gateways or Earth stations becomes necessary. Due to the distance between the main and backup sites, implementing *RF Over Fiber* links to connect the ground based systems is the only viable option. *Dense Wavelength Division Multiplexing* (DWDM) will be a key enabler of "*between gateway*" communications; however, this will require fiber to be in place or a specific installation to be built. The latter is not straightforward in remote regions where existing infrastructure is scarce.

MENA is a growing market for the satellite industry. However, while there is a demand for data services at an affordable price, also important is that these services are reliable in keeping the region connected and enabling consumers to tap into a wide array of services that satellite enables.

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A Space Data Association Focus

The current state of Space Situational Awareness (SSA)

By Dr. Mark Dickinson, Chairman, Space Data Association

***Space Situational Awareness* (SSA) is absolutely critical for safety of flight — SSA always been important, helping satellite operators determine the precise location of other objects in space, thus reducing the risk of collision. As space gets more and more crowded, this is becoming increasingly challenging. Ensuring the correct SSA tools and processes are in place is more important now than ever before.**

The State of SSA

According to the *United Nations Office for Outer Space Affairs* (UNOOSA), there are 4,857 satellites currently in orbit, representing an increase of 4.79 percent when compared to the number in orbit in 2017.

When you consider the number of mega constellations due to launch in Low Earth Orbit (LEO) in the near future, that number is set to become even more challenging. Indeed, a recent study by the *University of Southampton* has estimated that mega constellations will increase the risk of collision by as much as 50 percent.

Any collision in any orbit could be extremely detrimental for not only the objects involved, but for the entire space environment. The debris from such a collision would add to an already growing problem in space and further increase the risk of collision. It is in all of the industry's interests — commercial and military/agency government — to do everything possible must be done by commercial and military/agency/government actors to prevent such from occurring.

There are a number of SSA tools on the market, including the ***Space Data Center*** (**SDC**) that is run and operated on behalf of the ***Space Data Association*** (**SDA**).

However, over the past few years, the SSA landscape as far as the capabilities of these tools has not substantially progressed, even though the environment has become more and more challenging. The result is that the existing flight tools are not nearly accurate enough for today's spatial environment.

However, many satellite operators are content to remain with the status quo. To some degree, it is easy to see why — there are a number of free tools available that seem to be accurate enough and, in certain circumstances, they seen to be quite adequate — why pay the amounts necessary for more accuracy?

Current Systems

Existing systems are certainly good enough... to a certain degree. In LEO, they are generally good enough for most circumstances. That said, in lower altitudes, space weather continues to be challenging to predict and in higher altitudes, debris is problematic. The most significant problems with current systems is their inability to track small objects and the lack of precise and actionable data.

Even debris as small as 20 cm. can cause catastrophic debris-generating collisions. Current services can only track objects in size down to around 1 meter for collision warnings in the geostationary (GEO) arc.

Currently, operators receive collision warnings even when there isn't a risk of such occurring because the data is not accurate enough to result in accurate forecasts. Even if the operator believes the satellite does need to be precisely moved, knowing where to move without actually impeding the situation is difficult to accomplish. This means that quite often, no action is taken.

If warnings were more accurate, such should lead to less frequent, but actionable, collision warnings. This would save time and money for the operator in terms of not having to review inaccurate warnings. The space environment would be far safer by ensuring genuine collision risks are flagged in time to avoid unnecessary maneuvers being performed.

The Space Data Center

The Space Data Center uses a combination of owner operator and other freely attainable data to deliver accurate collision warnings. While for the future environment, even this data needs to become much better as described above — and as of this writing, this information is probably the most accurate data source currently available.

The inclusion of owner operator data brings precise and timely location information and SDA members can also enter future maneuver information. This means it is possible to spot any issues that could arise from those actions, especially when two operators are looking to perform maneuvers at the same time.

Commercial Operators

Many commercial satellites are owned by operators that are members of the SDA. This means they are sharing owner operator data with the SDC, helping improve the accuracy and timeliness of the data the organization holds. It also means these operators obtain warnings from the SDC whenever there is a potential issue. However, there are still a large number of commercial operators who are not members of the SDA, which has two major consequences. First, those operators are not getting the benefit of the shared owner operator data that will help determine any potential risks of collision. Second, it means that we aren't getting data from those operators to further increase the accuracy of this important catalog.

If all satellite operators were to join, the SDC could be far more accurate regarding the available data concerning satellites. Of course, this doesn't solve tracking debris; however, it would definitely be a step in the correct direction.

Military Operators

For the most part, military and government satellite operators rely solely on freely attainable data. There are exceptions and the SDA has a few of these organizations sharing data with the SDC.

Military operators are generally far much more cautious about sharing data than operators within the commercial environment. While that is understandable, given the sensitive nature of their operations, it is absolutely critical that all operators share their data for the improvement of SSA capabilities.

The SDA and SDC are setup with a framework that enables data sharing, even given all of those considerations. Data is shared within the SDC but other operators do not have access to each other's data and are only alerted when there is a risk of collision.

The Future of SSA

As the space environment continues to evolve, the need for accurate SSA will become more and more crucial for all involved in the space industry. While it is clear that we need to get better at ensuring accurate and actionable data, even for small items of debris, there are some immediate actions all operators should undertake:

- *Development of, and adherence to, space standards, best practices and established norms of responsible behavior*
- *Reliance on STM systems that always seek the best, most actionable and timely collision avoidance data, techniques and mitigation strategies*
- *Collaborative, mutual and transparent sharing of key satellite operations information elements, including planned maneuvers, spacecraft characteristics and RF information*
- *Adherence to station-keeping boxes, authorized RF levels and national, international and organizational space debris and RFI mitigation policies and practices.*

Currently, the best way to ensure SSA is by joining the SDA and sharing data with the SDC.

www.space-data.org/sda/

After completing a Ph.D. in High Energy Astrophysics (University of Durham) in 1997, Mark joined the Vega Group as a software engineer working on various defence and space systems. In 2000, Mark joined the Satellite Operations department at Inmarsat as part of a team developing that company's new satellite control system. In 2005, he became manager of the Satellite Operators Support Group and, in 2009, became the Director of Satellite Operations. In 2013, Mark was appointed Vice President of Satellite Operations. In this role he is responsible for the operation of Inmarsat's fleet of geostationary telecommunication satellites, as well part of the team defining the specifications and following the development of Inmarsat's future satellites. Mark represents Inmarsat at the Space Data Association (SDA) and is currently the organization's Chairman. The SDA is a non-profit association that brings together satellite operators who value controlled, reliable and efficient data-sharing critical to the safety and integrity of the space environment and RF spectrum. The SDA was founded by commercial satellite operators for the benefit of the satellite community.

An Out of This World Idea...

Blockchain and space...

By David Logsdon, Executive Director, Space Enterprise Council and Senior Director, Emerging Technologies, CompTIA

Blockchain technology is one of most hyped technologies to emerge in the last few decades.

Gartner has poised blockchain technology as one of the most influential technologies in the next decade on its annual hype cycle for emerging technologies. On both the federal and state level, there have been several blockchain inspired pieces of legislation introduced.

What is this technology and, more importantly, how will it impact the space industry today and in years to come?

IBM defines blockchain as a distributed digital ledger that permanently records, in a sequential chain of cryptographic hash-linked blocks, the history of transactions that take place between two entities. In short, blockchain is an immutable, highly encrypted ledger with high transparency into all the connected transactions.

According to **CompTIA's *"Harnessing the Blockchain Revolution: A Practical Guide for the Public Sector*,"** Blockchain is considered one of the most secure technologies emerging today because of its inherent security features that include:

- *Immutable data records*
- *Audit trails can verify the authenticity of data*
- *Confidential or private information can be secured through additional encryption*
- *Data protection is built into blockchain because the decentralized nature of the records means that copies can be assessed via the multi-node aspect of the technology*
- *Privacy applications could allow large groups of data to be anonymized to gain insight from that information while hiding or eliminating the personally identifiable information, or PII, within*
- *System Verification and Access IDs ensure that systems talking to each other are verified and authorized to access/exchange data, while access IDs combine two or more factor authentication to ensure secure and authorized access.*
- *Public/Private/Court Keys could allow access to data or other records, such as communication records or bank transactions, for law enforcement investigations.*

According to **Grand View Research**, the global market size for blockchain technology is expected to reach $7.59 billion by 2024.

The potential for blockchain use is endless. Several different business verticals have started to integrate blockchain into the lifecycle of their business transactions.

Those that are farthest along include financial services, supply chain management and logistics, and records management. There are several pilot programs ongoing on the federal level and over a dozen states have introduced blockchain legislation.

The use of blockchain technology in the space industry is in its nascent stages, though such holds great potential.

Blockchain and Education for Space Professionals

In December 2018, the **U.S. Air Force Institute of Technology** (the U.S. Air Force's Graduate School) announced the development of an educational tool for supply management.

This tool comes in the form of a live application coupled with a set of tutorial videos. Video tutorials are important because they add another dimension to learning that makes a student's educational experience more effective.

The videos allow a classroom setting that offers different perspectives and tools that students might not normally be able to take advantage of in their learning.

Blockchain, NASA, and Space Exploration

Space exploration is a difficult endeavor because there are significant supply chains involved on both the human and robotic fronts.

NASA defines the space exploration supply chain as the integration of the field centers, private industry operations, and facilities that join together products and services to support the mission from inception to launch to after delivery support and services.

On April 18, 2018, NASA awarded a $330,000 grant to **University of Akron** Assistant Professor of Electrical and Computer Engineering ***Jin Wei Kocsis*** to support her research that will examine the use of ***Ethereum*** in developing a highly secure operational system to be used in deep space.

Ethereum is the open-source, public, blockchain-based distributed computing platform and operating system featuring smart contract functionality.

According to Kocsis, "*the system will utilize the Ethereum platform to build a spacecraft that could "think" for itself, enabling it to automatically detect and dodge floating debris in a timely manner, thus being able to complete more tasks, provide more data and time for information analysis.*"

NASA is very bullish on the idea. The project could lead decentralized processing being incorporated into future earth and space science missions, meaning a more responsive, resilient, and scalable network.

Space Chain

According to their website, **SpaceChain** is a community-based space platform that combines space and blockchain technologies to build the world's first open-source blockchain-based satellite network, allowing users to develop and run decentralized applications in space.

As an open-source platform, it brings many benefits, including cost, flexibility, security, transparency, and accountability.

SpaceChain's vision is to remove barriers and allow a global community to access and collaborate in space.

As of November 2018, Space Chain has started testing the functions of the space node in orbit.

XYO Network

The **XYO Network** (***XY Oracle Network***) is an open-source location network built on the blockchain. The XYO Network is a cryptographic location network that enables layered location verification across many devices. The network uses a cryptocurrency called XYO to function. XYO uses the Ethereum blockchain to allow users to ask for specific queries that revolve around location requests.

In a spaceflight agreement that was announced in December, SpaceX plans to launch XYO's first blockchain satellite '***EtherX***' in late 2019. XYO is aiming to decentralize global location infrastructure which is currently reliant on *Global Navigation Satellite Systems* (GNSS), heavily dominant by the GPS constellation.

Blockchain and Export Licensing

Satellite export licensing can be a barrier to entry for entrepreneurial and smaller companies. For medium to large companies, it is part of the nature of doing business. Quite often, the delay in expediting an export license lies in the validation and verification of a company's supply chain. As stated earlier, blockchain is an immutable, highly encrypted ledger with high transparency into transactions.

Because the data provided in the blockchain is highly trusted, a company's supply chain bonafides could be approved in a much more expeditious fashion. This could conceivably shrink the time it takes to process a license, and could save both private industry and the federal government a significant amount of money.

Blockchain is changing how many industries operate and the space industry is already seeing an impact from the new technology through improved supply chains and the potential improve operational efficiencies across the board.

The initial success (both in private industry and at NASA [and other federal agencies]) of the first "blockchain in space" endeavors will certainly lead to more efforts and, in time, a more decentralized way of conducting space operations.

www.comptia.org

David Logsdon is duel hatted at CompTIA. He is the Executive Director of CompTIA's Space Enterprise Council as well as Senior Director, Emerging Technologies at CompTIA. As Space Enterprise Council Executive Director, he runs a 22-member council focused on the U.S. space enterprise (commercial, civil, and national security). Under Logsdon, the Council is particularly focused on the satellite platform/data/data analytics/innovative technology/cyber ecosystem.

