SATCOM For Net-Centric Warfare November 2015

MilsatMagazine

A United Launch Alliance (ULA) Atlas V rocket carrying the GPS IIF-11 mission lifts off from Space Launch Complex 41 at 12:13 p.m. EDT on October 31, 2015. Photo is courtesy of United Launch Alliance.

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DISPATCHES

FEATURES

ADVERTISER INDEX

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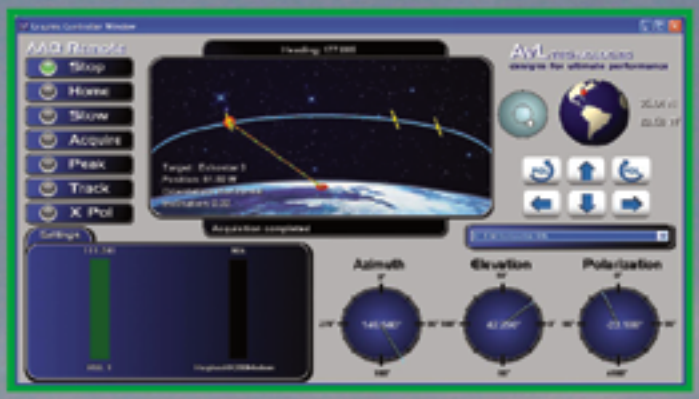

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DISPATCHES

A Danish Evolution... From iDirect

VT iDirect, Inc. (iDirect), a company of Vision Technologies Systems, Inc. (VT Systems), has signed a framework agreement with specialized procurement center and logistics authority Danish Acquisition and Logistics Organization (DALO) to deliver hardware, software, and services to the Danish Armed Forces.

Using the iDirect defence portfolio, the Danish Armed Forces can ensure high quality support for multinational missions quickly and efficiently at all times and in any location.

In order to carry out a wide range of missions, the Danish Armed Forces require a communication system that can deliver secure, effective Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR). The

iDirect Evolution portfolio enables the Danish Armed Forces to leverage the Wideband Global SATCOM (WGS) program, along with partner nations defence satellites, and commercial satellites.

The advanced Quality of Service (QoS) capabilities of the iDirect platform allows the Danish Armed Forces to dynamically balance traffic between operational and welfare requirements, and mobile and static deployments depending on the varying levels of priority.

iDirect's TRANSEC capabilities will help to build added security into their networks, and the technical expertise of the 24/7 iDirect Technical Assistance Center (TAC) provides a high level of reliability to the Danish Armed Forces.

The rollout of new products in the iDirect defence portfolio will provide the Danish Armed Forces with a highly efficient and resilient portfolio of remotes, designed to lower operating costs.

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This highly informative symposium will be conducted on Tuesday, February 23, and Wednesday, February 24, 2016.

The event takes place at the **Hogan Lovells Conference Center, Menlo Park,** located in Silicon Valley, California, and is organized and sponsored by ***Satnews Publishers***.

For further details and to register, please visit ***smallsatshow.com/?page_id=18***

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DISPATCHES

GPS IIF-11 Soars Spacewards

A United Launch Alliance (ULA) Atlas V rocket carrying the Global Positioning System (GPS) IIF-11 satellite for the U.S. Air Force lifted off from Space Launch Complex-41 October 31 at 12:13 p.m. EDT.

GPS IIF-11 is one of the next-generation GPS satellites that incorporate numerous improvements to provide greater accuracy, increased signals and enhanced performance for users.

"Congratulations to the entire team on today's successful launch of the GPS IIF-11 satellite! Today's launch was made possible by the exceptional performance and teamwork exhibited by the entire team, including the men and women of ULA, our many mission partners, and our U.S. Air Force customer," said Jim Sponnick, ULA vice president, Atlas and Delta Programs. "GPS is omnipresent in our everyday lives and the system provides a critical service to the all of those serving in our military around the world. All of the operational GPS satellites have been launched on Atlas and Delta rockets and the U.S. Air Force does an outstanding job of operating this essential system."

This mission was ULA's 11th launch in 2015 and the 102nd successful launch since the company was formed in December 2006.

