Worldwide Satellite Magazine – July/August 2017

SatMagazine

New Antenna Efficiencies
Going Where Angels Fear to Tread
What's Next for OneWeb
Flying Smallsat Constellations
Surf @ 30,000 Feet
Satellite Data Solutions
IBC's Golden Age
InfoBeam

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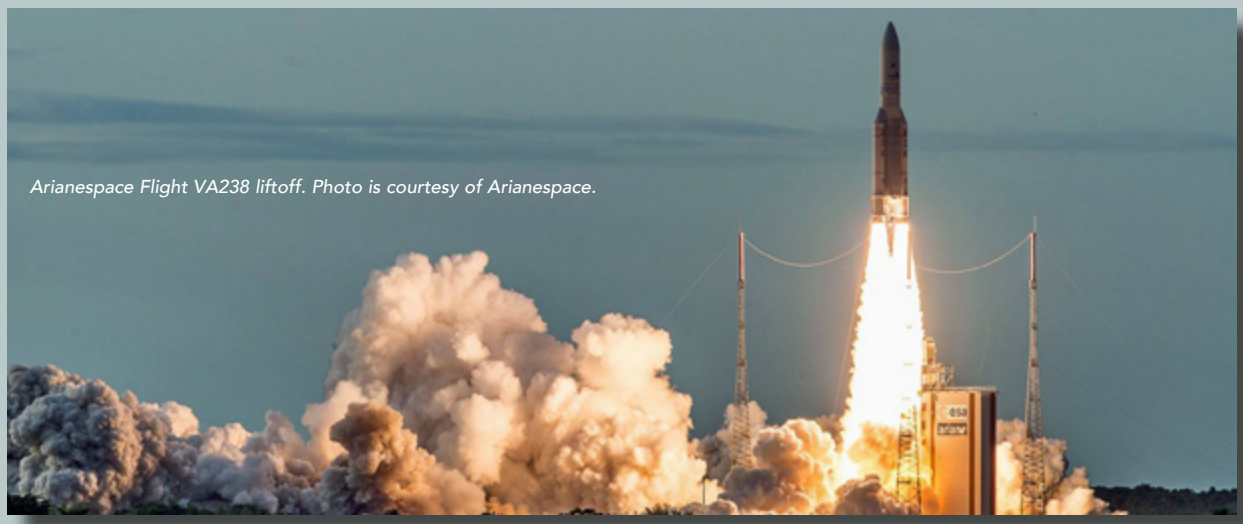

Arianespace Flight VA238 liftoff. Photo is courtesy of Arianespace.

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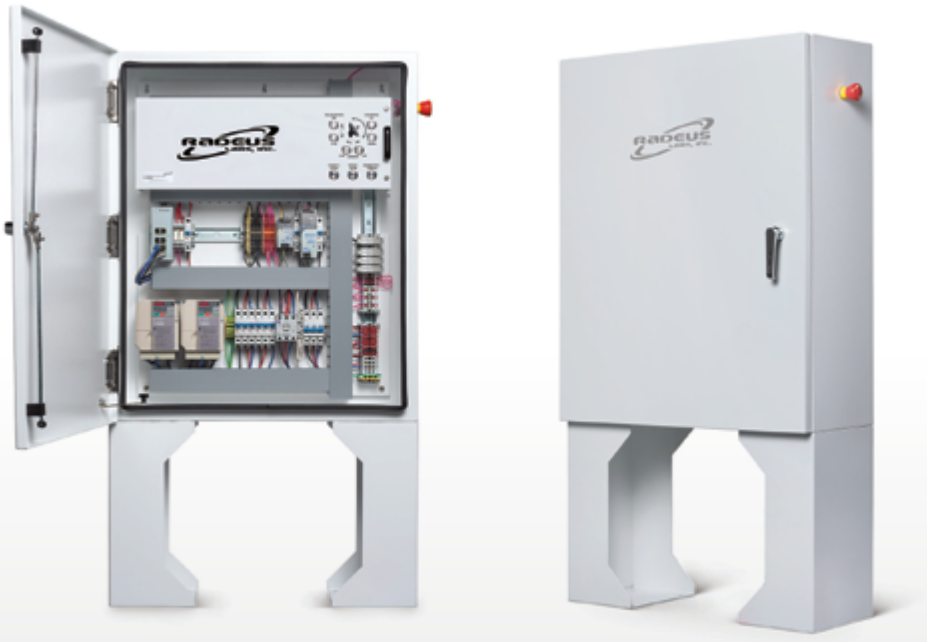

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A "CondoSat" Launched by Arianespace for Hellas Sat and Inmarsat

Arianespace's Flight VA238 took off after a brief delay of a few minutes on Wednesday, June 28, burning through five tons of fuel per second.

According to Arianespace, this 80th consecutive success for the company's heavy-lift Ariane 5 lofted two satellites, delivering new capacity for use in the distribution of TV and video content, telecommunications services, mobile satellite services, data relay, along with coverage of search and rescue missions.

Flight VA238 from the Spaceport in French Guiana was a so-called "condosat" because the launch was composed of two payloads for Hellas Sat and Inmarsat, as well as for the Indian Space Research Organisation (ISRO).

The Ariane 5 had a payload lift performance estimated at 10,136 kg. to GEO, maintaining the company's sustained launch pace in 2017.

Riding as the upper passenger on Flight VA238 was Hellas Sat 3-Inmarsat S EAN, which integrated two relay payloads.

The payload for Hellas Sat 3 will expand that company's business reach by providing DTH TV broadcast and telecommunications services, as well as the distribution of HD and UHD video content in Europe, the Middle East and sub-Saharan Africa.

These fixed satellite services (FSS) and broadcast satellite services (BSS) include a cross-strap service between Europe and South Africa.

Christodoulos Protopapas, the CEO of Hellas Sat, congratulated Arianespace on successfully orbiting the Hellas Sat 3-Inmarsat S EAN spacecraft and said he was looking forward to the launch of his company's next satellite — Hellas Sat 4 — which is scheduled for an Arianespace mission in 2018.

Also integrated on the Hellas Sat 3-Inmarsat S EAN satellite is a relay payload for a system developed by Inmarsat with Deutsche Telekom to offer high-speed, high-capacity Wi-Fi connections for airline passengers.

The first Inmarsat customer for this airborne connectivity is the International Airlines Group (AIG) which has started to equip their aircraft with this technology and aims to have 90 percent of their short-haul fleet installations complete by early 2019.


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Inmarsat CTO Michele Franci thanked Arianespace as part of the European effort that will bring cabin connectivity to passengers across Europe. "*This satellite was riding on one of Europe's best successes – Ariane*," he added.

Weighing an estimated 5,780 kg. at liftoff, Hellas Sat 3-Inmarsat S EAN was produced by Thales Alenia Space using their Spacebus 4000C4 platform. With the satellite's successful launch, Arianespace has now orbited a total of 149 spacecraft built by Thales — continuing a long and successful partnership.

Bertrand Maureau, the EVP of Telecommunications at Thales Alenia Space, acknowledged Ariane 5's mission performance and noted that Hellas Sat 3-Inmarsat S EAN was the fourth satellite from his company launched by Arianespace so far this year.

Hellas Sat 3-Inmarsat S EAN also marks key milestones: this was the ninth satellite launched for Inmarsat.

This was also the first satellite launched for Hellas Sat, which will operate from the 39 degrees East orbital slot.

The ISRO's GSAT-17 with one antenna deployed. Photo is courtesy of isro.gov.in.

GSAT-17 was the 21st spacecraft orbited by Arianespace for the ISRO, extending a relationship with them that dates back to 1981 with the launch of the APPLE experimental satellite.

Built by ISRO/ISAC (the ISRO Satellite Centre) using the Standard I-3K satellite bus, GSAT-17 — with a mass at liftoff of 3,476 kg. — expands the Indian national space agency's current fleet of 17 telecommunications satellites and will provide continuity of FSS in Normal C- and Upper Extended C-bands, as well as MSS in S-band and Data Relay and Search & Rescue services in UHF band — operating from a final orbital position of 93.5 degrees East.

Dr. K. Sivan, Director of the ISRO's Vikram Sarabhai Space Center described Ariane 5's launch this evening as "glorious" and offered "congratulations, complements and thanks to Arianespace for a wonderful job."

Arianespace's next mission is set for August 1 using the lightweight vehicle Vega on a mission to Sun-synchronous orbit with two passengers: OPTsat-3000 for the Italian Ministry of Defense and VenμS for the French and Israeli space agencies.

www.arianespace.com

RUAG'S New Fairing Makes Debut on the Ariane 5 Launch

On June 28, Ariane 5 flight VA 238 started from the launch pad in Kourou — on the top of the rocket, protecting the satellite, was RUAG Space's payload fairing, the first of its kind that was manufactured out of autoclave. Going forward, this technique, designed for the future European launcher Ariane 6, will bring costs down by 40 percent.

With the new facility and required infrastructure up and running, RUAG is immediately able to run this new process. As a result, the first-of-its-kind payload fairing successfully performed on flight VA238.

Meanwhile, Arianespace has ordered from RUAG an additional 18 of these 17-meter long payload fairings for Ariane 5, manufactured out of autoclave. Airbus Safran Launchers is prime contractor and design authority for Ariane 6, an ESA program.

To run the new out-of-autoclave process, RUAG has invested in a state-of-the-art manufacturing hall in Emmen, Switzerland. Relying on tailor-made machinery and automated processes, the new composite center was inaugurated in 2016. The carbon-fiber based payload fairing consists of two half-shells, which separate in space.

These shells are newly cured in an industrial oven instead of an autoclave. This requires less energy, and — thanks to its size — the industrial oven can cure an entire half-shell in one piece.

The costly and time-consuming vertical integration of individual shell elements can be avoided. This reduces throughput time by 50 percent and enables RUAG to increase the delivery volume and sequence for its payload fairings.

Already ahead of VA238, Arianespace and RUAG Space signed the contract for an additional 18 payload fairings for Ariane 5 — which will be delivered from the Emmen facility between 2019 and 2022 with an annual cadence of 6. RUAG will also execute the integration and provide operational support in Kourou. With this contract, the transition towards the upcoming Ariane 6 can be smoothly prepared.

In another first, the next payload fairing manufactured out of autoclave is planned for launch on Vega flight VV10 on August 1, 2017.

In addition to the manufacturing facility in Emmen, Switzerland, RUAG also ramps up a site in Decatur, Alabama, to manufacture the Atlas payload fairing out-of-autoclave, as well as started work on the Interstage Adapter for NASA's Space Launch System — also an out-of-autoclave product.

The new payload fairing was not the only RUAG product on the Ariane 5 flight. RUAG also provided the on-board computer steering the rocket toward orbit, as well as the payload adapter connecting the satellites with the rocket.

Peter Guggenbach, the CEO of RUAG Space, indicated that this is a milestone step for the launcher industry in its efforts to make access to space more affordable. Meeting the needs of RUAG customers, the company has invested in new infrastructure, accelerated the process and reduced cost. Highest performance remains guaranteed — as the latest flight proves.

Stéphane Israël, CEO of Arianespace and Head of Civil Launchers of ArianeGroup, stated that this partnership dates back for several decades — with RUAG always proving its readiness to reinvent itself, invest and respond to market needs. Arianespace is proud that the first payload fairing manufactured out of autoclave was launched on an Ariane rocket. This outstanding achievement foreshadows the large gains in competitiveness that will benefit our future Ariane 6 launcher thanks to all partners involved in this program.

www.ruag.com/

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KEYNOTE SPEAKER

Mark Dankberg
Chairman & CEO
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Major Move into Satellite Servicing by SSL MDA and Finance Technology Leverage LLC — SES First Customer

SSL MDA Holdings Inc., a global communications and information company, has announced important milestones in the company's progress to bring transformational on orbit satellite servicing to market.

Space Infrastructure Services LLC (SIS), a new U.S. company, will commercialize sophisticated satellite servicing capabilities, including refueling.

SIS will be majority owned by Finance Technology Leverage LLC (FTL), a global investment company headquartered in Silicon Valley, along with other U.S. investors, with SSL MDA Holdings maintaining a minority ownership share.

Full financing for the venture is expected to be concluded over the coming weeks.

On orbit satellite servicing will provide operators with the ability to enhance the existing use of space assets through life extension, inspection, and repair.

In addition, satellite servicing provides a capability to perform partial assembly in orbit, either augmenting existing satellites, replacing elements from modular satellites or constructing larger satellites freed from the mass and size constraints of launch.

SIS has awarded a contract to SSL to design and build the highly capable satellite servicing spacecraft vehicle.

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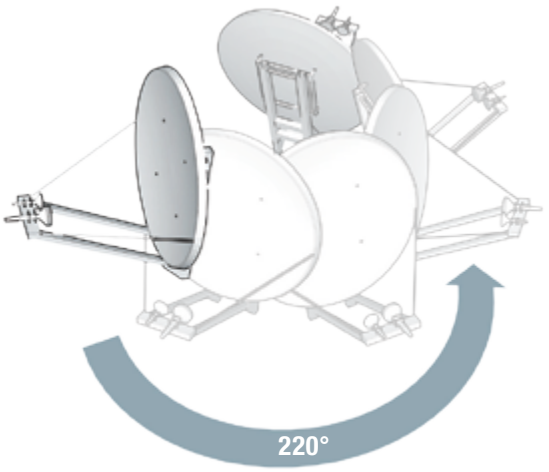

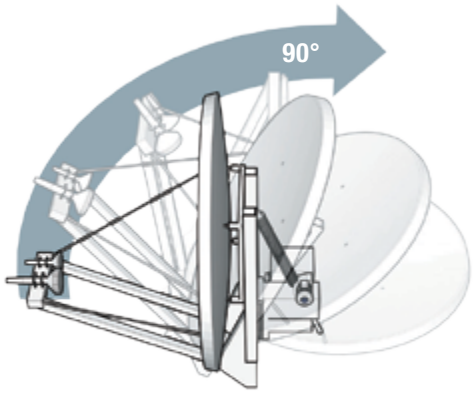

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The vehicle will fully meet the specifications for the Defense Advanced Research Projects Agency (DARPA)'s Robotic Servicing of Geosynchronous Satellites (RSGS) program.