Under the Emerging Technologies role, he runs the association's New and Emerging Technologies Committee (focused on the policy surrounding big data/open data/data analytics, cloud, mobility, Internet of Things, smart cities, automation, AI, blockchain technology, and digital infrastructure.

Logsdon holds a Bachelor's Degree from the University of Delaware in Criminal Justice and a Master's Degree from George Washington University in Political Management. He served on the inaugural Space Based Positioning, Navigation, and Timing Advisory Board. He currently serves on the Department of Commerce International Trade Advisory Committee (ITAC) on Aerospace, where he Chairs the ITAC's Space Subcommittee. He is also the US industry space industry lead for the US-Brazil Defense Industry Dialogue.

Change Is In The Air

Flat Panel Innovation...

By Kfir Benjamin, Chief Executive Officer, Get SAT

Electronically Steerable Antennas (ESA) represent one of the more exciting advances in the satellite industry.

Flat Panel technologies that enable ESA is one of the specific areas garnering tremendous interest and many ventures are leading the way toward the next evolution in SATCOM antenna innovation.

No technological advance is smooth, all are challenging, and ESA flat panel technologies are no different in that aspect. The industry has had to — and is still — dealing with serious obstacles that must be overcome in technology and unit production that have adversely affected potential and actual users. These issues boil down to the cost of addressing size, weight, bulk and power consumption — the infamous SWaP challenge.

Full ESA antennas, where azimuth and elevation are electronically steered, use a myriad of elements including RF and phase-shift chips to coordinate antenna moving and tracking. Depending on a terminal's size, many of these antennas have a significant number of chips, which significantly drives up acquisition costs for the customer as well as challenges engineers to ensure they operate properly and efficiently. The large number of chips also consume a lot of power, create a great deal of heat that requires heat dissipation technologies and have lackluster RF performance

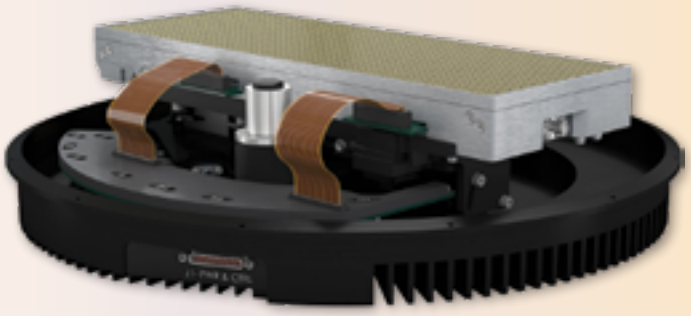
With ESA antennas using different panels for Tx and Rx, a terminal's structure is bulky, large and heavy. Separate panels take up a great deal of space and add significantly more bulk and weight to their structure. Separate panels necessitate a unit that is large and not easy to create, aerodynamically — that damages potential opportunities where aerodynamic contours are a mission requirement. Additionally, ESA antennas are not built to support wide bandwidths.

An additional issue plaguing traditional ESA architecture is that ***Look Angles*** are limited when the antenna points outside its limits, leading to signal weakness. ESA antennas have challenges supporting low elevations. For instance, at <20 degrees, there is a general degradation of 12 dB. For users seeking better signal strengths, it becomes difficult to move forward with this type of flat panel technology.

To address these issues, and more, flat panel antenna technologies require a change, something that offers better and different technological methodologies.

One area of special interest for flat panel enthusiasts is miniaturization or micronization of elements that also do not sacrifice quality to ensure that all critical operational requirements are met. Leading this movement to micronize military and commercial SATCOM antenna technologies is **Get SAT**, an innovator in small, lightweight satellite communication terminals. The company's micronized, integrated terminals specifically target SOTM (*Satellite-On-The-Move*) applications: in the air, on the ground or on the seas.

Instead of creating an all ESA antenna (two dimensional—2D), the company has created a one dimensional (1D) ESA: **Active Blade.** Active Blade's technologies reach beyond and mitigate the challenges mentioned earlier in this article. The firm's highly efficient antennas cover a 2 GHz bandwidth to support commercial and military Ka-bands. The terminal comes in multiple sizes to accommodate the needs for secure and mobile connectivity applications.



Get SAT's Active Blade, folded.

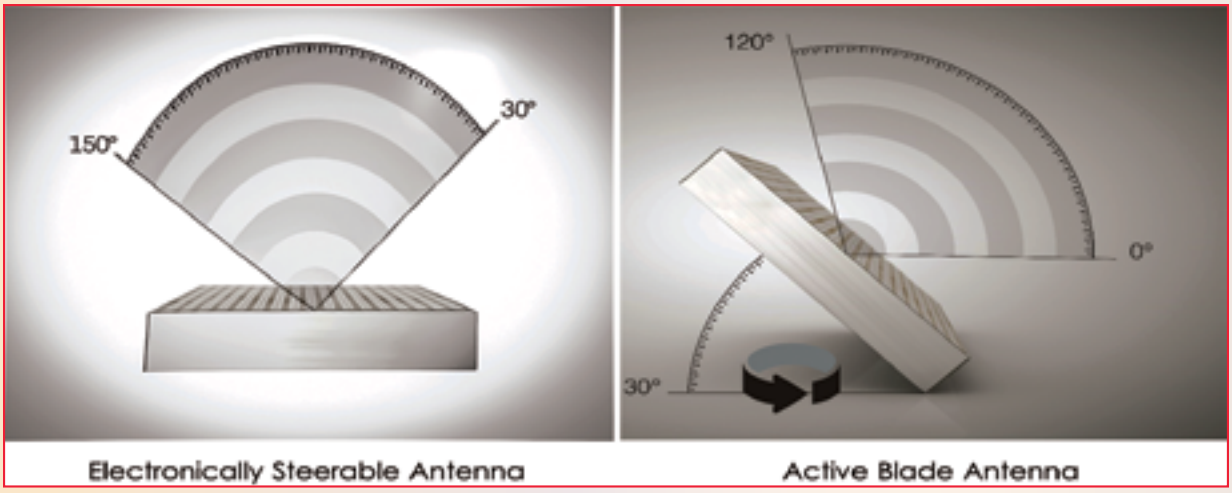
The 1D architecture has a single motor, azimuth is mechanical and elevation is electronic, which enables the terminal to be significantly lighter and more efficient than competing product. A 1D unit has a far lower physical, aerodynamic profile in comparison to fully mechanical terminals. In addition, the company's miniaturized antenna hardware and its software algorithms ensure that all connections and pathways within the architecture exceed industry standards.

The Benefits

Without the need to electronically control antennas in two dimensions, Active Blade employs fewer chips that are all high-performance. Also, by creatively using other components such as RF chips, the terminal boosts the system's overall efficiency to more than 60 percent, almost a two-fold improvement when compared to other ESA antennas on the market, as well as providing more G/T and EIRP for the given area.

Fewer chips also means reduced power consumption, streamlined power sources and a decreased need for heat dissipation technologies. Having fewer cooling techniques leads to fewer parts and additional space, which leads to an assembly that is further micronized.

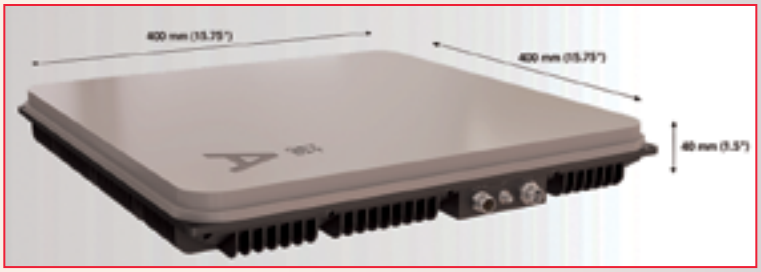
With mobility, weight, size, advanced aerodynamics and low-profile requirements at the top of client requests, Active Blade takes advantage of Get SAT's patented, fully-interlaced, ***InterFLAT*** flat panel technology that transmits and receives signals on the same panel. InterFLAT's dual capabilities significantly decrease antenna (and thus terminal) size, bulk and weight creating an advantage over traditional ESA antennas that use different panels for Tx and Rx. An ESA unit with separate panels needs to be four times the size of Active Blade just to reach a similar performance.



Get SAT Active Blade versus ESA.

Regarding Look Angles, Active Blade's micronized architecture enables the antenna to reach more angles that see the entire sphere, 360 degrees azimuth and 0 to 90 degrees elevation wherever the satellite resides.

Lastly, as a fully integrated terminal, clients save significant effort, time and resources. They can simply connect the power and an IP connection with data is at the ready.



Beyond Active Blade, Get SAT is targeting an additional growth area: L-band SATCOM applications. Under the ***Ultra Blade*** brand, this versatile, super low-profile, L-band antenna will be compatible with various land mobile L-band terminals and L-band satellites.

Ultra Blade will become the market's leading, complete, all-planes ESA antenna with no moving parts. The antenna's streamlined physical characteristics and technical achievements will change the future of mobile broadband SATCOM.

The number of elements used are reduced when compared to Ka- and Ku-band offerings. The company is able to develop an extremely flexible, efficient and powerful full L-band ESA antenna. Ultra Blade's L-band antenna passes the industry's current maximum data rate by reaching more than 2 Mbps via a 500 Khz channel. No terminal has ever reached that level in the L-band sphere.

Expanding Get SAT's SOTM L-band applications, Ultra Blade will combine unbeatable SWaP all in a single package of less than 5 lbs. (2.4 kg). The company expects this will be an innovative product that will change the physical make-up of L-band terminals for the better — Get SAT is excited by the opportunities Ultra Blade will offer customers.

Get SAT, with the firm's technologies and innovations, plans to be a leader in providing creative solutions to push the industry further and farther with antenna innovation.

www.getsat.com

Kfir Benjamin is a business executive with more than 16 years of international experience in multiple technological disciplines. Kfir has lived and worked in various international locations working in various technological and business positions to conduct worldwide, multi-cultural business in North-America, Europe and Asia-Pacific. Previously, Kfir worked in several senior business development and sales positions at Roche, Surf Communication Solutions (U.S.), Microwave Networks (U.S., UK), and Helios communication (UK, China, Israel). During his military service, Kfir served as a Captain in the IDF UAV unit.

Secure World Foundation: Insight

Space Situational Awareness and commercial rendezvous and proximity operations

By Dr. Brian Weeden, Director of Programming, and Victoria Samson, Washington Office Director