This mission was launched aboard an Atlas V Evolved Expendable Launch Vehicle (EELV) 401 configuration vehicle, which includes a 4-meter-diameter payload fairing.

The Atlas booster for this mission was powered by the RD AMROSS RD-180 engine and the Centaur upper stage was powered by the Aerojet Rocketdyne RL10C-1 engine.

GPS IIF-11 will join the GPS worldwide timing and navigation system utilizing 24 satellites in six different planes, with a minimum of four satellites per plane positioned in orbit approximately 11,000 nautical miles above the Earth's surface.

The GPS IIF series provides improved accuracy and enhanced performance for GPS users.
ULA's next launch is the Atlas V OA-4 capsule for Orbital ATK scheduled for December 3 from Space Launch Complex-41 from Cape Canaveral Air Force Station, Florida.

The EELV program was established by the U.S. Air Force to provide assured access to space for Department of Defense and other government payloads.

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The commercially developed EELV program supports the full range of government mission requirements, while delivering on schedule and providing significant cost savings over the heritage launch systems.

With more than a century of combined heritage, United Launch Alliance is the most experienced and reliable launch service provider. ULA has successfully delivered more than 100 satellites to orbit that provide critical capabilities for troops in the field, aid meteorologists in tracking severe weather, enable personal device-based GPS navigation and unlock the mysteries of our solar system.

Orbital ATK, Inc. contributed integrated hardware to the successful launch of the United Launch Alliance (ULA) Atlas V rocket GPS Block IIF satellite payload.

Now in geosynchronous orbit above the Earth, the eleventh GPS IIF satellite in the constellation will replace older, first-generation GPS satellites and provide improved accuracy, signal strength and quality to America's warfighters, allies and civilian users worldwide.

Boeing designed and built the GPS IIF satellite for the U.S. Air Force.

"It is exciting to see Orbital ATK produced structures and components on both the launch vehicle and satellite of another successful EELV launch," said Scott Lehr, President of Orbital ATK's Flight Systems Group. "We look forward to adding our new GEM-63 solid rocket boosters—which are currently under development—to ULA's Atlas V launches beginning in late 2018."

For the ULA Atlas V rocket, ATK produced the 10-foot diameter composite heat shield, which provides essential protection for the first stage of the launch vehicle.

The Orbital ATK components, in both the ULA Atlas V launch vehicle and satellite, use the latest, cutting-edge technology across multiple divisions. These include large composite structures, retro motors, propellant tanks, state-of-the art solar arrays and other critical components on the GPS IIF satellite.

For the ULA Atlas V rocket, Orbital ATK produced the 10-foot diameter composite heat shield, which provides higher performance with lower weight, and essential protection for the first stage of the launch vehicle from engine exhaust temperatures manufacturing techniques at Orbital ATK's Iuka, Mississippi, facility This is the 59th ULA Atlas V launch using Orbital ATK-built composite structures.

This flight marked the 23rd successful flight of the Orbital ATK retro motors. Eight of these solid motors provided thrust for separation of the spent first stage. The ULA Atlas V retrorocket is built at Orbital ATK's Elkton, Maryland, facility.

Orbital ATK's Space Components Division facility in Commerce, California manufactured the Reaction Control System (RCS) propellant tanks for the ULA Atlas V rocket.

For the GPS IIF-11 satellite, Orbital ATK provided a host of products and services that included:

- *Orbital ATK's Goleta, California, facility designed and manufactured the satellite solar arrays and a deployment boom. Orbital ATK has achieved 100 percent on-orbit success on all solar arrays and deployable systems delivered and launched to date.*
- *Orbital ATK's San Diego, California, facility manufactured the composite solar array substrates and structural components.*
- *Orbital ATK's Commerce, California, facility had responsibility for the ullage tank assembly, including the blankets, heaters, thermistors and pressurant lines. This tank is a spherical vessel constructed of titanium.*
- *Orbital ATK's Beltsville, Maryland, facility provided heat pipes for the GPS IIF equipment and radiator panels.*
- *Orbital ATK's Rancho Bernardo, California, facility performed final assembly and RF (Radio Frequency) testing of the antenna suite for GPS IIF between 2003 and 2010.*

The Block IIF series provides improved accuracy, enhanced internal atomic clocks, better anti-jam resistance, a civil signal for commercial aviation and a longer design life. The GPS IIF-11 satellite provides space-based system global location and time information in all weather conditions.