The DARPA specs are designed to inspect, repair, and augment geosynchronous satellites and plans to include a refueling payload to extend the life of satellites that are low on propellant.

The contract is valued at US$228 million (CA$305 million). SSL is working with the Naval Research Laboratory (NRL), The Charles Draper Laboratory and MDA robotics divisions in Brampton, Ontario and Pasadena, California, to develop the servicer.

The company also announced that SES has entered into an agreement for an initial life extension mission with options for further missions.

Under this agreement, SES will be the first commercial customer to benefit from satellite refueling that can be called up as needed with minimal disruption to spacecraft operation.

Once orbital demonstrations under the RSGS program are complete, SIS will receive the satellite servicing vehicle to operate throughout its lifetime. Steve Oldham, Senior Vice President Business Development with SSL MDA, is responsible for the SIS business.

Howard L. Lance, the President and CEO of SSL MDA Holdings, noted that this new venture is designed to provide satellite operators with more options in fleet management. Both commercial and government satellite operators are looking for flexibility in managing capital expenditures and better ways to incorporate resiliency into their fleets. He added that by combining the company's world-class capabilities in satellite manufacturing and robotics together, SSL MDA is uniquely positioned to enable this next-generation capability.

Ray Conley, Managing Partner of FTL, stated that his company is committed to advancing space-related industries by supporting key technologies and markets. On orbit refueling and the repairing of spacecraft is a critical step in humanity's march toward a vibrant and exciting frontier.

Martin Halliwell, the CTO at SES, indicated that satellite servicing on orbit will be essential to next-generation architectures for communications satellites. SES is pleased to be working on a refueling mission that may enable the firm to obtain more value from satellites already on orbit. Refueling will be relatively quick and control of SES spacecraft will be maintained at all times.

At the SES infosite, Carlo Tommasini, the company's VP of Fleet Engineering, noted that MDA's refueling approach is conceptually similar to a traveling space gas station that is capable of refueling satellites through robotic arms.

MDA relocates the space gas station (robotic servicer) to the orbital location of the SES satellite where it docks to the aft end of the SES satellite for approximately nine days.

While the SES satellite continues providing customer services, automatic and tele-operated robotic servicing tools are used to survey the SES satellite, manipulate thermal blankets, valves and pump fuel.

After the fuel transfer is completed, the worksite is closed and the robotic servicer undocks from the SES satellite and moves away.

Thereafter, the SES satellite operates standalone and can continue to serve our customers beyond its usual 15 year-lifespan.

He explained that many satellites are healthy and in good operating condition on orbit and are able to operate beyond their 15 year design life. For these satellites, the limiting lifetime factor is the remaining fuel on board to maintain attitude control and orbital position station keeping.

For satellites low on propellant, satellite on orbit refueling provides life extension maintaining revenue streams and/or provides time to determine the optimal fleet management strategy.

Currently, he noted, the satellite life extension service is applicable to GEO fleet. He also stated that SES, being the first satellite operator to sign up for the MDA SSL services, is confident in the viability of this new technology.

MDA is a leader in space robotics and automated systems enabling on orbit servicing missions. SSL is a leading supplier of commercial GEO satellites and is also designing the satellite servicing spacecraft vehicle for the U.S. Defense Advanced Research Projects Agency (DARPA) Robotic Servicing of Geosynchronous Satellites (RSGS) program.

SES has spent months working closely with MDA and SSL to jointly develop the refueling services concept which meets SES's needs. As SSL embarks on building the servicer, SES will be closely involved in reviewing the design and performance and all are confident this service can be delivered in 2021. This service, when ready, will bring powerful options to our fleet management capabilities. Together with the MDA and SSL, SES is proud to be pioneering this technology.

www.sslmda.com

www.ses.com

GPS III in Full Production

In a specialized cleanroom designed to streamline satellite production, Lockheed Martin is in full production building GPS III — the world's most powerful GPS satellites.

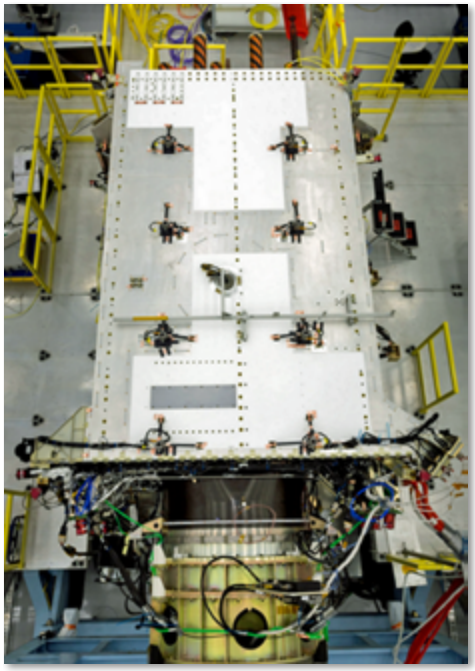
The company's second GPS III satellite is now assembled and preparing for environmental testing, and the third satellite is close behind, having just received its navigation payload.

In May of this year, the U.S. Air Force's second GPS III satellite was fully assembled and entered into Space Vehicle (SV) single line flow when Lockheed Martin technicians successfully integrated its system module, propulsion core and antenna deck. GPS III SV02 smoothly came together through a series of carefully-orchestrated manufacturing maneuvers utilizing a 10-ton crane.

GPS III SV02 is part of the Air Force's next-generation of GPS satellites, which have three times better accuracy and up to eight times improved anti-jamming capabilities. Spacecraft life will extend to 15 years, 25 percent longer than the newest GPS satellites on-orbit today.

According to Mark Stewart, VP of Navigation Systems for Lockheed Martin, GPS III SV02 will begin environmental testing this summer to ensure the satellite is ready for the rigors of space. This testing simulates harsh launch and space environments the satellite will endure, and further reduces any risk prior to it being available for launch in 2018.

Directly following GPS III SV02, eight more contracted GPS III satellites are moving through production flow at Lockheed Martin's nearly 40,000 sq. ft., state-of-the-art GPS III Processing Facility near Denver.



First photo of the GPS III Space Vehicle #2, now fully-integrated. Photo is courtesy of Lockheed Martin.

GPS III SV03 recently completed initial power on of its bus, which contains the electronics that operate the satellite. The company received SV03's navigation payload from its supplier, Harris Corporation, in May. After further system testing, SV03 will be ready for full integration later this fall.

GPS III SV04's major electronics are being populated as it prepares for its own initial power on. This satellite's navigation payload is expected to arrive and be integrated into its space vehicle before the end of the year.

Components of the next six satellites, GPS III SV05-10, are arriving at Lockheed Martin daily from more than 250 suppliers in 29 states. To date, more than 70 percent of parts and materials for SV05-08 have been received. The company was put under production contract for SV09-10 in late 2016.

All of these satellites are now following the Air Force's first GPS III satellite, GPS III SV01, through a proven assembly, integration and test flow. SV01 completed its final Factory Functional Qualification Testing and was placed into storage in February 2017 ahead of its expected 2018 launch.

With multiple satellites now in production, Lockheed Martin engineers are building GPS III smarter and faster. Key to their success is the company's GPS III Processing Facility, a cleanroom manufacturing center designed in a virtual-reality environment to maximize production efficiency. Lockheed Martin invested $128 million in the new center, which opened in 2011.

The company's unique satellite design includes a flexible, modular architecture that allows for the easy insertion of new technology as it becomes available in the future or if the Air Force's mission needs change. Satellites based off this design also will already be compatible with both the Air Force's next generation Operational Control System (OCX) and the existing GPS constellation.

The GPS III team is led by the Global Positioning Systems Directorate at the U.S. Air Force Space and Missile Systems, Center. Air Force Space Command's 2nd Space Operations Squadron (2SOPS), based at Schriever Air Force Base, Colorado, manages and operates the GPS constellation for both civil and military users.

Stewart added that from day one, GPS III has been a team effort and Lockheed Martin's successes would not have been possible without a strong Air Force partnership. GPS III will ensure the U.S. maintains the gold standard for positioning, navigation and timing.

www.lockheedmartin.com/gps

Inmarsat's S-Band for the European Aviation Network

Inmarsat has confirmed the successful launch of their S-band satellite (Inmarsat S EAN) for the European Aviation Network (EAN). The launch is a key milestone for Inmarsat's unique EAN service, which is on course to commence commercial service in the second half of 2017.

The Inmarsat S-band satellite, built by France's Thales Alenia Space, was launched on an Ariane 5 rocket by Arianespace at 22:15 BST/17:15 EDT from Kourou in French Guiana.

Following satellite separation, telemetry from the satellite was acquired by Inmarsat's Mingenew Ground Station in Western Australia.

The launch team from Inmarsat and Thales Alenia Space will now raise the satellite into its geostationary orbit over Europe and the Middle East, at which point the spacecraft will deploy its solar arrays and reflectors, and undergo rigorous payload testing.

Inmarsat's EAN is the world's first dedicated aviation connectivity solution to integrate space-based and ground-based networks to deliver a seamless WiFi experience for airline passengers throughout Europe.

Inmarsat's strategic partner, Deutsche Telekom, is well advanced in the construction of the complementary ground network, which will be fully integrated with the S-band satellite to deliver a truly seamless service for Europe's airlines and their passengers.

International Airlines Group (IAG), which includes world renowned airline brands such as British Airways, Iberia, Aer Lingus and Vueling, is confirmed as the launch customer for the new service. IAG has begun equipping its aircraft and aims to have 90 percent of its short haul fleet complete by early 2019.

The successful launch of the S-band satellite underlines the momentum that Inmarsat is building in the high-speed broadband inflight connectivity (IFC) market, which Inmarsat entered in October 2016 with the commercial introduction of GX Aviation, a worldwide service powered by its Ka-band, Global Xpress satellite constellation.

Inmarsat now has more than 1,200 aircraft installations expected under signed contracts for its IFC services. Mandates have been won from leading airlines worldwide including Avianca, Qatar Airways, Deutsche Lufthansa Group, International Airlines Group, Air New Zealand, Singapore Airlines and Norwegian Air Shuttle.

"The successful launch of Inmarsat's S-band satellite means that the start of our revolutionary European Aviation Network is now just months away," said Rupert Pearce, CEO, Inmarsat.

"We first announced our plans for EAN in 2014, seeking to take advantage of a visionary and unique commercial and technological opportunity created by the European Commission's DG CONNECT and then supported by Member State telecoms regulators.

"This is a testament to the continued support of European Institutions and national regulatory authorities, the hard work of multiple teams across Inmarsat and the commitment of our vital strategic partners, including Deutsche Telekom, Thales Alenia Space, Thales Aviation, Cobham and Arianespace, that we now stand on the threshold of a new aviation WiFi service that will transform the experience of passengers flying throughout Europe.

"Although Inmarsat is a relatively new entrant into the high-speed aviation passenger broadband market, we have secured commitments for our IFC services from major airlines in Europe and across the world. Their confidence underlines the strength of Inmarsat's IFC strategy and the long-term, scalable capabilities of our two core IFC networks – GX Aviation and EAN."

www.inmarsat.com/inmarsat-s

Vector Garners $21 Million for Their Launcher Family

Vector is a self-described disruptor — the company connects space startups and innovators with access to space that is, according to the firm, affordable and reliable.

Vector's vision is to reshape the multi-billion launch market and to combine dedicated, lower-cost launches for smallsats as well as for software defined satellites (Galactic Sky) to dramatically increase access and speed to orbit. The company has just received an infusion of capital from the Silicon Valley VC firm, Sequoia Capital, to the tune of $21 million. Formerly, in April, Vector had bagged some $4.5 million in a bridge round that was used to float the firm until they could complete their Series A financing. In addition, Vector was awarded a Small Business Innovation Research award from NASA and DARPA, along with $2.5 million just prior to their bridge round.

The Vector launch vehicle family consists of the Vector R (Rapid) and the Vector H (Heavy) launchers. The Vector R places 50 kg into orbit and is the company's basic, first use capability. The Vector-H places 100 kg into orbit and is a block upgrade to the Vector-R. On May 3 of this year, the company's prototype Vector-R launch vehicle was successfully launched from the Mojave Desert in California.

The two launch vehicles share common technology and launch facilities that include pressure fed ablative engines, carbon fiber fuselage, LOX/Propylene fuels and mobile launch capability — their launchers are the only launch systems that are dedicated to smallsats and will allow for satellite launches whenever needed.

The firm's Galactic Sky division transforms the space segment from the current hardware centric state to a much simpler software development proposition with software defined satellites. Vector's ultimate vision is one where space app developers will be able to develop satellite applications on their desktops and then upload that data to an at-the-ready satellite constellation for nearly instant data and revenue receptions.

vectorspacesystems.com

New Antenna Efficiencies with SATCOM

An AvL Technologies' Focus

By Krystal Dredge, Director of Marketing, AvL Technologies

Communicating by way of satellite is robust, versatile and impactful — in recent years, satellite communications (SATCOM) has also become incredibly efficient in ways that many of us don't consider, plus, SATCOM contributes immensely to efficiencies for terrestrial networks and many industry-specific applications.