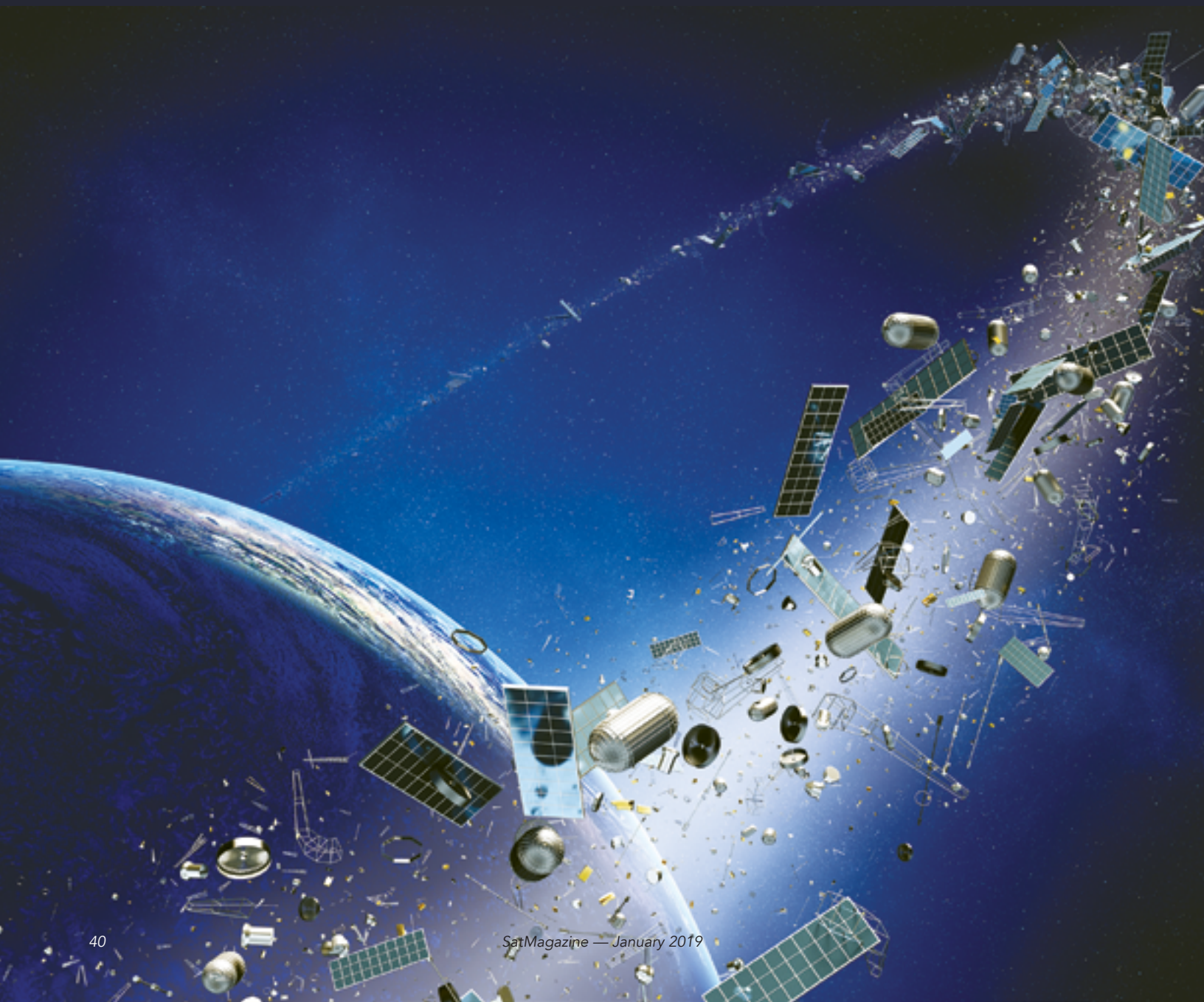
The next major step in space applications, market creation, and robotic and human exploration is potentially being created through the advent of *on orbit satellite servicing* (OOS).

The ability to approach, grasp, manipulate, modify, repair, refuel, integrate, and build completely new platforms and spacecraft on orbit is underway through new OOS vehicles and experiments.

A closely related field, on orbit rendezvous and ***proximity operations*** (**RPO**) that are part of many servicing activities, is also being actively explored by commercial firms, civil government organizations and militaries for a wide variety of applications. While commercial RPO and OOS services hold great promise, the development and use of these capabilities also creates challenges for government oversight of private sector space activities and ensuring RPO and OOS are completed in a safe and responsible manner.

Under *Article VI of the 1967 Outer Space Treaty*, States have the responsibility to provide authorization and continuing supervision of their private sector entities' space activities. A growing number of States implement this responsibility through national licensing of commercial space activities and operate space situational awareness (SSA) capabilities to monitor space activities. However, the commercial RPO and OOS capabilities under development are pushing the boundaries of what the existing national licenses and SSA capabilities are designed to handle.

To further discussions on these issues, the ***Secure World Foundation*** (**SWF**) co-hosted a discussion of the links between SSA and commercial RPO and OOS during the sixth annual ***Advanced Maui Optical and Space Surveillance Technologies*** (**AMOS**) *Dialog*. The AMOS Dialog was a small, invitation-only workshop co-hosted by the ***Maui Economic Development***



Board (***MEDB***) and SWF during the ***2018 AMOS Conference***, held on the Hawaiian island of Maui, September 11-14, 2018.

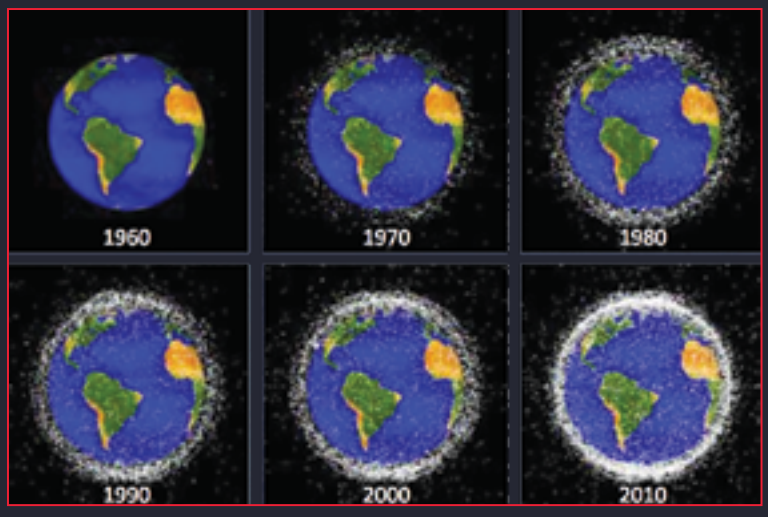
The goal of the AMOS Dialog series is to facilitate discussion among key stakeholders in the SSA community, thereby promoting greater collaboration and cooperation to enhance SSA for safe and responsible space activities. To accomplish this, the Dialog brings together representatives from current and future SSA programs and initiatives around the world with a variety of end users and stakeholders so that they may exchange information and views in a not-for-attribution setting.

Previous Dialogs looked at bringing together SSA providers and end users, collaboration between private sector and governmental SSA programs, evolving current close approach warnings processes toward space traffic management (STM), the links between smallsats and SSA as well as future scenarios for global SSA and STM.

The topic of the 2018 AMOS Dialog was the connection between SSA, RPO, and OOS. The participants examined the new RPO technologies and capabilities being developed to support commercial OOS, and how they impact current SSA capabilities and practices. The group also debated what role SSA should play in the development of international standards for RPO and OOS, how SSA capabilities should evolve to support future RPO and OOS missions, and how SSA and RPO impact the development of future space traffic management regimes.

The main takeaways from the Dialog were that licensing for on orbit activities remains a work in progress. The United States recently changed its licensing rules to allow ***non-Earth imaging*** (NEI), a key part of RPO and OOS, but licensing and oversight for other aspects of RPO and OOS are still under discussion.

More work is needed to define the SSA needs to support commercial RPO and OOS, which will vary depending on the orbital regime and what the specific activity is that is being monitored. Discussions have started to develop industry best practices and technical standards for OOS/RPO; however, as of this writing, classification concerns have prevented the industry discussions from incorporating a lot of the historical lessons learned from military RPO. There was also agreement on the need to encourage and empower multiple private sector and governmental data providers to increase SSA capabilities, but a recognition that the SSA world will need to find ways to deal with the "big data" challenges stemming from greatly increased SSA capabilities.



Satellites and debris in low Earth orbit, 1960-2010. Courtesy of NASA.

Moving forward, SWF plans to address several of these topics through a variety of initiatives in 2019. Through the organization's continued role supporting the Secretariat of CONFERS, SWF expects to play a key role in facilitating the ongoing discussion among industry members to develop principles, best practices, and, eventually, technical standards for commercial RPO and OOS.

SWF will work with the United States and other countries on developing national policies and regulations that incorporate industry best practices and provide regulatory certainty that enables safe and sustainable commercial space development. The organization also plans to extend the work on fostering industry best practices on other aspects of commercial space activities, such as the potential role of insurers and investors in incenting responsible behaviors in space.

SWF will continue to work with the private sector, civil society, and governments on implementing the 21 guidelines for improving the long-term sustainability of space activities under the ***United Nations Committee on the Peaceful uses of Outer Space*** (UN COPUOS).

Finally, the SDA will continue to work on enhancing national and global SSA capabilities and combining them with national oversight to develop future STM frameworks.

swfound.org/

Dr. Weeden directs strategic planning for future-year projects to meet the Foundation's goals and objectives, and conducts research on space debris, global space situational awareness, space traffic management, protection of space assets, and space governance. Dr. Weeden also organizes national and international workshops to increase awareness of and facilitate dialogue on space security, stability, and sustainability topics. He is a member and former Chair of the World Economic Forum's Global Future Council on Space Technologies, a member of the Advisory Committee on Commercial Remote Sensing (ACCRES) to the National Oceanic and Atmospheric Administration (NOAA), and the Executive Director of the Consortium for Execution of Rendezvous and Servicing Operations (CONFERS).

Prior to joining SWF, Dr. Weeden served nine years on active duty as an officer in the United States Air Force working in space and intercontinental ballistic missile (ICBM) operations. As part of U.S. Strategic Command's Joint Space Operations Center (JSpOC), Dr. Weeden directed the orbital analyst training program and developed tactics, techniques and procedures for improving space situational awareness. Respected and recognized as an international expert, Dr. Weeden's research and analysis have been featured in The New York Times, The Washington Post, National Public Radio, USA Today, The BBC, Fox News, China Radio International, The Economist, The World Economic Forum's Annual Meeting in Davos, academic journals, presentations to the United Nations, and testimony before the U.S. Congress.

Before joining SWF, Ms. Samson served as a Senior Analyst for the Center for Defense Information (CDI), where she leveraged her expertise in missile defense, nuclear reductions, and space security issues to conduct in-depth analysis and media commentary. Prior to her time at CDI, Ms. Samson was the Senior Policy Associate at the Coalition to Reduce Nuclear Dangers, a consortium of arms control groups in the Washington, D.C. area, where she worked with Congressional staffers, members of the media, embassy officials, citizens, and think-tanks on issues surrounding dealing with national missile defense and nuclear weapons reductions. Before that, she was a researcher at Riverside Research Institute, where she worked on war-gaming scenarios for the Missile Defense Agency's Directorate of Intelligence. Known throughout the space and security arena as a thought leader on policy and budgetary issues, Ms. Samson is often interviewed by multinational media outlets, including the New York Times, Space News, and NPR. She is also a prolific author of numerous op-eds, analytical pieces, journal articles, and updates on missile defense and space security matters

Delivering Fault Tolerance in a Low Footprint for PMAD Systems in Space

By Dr. Sorin Spanoche, System Architect, Microchip Technology

An important determinant of spacecraft reliability is the fault tolerance of its power management and distribution (PMAD) system in a radiation environment.

Also advantageous is to reduce the footprint of a redundant PMAD system using ICs that offer a high degree of integration. These goals can be achieved with a new PMAD topology consisting of a series of *metal-oxide-semiconductor field-effect transistors* (MOSFETS) driven by a single *analog front end* (AFE) IC that implements sense and control interfaces to the power devices.

Taking this approach also requires a system design that alleviates parametric drift due to radiation effects on the AFE. This is accomplished by adding a radiation-hard FPGA that enables the AFE sub-system to run *maximum power point tracking* (MPPT) on multiple strings of photovoltaic modules while also delivering power to the main power distribution bus. Meanwhile, additional protection circuits manage power distribution to loads and to and from a battery unit.

A New PMAD Topology

The PMAD system must optimally transfer power from the input sources and manage all power transmission.

Key system components include DC/DC converters, protection circuits and a power transfer and fault management function that is partly local and partly remote. A footprint-reducing topology for these functions that uses *photovoltaic* (PV) module strings as inputs must ensure fast and accurate MPPT control to track varying angle, shading and/or temperature condition per string. This allows several boost DC/DC power converters to independently seek maximum power point (MPP) per string while driving the power distribution bus.