The U.S.A.F. reports that the GPS constellation is healthy, stable and robust with two GPS IIAs, 12 GPS IIRs, seven GPS IIR-Ms, and 10 GPS IIF satellites on orbit providing precise global positioning, navigation, and timing services to users around the globe.

"The successful outcome of this mission is due to the tremendous commitment of a world class team focused on mission success," said Col. Steve Whitney, director of the Space and Missile Systems Center's Global Positioning Systems Directorate. "To the men and women of SMC, the 45th, 50th, 310th Space Wings, Boeing, United Launch Alliance, The Aerospace Corporation, GPS IIF and the Atlas V launch teams, thank you!"

Operated by Air Force Space Command's 50th Space Wing at Schriever Air Force Base, located east of Colorado Springs, Colo., the GPS constellation provides precise positioning, navigation and timing services worldwide as a free service provided by the U.S. Air Force, seven days a week, 24-hours a day.

SMC, located at Los Angeles Air Force Base in El Segundo, Calif., is the Air Force's center of acquisition excellence for acquiring and developing military space systems. Its portfolio includes the Global Positioning System, military satellite communications, defense meteorological satellites, space launch and range systems, satellite control networks, space based infrared systems and space situational awareness capabilities.

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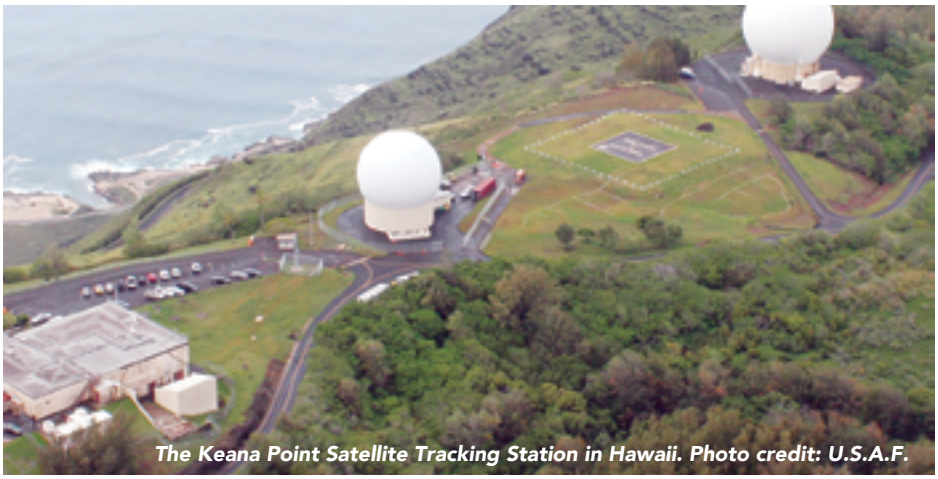
DISPATCHES

U.S.A.F. Satellite Control Network Support Goes To Harris



The Keana Point Satellite Tracking Station in Hawaii. Photo credit: U.S.A.F.

The United States Air Force has awarded Harris Corporation a $40 million, nine-month extension of the Network and Space Operations and Maintenance contract to support the Air Force Satellite Control Network at two network control locations in the U.S. and at antenna sites throughout the world—the contract was awarded during the first quarter of Harris' fiscal 2016.

Under the contract, Harris will provide operations, maintenance and logistics support to Air Force satellite operations at the 50th Space Wing at Schriever Air Force Base, Colorado, and other worldwide locations, including Colorado Springs, Colorado; Vandenberg Air Force Base, California; Diego Garcia Station; Guam Tracking Station at Andersen Air Force Base; Hawaii Tracking Station at Kaena Point; New Boston Air Force Station, New Hampshire; Eastern Vehicle Checkout Facility, Cape Canaveral Air Force Station, Florida; and Thule Tracking Station, Thule Air Base, Greenland.