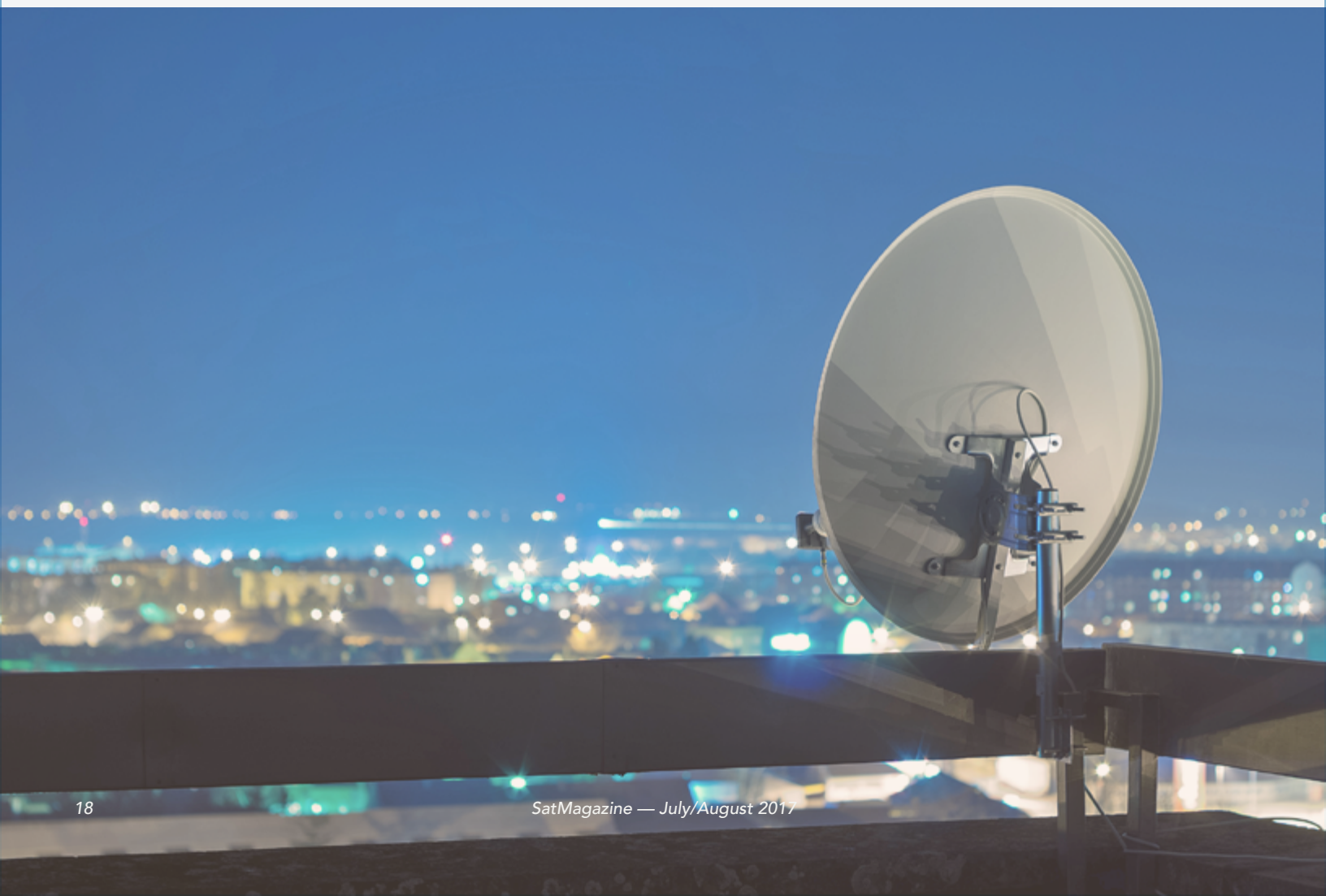
High-Throughput Satellite (HTS) and Network Efficiencies
HTS is a game-changer for users of Ku- and Ka-band in geostationary (GEO) and non-GEO orbits. Newer technologies enable satellites to reuse frequencies to maximize bandwidth via numerous spot beams, which dramatically increases the data throughput while reducing operational costs.

By definition, efficiency in SATCOM is defined as the amount of error-free data delivered to the end-user. With HTS networks, efficiency is a complex trade-off between the volume of data transmitted via spot beams and the proximity of spot beams of the same frequency, which can cause interference and signal degradation.

Highly efficient HTS networks enable lots of end-users access to lots of data simultaneously. We all have increased appetites for demand as consumers and business professionals — anywhere, anytime and with any device — which is fueling the demand for terrestrial systems and SATCOM backhaul. With SATCOM backhaul or direct SATCOM service, geographic constraints disappear.

New Medium Earth Orbit (MEO) networks, such as the O3b Ka-band network, are enhancing efficiency with minimal fiber-like latency, high capacity and lower cost bandwidth. O3b's satellites are orbiting 8,062 km (5,009 miles) above Earth (versus GEO orbits at 22,000 miles), and this proximity enables dramatically reduced latency, which means that the network can be used for applications that are latency sensitive.

The network's steerable spot beams can manage up to 2 Gbps each for a total of 84Gbps available with the network's configuration today. TheO3b network coupled with AvL transportable tracking antennas provides powerful and



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efficient performance and the throughput delivered with one antenna system can replace numerous older GEO systems.

Antenna Efficiencies

Greater efficiencies on the space side of the beam drive an expectation for greater efficiencies on the ground side, as well.

SATCOM efficiency is also measured in terms of antenna operation, which includes gain, aperture taper, surface accuracy, cross polarization and blockage. Blockage occurs when the feed or support structures block part of the beam's path, and this is eliminated with offset or prime focus antennas. Accordingly, the efficiency – or gain – of an offset antenna can be improved by up to +1 db relative to the same size symmetrical antenna. This translates into an efficiency for the offset antenna that can be as high as 80 percent.

Aperture taper efficiency is a measure of the uniformity of the antenna's parabolic shape such that radiation reflects uniformly in amplitude and phase across the surface, while the main beam is maximized and the overall side lobe envelope is lower.

Surface accuracy is a measure of the reflector's surface such that the radiation bounces cleanly without blockages or misdirection. Reflector materials also have a significant impact on radiation performance, and carbon fiber reflectors are the highest performing materials due to their rigidity and tolerance to withstand extreme heat and cold — unlike aluminum reflectors, which lose shape and gain with extreme temperatures.

While carbon fiber reflectors are high-performing and very efficient, an antenna must have sufficiently stiff pointing for the terminal or system to operate efficiently. Key to stiff pointing is the antenna's positioning system.

AvL Technologies has offered industry leading positioners for 20+ years, with the AvL Cable Drive positioner being the foundation of most of the company's antennas. The zero-backlash cable drive technology provides the ultimate in precision and stiffness over geared and other drive systems, and the system utilizes the averaging effect of many cables wrapped around a capstan and an output shaft.

The AvL Cable Drive is a maintenance-free mechanism that is able to operate in a wide range of difficult and hazardous conditions without degradation and the many cables provide significant redundancy to ensure antenna performance and efficiency.

For O3b's MEO network, antenna efficiencies also include tracking the satellites as they quickly move from horizon to horizon, and seamlessly managing make-before-break communications in the process. O3b efficiently manages a global network of gateways that are strategically located on the Internet backbone, and offers a wide range of terminals that support many types of customer applications.

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The terminals available include fixed terminals, marine terminals, and case-based transportable terminals. The Transportable Terminal Antenna Systems are made by AvL Technologies and enable users to rapidly deploy O3b's network capabilities to meet changing requirements and evolving needs. The Transportable Terminal Antenna System is designed to be transported in durable transit cases and to be set up and on-the-air within two hours.

Many new Earth terminals now offer multi-band and multi-application operations, thus the efficiency of two or more antennas in one is offered. With multi-band enabled antenna operations, weather conditions, transponder capacities and other issues are less limiting. An operator can simply direct the antenna to select a different feed and RF kit, and point the antenna to a different satellite within minutes.

DVB-S2, or Digital Video Broadcasting — Satellite Second Generation — is an established standard that has dramatically increased the efficiency and quality of satellite data transfer for video. The standard uses an enhanced modulation schemes, code rates and a generic transport mechanism for IP packet data — all of which means that DVB-S2 dramatically increases performance over past standards.

Satellite News Gathering (SNG) users and others have seen impressive performance over the previous DVB-S (Digital Video Broadcasting — Satellite) standard, as well as significant improvements to transmission quality and a higher degree of transponder availability due to the use of satellite spot beams being optimized.

Industry Efficiencies and Impacts

Efficiencies with HTS satellites, MEO networks, Earth terminals and modems have paid it forward to numerous industries, including telecom, oil and gas, SNG, and civil and government services.

Telecom networks use SATCOM services on a regular basis, yet phone and data end-users rarely recognize this due to the seamless integration of satellite and telecom services.

Telecom networks — both landline and wireless — use SATCOM for backhaul on a regular basis as well as to increase bandwidth at events that draw crowds. SATCOM is not as easily impacted by extreme weather, so telecom networks use SATCOM to restore communications after severe weather when terrestrial systems are down. With SATCOM, telecom networks are incredibly efficient.

The oil and gas industry often uses satellite communications to efficiently and effectively communicate from remote and unmanned locations.

Transportable Earth terminals can be set up in any remote location and in any environment, and transmit machine-to-machine data back to oil and gas company headquarters located thousands of miles away. By doing so, oil and gas companies efficiently manage equipment operating remotely without staffing remote sites, and are quickly alerted via SATCOM when issues arise at remote sites.

Transportable SATCOM also enables operations in other unmanned, risky or dangerous activities, such as border patrol and nuclear monitoring. With SATCOM, these activities can be remotely monitored continuously with streaming video — and without an army of staffers or without placing employees in harm's way.

Efficiencies at Both Ends of the Beam

SATCOM has always been groundbreaking — it is rocket science, after all. Radio frequency (RF) engineers and other incredibly smart and talented folks in the satellite industry have continued to innovate to make our communications more and more efficient and effective by the day. And these efficiencies are realized in space, on Earth and among the many industries we serve.

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Krystal Dredge is the director of marketing for AvL Technologies. Krystal has 15+ years of product marketing experience in satellite and wireless communications, and most recently worked at Honeywell and EMS Defense & Space Systems prior to joining AvL in 2012.

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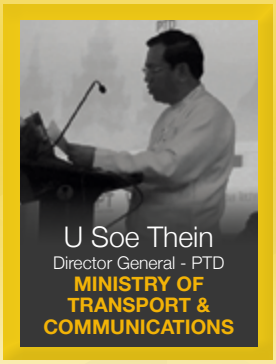

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Going Where Angels Fear to Tread

A CPI ASC Signal Division Focus

by Tony Russell, President, CPI ASC Signal Division

Disasters, natural or human-made, cause demand for communications to spike at precisely the time when the supply can drop perilously close to zero.

Floods, fires, earthquakes and storms destroy communications infrastructure as readily as roads, bridges and buildings. Even when networks survive, they are rapidly overwhelmed by the volume of traffic as people seek reassurance about those they care for and disaster relief springs into action.

Disasters are also when satellite communication (SATCOM) proves indispensable. Flexible, mobile and quick to deploy, satellite provides the vital voice, Internet and video channels needed to manage both the human and logistical challenges of disaster.

The first satellite ground systems to arrive in a disaster are typically satphones or Inmarsat BGAN terminals. Quick-deploy VSAT with sub-meter antennas quickly follow to provide more bandwidth.

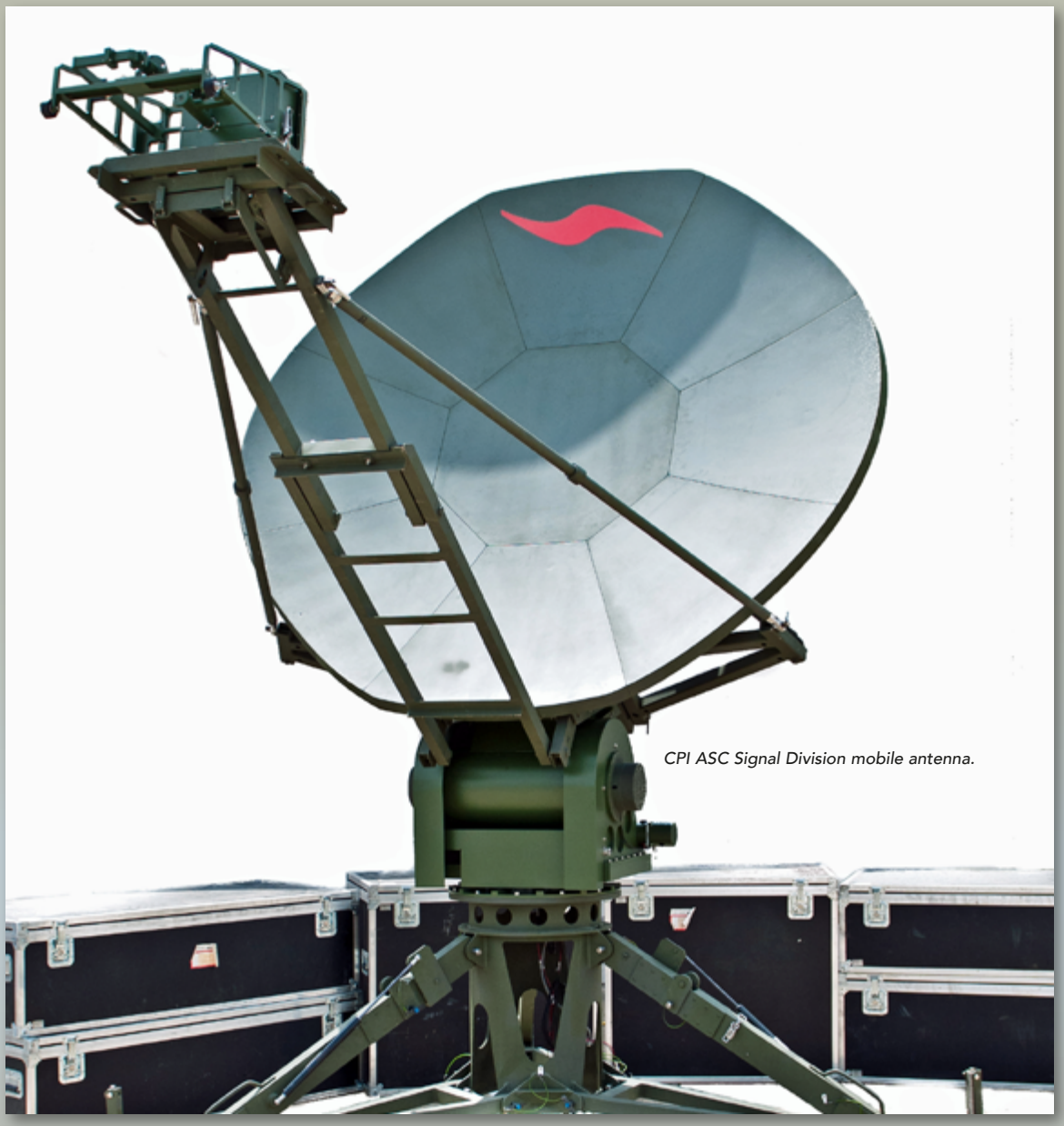
However, the data and video demands of a disaster zone can quickly outstrip these portable early-response systems creating a requirement for a full-size ground segment able to get to the site fast and operate reliably in a challenging environment.