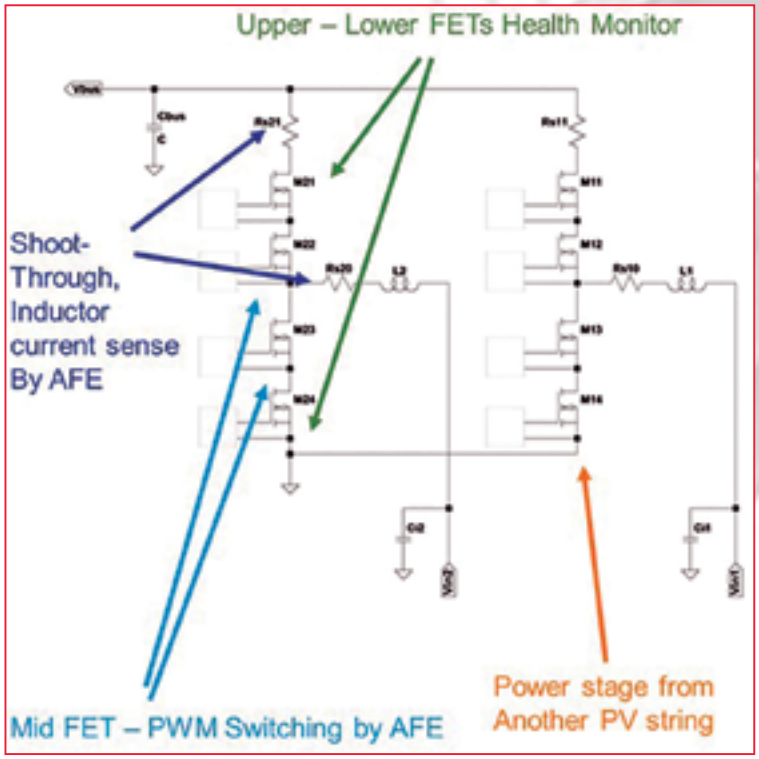


Figure 1: The DC/DC boost fault tolerant power stage.

The topology also must ensure that voltages on input and output nodes and currents through each converter are monitored and used to control each DC/DC converter. Temperature must be monitored at key points and DC arc fault detector circuits should be used per string to detect arc on each high current/voltage rail where it could develop.

Control is performed digitally using the combination of an AFE to convert all sense lines to digital and to drive MOSFETs from digitally generated pulse width modulation (PWM), and an FPGA to implement DC/DC control, MPPT and power and safety management.

Topology of the Fault-Tolerant Power Stage Control

The DC/DC boost unit converter is implemented using a series connection of two n-channel metal-oxide semiconductor (NMOS) transistors for each high and low side. This ensures the controller can disable both high and low side paths in case of a short circuit developing in one of the four MOSFETs at the expense of some converter efficiency loss (***see Figure 1 in the left column.)*** .

During regular switching periods, the uppermost and lowermost MOSFETs are on continuously, while the middle ones are switching. Switching is periodically exercising the uppermost and lowermost MOSFETs to verify their health state while the middle ones are turned on continuously. If shoot-through current or inductor current sensors detect a large change when moving from middle to uppermost and lowermost MOSFETs, a fault is identified, the power stage is disabled, and a redundant power stage is enabled.

The AFE can sense any inductor and shoot-through current. The shoot-through current measure is based on a difference measurement. First the switching is done with enough dead band to guarantee no shoot-through current and the peak current is measured. In the next switching cycle, the timing to be measured is applied and the peak current is measured again.

The difference between these values is a measure of the timing dependent shoot-through current. This measure is repeated several times and the controller low pass filters it to eliminate input or output transient influence.

The shoot-through current, together with a conversion efficiency measure (using input and output current and voltage sensing), is used by the FPGA-based controller to constantly fine-tune MOSFET timing in order to track the actual value and compensate for any long-term radiation or temperature-induced timing drift. This avoids needing to add a lot of margin for timing degradation and using a large dead time as in a classical design. The other alternative to classical design is to use a circuit that includes some loop-controlled delay in the gate drivers, but these circuits are more complex and expensive to build.

For better results, the MOSFET-driving capabilities of radiation-tolerant devices traditionally used in space motor control applications can be leveraged for the integrated PMAD AFE to compensate for all variation. The extra current sensor of these devices enables PMAD systems to compensate for all variation. Their capabilities are illustrated in ***Figure 2*** using Microchip's ***LX7720*** radiation-tolerant spacecraft motor controller as an example.

Four high-side / low-side pairs of gate drivers are used to drive all 8 MOSFETS required to implement the two fault-tolerant power stages. The device's internal charge pump is activated to turn permanently on the uppermost side's MOSFETs connected directly to the rail (except when the estimation of the health of the system is done and MOSFETS change roles). Additionally, the device's resolver driver outputs are employed to drive the primary of an isolated forward DC/DC converter to power an auxiliary circuit used for PV arc fault detection.

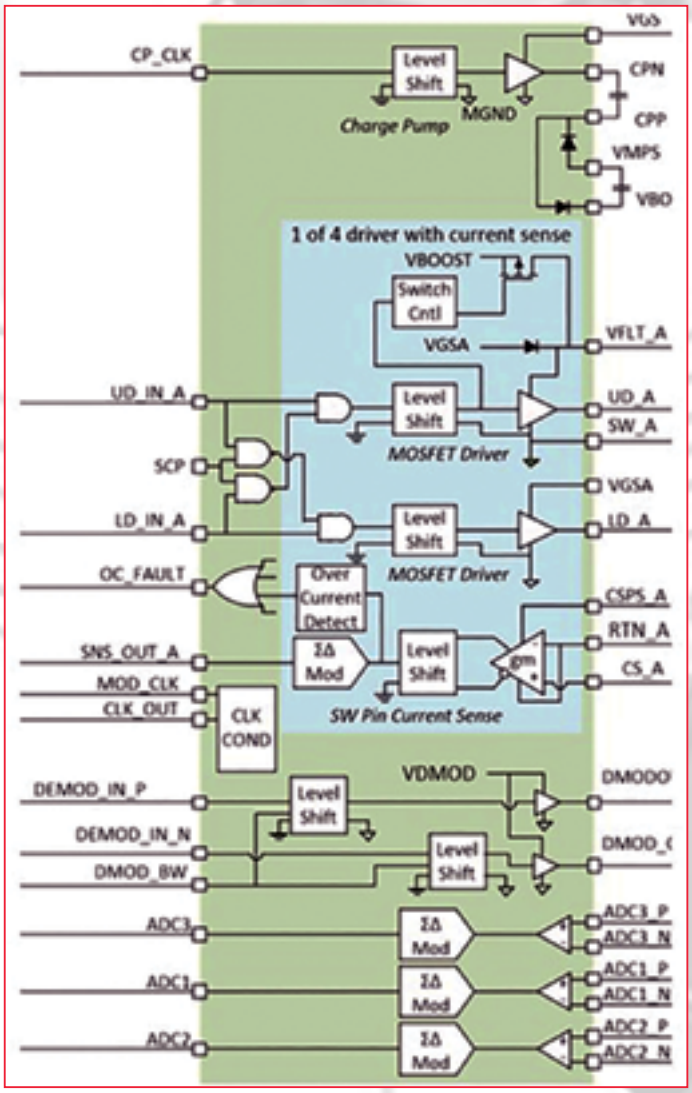


Figure 2: Microchip LX7720 motor controller block diagram.

The next step is to combine the AFE with power line protection devices for power distribution. An example is Microchip's ***LX7712*** featuring a solid-state P Channel MOSFET switch and catch diode. It uses switch temperature to trigger an optional thermal shutdown and can be configured as a latch-able or fold-back current limiter. Multiple devices can be paralleled in a master/slave arrangement if an increased *latching current limiter* (**LCL**) class is needed.

The latch-able current limiters of these devices' can be configured to latch in the off state due to a fault (operating as an LCL) or to attempt to restart in a hiccup mode operating as a retriggerable LCL (RLCL). A fault time integrating function remembers the cumulative effect of short fault pulses and should be configurable for a fixed duration or a duration that is a function of the voltage drop from line-to-load across the device. In fold-back current limit mode the profile of the fold-back load current versus load voltage curve should be resistor-programmable. It should also be possible to configure the fold-back feature for bi-stable operation; applying an overload forces the current limit to a safe trickle level and, when the fault is corrected, the current limit returns to its normal level. This prevents "soft short" power dissipation situations.

Operating the AFEs

An FPGA is used to implement several state machines and must also run load on/off control, diagnostics and communication functions. Because the DC/DC converter source is a PV module or string, the associated control should be based on a slow/fast input voltage regulation loop approach. The fast loop implements a PID loop to regulate the input voltage of the boost DC/DC to a target voltage, and the loop uses the difference of the input voltage to target voltage to drive the DC/DC converter duty cycle. This loop limits duty cycle such that SOA of devices is met.

While the fast loop regulates the input voltage to a target voltage, the slow loop (MPPT state machine) dynamically determines that target voltage to reach MPP. One approach that can yield a very fast control for the slow loop is to use a PV model and minimum number of off-MPP experiments to determine directly the ideal PMM after a light, temperature or shading change happens. The MPPT response time of this method after an abrupt shading change is approximately 1 millisecond (ms, or 20 switching cycles) if the input filtering is not excessive. In case of partial shading, the control avoids large reverse biasing of the affected cell (hot spot suppression).

The shoot-through current/dead time optimizer should be designed to adjust timing of the high / low side MOSFETs for maximum efficiency while ensuring estimated shoot-through current is negligible and dead time is minimal. The value of the shoot-through current is a relative measurement as previously described and represents an averaged difference between the measured current at large margin and the estimated margin. The sense chain is limited to a known resolution. If the difference is smaller than that resolution then the timing does not yield shoot-through current and the loop can further reduce the dead time, otherwise dead time is increased.

Efficiency optimization is performed by changing the switching frequency and observing a measure of losses in the converter. The optimization space is a range of switching frequencies. This can be a discrete set for systems that cannot tolerate any switching frequency, or a frequency range. The optimizer starts from the largest frequency and uses a steepest descent algorithm.

ICs traditionally used in actuator control are poised to help solve the challenges of implementing a PMAD AFE used in space. They enable developers to build systems that dynamically perform MPPT while tracking temperature- and/or radiation-induced drift of the power stage and gate drivers and optimizing dead time and conversion efficiency.

A radiation-hard FPGA and a group of LCLs/RLCLs using power line protection ICs complete the system, delivering PMAD fault protection through a topology that can be implemented in a small footprint.

www.microchip.com/

Dr. Sorin Spanoche is a system architect at Microchip Technology, leading the architecture definition for mixed-signal high reliability IC products. With 30 years of experience in the industry, Dr. Spanoche is an expert in analog and mixed signals circuits and IC design (low power/noise, sensors, power, telecommunications, RF), algorithm design, digital architecture, system specification and architecture design for mixed signal systems.

SSPI: A Better Satellite World Perspective

Why connected cars need satellite...

Produced for SatMagazine by Space & Satellite Professionals International (SSPI)

The world's citizens purchase more than 78 million cars every year. They shop for horsepower and acceleration, leg room and cargo space, and how many miles the car can travel on a tank of fuel or on a single charge — and every year, more of them want to know just how smart their car is...

The "connected car" is poised to make your time behind the wheel safer and more productive. Connected cars can stream music from your favorite web service, help you navigate, provide internet access and offer road-side assistance in an emergency. But that's just the start.

A Computer on Wheels

Why does your car need to be connected? Behind the dashboard and under the hood, today's cars contain more than 100 million lines of computer code and process up to 25 gigabytes of data per hour.

A high-end model has more computing power than a supercomputer from the year 2000.

There are already millions of connected cars on the road and some of them connect over the same cellular network that your phone does — in 2016, for the first time, cellular connections for cars grew at a faster rate than new phone connections.

Those cellular connections are okay for the fun stuff — the music, the maps and the internet access. But when it comes to keeping you safe, there's a problem.

Cellular doesn't go everywhere. You may get great service in a city or along a highway; however, travel out into the countryside, even in one of the world's richest nations, and it's another story. Drive in a developing nation and the problem is even greater.

A Google driverless vehicle going through its paces. Photo is courtesy of Steve Jurvetson, Wikimedia.

That's why serious designers of the connected car are mixing cellular connectivity with satellite.

The Next Generation of Connected Car

The **Kymeta Corporation** is delivering the next generation of the connected car.

The company has developed a service called ***KĀLO***, making it possible to gain access to satellite connectivity to deliver seamless, global, internet access.

KĀLO works just like a cellular plan for your car but, because it can use satellite networks, it works even where there are no cell towers.

To connect to those satellites, Kymeta has developed the world's first flat satellite terminal, called ***KyWay***™, using revolutionary metamaterials.

KyWay can be built directly into the roof of a vehicle. Kymeta manufactures the terminals using liquid-crystal-filled glass panels on the same production lines as LCD TVs. Small, lightweight, and with no moving parts, they are still powerful enough to communicate with satellites thousands of miles overhead.

The Kymeta Corporation's KĀLO service is being extended to support cellular-satellite connectivity.

Providing Safety and Security

What's going on in your car that needs all the data a satellite can provide?

Your car runs on software and that software needs to be updated regularly.

Currently, that means taking your car to the repair shop. That costs manufacturers billions and the inconvenience means that a lot of software never gets updated.

With satellite, the update can be transmitted to millions of cars simultaneously, ensuring that everyone on the road has the required safety enhancements.

Satellite updates aren't just convenient; they're also secure. We've all heard the scary stories about cars of the future being hacked. Satellite is secure because it touches just one place — your car — instead of traveling across the internet or phone network. That's why the government turns to satellite to protect its most secure communications.

Security matters more and more every year, as cars are starting to drive themselves. Self-driving cars are a miraculous blend of computers and sensors — and one more vital component. Smart cars run on digital maps — incredibly detailed, always up-to-date maps of highways, streets, alleys, corners, sidewalks, stoplights and all the rest.

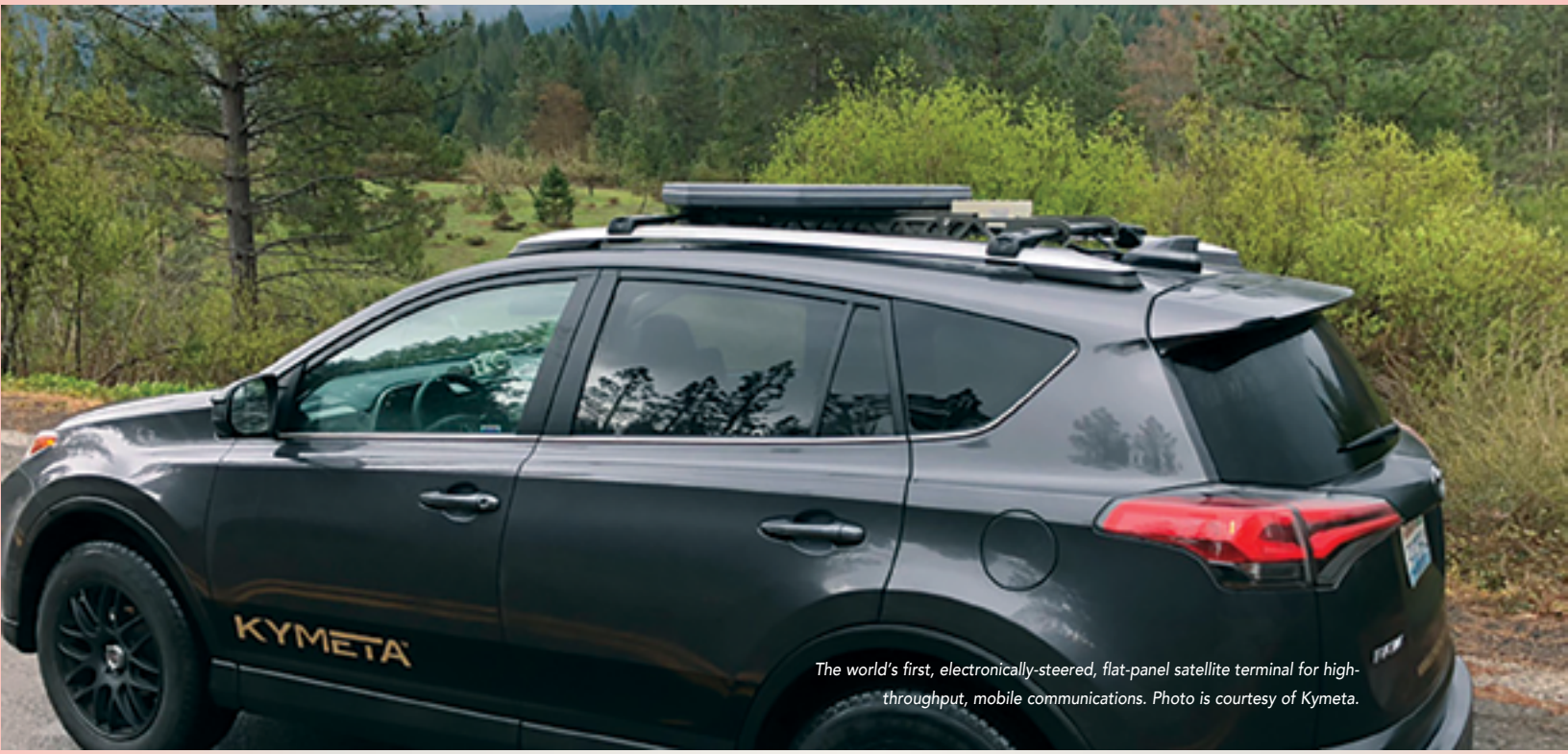
In a world of constant change, maps become out of date quickly. Buildings rise and are torn down... roads are closed and opened... stop signs are replaced with stoplights... stoplights are being replaced by roundabouts. Only satellite can send cars the massive amounts of map data that will keep people safe when computers take the wheel.

The connected car got its start in 1996, when General Motors introduced its OnStar roadside assistance program. By 2015, OnStar had handled more than one billion requests from drivers.

That's why car shoppers are now looking for horsepower or leg room as well as smarts.

Kymeta is working today with satellite operators and automobile companies to make certain your next car will keep your passengers more entertained, get you where you want to go faster and keep you safer than ever before possible.

www.sspi.org



The world's first, electronically-steered, flat-panel satellite terminal for high-throughput, mobile communications. Photo is courtesy of Kymeta.

A Teledyne Defense Electronics Focus

Thermal management in high performance RF and microwave PCBs...

By John Priday, Chief Technical Officer, Teledyne Labtech

As new RF and microwave systems evolve, we are seeing a greater need for effective thermal management and significantly higher RF performance from Printed Circuit Boards (PCB's) and subsystems; at the same time these systems are required to decrease in mass and still offer greater functionality than ever before.

Constraints such as these are often most acute in applications where *Size, Weight and Power* (SWaP) are high priorities, such as military and aerospace, and typically include RF power amplifiers and phased array TxRx modules. This article reviews the various methods of thermal management and reviews in detail the advantages of "*Coin*" technology versus traditional thermal via technology.

High density active power devices, such as GaN power transistors, can dissipate significant heat. One of many roles that the PCB has to perform is to channel heat from the underside of the semiconductor device through to the chosen heatsinking scheme as efficiently and effectively as possible. The design challenge is how best to accomplish this while achieving the other trade- offs required such as RF performance, manufacturability and cost.

Methods of Thermal Management

Traditionally, designers have simply added *plated through holes* (PTHs) to thermal/ground pads under components to take heat away through the circuit to a thermal sink such as a cold wall. Unless the assembly process includes a step to pre-fill these PTHs with solder, there is a high risk that solder will be robbed from under the component into the holes leading to a poor and potentially unreliable connection.

Another solution often used is to have these PTHs under the components filled with a proprietary via plugging paste and plated over the top to give an uninterrupted ground pad. The plugging pastes typically used are electrically non-conductive and offer a relatively low thermal conductivity of around 0.6 W/mK compared to a conductivity of copper of 400 W/mK, so do not contribute much to the thermal transfer. Electrically and thermally conductive paste, for example silver (Ag) loaded epoxy, can be used to fill the thermal PTHs but even with Ag epoxy the thermal conductivity of these pastes is typically in the range of 4 to 30 W/ mK depending upon type — still very low. *See figure 1a*) shows an example of a cross section though a filled and over- plated via. *See Figure 1b*) shows a typical application with filled thermal vias within the ground pad. Look closely and you will notice subtle outlines of the thermal vias in the central large ground pad.

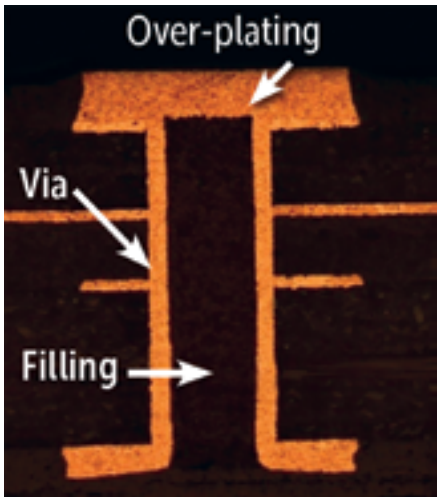


Figure 1a. Cross-section of filled via.

To improve thermal conductivity, one option is to increase the plated wall thickness of the PTHs from the standard 25um, to 100um, for example. Often a greater number of smaller PTHs within a ground pad can provide a more effective thermal path than fewer larger PTHs.

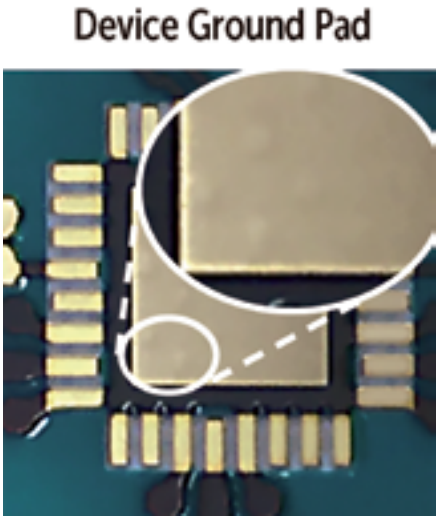


Figure 1b. Photo of typical device ground pad with over-plated vias just visible

There are limits to the effectiveness of heat transfer using a traditional ground pad with PTHs.

Figure 2 shows the results of calculations of four different cases, with detailed calculations shown in *Appendix 1*.

Starting with a typical case of PTHs with 0.1 mm thickness of wall plating[1], it examines the overall thermal conductance with vias filled with a non-conductive filler (*see Figure 2a*). Using this as the base case, it then examines increasing the number of vias (*see Figure 2b*), then changes the filling from non- conductive to conductive silver epoxy of two different thermal conductivities (*Figure 2c and d*).

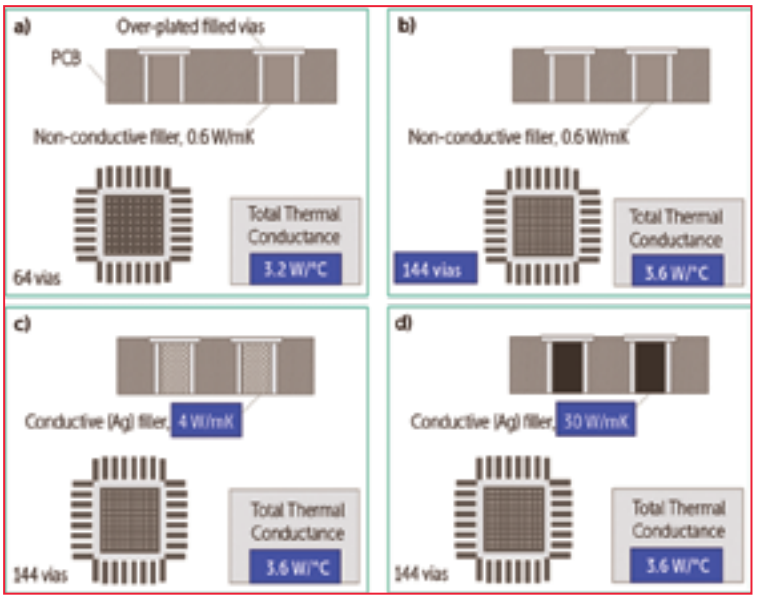


Figure 2: Comparison of total thermal conductance of different filled vias

As can be seen, the benefit of using Ag epoxy instead of standard, non-conductive plug paste to fill the vias is limited and generally not worth the additional expense.