Antenna Origami

The biggest challenge for responders is the sheer presence and bulk of a full-size antenna's reflector and the pedestal required to stabilize the unit.

The mechanical and electrical performance of that reflector are critical to delivering the results needed in the field, particularly at the higher frequencies that are quickly growing as a percentage of total available bandwidth.

Indeed, one of the advantages of the new generation of high-throughput satellites is the ability to place beams where demand is highest, whether on a permanent or temporary basis. The higher the frequency, however, the greater the stakes for antenna performance on the ground.



CPI ASC Signal Division mobile antenna.

CPI's ASC Signal Division has had numerous successes in meeting both the portability and performance requirements with a bit of antenna origami. The company developed nomadic antennas in the 2.4 to 2.5 meter range whose lightweight carbon-fiber reflectors are divided into as many as nine pieces.

A fully-motorized version including feeds weighs under 500 pounds and can be deployed by two trained people in under 30 minutes. But the antenna's mechanical properties and high-accuracy tracking mount ensure that it performs well across all bands as well as in low-PIM configuration.

For bigger requirements, the company developed Trifold antennas with spun aluminum reflectors that fold three ways to fit in standard shipping containers for either ocean or air transport. With three-axis motorization, they feature tracking and auto-acquisition and can be configured with C-, X-, X-band Low PIM, Ku- and Ka-band feeds. A trailer mount provides fast positioning in the field for antennas ranging from 3.9 to 4.6 meters — substantial workhorses able to support very high throughput requirements.

The world snaps to attention in the face of a natural or human-made disaster but interest quickly fades once those emergencies vanish from the headlines. The reality on the ground, however, can be different. Months or years may be required for disaster zones to partially or fully recover and their communications needs expand as disaster relief turns to disaster management.

One frequent change is that antennas that were "nailed up" to a satellite to meet a short-term need become more general-purpose. To serve those needs, ASC Signal designed an outdoor version of a next-generation antenna controller that can operate one or multiple antennas from a mount on the antenna structure.

CPI ASC Signal Division Trifold Transportable antenna.

This controller manages motorized mounts, stepper motors for polarization, interfacility links, and even tracking of sub-reflectors for very high performance operation. This product can turn a temporary site with one or two antennas into a functioning teleport.

Survivability

Antennas are sophisticated pieces of metal or carbon fiber, precision-engineered to meet the need. However, they are of little use in a disaster zone without electronics rugged enough to survive.

That calls for low-noise amplifiers, low-noise block down converters, block up converters and power amplifiers able to stand up to outdoor life in climates ranging from ice and snow to rainforest.

The company's outdoor product lines ares specified to operate in temperature ranges from -40 degrees C up to 60-70 degrees C (-40 to 140-158 degrees F) and in humidity up to 100 percent. Everything is engineered to withstand operating conditions as well as the often bumpy ride on the way to and from the sites.

Flexibility is also at a premium. For disaster relief operations, the company recommends interchangeable feeds and multi-band capability.

Many of the ASC Signal systems are equipped with internal self-resetting protection that protects against temperature spikes, prime power fluctuations, RF output overdrive and open/short output conditions. There is also high value to integrated and comprehensive monitor and control functionality that can be managed remotely over a broadband or mobile connection.

Long Walks

The company is proud of the quality technology leaving the firm's manufacturing centers. However, delivering real value requires "feet on the street."

ASC Signal has been privileged to work with amazing integrators who get equipment into the country, get it to the site and get it up and running, each a major feat. During major disasters, confusion may reign — but some of the normal bureaucratic inertia of customs agencies can be set aside when lives are on the line. The stories colleagues bring home are remarkable.

Installing some sites in Central America has required travel by chartered plane and canoe, with a long walk at the end, lugging the antenna, racks of equipment, outdoor enclosures and portable power.

An integrator told about one site in which the installation engineer was riding shotgun with a Cessna pilot when the plane overshot the runway. The aircraft went crashing into bushes and trees and stopped just ten feet short of a river.

The engineer was injured — but he hiked into the disaster site, did the installation and managed to get a plane out the next day — that's true dedication.

Bringing SATCOM to war-torn regions is equally difficult, even when guns fall silent. Another integrator described trucking in the portable equipment cross-country in a war zone only to find that the fully-laden truck couldn't navigate streams.

The team repeatedly unloaded trucks in the middle of nowhere, hand-carried electronics and antenna components across streams, and loaded them all back onto the truck before proceeding on their way. They also spent the entire time looking over their shoulders for signs of danger.

Serving disaster sites is one of the most challenging assignments in SATCOM. A favorite story comes from a satellite services company called Disaster Truck. When a 7.0 magnitude earthquake struck Haiti in 2010, CBS wanted to provide live coverage and dispatched the company to the scene.

After erecting a portable antenna, however, the personnel could not locate a generator to power the unit. With the newscaster Katie Couric soon to arrive, a solution had to be quickly invented. They ended up wiring two Haitian taxi cabs batteries together to produce enough power for the terminal and camera — the coverage went live, on schedule.

That's the spirit that the ASC Signal team, and every individual and organization in this business, brings to the locations — where angels fear to tread.

www.cpii.com/division.cfm/13

CPI ASC Signal Division, a unit of Communications & Power Industries LLC (www.cpii.com), manufactures fixed and transportable satellite antennas, high-frequency antennas, radar antennas and other specialized products. It works closely with CPI Satcom & Medical Products Division, a manufacturer of uplink amplifier products and systems for satellite communications.

ASC Signal is a sister division to CPI Satcom & Medical Products Division, a manufacturer of uplink amplifier products and systems for satellite communications.

You can reach Tony Russell at ***susan.wojs@cpii.com***

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The Forrester Report

What's Next for a OneWeb "Mega-Merger?"

By Chris Forrester, Senior Contributor

The June first death of the merger between Intelsat and OneWeb — and engineered by Japanese media giant SoftBank — only managed to confirm the desire of these major players to see consolidation in the satellite market.

However, before that can occur, the key elements must first be in place. OneWeb, and SoftBank's cash, are two essential ingredients in this mix.

Then there must come a Geo-operator, and in the days that followed the June first collapse of the Intelsat scheme, the market placed its cash into most of the planet's large operators. Inmarsat saw its London share price rise from £8.08 a share to £8.55 in just 30 minutes. SES of Luxembourg also saw healthy support, as did Eutelsat of Paris, Telesat of Canada and AsiaSat of Hong Kong.

The benefit of each of these five operators is that they are not burdened by the sort of complicated debt-levels that hampered Intelsat. There are shareholders, of course, and some of these represent challenging hurdles yet to be overcome. For example, SES has the Luxembourg government as a significant shareholder. SES also has its own MEO fleet in the now wholly-owned O3b division with 12 satellites on orbit, and another 20 in the planning stage.

Eutelsat of Paris also has some 'strategic' investors, not the least in the shape of Fonds Stratégique de Participation. Telesat of Canada has a complex split shareholding with cross-investments held by Loral Space & Communications and Canada's Public Sector Pension Investment Board. AsiaSat has a very large Chinese investor (CITIC Group).

Inmarsat has no such problems and is publicly held with its largest stock-holders being equity houses, such as Landsdowne Partners (11.4 percent), Jupiter Asset Mgt (6.18 percent), Capital Research & Mgt (5.06 percent) and Aberdeen Asset Mgt (4.8 percent).

The second key requirement is that OneWeb — ideally — would want their Geo-partner to have global coverage. Intelsat meets that requirement. Same with SES.

Artist's rendition of OneWeb's satellite constellation. Image is courtesy of OneWeb,

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Telesat	117 satellites
LeoSat	108 satellites
O3b	12 today (32 in prospect)

OneWeb satellite terminal solar array.

Eutelsat, now with its 'Eutelsat Americas' (the former SatMex satellites) also fits the bill. Telesat of Canada is also a contender helped by the international coverage provided by the former Loral Skynet/Telstar/Vantage fleet assets that it held onto and condominium satellites in place with ViaSat-1 and Eutelsat 113WA.

Telesat also has plans in place for its own 117-satellite fleet of LEO craft. AsiaSat is an important regional player, but currently does not possess global coverage.

With Intelsat not included in the mix (although in media-land, one would be wise to 'never say never' as far as SoftBank is concerned), it is then difficult to drill down beyond these handful of large players. There are many other satellite operators happy to see themselves sold, not the least of which is Telenor of Norway, ABS of Hong Kong/Manila, and Israel-based Spacecom.

Again, important as these companies are, none of them have a global presence. It is not impossible that SoftBank, helped by a near-$100 billion equity fund, couldn't spend wisely and bring two of these players together for a near-global operation.

But who, exactly, is SoftBank? SoftBank is a massive multinational telecoms and Internet supplier with operations in broadband, media, Internet and technology services. They own a very large (80 percent) slice of the U.S. telco Sprint, and also owns Vodafone Japan.

In July 2017, Softbank paid $32 billion for chip-designer ARM Holdings. The company has also established a near-$100 billion technology fund, with the cash coming from its own resources plus help from sovereign wealth funds from Kuwait and Qatar, as well as earlier commitments from Saudi Arabia.

Other named investors in the $100 billion fund include Apple, Qualcomm, Foxconn Technology and Abu Dhabi's Mubadala Investment Company as well as reports of a couple of Canadian pension funds looking to invest.

One fascinating coincidence is that some of the SoftBank investors (including SoftBank itself, and not the least Qualcomm) are also investors in OneWeb.

Intelsat remains committed to working with OneWeb in spite of the failure of the larger merger. Intelsat's CEO, speaking June first, said, "*Even without a merger of our companies, the pre-existing commercial agreement among Intelsat, OneWeb and SoftBank will continue. Under this agreement, we plan to jointly develop integrated solutions utilizing both of our fleets and to act as a sub-distributor to SoftBank for the attractive application segments of mobility, energy, government, and the connected car.*"

OneWeb's future certainly looks bright. With more than $1 billion in investment cash from SoftBank, plus additional backing from Virgin Group, Airbus, Qualcomm, Bharti of India and even Coca-Cola, as well as Intelsat, the company is well on its way to acquiring the initial 648 satellites for launch into orbit.

OneWeb is partnering with Airbus Space & Defence to build those satellites. The first pair of 'pilot' satellites will be delivered this autumn from the production line in Toulouse, France, although the bulk of the initial 648 satellites planned to be launched will be assembled at a brand new, $85 million factory in Florida at a production rate of about 15 satellites per week. The first OneWeb satellites are scheduled to be launched early next year.

The market is now awaiting the next stage of this fascinating development. However, by any measure, the growth and importance of the satellite sector should certainly no longer be in doubt.

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

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Innovation: Flying Smallsat Constellations in the Cloud

The intersection of constellations (new and big) and cloud technology

by Chris Beam, Project Manager, Kratos

The space industry is in the midst of numerous technological disruptions that include the proliferation of small satellites (smallsats) and the commercialization of cloud computing as a service.

The growth of smallsats, exemplified by the number of planned constellations, is made possible by cubesat standards, normalized smallsats launch vehicles and continued miniaturization of electronics. The smallsat revolution has created new business, science and defense based opportunities resulting in numerous proposals for sizeable smallsat constellations.

Organizations such as OneWeb, Boeing and SpaceX are developing smallsat constellations that will include thousands of satellites. While Earth Observation (EO) and remote sensing are currently the dominant applications for smallsats, broadband services, communications and situational awareness (SA), especially for maritime and aviation markets, present rapidly growing, multi-million-dollar opportunities and some of the largest near-term markets for smallsat ventures.

Similarly, cloud computing as a service, has made possible the advent of high performance computing platforms and the emergence of commodity virtual machine technology. Hundreds of cloud computing service providers have emerged, including Amazon, Microsoft, IBM, and HP.

Commercial and government organizations have embraced cloud computing for its numerous benefits, including self-service provisioning where users can access computer resources as required — scale up when computing needs increase and scale down as needed.

Out of Convergence — Opportunity

The convergence of these two technological upheavals creates an opportunity, and perhaps even a mandate, to transition traditional satellite group processing from dedicated operations centers to cloud computing centers.

The cloud processing option is the same for smallsat operations... a tradeoff between building out and maintaining an operations center versus "leasing" infrastructure from a cloud provider.