[1] *While a through-hole wall thickness of 0.025mm is standard in non-thermally challenged applications, we usually recommend 0.1mm where heat transfer is important. Note that if standard 0.025mm plating was used for case 2a, then thermal conductance would only be 0.96 W/°C.*

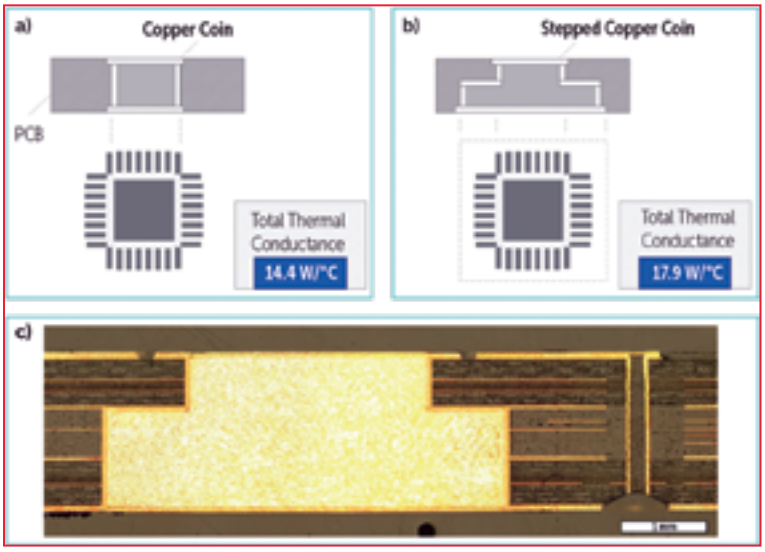


Figure 3: Examples of the use of copper coins

For many leading edge applications the total thermal conductances shown on previous page are not up to the task. A more effective approach is to use copper coins that are integrated into the circuit's structure.

For ease of comparison, a simple approach is shown in (***see Figure 3a***), where a 6mm x 6mm square coin is modeled. A more frequently used approach is to have the coin stepped so that heat is not only efficiently conducted away but also spread.

This is modeled in (***Figure 3b***), and a cross sectional photograph of a real stepped copper coin shown in (***Figure 3c***). The larger area of copper

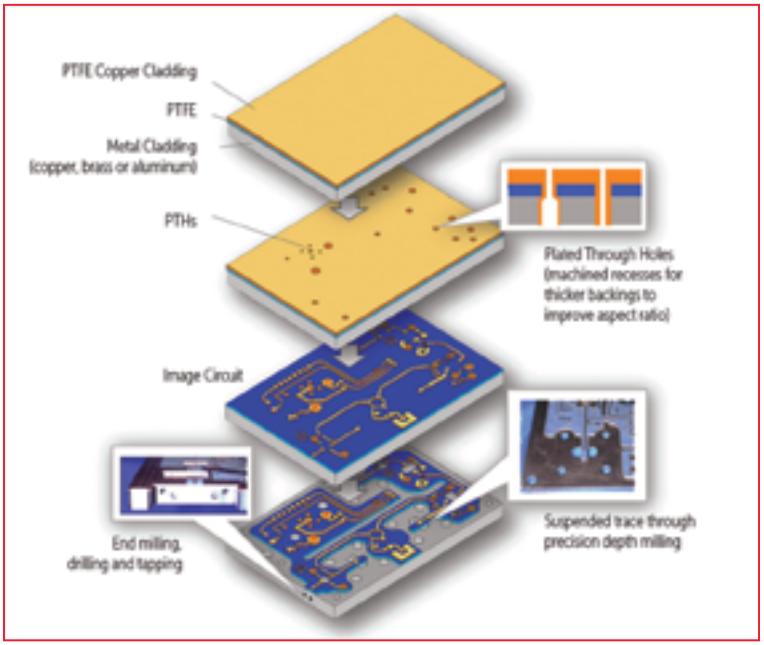


Figure 4: construction of metal-backed circuits.

provides a larger surface area in contact with the cold wall, providing improved thermal transfer. More detailed calculations are given in *Appendix 2*.

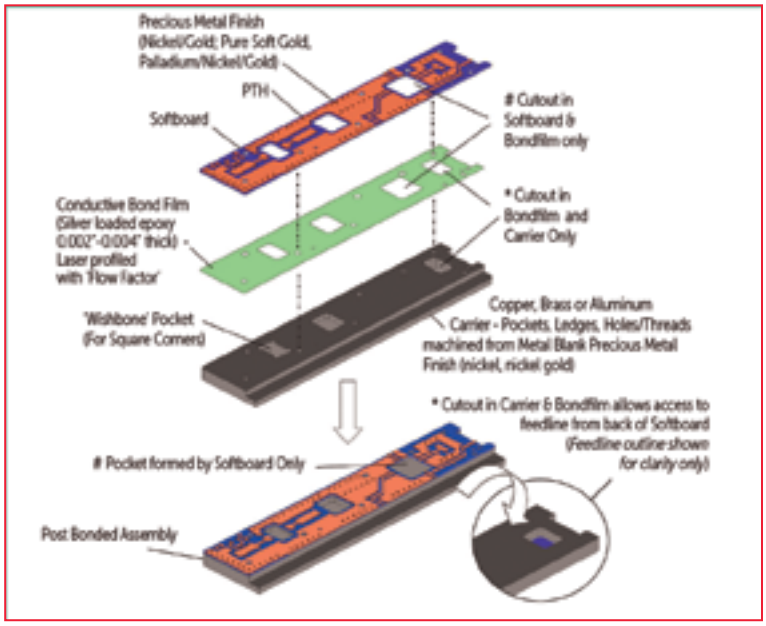


Figure 5: The assembly of post-bonded circuits.

Ultimately metal backed circuits offer an ideal solution where large amounts of thermal energy need to be dissipated, as shown in ***Figure 4***. The metal backing can be copper, aluminum or brass as this type of circuit is typically used for solid state power amplifiers (SSPA) and can be of either pre-bonded or post bonded structure.

In the case of pre-bonded circuits this is where the substrate is supplied pre-bonded to a thick metal backer. This does limit tracking to a single layer and presents issues during processing as invariably machining operations have to take place after the circuit traces have been formed. Great care needs to be taken to avoid damaging critical circuit features. The advantage is that this provides an excellent ground plane reference. The post bonded alternative is easier to manufacture in so much as the circuit is produced and verified before being attached to a pre-machined and plated metal backer as shown in ***Figure 5*** above.

Post bonded circuits can have more than a single layer of conductors. Generally the circuit is bonded to the metal backer using a conductive adhesive layer. For both pre- and post-bonded circuits the components that require heat to be transferred away are mounted directly onto the metal backer through openings within the circuit.

A more complex solution is metal-cored circuits. These can be usefully employed where space is limited and high isolation between RF and control is required in addition to thermal management.

Heat being transferred from components to the core can either be through thermal vias or by direct contact through cavities within the circuit that the components are mounted on.

Consideration must be given to removing heat from the core. Typically circuit substrate is machined away from two edges to expose the core so it may be clamped within the chassis to transfer heat.

In the case of thermal vias where holes are blind with diameters <0.2mm and depths <0.3mm the holes can be filled with copper using a blind hole plating process**.** ***Figure 6*** on the next page shows examples.

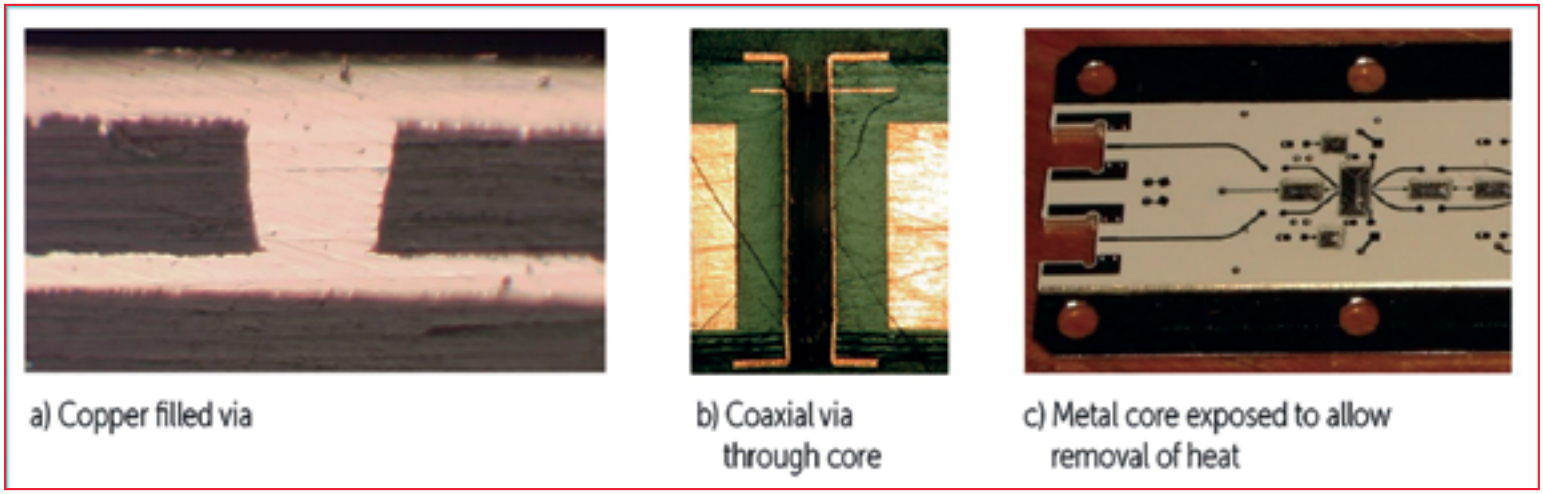


Figure 6: Examples of metal-cored circuits.

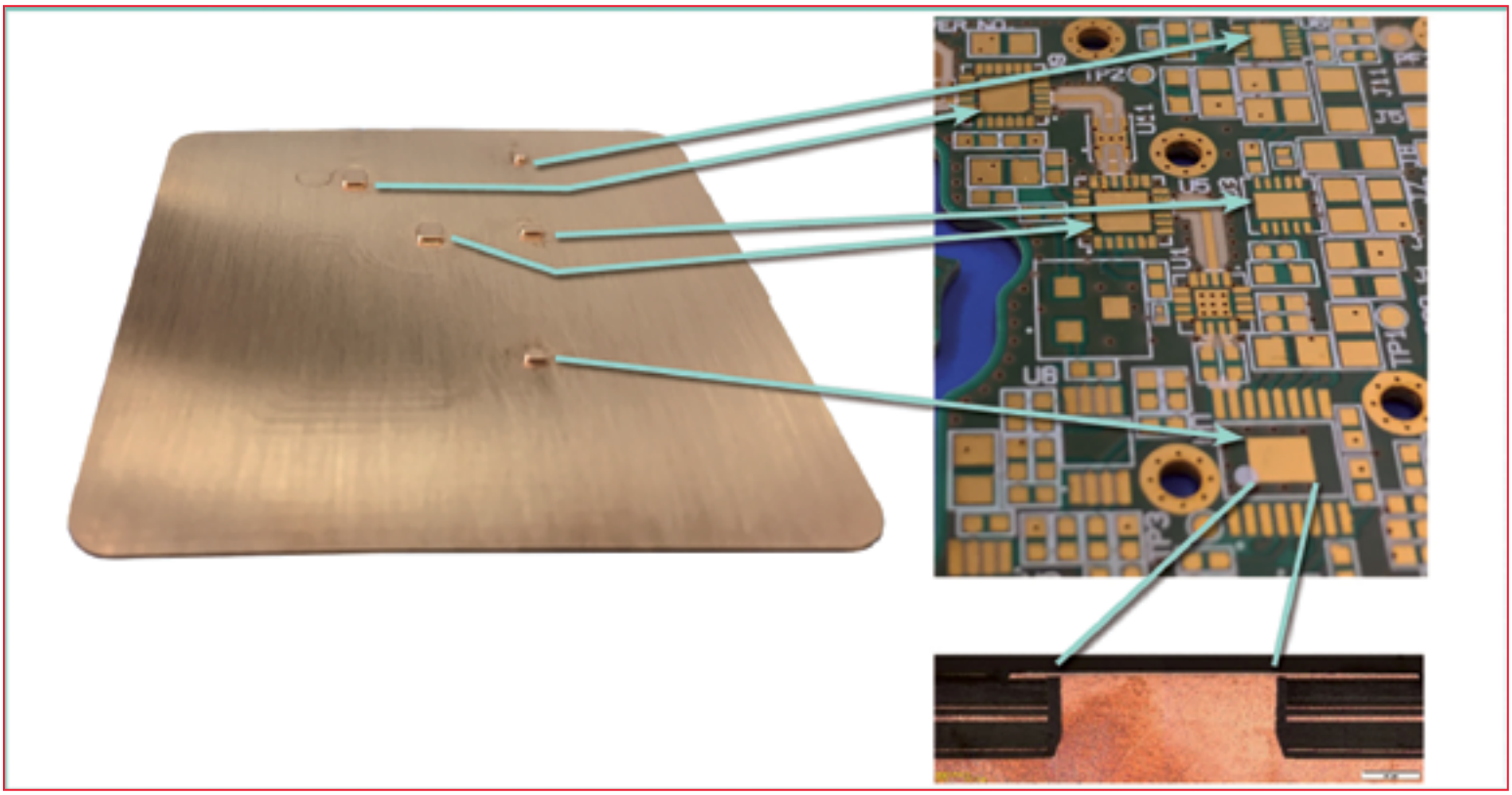


Figure 7: Machined copper plane with up-stands, applicable for small circuits.