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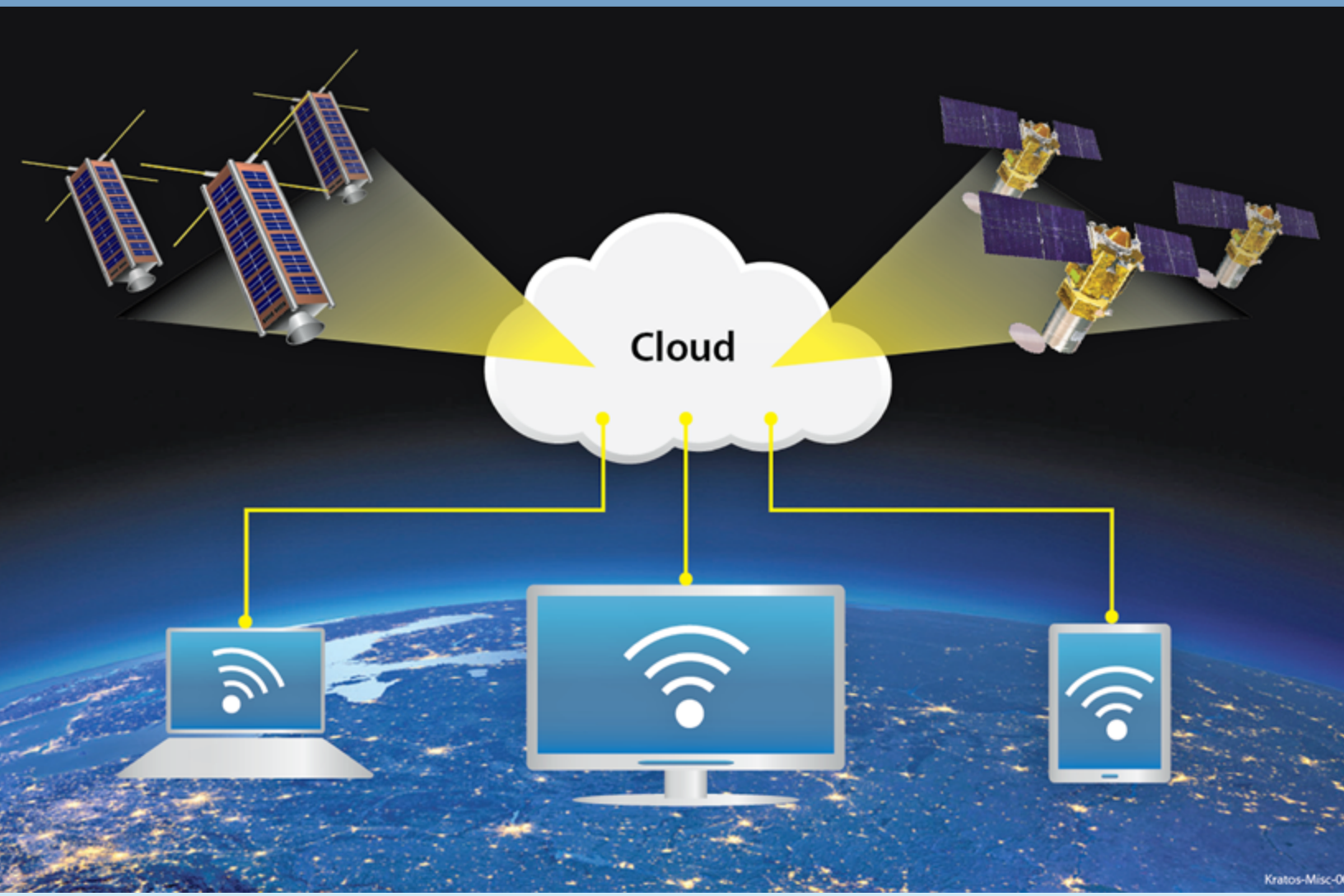

In the latter scenario, the hardware platforms and network backbone required to run operations are hosted by the cloud provider. The cloud itself does not necessarily lend any specific functionality for satellite operations other than the computing power and network infrastructure required.

Smallsat operators would provide setup and operate their own applications in the cloud Virtual Machines (VMs) and containerized applications without having to worry about purchasing hardware (servers, racks, cabling, network routers/switches, workstations, etc.) or maintaining the hardware (replacement, failover, backup, upgrades, etc.).

Using virtual machine technology, Kratos has hosted a software based ground system with a significantly smaller footprint than traditional ground systems. While this was a step in the right direction and works well for a single satellite or small constellation, the reality is smallsat constellations containing 5000 to 1,000+ satellites are currently in development and traditional ground processing resources may not be viable solutions.

Simulated Cloud-based Fleet Management

As a research initiative, Kratos used Amazon cloud computing services to simulate the deployment and operations of a large fleet operations center capable of supporting 1,000 spacecraft with 30 simultaneous contacts and 100 users.

Kratos' smallsat command and control (C2) products — quantumCMD and quantumFLEET — were used in the initiative. Working with Amazon cloud computing services, the goal of the research was to validate that these products can perform in a full scale environment representative of a large smallsat constellation's mission operations.

Specifically designed for smallsats, quantumCMD provides central data management of all core command, telemetry and ground Monitor and Control (M&C) needs common to smallsat missions.

A related product, quantumFLEET, is a pure software application designed to meet the situational awareness and management needs of smallsat constellations by coordinating the operations of multiple quantumCMD applications with enterprise-grade functionality.

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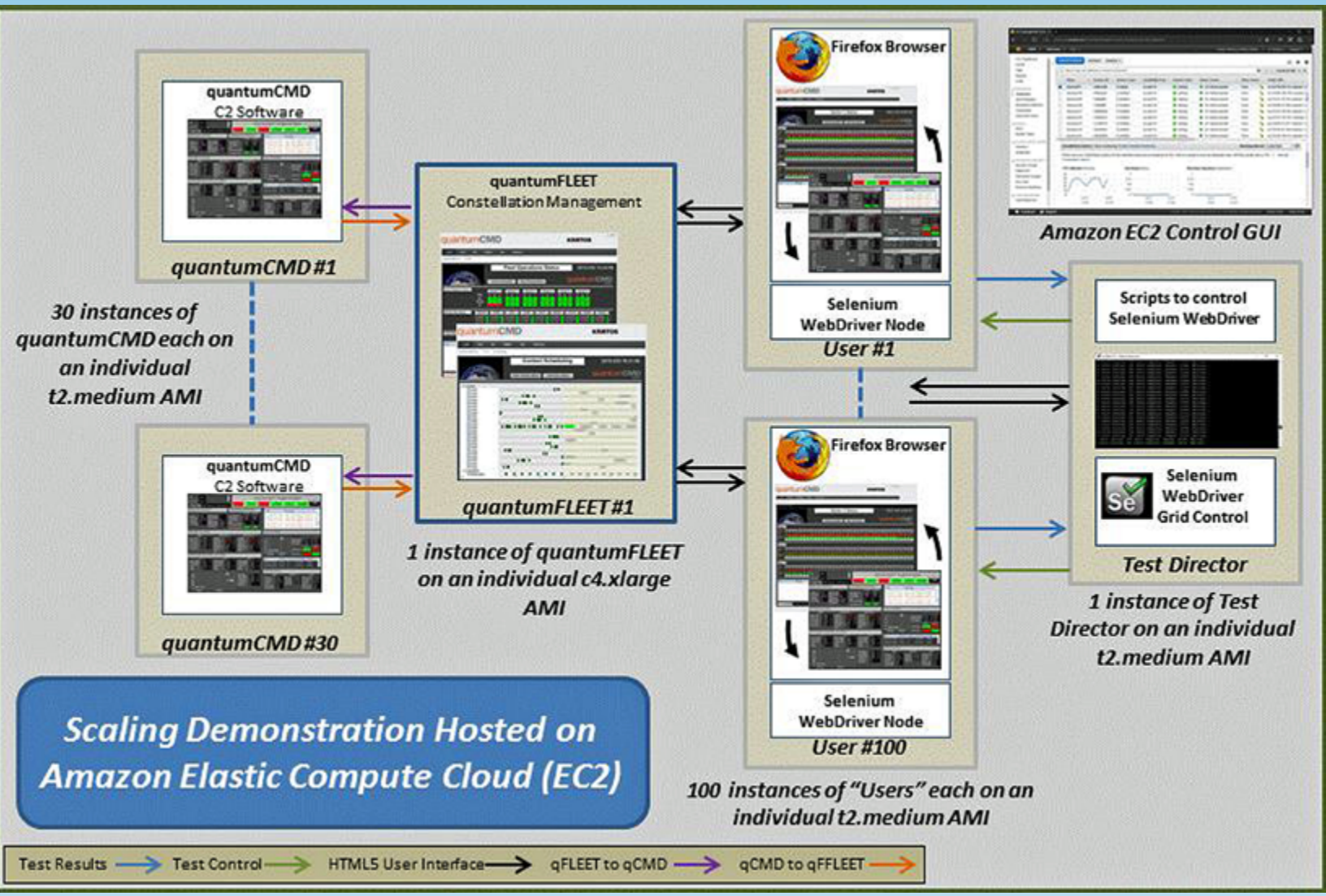


To validate performance, 30 quantumCMD products had to operate concurrently and connect to quantumFLEET; 100 users had to simultaneously perform operations through quantumFLEET and the system had to demonstrate that it could support the command processing requirements of 1,000 unique satellites and manage their data processing needs.

Test Parameters

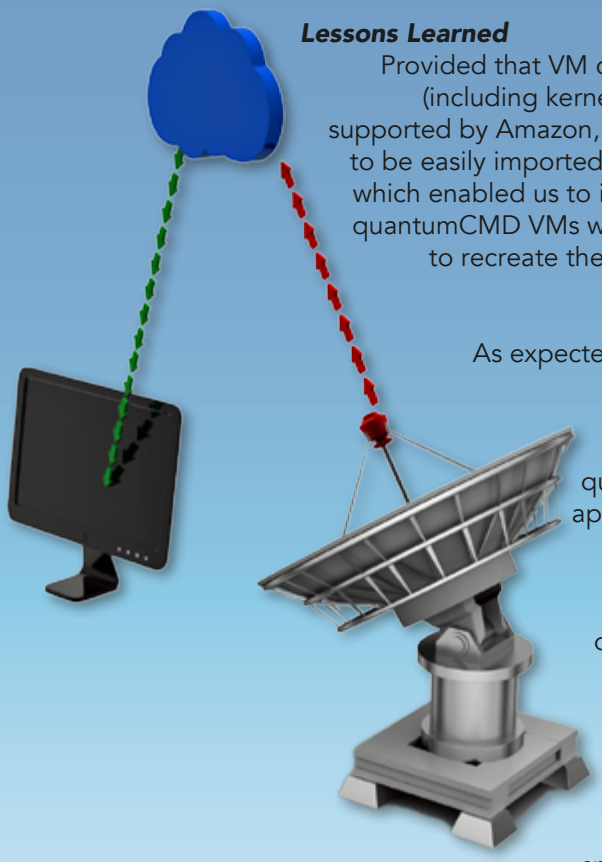
In this test environment, all of the satellite data was simulated. Instead of buying and setting up racks, servers, routers, switches, networks, workstations, and so on, Amazon cloud services provided the virtual environment where the applications resided and the network backbone where all the users accessed the applications.

In a real-time environment, the user would log into a quantum application hosted in the cloud to run their satellite contact. Any commands sent from quantum would then be sent out over the cloud's network infrastructure to a remote antenna site to be radiated up to the spacecraft. Telemetry would work in the reverse with telemetry monitoring being performed on the quantum applications in the cloud. Theoretically the telemetry data could also be stored within the cloud.

The test setup included the instantiation of each of the 1,000 satellites in the constellation, including command and telemetry databases as well as archived telemetry data. Each of the 30 virtual machines established with an instance of quantumCMD included all 1,000 instantiations of the constellation allowing all of the quantumCMD instances to be able to handle any one of the satellite contacts at a given time.

A single VM was setup to host the quantumFLEET application that provided contact scheduling and managed each quantumCMD contact through automation functionality inherent in quantumFLEET. Another 100 VMs were established to host each of the simulated user web browsers which, controlled by scripts, allows the "users" to maneuver through the quantumFLEET and quantumCMD pages. A final VM hosted the Test Director which initiated the test scripts and collected test data for subsequent evaluation.

Kratos used Amazon cloud computing services to simulate the deployment and operations of a large fleet operations center capable of supporting 1,000 spacecraft with 30 simultaneous contacts and 100 users



Lessons Learned

Provided that VM characteristics (including kernel version) are supported by Amazon, VMs are able to be easily imported to the cloud, which enabled us to import official quantumCMD VMs without having to recreate them, improving test realism.

As expected, the largest performance concern was the quantumFLEET appliance, since it maintains connectivity to all of the quantumCMD appliances, maintains a wide data set for active and inactive spacecraft, and receives frequent network traffic from user browsers.

By running on a more powerful instance type–varying combinations of CPU, memory, storage, and networking capacity that provide the flexibility to choose the appropriate mix of resources for your applications — we were able to neutralize any performance concerns.

Architectural Considerations

Architectural considerations may focus on concerns with the maturity or general business model of a cloud service such as access to the cloud, intellectual property rights, or data security. As access to a cloud provider is provided by ISPs and communication companies, access could be subject to outages and/or rate increases controlled by external entities.

Secondary access may be purchased through alternate means at additional cost or the risk of being unable to communicate with one's satellites must be accepted. Another risk to be considered is where, and how, data would be stored as the access and intellectual property rights of data stored by a second party continues to be a legal issue.

Finally, security weighs heavily on many ground systems, especially those supporting government entities as the government continues to be very risk adverse. Securing a traditional ground system to government standards can be difficult enough when the system is maintained internally.

Venture Validation

The research initiative validated that quantumCMD products can work in a full scale environment representative of a large constellation's (up to 1,000 satellites) full mission operations by ensuring that 30 quantumCMD applications could be operational concurrently and connect to quantumFLEET, that 100 users simultaneously can perform operations through quantumFLEET and that the system could support the definition of 1,000 satellites and manage the data needs for them.

Up-front costs for building out the infrastructure simulated in this demo could theoretically run up over $1M, not to mention the long-term costs of maintaining it. At $0.05 to $0.22 an hour (and most providers offer flat rate discounts for long term contracts) the cost difference can be pretty significant not to mention the manpower for maintenance.

While this demo explored a specific architecture with a single cloud provider and the concept of operations was fairly simple in only considering the command and control aspect of satellite operation, the primary goal of operating a significant sized constellation using a cloud computing services was indeed validated as a feasible option.

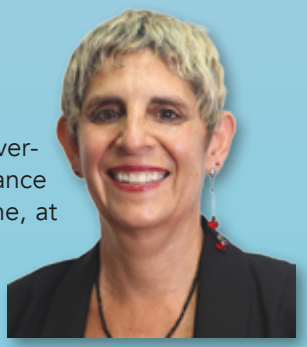
Kratos understands that the advent of smallsat constellations poses a unique challenge to traditional satellite ground system architecture. While smallsat technical requirements are similar to traditional satellites, their smaller budgets and accelerated schedules demand significant enhancements to their ground operations through virtualization, centralization and automation to keep recurring system and operations costs controlled and manageable.

To satisfy the needs of smallsat programs Kratos has leveraged its hardware-agnostic ground system software FEPs, software modems, digital IF technology and smallsat command and control, to create quantum, a pre-integrated, software based, smallsat ground system solution.

Innovation: Surf @ 30,000 Feet — Just Like You Do @ Home

A Gilat Satellite Networks Focus

by Doreet Oren, Director of Product Marketing, Gilat Satellite Networks



You're sitting on the plane, waiting for your flight to take off — you're still sending text messages from your smartphone and your laptop is open with the presentation you need to send to your customer for tomorrow's big meeting... then you hear the dreaded announcement, "*Please switch all portable electronic devices to flight mode***."**

For the next six hours you're going to be cut off from the outside world. No web surfing, no email, no Facebook and no phone calls. For those used to being connected round the clock, having Internet access between take-off and landing is even a more basic need than being served a in-flight meal.

And, it doesn't stop there. When today's passengers get on a plane, they expect the same fast mobile broadband and user experience in the cabin that they receive in their living room — they want that access on their smartphones, tablets and laptops they carry with them for use on the plane.

A recent survey conducted by Inmarsat of more than 9,000 passengers in 27 countries confirms this demand. While 92 percent of passengers wanted in-flight broadband services, 83 percent went so far as to say that their choice of airline is based on whether or not the airline offers in-flight connectivity.

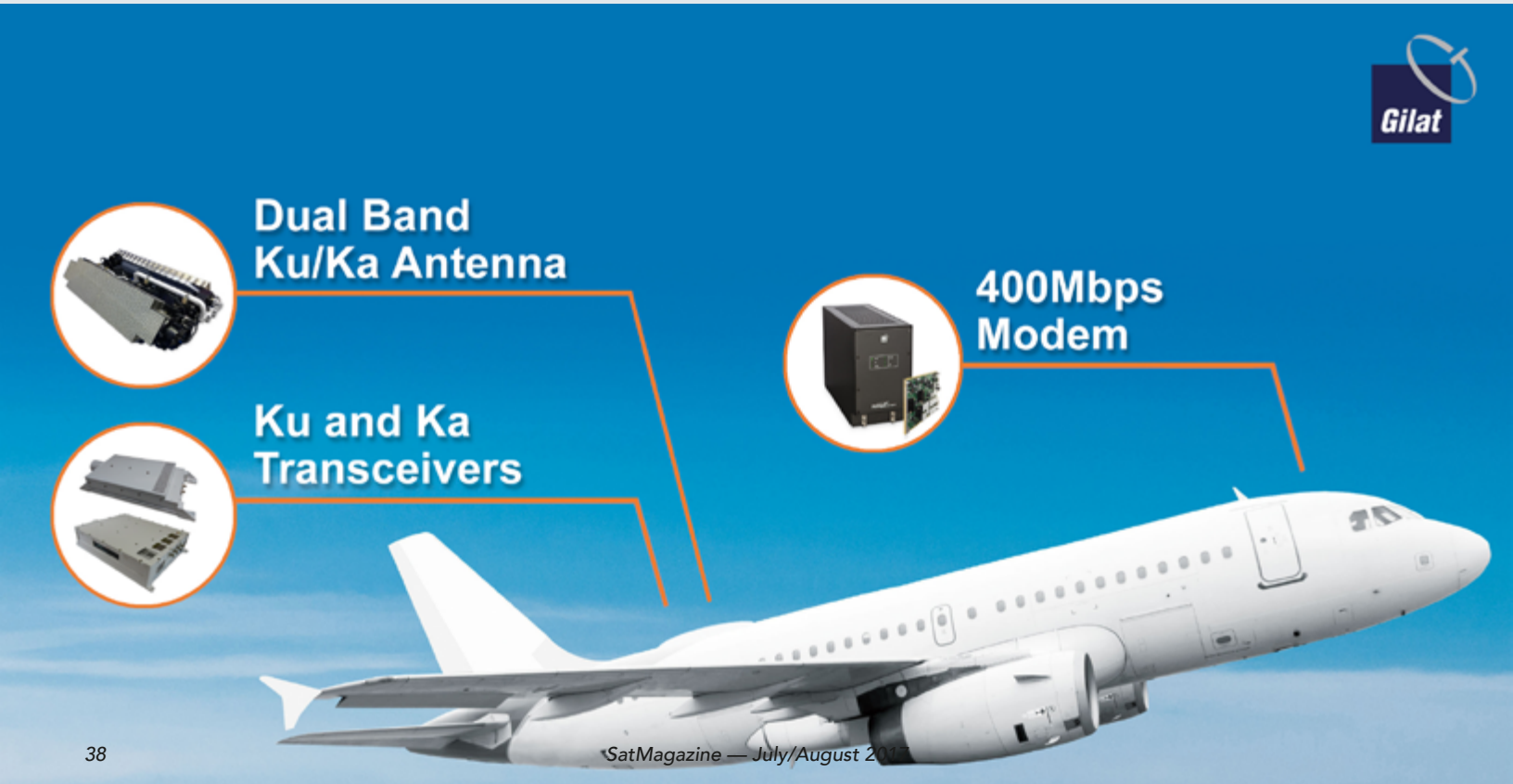
Communications on the Move

In today's always-on world, there is an ever-increasing demand for high-performance broadband communications — at home, at work and also on the move.

Providing on-the-move connectivity is particularly challenging, as fiber (and often cellular) is not an option for airplanes, boats, trains and the like. For that reason, satellite-based communication is the most cost-effective and, at times, the only feasible way to ensure reliable broadband connectivity on moving platforms anywhere on the planet.

In fact, the growing demand for global and affordable broadband coverage is revolutionizing the satellite industry. Major investments in infrastructure and a host of new players are developing innovative technologies to meet emerging communication needs.

Advancements in satellite technology, coupled with new types of onboard communications equipment, have enabled commercial aircraft, trains and cruise ships to offer high-speed Internet connectivity for their passengers.



The In-Flight Connectivity Challenge

Fueled by the availability of high-speed Internet connectivity delivered over satellite connections, a new service market is emerging known as In-Flight Connectivity (IFC). Many new and existing players in the satellite market, led by companies such as Gogo, Panasonic, Thales and others, currently offer IFC services for commercial airlines.

Make no mistake — offering passengers a high-quality online experience in the air is anything but a trivial matter. Delivery of uninterrupted Internet connectivity for hundreds of passengers over the course of a 10-hour flight is a highly complex undertaking.

In-flight connectivity services require sophisticated airborne SATCOM equipment as well as the management systems on the ground that are needed to ensure constant satellite coverage along a route — under any conditions.

Let's take a closer look at some of the key challenges facing IFC service providers, as well as the innovative solutions and technologies developed by companies that have paved the way for the commercial launch of IFC services.

Challenge #1— Bandwidth capacity and cost

In order to provide an outstanding user experience for passengers accustomed to 4G mobile and high-speed fiber connections at home, bandwidth capacity is crucial. Multiply what you enjoy at home by 350 passengers or more and the magnitude of the challenge becomes clear.

What's more, this bandwidth must be managed and shared between connected passengers to deliver a quality experience for everyone. In addition to entertainment and passenger connectivity, IFC systems also need to support the needs of bandwidth-hungry applications for internal aircraft systems, weather monitoring and the like.

In the past, the high cost of satellite capacity (vis-a-vis fiber and other land-based options) often rendered satellite-based communications prohibitively expensive for broadband services. Today, improvements in satellite technology, particularly the emergence of high throughput satellites (HTS), make satellite communications an attractive option for the IFC market.

HTS satellites provide an estimated 300 to 400 percent improvement in throughput over traditional wide beam satellites. This, in turn, is driving down bandwidth costs. HTS enables the global coverage, high capacity and performance that end-users require for a wide variety of broadband applications.

While this type of satellite used to be a niche market, low-cost HTS bandwidth capacity is now going mainstream. It is now being used to enable a wide variety of applications — from cellular backhaul to IFC and consumer broadband access.

Challenge #2 — HTS requires new types of sophisticated equipment

With the availability of relatively affordable satellite capacity, the next step — which is happening right now — is to create the sophisticated airborne and ground equipment necessary to deliver this satellite capacity to end-users.

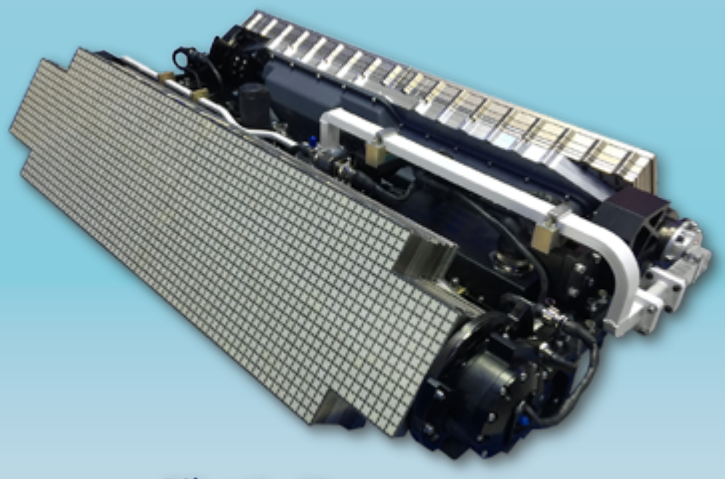
Gilat Satellite Networks has embraced this challenge and became a leader in offering HTS-compatible equipment to support the needs of a wide variety of mobility applications, including IFC and train connectivity.

Gilat offers a comprehensive broadband solution for in-flight connectivity service providers. The solution is comprised of high-speed modems and onboard antennas in the Ka- and Ku-bands, as well as ground equipment, and is currently being deployed on Boeing, Airbus and other aircrafts.

The airborne modem achieves aggregate data rates of up to 400 Mbps, enabling Internet and multimedia applications that support hundreds of airplane passengers without compromising on service quality and user experience.

In addition, the modem manages the entire in-flight satellite communications system, including web surfing and live TV for passengers, Wi-Fi and cellular backhauling, and provides connectivity for other aircraft systems.

However, high performance is not enough. In order to make certain that passenger connectivity remains uninterrupted wherever an airplane travels, the onboard antenna must be able to "talk" to any satellite in either Ka- or Ku-band.



Gilat Ku/Ka aero antenna

Gilat has solved this dilemma by developing a single dual-band antenna that enables continuous broadband connectivity for commercial aircraft traveling air routes that require a combination of Ka- and Ku- coverage. Moreover, using one dual-band antenna significantly reduces weight and drag versus the use of two separate antennas, saving airplane fuel costs.

Challenge #3 — Ensuring reliable "on the move" communications

Whether commuting to work on the train or flying to an important business meeting, passengers expect to be able to make a voice call or access the Internet at a moment's notice.

According to the Inmarsat survey, passengers value reliability more than any other parameter in terms of what they want from in-flight broadband services.

Sophisticated satellite communications equipment is required to ensure reliable communications on planes and other moving platforms. While HTS addresses the need for high throughput, it poses a new need with respect to reliability.

Unlike traditional communication satellites that use a single wide beam, HTS uses multiple spot beams designed to provide greater capacity and high data rates over smaller surface areas. As these spot beams cover a smaller area, the challenge here is to switch seamlessly between beams and satellites (as needed) while the plane travels.

IFC is being deployed worldwide — from North America to Europe and the Far East — for domestic and transcontinental flights. This requires continuous global coverage and the ability to seamlessly switch among satellites and satellite beams.

To address these requirements, Gilat has developed advanced technologies that enable transparent beam switchover that ensures passengers will be able to experience the highest quality, high-speed connectivity they expect throughout their entire journey.

Future Directions in IFC Technologies

What does the future hold for IFC services and technologies?

IFC is a dynamic, rapidly growing market that will require constant technological innovation going forward. While the need for a fast modem has been solved (Gilat's 400 Mbps modem, for example, which overcomes the satellite delay and seamlessly tracks satellites and satellite beams), the continued development of technological innovations is underway to create the next-generation airborne antenna.

The requirement for on-the-move applications, and IFC in particular, is for a flat antenna that can be electronically-steered with no moving parts. This type of electronically-steered array/phased-array antenna (ESA/PAA) is ideal for platforms that are constrained in size and weight.

To this point, Gilat was selected by Airbus to develop a more efficient and "greener" type of IFC antenna. The Clean Sky 2 research program, aimed at developing cutting-edge technology, to reduce pollution and noise levels, produced by aircraft, funded this joint development project.

The development of an ESA/PAA antenna based on an array of flat panels that are embedded into the wing structure of the airframe is ongoing. A key advantage of this design is that it supports IFC capabilities without any impact on aircraft performance and maneuverability.

As there are no protruding or moving parts, this innovative technology also avoids aerodynamic drag, while reducing fuel consumption and CO2 emissions.

As IFC continues to evolve and service providers gain feedback from their commercial airline customers, technologies will continue to be developed and adapt quickly to new requirements.