Another technique developed by Teledyne Labtech for thermal management on small circuits (<25cm2) and where the overall thickness is limited, yet several devices require thermal management is to employ a machined copper plane with up-stands (pillars). This provides an excellent thermal path way and the heat can be distributed efficiently through the thermal plane for transmission to a cold wall. An example is shown in ***Figure 7***.

Summary

For very high power applications, metal backed circuits currently offer the best solution for high power solid state RF devices that are flange mounted; they do not cater well for SMT components requiring thermal management.

Where SMT components with high dissipation requirements are used, coins provide an effective solution for thermal management. If the required power dissipation is lower, thick walled filled vias offer a lower cost alternative to coins.

Metal core and machined copper planes are generally only employed where space is limited and cost is not the overriding factor. There are thermally conductive substrates available for RF applications but even these generally have rather modest thermal conductivity of typically 1.0 to 1.5 W/mK

For additional information, or for inquiries regarding a specific application, please email ***ptn_sales@teledyne.com***.

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Appendix 1 – Modelled PTHs

The following simplified calculations relate to Figure 2.

a) Thermal Vias assuming non-conductive filler

Drill ø	0.500	
Plate through with	0.100	
Via Length	1.000	mm
Pitch	0.700	
Area for thermal vias	6.000	long
	6.000	wide
Number vias	64.000	
Total area of copper through vias	8.042	mm^2
Thermal conductivity of Cu	400	W/m.K
Non-conductive filler	0.6	W/m.K
Total area of epoxy in vias	4.524	
Thermal resistance copper Rth=L/kA	0.311	°C/W
Thermal resistance Epoxy Rth=L/kA	368.414	°C/W
Total Thermal resistance	**0.311**	°C/W
Total Thermal conductance	3.220	W/°C

b) Thermal Vias assuming non-conductive filler

Drill ø	0.300	
Plate through with	0.100	
Via Length	1.000	mm
Pitch	0.500	
Area for thermal vias	6.000	long
	6.000	wide
Number vias	144.000	
Total area of copper through vias	9.048	mm^2
Thermal conductivity of Cu	400	W/m.K
Non-conductive filler	0.6	W/m.K
Total area of epoxy in vias	1.131	
Thermal resistance copper Rth=L/kA	0.276	°C/W
Thermal resistance Epoxy Rth=L/kA	1473.657	°C/W
Total Thermal resistance	**0.276**	°C/W
Total Thermal conductance	3.620	W/°C

c) Thermal Vias assuming conductive filler 4W/mK

Drill ø	0.300	
Plate through with	0.100	
Via Length	1.000	mm
Pitch	0.500	
Area for thermal vias	6.000	long
	6.000	wide
Number vias	144.000	
Total area of copper through vias	9.048	mm^2
Thermal conductivity of Cu	400	W/m.K
Thermal filler Ag epoxy	4.0	W/m.K
Total area of Ag epoxy in vias	1.131	
Thermal resistance copper Rth=L/kA	0.276	°C/W
Thermal resistance Ag Epoxy Rth=L/kA	221.049	°C/W
Total Thermal resistance	**0.276**	°C/W
Total Thermal conductance	3.624	W/°C

d) Thermal Vias assuming conductive filler 30W/mK

Drill ø	0.300	
Plate through with	0.100	
Via Length	1.000	mm
Pitch	0.500	
Area for thermal vias	6.000	long
	6.000	wide
Number vias	144.000	
Total area of copper through vias	9.048	mm^2
Thermal conductivity of Cu	400	W/m.K
Thermal filler Ag epoxy	30.0	W/m.K
Total area of Ag epoxy in vias	1.131	
Thermal resistance copper Rth=L/kA	0.276	°C/W
Thermal resistance Ag Epoxy Rth=L/kA	29.473	°C/W
Total Thermal resistance	**0.274**	°C/W
Total Thermal conductance	3.653	W/°C

Appendix 2 – Modelled Copper Coins

The following simplified calculations relate to Figure 3.

a) Solid Copper Coin non-stepped

Dimensions of coin	6.000	long
	6.000	wide
Thickness of coin	1.000	mm
Total area of copper coin	36.000	mm^2
Thermal conductivity of Cu	400	W/m.K
Total Thermal resistance Rth=L/kA	**0.069**	°C/W
Total Thermal conductance	14.400	W/°C

b) Solid Copper Coin stepped

Dimensions of coin Top	6.000	long
	6.000	wide
Thickness of coin to step	0.300	mm
Area of copper coin Top	36.000	mm^2
Thermal resistance Top Rth=L/kA	**0.021**	°C/W
Dimensions of coin Base	8	long
	8	wide
Tickness of Base	0.7	mm
Area of copper coin Base	64.000	mm^2
Thermal resistance Base1 Rth=L/kA	**0.035**	°C/W
Thermal conductivity of Cu	400	W/m.K
Total Thermal resistance	0.056	°C/W
Total Thermal conductance	17.910	W/°C

*Assumes only 50% of increased base area is effective (50mm^2)

MISCONCEPTIONS REGARDING GDPR...

... and data processing for the telecom industry

By Eric V. Holtzclaw, Chief Strategist, PossibleNOW

The GDPR (*General Data Privacy Regulation*) passed in the European Union (EU) in May of 2018 is one of the most popular topics of discussion amongst telecom businesses who may or may not conduct business on an international level.

Time and time again, businesses and media publications have stated that GDPR isn't important to them, simply because they're either "*not affected*" or "*not governed*" by these regulations.

Many hold the perception that GDPR only applies to those in the EU, or those who manage business directly in the EU. There is a misconception that the GDPR does not apply to telecom businesses who do not offer goods or services to EU consumers, or process personal EU data. However, in all these scenarios, the GDPR rules and regulations still apply. Here are three of the most common misconceptions about GDPR and businesses:

My Organization Does Not Process EU Personal Data

One of the first misconceptions about GDPR results from an organization's belief that they do not process personal data from the European Union. However, many people do not understand the full scope of the GDPR definition of personal data.

The definition as allocated in the GDPR defines personal data as "anything that can directly or indirectly identify a natural person," which almost all telecom companies store in one way or another..This is in reference to any identifier such as name or identification number, location data or any online identifier such as IP address.

Additionally, many fail to realize the definition of processing as defined by the GDPR actually applies to any set of operations performed around data. This includes collecting information on customers, recording, alteration, retrieval of this information, consultation, use, erasure or destruction.

Combine the far-reach of modern technology and the number of people living abroad, there's likely information stored somewhere that affects EU citizens.

My Organization Does Not Have an EU Presence

GDPR applies to 'controllers' and 'processors.'

A controller determines the purposes and means of processing personal data. In other words, the controller is the business that is selling a good or service. If any telecom organization processes any sort of data for a "controller," they are therefore considered a "processor" under the GDPR.

*Any size enterprise that processes data on behalf of their controllers is subject to governance, whether or not the organization in question has a physical presence in the EU. Additionally, any company that is located outside of the EU is still subject to the law if that organization is operating an online business that **EU customers can access, interact with or purchase products**.*

My Organization Does Not Offer Goods or Services to EU Customers

Whether or not the telecom agency offers goods or services to the EU does not matter if the organization is again processing for their controllers. This labels the organization as a legal "processor."

Data processors include software providers such as Salesforce and Microsoft, call centers, payroll, accounting, and market research firms to name a few. All of these functions within any company are considered departments that store or analyze data in some fashion.

If a EU citizen is affected, they are protected under the GDPR and the company must comply with the legalities surrounding that individual.

Many companies that do not believe GDPR impacts them do, in fact, process data of EU data subjects. What's more, GDPR has created a ground swell of countries and states that have decided to update or create new regulations that mirror GDPR.

More important than ever before is the requirement for privacy to be a top priority. We recommend establishing a proactive practice of collecting country of residence of the prospects and customers with whom you conduct business. Then, as appropriate, collect consent and communication preferences for each data subject.

Today, "*unsolicited email*" in the EU is an easy target for class action lawsuits, especially as it seems consumer opinion on data protection has become increasingly negative.

Organizations today must reconsider whether or not they are governed under the laws of GDPR, as it is likely that they do fall under these regulations.

The best defense is a good offense — consider methods to collect, store and easily change consent and privacy information — these should be a top concern for all companies.

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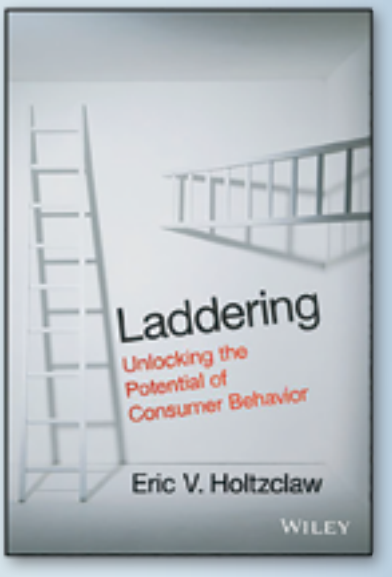


Eric V. Holtzclaw is Chief Strategist of PossibleNOW. He's a researcher, writer, serial entrepreneur and challenger-of-conventional wisdom. Check out his book with Wiley Publishing on consumer behavior – Laddering: Unlocking the Potential of Consumer Behavior. Eric helps strategically guide companies with the implementation of enterprise-wide consent and preference management solutions.

PossibleNOW leverages powerful technology and industry-leading expertise to enable companies to listen to customers, remember what they like and dislike and respond in useful, personalized ways. Its enterprise consent and preference management platform, MyPreferences®, collects customer and prospect preferences, stores them safely and makes them available to any other system or application in the enterprise.

PossibleNOW strategic services experts identify opportunities, plan technology deployments, design preference collection interfaces and position clients for a win. MyPreferences is purpose-built to help large, complex organizations gain control over communications, mitigate compliance risk and reduce marketing expenses while improving customer experience and loyalty.

A World Teleport Association Focus

Factoring 5G into satellite's future

By Elisabeth Tweedie and Robert Bell

This article has been excerpted from the full-length report, ***Factoring 5G into the Future****, published by the World Teleport Association (WTA), available at* ***www.worldteleport.org/store/ViewProduct.aspx?id=12322305****.*

The first generation of mobile phone service, known as 2G, was all about voice: it allowed people to make phone calls away from their home or office and on the move. 3G added data, allowed people to send text messages and enabled basic internet access including online shopping. 4G did everything that 3G did, but faster. With LTE came the realistic capability to stream and share music and video. This is the broadband network.

5G will also be a broadband network — but on steroids. Today a speed of 100 Mbps to a handset is considered exceptionally fast, with most users considering themselves lucky if they get 20 Mbps. 5G will operate up to 100 times faster — fast enough to download a 400 MB feature film in seconds and support intensely augmented reality.
The latency of 5G connections also promises to be a fraction of 4G: one to four milliseconds compared with around 20 milliseconds for today's networks.

Anyone who has tried to use a cellphone at a major concert or sporting event knows how difficult it can be to get a connection, much less send a photo. 5G is promising to support one million devices per square kilometer.

However, 5G is more than just a bigger, faster 4G network. It is also poised to be the major driver of the Internet of Things (IoT), enabling machine-to-machine communications on an unprecedented scale and ushering in the era of machine-to-human communications.

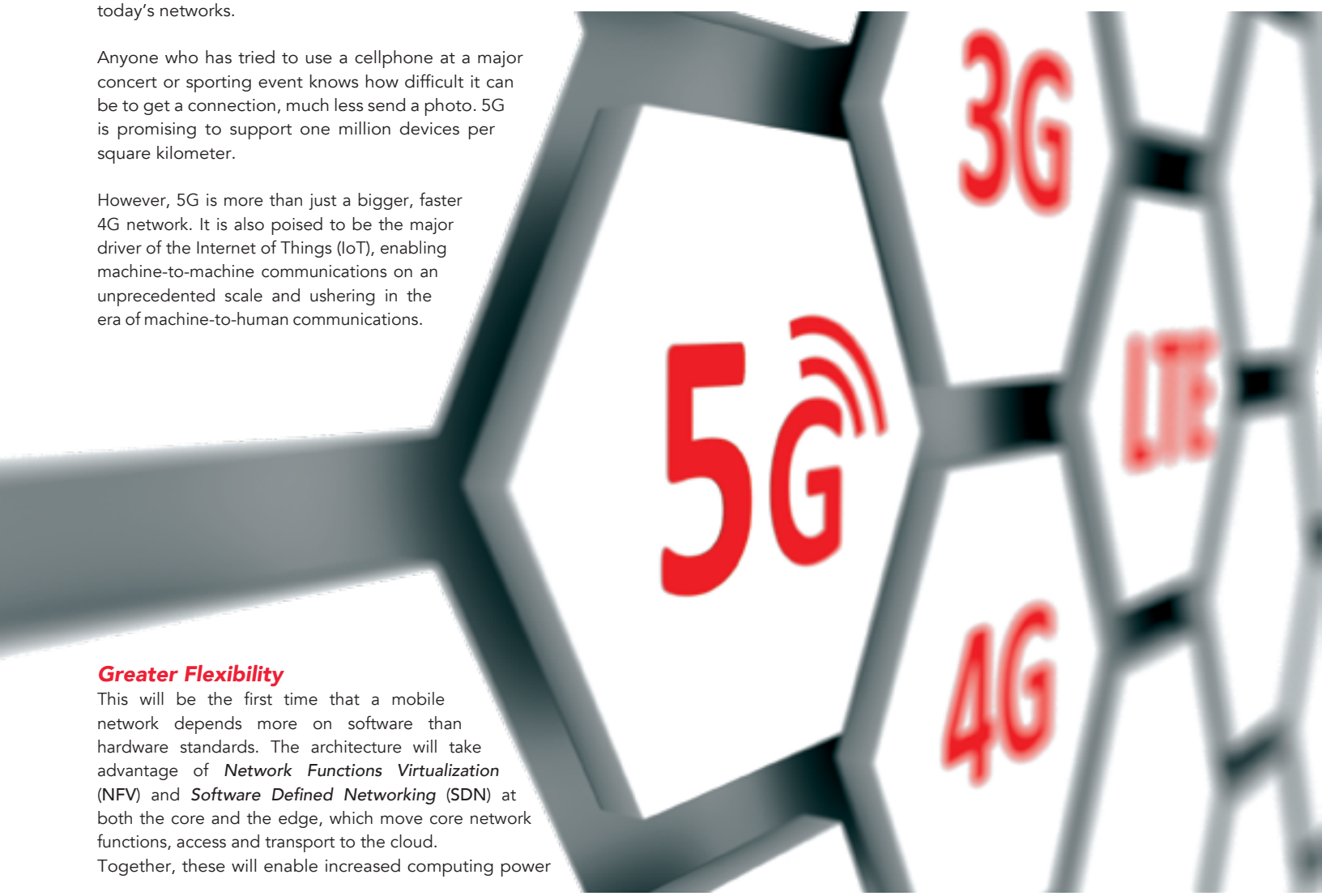
Greater Flexibility

This will be the first time that a mobile network depends more on software than hardware standards. The architecture will take advantage of *Network Functions Virtualization* (NFV) and *Software Defined Networking* (SDN) at both the core and the edge, which move core network functions, access and transport to the cloud.
Together, these will enable increased computing power and scalability, and support multiple applications by taking advantage of "*network slicing.*"

This feature allows for the creation of multiple virtual networks on top of a common physical layer, essentially decoupling the data and control planes. Mobile network operators (MNOs) will be able to offer dedicated virtual networks with functionality specific to the service or customer over a common network infrastructure. This common network infrastructure represents the most profound improvement delivered by 5G.

The network's reliance on software definitions enables it to manage multiple frequencies, user density and data rates. Depending on the frequencies used, density of users and applications required, the cells will vary in size. Many of them, particularly at the higher frequencies, are likely to be significantly smaller and support far more devices than today's cells. But macro cells will continue to function within the standard at lower frequencies.

Meeting the speed and latency requirements of 5G in its fullest implementation requires a much greater density of base stations operating in higher frequency bands. This presents an obvious cost issue. New



developments in 4G/LTE and 5G, however, provide the ability to set up baseband "*hotels*" or data centers to handle most processing, which makes better use of baseband equipment and requires less physical space and power for base stations. This near-edge architecture will tend to increase not only backhaul but fronthaul requirements.

The investment requirements for the rollout of 5G will be staggering. In an analysis of one European country, **McKinsey** predicted that network-related capital expenditures would increase 60 percent from 2020 through 2025, roughly doubling *total cost of ownership* (TCO). This challenge to the mobile industry may present the satellite and teleport market with an opportunity. According to **NSR**, satellite capacity revenue from backhaul will grow from roughly $1.1 billion in 2016 to more than $3.4 billion in 2026.

Mobile Backhaul Today

For the satellite industry, mobile backhaul is significant business. Nearly every satellite service provider provides satellite backhaul and has been doing so for many years, principally to markets in developing nations.

The rural areas of developed nations represent another opportunity, but one that calls for careful selection. In some wealthy nations, every village of more than 1,000 people already has a fiber connection, while in others, satellite backhaul is a necessity. The major metro areas are also satellite backhaul markets in specialized situations: with short-term surges in demand and during disasters.

For all the excitement around 5G, there remains plenty of life left in earlier standards. In the least developed economies, 2G is still prevalent. Because of widespread poverty and correspondingly low ARPUs, carriers cannot justify upgrading the network unless they receive subsidies. In some nations, however, government policy and private-sector ambition have led to leapfrogging directly from 2G to 4G, which provides better ARPUs than 3G.

Global satellite service providers are working with MNOs at all stages of the evolutionary path, from 2G to 4G in developing nations and remote areas. They are bringing not just bandwidth but managed services, site installation and maintenance, network management and hosted switching. On satellite operator is beginning to build and own infrastructure including cell towers to provide a complete ecosystem to *Multi-National Organizations* (MNOs).

The 5G Opportunity

While satellite service providers vary in their enthusiasm, none perceives 5G as a threat to their business. Everyone emphasizes the significant increases in bandwidth and data consumption it will bring. 5G is meant to be ubiquitous, requiring hybrid satellite and terrestrial solutions that will create more demand on the satellite industry for services. Traditional MNOs will continue to grow their business, and as the increased consumption starts to reach rural areas and islands, satellite will be needed.

Backhaul will continue to be a vital market, particularly in hard-to-serve markets. The rollout of 5G to lower-density markets will demand significantly more base stations than 4G. One mobile operator projected a 50 percent increase in the number of base stations by 2025.

Given that 5G will be a software-defined network, it should provide more flexibility and allow the MNO to structure a network according to the

needs of its target markets. An MNO executive points out that one of the advantages of using satellite for backhaul is that the ability to share capacity between different locations, meaning that it will be enabler for expansion into otherwise difficult to reach or low-bandwidth locations.

Opinions differed sharply as to whether satellite could have a role in fronthaul. The mobile operators are very clear that it could not. Other technology providers are more optimistic, arguing that the huge lack of capacity in some markets will require microwave and satellite to be strong player, not just in backhaul, but in fronthaul as well.

New Opportunities

At least one respondent is already involved in the *Internet of Things* (IoT) market and expects to be providing more value-added IoT services across 5G via satellite, microwave and fiber.

Opinions differed on whether automotive represents a meaningful target. Respondents argued that satellite connectivity to moving objects requires critical mass of users, as are found on cruise ships, trains and buses. Others believe that video downloads, software updates and map data will create a robust automotive market. If current developments hold true, however, the value is likely to be gained by antenna manufacturers and satellite operators working in vertical alignment rather than teleport operators.

Respondents expect 5G to open new markets for video as it drives consumption to mobile devices. In this view, satellites will be used to deliver video to base stations, leveraging the ability of 5G to decouple the data and control planes.

Overall, contributors believe that, by delivering much greater bandwidth to users, 5G will stimulate demand for even more, and will require satellite as a core element for moving video and data within the 5G environment. This will put a greater premium on the expertise of service providers, because MNOs will rely on them to manage this element of the network.

Lower Prices Mean More Business

Satellite service providers expect that the price erosion brought by high-throughput satellites will continue and accelerate with the coming of LEO communications. Every drop in price makes the business case more appealing and enables more competitive pricing.

The huge increase in the number of base stations alone translates into significant capital expenditure for the MNOs. A satellite service provider offering a managed network service can help the MNO by transferring some of the *upfront capital cost* (CAPEX) into *operating cost* (OPEX). Not only does this ease the financial burden on the MNO, but economies of scale achieved by a satellite service provider serving multiple MNOs also lowers the total cost of ownership.

How the Satellite and Teleport Industries Engage with 5G

As previous generations of mobile technology were developed, satellite sat on the sidelines, watching developments and shaping products to meet new needs, most of which related to backhaul.

That remains the approach of some respondents today, but larger and more international companies see the need to proactively engage. They are responding to the fact that 5G is being conceived as more than a mobile standard — it aims to be an overarching architecture into which the full range of transmission technologies will fit. Inaction risks the emergence of standards that are unfriendly to the fundamental requirements of satellite, which would close the door on much of the 5G opportunity.

Service providers, satellite operators and technology providers are all engaging with companies and multilateral organizations developing 5G standards, with the goal of positioning satellite as complementary, requiring common interfaces.

One contributor noted that other wireless technologies, such as Bluetooth and WiFi, saw the value of creating a win-win partnership as far back as 2G. They now have a strong voice within the standards committees, which the satellite industry needs today. The standards bodies and associations at work on 5G include:

5G Standards Bodies

- *International Telecommunication Union*
- *3rd Generation Partnership Project*
- *European Telecommunications Standards Institute*
- *Alliance for Telecommunications Industry Solutions*
- *5G Infrastructure Public Private Partnership*
- *5G Verticals INNovation Infrastructure*
- *Satellite-Focused 5G Organizations*
- *SaT5G*
- *SATis5*

The Search for Integration

One word was constantly repeated in the interviews for this report. The word was "***integration.***" The ultimate value of 5G to the satellite industry may be in making satellite a more integral and integrated part of global telecommunications.

This wider vision means that 5G must have a multi-network aspect. One contributor gave an example: high speed and wide area mobility for land vehicles cannot be accomplished just with cellular — so hand-off to satellite should be a core part of the standard. If multicast to data centers and devices on the edge is to become an important part of the 5G business model, satellite multicast capabilities must be anticipated in the standard.

With IMT-2020 not scheduled to be finalized until that year, deployment will proceed at evolutionary speed, just as with previous generations. The common wisdom is that early deployment of 5G will focus on urban areas where the density of customer makes the business case for greater density of cell sites more attractive. At least where standard backhaul is concerned, there will be little role for satellite until 5G begins to deploy into suburban and exurban markets.

A number of experienced executives, however, offered an alternative vision. Partly because it represents such a technology leap, its deployment may be driven less by geography and population density than by use cases.

One described "islands of coverage," such as an industrial park in an otherwise unserved area with its own 5G network, enabling automation and/or logistics for particular location or company. The executive also noted the opportunity to overlay 5G architecture on existing 4G macro cells. "*It could scale faster than we think.*"

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Workshops: February 4th
Conference: February 5th-7th

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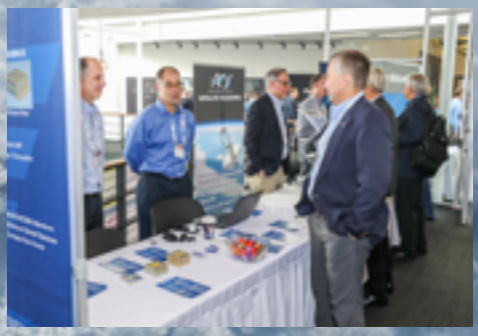

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