For information regarding Gilat's 400 Mbps modem, please see: ***www.gilat.com/technology/taurus/***

*Doreet Oren (**doreeto@gilat.com**) is the Director of Product Marketing for Gilat Satellite Networks and has been performing in this role since 2012. She has also has been responsible for defining product positioning, messaging, go-to-market strategies, market research, and analyst relations.*

Oren has more than 20 years of industry experience and has held management positions in R&D, product management and product marketing for international high-tech companies. In this capacity, she contributed to next-generation product definition and was responsible for delivering the company's vision to the media and analyst community.

Oren has published thought leadership articles in renowned international journals, and has spoken at numerous industry conferences worldwide. Oren received a BSc in Computer Science from George Washington University.

Innovative Technology Powering IFC Deployments

Not only have innovative technologies been developed for IFC, they have achieved stellar performance in live flight testing by IFC service providers.

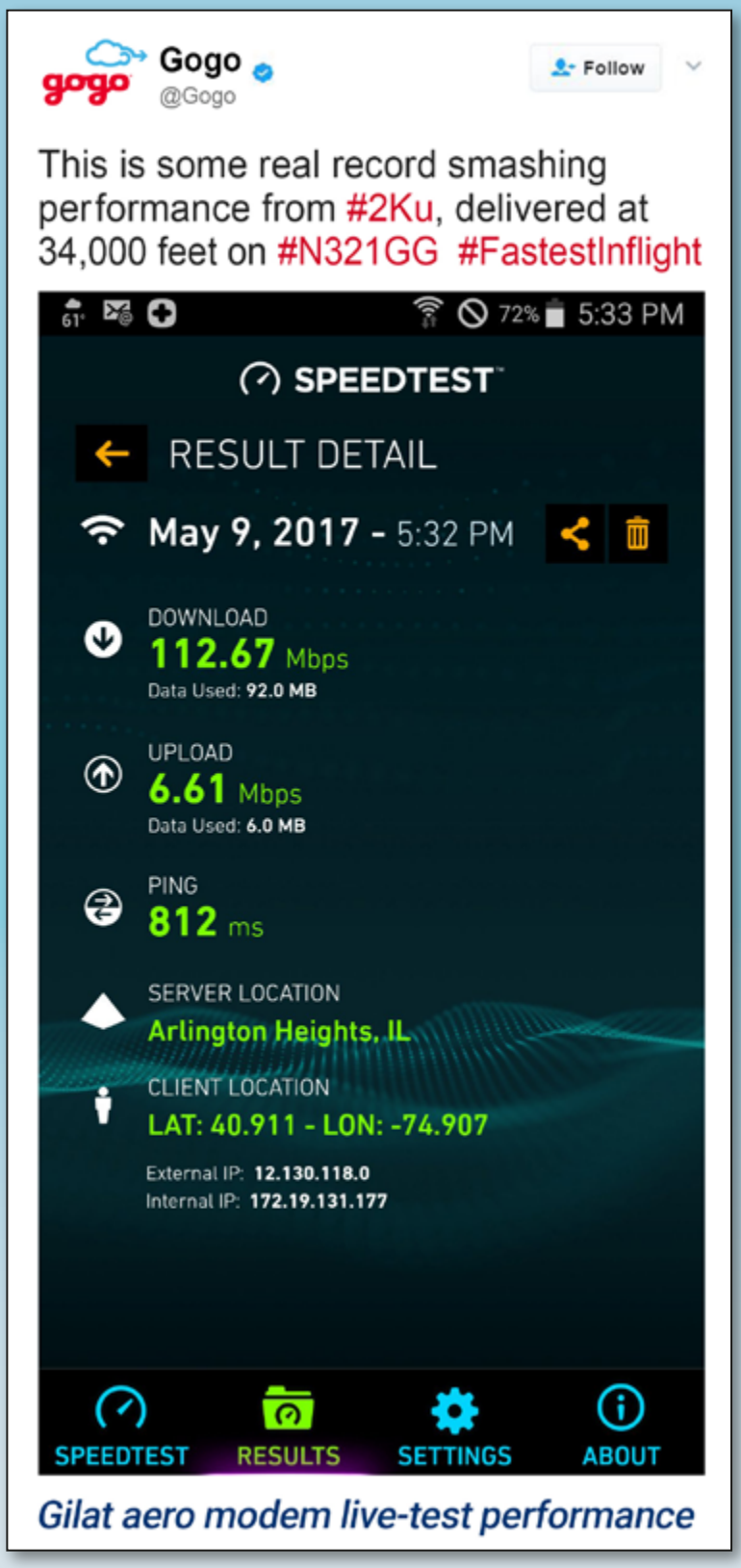
On May 9, 2017, Gogo, one of the world's leading providers of in-flight entertainment and communication systems, hosted a live media event on their Boeing 737 test plane.

Analysts and the media applauded the performance of Gogo's 2Ku system, which uses Gilat's airborne modem and satellite capacity from Intelsat's high throughout satellite.

In multiple flights, the 2Ku system demonstrated over 100Mbps data rates for video streaming, file downloads and other applications.

This is acknowledged to be the highest performance ever achieved onboard a commercial aircraft, as well as demonstrating continuous service (including takeoffs and landings) with excellent user experience.

Gogo plans to install Gilat's modem as part of its 2Ku service on more than 1600 aircraft for 13 airlines, beginning this year.



Satellite Data Solutions

A Yippy Focus

by Richard Granville, Chief Executive Officer and John Macartney, President, Yippy

In 2015, Globalstar announced their partnership[1] with Yippy for its search, data compression, document retrieval, and management services.

Through a series of follow-on agreements[2], Globalstar will offer Yippy's compression and data services to their existing subscriber base, as well as other service providers[3] and enterprises using Mobile Satellite Services (MSS) and Fixed Satellite Services (FSS).

The initial partnership goals were to reduce clocktime for up and down requests as well as materially reduce the bandwidth utilization of the subscriber. For clarity, the Pilot Program stated goals were that a Globalstar subscriber at 8 kbps be able to access CNN.com/mobile webpage and an internal corporate pdf document with single sign on (SSO) in under 15 seconds in a highly secure environment. Yippy achieved much better results than those required.

The Data Compression industry for MSS, FSS, and terrestrial mobile networks is forecasted to grow[4] with two-thirds of the Earth are not connected to the Global Economy due to unaffordable, unavailable, or unreliable networks. Yippy provides a plug-and-play appliance solution that provides extremely aggressive reduction in downstream bandwidth utilization for webpage or document retrieval. The appliance also provides document security, encryption, management, and storage of indices for the global enterprise to the individual subscriber.

"*Globalstar's push into the compression market could prove to be viable as the compression industry grows. The move could also help increase the company's buyout chances. Globalstar has positioned itself well by partnering with compression technology leader Yippy.*" — Zacks Investment Research[4]

"*Globalstar is constantly modernizing the MSS industry, including next generation data services for our customers who demand usable and reliable connectivity. Yippy was chosen because their platform provides a highly unique software solution that will allow us to better leverage our satellite services capabilities including Sat-Fi and the Globalstar 9600 by more closely aligning the user's satellite experience with terrestrial applications.*"[5] — Jay Monroe Chairman and CEO, Globalstar, Principle of Thermo Companies.[6]

The Challenge with Satellite Internet Speeds

Consumers are accustomed to broadband and cellular data speeds. Satellite is much slower. To exacerbate the problem, as broadband and mobile speeds increase, the size of websites will continue to grow making the satellite connection even slower.

Let's Talk Speed

Satellite voice communications are on par with the late 90's cellular networks, but for data it's a daunting as well as the capital intensive challenge. In general, mobile satellite data communications are slow; typically, 5kbps - 56kbps. The average Internet webpage weight downstream has ballooned to over 2MB and growing.[7] It is expected that the average Internet webpage will reach 3MB by the end of 2017.[8]

This explosion in downstream payloads could not have been accounted for by satellite providers as most Internet content is created to be consumed with a terrestrial broadband connection. Even mobile optimized websites are relatively large by satellite and terrestrial communications standards already topping 1MB downstream.[9]

Yippy's compression technology allows Globalstar subscribers to access mobile webpage content in typically 5-10 seconds @ 8 kbps, as opposed to 3 to 7 minutes with other MSS service providers. Using the Yippy EASE 360 platform, the service enhances the customer's experience and enables downloads and uploads to be completed faster. This is achieved while maintaining a secure connection and reducing critical overhead on satellite networks.

For terrestrial networks such as 3 and 4G as well as LTE, the compression technology provides the fastest mobile browsing experience available. Downstream latency is milliseconds with nearly instantaneous content retrieval. Yippy's combined satellite and terrestrial service offerings are language, network, and platform agnostic.

The platform is designed to integrate with large intranets or global networks utilizing multiple wireless, fiber or satellite protocols. For satellite connection speed, data links to low-Earth orbit (LEO) mobile satellites are slower than dial-up. Globalstar's current product offering is at 9 kbps (in the next generation product offering Globalstar is said to offer up to 72kbps, nearly ISDN speed).[10]

Let's Talk Size

You can imagine that if you're trying to access the Internet using a satellite phone with connection speeds approaching 10 kbps, the Internet is primarily unusable. To put this in perspective, the average 2 MB web page (and all its associated assets: images, css, javascript,etc.) will take between 15 and

20 minutes to load in a standard web browser. The same 2MB web page can take up to 20 seconds to load even on today's 3- to 4G terrestrial mobile[9] broadband networks. *Table 1* below was used for comparing download times with an optimal connection on the Globalstar Gen 1 network at 8 kilobits/second.

Table 1 displays the actual results from Pilot testing in early 2016, based upon the mobile websites for CNN, NOAA, WIKI. Yippy achieved data reduction of greater than 90 percent while maintaining the original content attributes including forward links, and image recall if desired.

Yippy acquired an unlimited worldwide perpetual license for Velocity in 2010 in a deal with Vivisimo[14], a leading enterprise search and discovery company out of Carnegie Mellon University[15] which was subsequently acquired by IBM in 2012.[16]

Yippy uses Watson algorithms to fetch the entire webpage in real-time then reconstructs the site in a single object while maintaining the formatting, links, menus and other attributed visualization including image recall with content proximity to the original webpage.

Mobile Website	Standard			Yippy		
8 kbps throughput Global Sat-Fi 1 MSFT OS	Size	Req[A]	Time[B]	Size	Req[A]	Time[B]
CNN.com/mobile	271 KB	160	5.1 min	5.2 KB	1	6.22s
National Weather NOAA mobile	234 KB	23	3.7 min	3.2 KB	1	4.25s
Trump Wikipedia Webpage Mobile	256 KB	77	4.0 min	4.9 KB	1	7.13s

[A] Req = Object requests

[B] Time = Best clock-time from 5 attempts with 300-400ms network latency

Table 1.

"*The Yippy technology compresses websites to provide a reasonably fast Internet browsing experience over a slow satellite data connection. For Terrestrial mobile networks, Yippy's compression adoption can alleviate concurrent bandwidth overhead for the service provider and allowing greater allocation of bandwidth for providing better streaming performance.*"[11] — Art Huffman, former CIO, Halliburton[12]

As Yippy can't change the satellite provider's infrastructure and make it faster, then we need to shrink the data being passed. Yippy can also shorten the path of the requests from the user to the destination by moving the destination closer to the user at the fringe of the network.

Yippy Addresses This Problem

The Yippy solution is *search engine-centric* and, in this case, the technology used is proprietary technology based on IBM's Watson Explorer® formally called Velocity from Vivisimo.[13]

Most Internet browsing experiences start with either direct navigation or search. That's why Google is so popular. But Google's not optimized for slow satellite data speeds therefore, it is not the right choice for opening new markets around the world were broadband is non-existent.

Yippy's EASE 360 platform is a search engine like Google but it's optimized with many attributes beyond the big three Google, Yahoo, and Bing.

Yippy is one of the top ranked search engines in the world.[17] Not only is it optimized, but Yippy can host the search engine on the satellite network fringe or gateways. This shortens the path of the request from the user to the search engine while providing a walled garden with windows architecture that never exposes the user to the Internet. True cloud computing, with all transactions computations on the cluster.

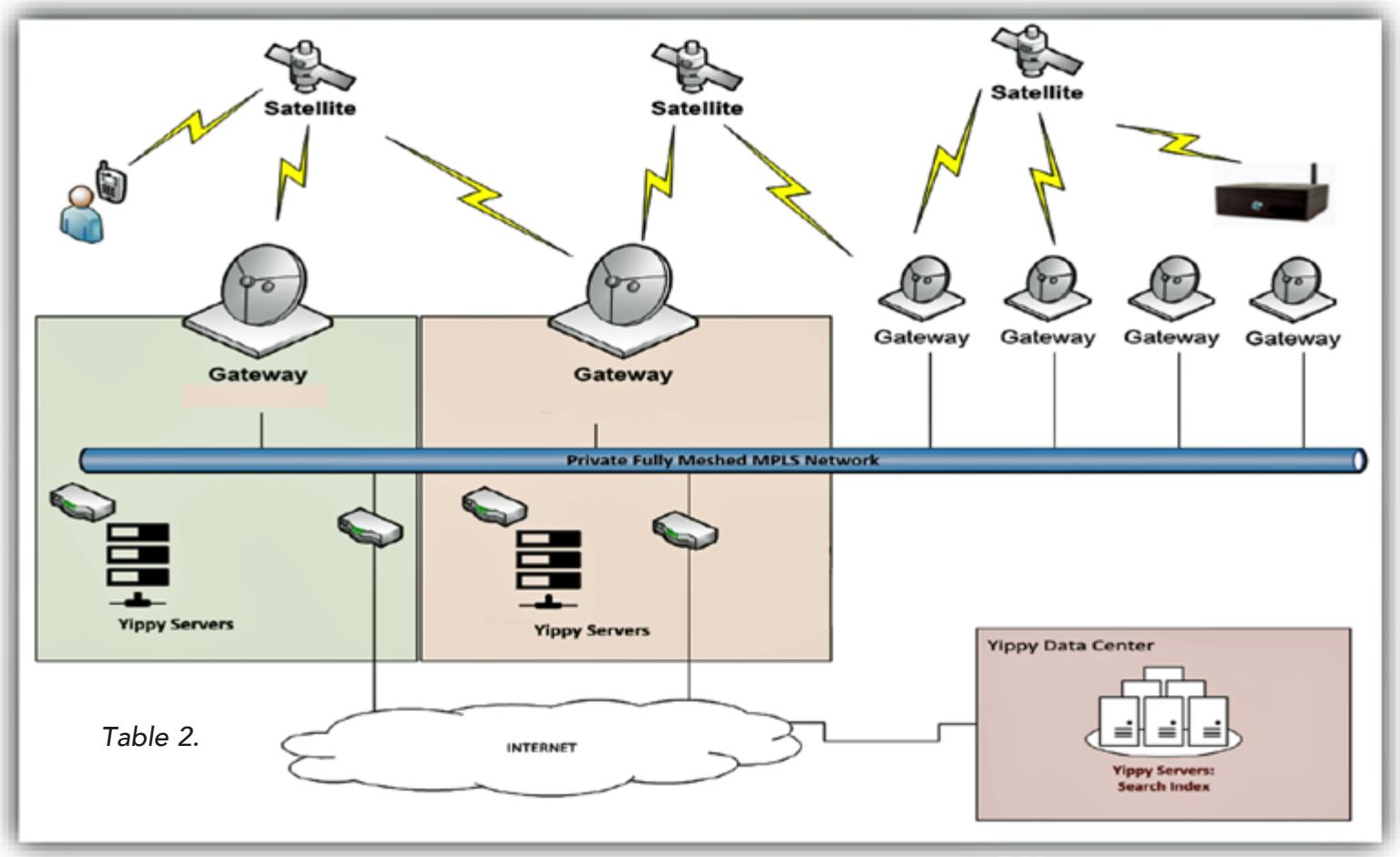


Table 2.

This also helps with language and cultural barriers, as the Yippy solution can be tuned for the environments it will serve. Meaning, a hosted platform in Japan, can serve all of Asia, and be accessible to comply with the rules or censorship required by those nations' users and/or subscribers. Assisting all governments reach those outside of terrestrial communications and giving them control over the content is key to adoption in many countries in the world.

Based upon Watson, which Yippy operates *autonomously from* IBM, and coupled with other internally developed and acquired technologies, Yippy has developed a suite of technology solutions which enhance the underlying technology's output while simplifying the deployment process. These solutions range from cloud, enterprise search, business intelligence, document security and data compression for MSS/FSS satellite and terrestrial wireless operators.

Additionally, the Company has developed middleware, connectors and associated programs which enable deployments to be successful with substantially less resources and personnel as typically required in the industry. Yippy creates solutions.

Yippy's EASE 360 platform creates a faster Internet experience for the unconnected world.

a. Best placed close to the satellite network - ground station

b. Compresses a webpage to single object format. Reduces images, css, and large JavaScript frameworks.

c. Recreates website on the fly for an optimized visualization that is content centric with all attributes of the original content including links and image recall. (Shown in Table 2 on the next page).

d. Perfect for opening remote markets to the Global Economy

The Globalstar Implemented Solution

In theory, the Yippy compression platform can be accessed from anywhere on the Internet. But to get the best possible reduction in latency, the Yippy compression platform was installed on the fringe of Globalstar's network.

Working with Globalstar's network team, Yippy deployed multiple clusters of servers at several ground stations throughout the world. *Table 2* to the right shows the key components of the implemented system.

Note, the inherent ***Edge or Fog computing network*** represented in this diagram to the right (***Table 2***). Clearly, the introduction of Yippy EASE 360 platform has transformed a primarily voice network architecture, into a global ISP with material benefits for IoT and IIoT sensors, transactions, analytics with Edge - Fog computing characteristics with data compression. Globalstar acquired 20 percent of Yippy[18] and Yippy acquired IP rights including, but not limited to, 20 percent of Globalstar's network and the ability to host servers on all their spectrum in every gateway, ground station, and/or NoCs.

The goal is to create a global ubiquitous cloud (World Wide Web 2)[19] in the 20 year deal signed in 2015. This network also provides a much-needed terrestrial backbone due to the recent approval of the spectrum known as TD-LTE.

With Yippy appliances hosted at the heart of the network, and on the TD_LTE NoCs, we will be able to provide a nearly Utopian unification of all business data through one system over a mash-up of wireless technologies.

Yippy's EASE 360 solution coupled to Globalstar network spectrum and hardware including, but not limited to, its simplex, duplex, and M2M sensor technology can provide a global reach today for many types of sensors and other connected devices. The primary mission for this partnership is to provide true global ubiquitous communications for all data driven initiatives worldwide.

Welcome to the Cloud®, the global cloud.

Additional information: ***www.yippyinc.com/***

www.globalstar.com

Footnotes

[1] *https://globenewswire.com/news-release/2015/06/02/741534/10137034/en/Globalstar-Selects-Yippy-Inc-to-Provide-Next-Generation-Cloud-Security-and-Access-Services.html*

[2] *http://globenewswire.com/news-release/2015/12/17/796458/0/en/Globalstar-Announces-Next-Generation-Technology-Agreement-With-Yippy-Inc.html*

[3] *https://www.otcmarkets.com/stock/YIPI/news/Yippy--Inc---YIPI--to-Support-Globalstar-s--GSAT--Software-Services-Initiative-to-Market-the-Worldwide-Distribution-of-Yippy-s-Data-Compression-Software-and-Associated-Technologies?id=155391&b=y*

[4] *https://www.zacks.com/stock/news/255912/after-atampt-buys-straight-path-globalstar-could-be-the-nexttelecom-takeover-target*

[5] *https://la.globalstar.com/pg/index.php?cid=7010&pressId=877*

[6] *https://www.globalstar.com/en/index.php?cid=6020*

[7] *https://www.sitepoint.com/average-page-weight-increased-another-16-2015/*

[8] *https://www.soasta.com/blog/page-bloat-average-web-page-2-mb/*

[9] *https://www.thinkwithgoogle.com/marketing-resources/data-measurement/mobile-page-speed-new-industrybenchmarks/*

[10] *https://www.globalstar.com/en/index.php?cid=7010&pressId=940*

[11] *http://www.marketwired.com/press-release/yippy-inc-yipi-adds-former-cio-halliburton-air-liquide-sa-as-chiefconsultant-board-1981321.htm*

[12] *http://www.prnewswire.com/news-releases/yippy-inc-yipi-adds-former-cio-of-halliburton-hal-and-air-liquidesa-to-the-board-of-directors-300467730.html*

[13] *https://en.wikipedia.org/wiki/Vivisimo*

[14] *http://www.lexissecuritiesmosaic.com/net/public/secfilings/DisplayExhibit.aspx?AccessionNumber=0001213900-10-002105&FileName=*

[15] *http://www.marketwired.com/press-release/clusty-the-award-winning-metasearch-engine-is-acquired-byyippy-inc-1261332.htm*

[16] *http://www-03.ibm.com/press/us/en/pressrelease/37833.wss*

[17] *https://www.searchenginejournal.com/going-beyond-google-comprehensive-list-search-engines/123880/*

[18] *https://seekingalpha.com/news/2991126-globalstar-expands-yippy-deal-takes-20-percent-stake*

[19] *Trademarks for Yippy, Inc. related to this document.*

IBC's Golden Age

An Industry Event of Major Proportions

by Jaisica Lapsiwala, Head of Event Content, IBC

In the media and entertainment industry, it can often seem as if the working year is measured by trade shows.

More and more niche events seem to spring up annually and it can be difficult to know which to visit or spend precious marketing dollars on. However, there are a few fixed markers in the calendar that take the temperature of the industry and as such are must-attend events —IBC is one of these.

IBC's remit is to be run "*by the industry, for the industry.*" Celebrating its 50th anniversary this year, IBC continues to evolve with the industry it represents and strives to be a trusted voice, bringing informed insight and expert opinions to hot topics and key markets.

While international travel these days is sometimes challenging, IBC2017 is an essential trip for global visitors, with a conference theme that examines the diversifying media ecosystem, featuring presentations from the industry's biggest and most influential individuals and organizations; several exclusive C-level micro-events where business leaders will look at the future of the industry, 5G, as well as the threat they pose from cyber-attacks; a start-up investment event that will bring tomorrow's solutions to the fore; an exhibition hosting a wide range of major manufacturers and SMEs; and plenty of opportunities to network with international decision makers.

The IBC Conference

Let's look first at the conference, themed '*Truth, Trust and Transformation.*' Its aim is to foster debate and seek clarity on the myriad challenges and opportunities facing all content creators and aggregators, both from the traditional media industry and in adjacent markets.

For the *Satnews* and *SatMagazine* audience in search of information and solutions for planning their OTT (Over-The-Top) entrance and streaming deliveries, there are several must-attend conference sessions addressing the growth of OTT content.

The *Platform Futures* strand of sessions insight, running on September 14 and 15, will be delivered from major industry players that include Viacom International, Sony Pictures Entertainment, Discovery Networks International, NBC Universal and Facebook, into the current state and future developments of the satellite and OTT markets.

The term 'platforms' refers to any organization that wants to aggregate content and get it out to a collection of consumers — such as existing pay-TV operators, including satellite, broadcasters and OTT providers. The niche content providers that may have once given their content to broadcasters are now bypassing them and going directly to the consumer.

Sessions spread across two days will explore the whole area of 'direct to consumer' from a number of different perspectives. Discussions will focus on companies that are bypassing broadcasters.

The VOD (Video On Demand) TV offering is delivering the latest in unscripted reality programming to viewers in other markets at the same time that they are broadcast in the U.S. As this new service from NBC Universal takes off, IBC will be asking if this is the future of TV channels.

The role of social media platforms in content delivery will also be addressed in this conference strand. Facebook will share how it is playing in the video space, while traditional broadcasters will discuss what they are doing to compete. With new content delivery models entering the broadcast space, the opportunity to personalize and get content out to audiences in different, more convenient ways, will be a hot topic.

Also of interest to the *Satnews* and *SatMagazine* audience will be the session, '*Video on Demand – How hard can it be?*' With representatives from regional and niche VOD players present, discussions will center on how to compete with global players.

Shaping the Industry

As part of IBC's role in helping to shape the changing industry, it will host two exclusive invitation-only micro-events for broadcast, telco, media and entertainment industry leaders.

The *Leaders' Summit*, held in partnership with the City of Amsterdam and IBC's research partner IBM Global Business Services, and sponsored by Aspera, HGST, Prime Focus and Sony, explores the theme '*Informing the Future,*' with speakers including Carsten Schmidt, the CEO of Sky Deutschland, Wim Ponnet, Group Director Strategy and Commercial Development, Endemol Shine Group and Aksel

IBC's Startup Forum.

Van der Wal, EVP Digital Ventures and Innovation, Turner International at Turner Broadcasting System.

IBC has also launched the *C-Tech Forum*, which highlights the latest technological advances, opportunities and threats affecting content creation and distribution. The topics to be covered at this inaugural C-Tech Forum are Cyber Security and the advent of 5G.

With the rapid progression of OTT services and digital broadcasting, the risk of cyber threats and hacking is also accelerating. Following recent high profile breaches, content creators and broadcasters are coming to terms with how exposed they are and how much is at stake. The *Cyber Security Forum* will bring together CTOs, CIOs, CIOSs and CDOs within media and broadcasting to have candid conversations regarding what the cyberwar means for content owners and distributors, how to anticipate the next cyber threat, and how to manage a breach.

Confirmed speakers include Latha Maripuri, Global CISO and Deputy CTO, News Corp (USA); Elaine Bucknor, Group Director – Strategy, Security and Governance, Sky (UK); Paul Lynch, Director Technology Management Office, ITV (UK); and Andreas Schneider, CISO, SRG SSR (Switzerland).

The C-Tech Forum on *5G: Finding Opportunity in Disruption* looks at the myriad of possibilities offered by 5G, from superfast mobile networks and 10 Gigabit data download and streaming rates, to VR and AR holographic bi-directional download and upload.

However, there is still much to assess and decide in terms of standards, alliances, competing technologies, infrastructure roll outs, regulation and many more issues. This program examines the facts about the development and technology behind 5G, and asks what needs to be done to make 5G a success in the broadcasting industry.

Startup Forum

New technology has seen media and entertainment business and delivery models transformed, and IBC is the place where you find the people driving those changes — making it a highly attractive venue for investors seeking new business opportunities in the media tech space.

IBC's *Startup Forum* on September 17, held in association with Media Honeypot, will bring together innovative digital media startups, media houses and investors for a day of keynote presentations, panel sessions, pitching and networking. As well as providing match-making and networking opportunities, the seminar program features key speakers who will share invaluable insights into the latest developments in media technology and how they can be harnessed into successful business opportunities.

Confirmed speakers to date include Marco DeMiroz, Co-Founder and General Partner, The Virtual Reality Fund; Steffen Keidel, Chief Financial Officer, Adblock Germany; and Michael Jaschke, CEO, Glomex/ ProSiebenSat1.

Exhibition

While IBC attracts thousands of businesses with products and services from pre-production to transmission, ***Satnews*** readers are likely to be most interested in **Halls 1** and **14** where exhibitors including Eutelsat, Intelsat and Globecast can be found.

Register Today

In this golden anniversary year, IBC shows no sign of resting on its laurels, but continues to relentlessly research new technologies and trends, seek expert opinions and invite debate and discussion for the benefit of the diversifying media industry.

Miss IBC2017 at your peril.

*Visit **https://show.ibc.org/** to register for your free exhibition pass, learn more about the conference sessions, register your interest in C-level events and view exclusive content including thought leadership articles and technical papers.*

Register Now!

Conference 14-18 September 2017
Exhibition 15-19 September 2017

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