"We have helped the 50th Space Wing provide critical information to decision makers and those on the front line reliably and cost effectively for more than 19 years," said Wayne Lucernoni, president, Harris Mission Sustainment. "The Air Force Satellite Control Network is crucial to our national security, and Harris is committed to providing mission excellence."

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DISPATCHES

New HM Satellite System For Mobility + Portability Debuts From Hughes

Showcased at AUSA 2015, the Hughes Airborne SATCOM System featuring the new HM200 Modem installed on a NorthStar Aviation Bell 407 Multi-role Helicoptem.

Photo is courtesy of Hughes.

Hughes Network Systems, LLC has unveiled their new HM System, engineered around the company's novel software-definable modem (SDM) technology and scrambled code multiple access (SCMA) waveform.

Hughes is launching with three Commercial-Off-The-Shelf (COTS) products for government applications.

The new HM System employs a commercially-based, open standards architecture and frequency band-agnostic platform that enables affordable, resilient solutions to meet a wide variety of mobility and portability requirements for government users.

In addition to supporting fixed applications, the HM System provides satellite-on-the-move (SOTM) capabilities for airborne, maritime and land mobility solutions, including a complete, ultra-compact and portable terminal for small teams reliant on quick-deploy connectivity

With the first gateway installed and fully operational in September 2015, the COTS products are now ready for market roll-out.

The three HM System product solutions based on the new waveform technology are as follow:

» *HM100: Enterprise Application Modem – A universal rack-mounted hub that is transportable and offers high-throughput to support ground station SATCOM operations.*

» *HM200: Satellite-on-the-Move (SOTM), Ruggedized Modem – A mobile, ruggedized modem for any communications-on-the-move (COTM) scenario, with real-time situational awareness and beyond-line-of-sight (BLoS) capabilities. Target applications include land mobile, maritime, and airborne platforms. The HM200 offers faster acquisition time, low power requirement, carrier-in-carrier capabilities, MIL-SPEC connectors, internal power supply and separate data and M&C ports. It is also equipped to deliver the best data rates in the market for SATCOM through rotor blades.*

» *HM300: Ultra-Compact, Portable Terminal – An ultra-lightweight man-packable communications solution that allows fast deployment and recovery while enabling up to 512 kbps of voice and data and is suitable for use in harsh environments. A complete terminal, the HM300 offers X-band communications with a small antenna footprint in a compact, low power package. It reduces the requirement for large and heavy satellite communications kits and also achieves significant service cost savings when compared to L-band service alternatives. The HM300 will launch as the portable terminal of choice for the XEBRA Service from Airbus Defence & Space.*

Suitable applications for the HM System include intelligence-surveillance-reconnaissance (ISR), border patrol, search and rescue, disaster response, wildfire monitoring, oil platform communications, cellular backhaul and airborne BLOS communications.

"The basis of the new HM System is our advanced waveform technology based on very low-rate coding and new multiple access techniques," said Rick Lober, vice president and general manager, Defense and Intelligence Systems Division, for Hughes. "Continuing the Hughes tradition of innovative satellite networking solutions, the waveform utilizes advanced software-definable SCMA technology enabling high-throughput, secure and efficient sharing of bandwidth, paving the way for government organizations to experience superior mobility and portability."

www.hughes.com/

DISPATCHES

A FAB-T Day For Raytheon

Photo to left: Satellite terminals and antennas undergo rigorous environmental chamber testing before deployment.

Photo is courtesy of Raytheon.

The U.S. Air Force has cleared its Milestone C decision briefing allowing Raytheon Company to start low-rate initial production of communications terminals for the Family of Advanced Beyond Line of Sight Terminal (FAB-T) program.

The Milestone C review marks the beginning of the production phase of the program. Raytheon will produce both airborne and ground terminal variants, deliver spares and provide training, installation and logistical support, under an exercised contract option of the previously awarded production program.

FAB-T is a highly secure satellite communications terminal that allows the President of the United States, senior military advisers and combatant commanders to receive and transmit voice, data, imagery and video across the world to support various military operations.

The terminals, which provide access to and command and control communication links to the Advanced Extremely High Frequency (AEHF) satellite communications system, will be manufactured at Raytheon's facility in Largo, Florida. Raytheon's Marlborough, Massachusetts, site will also provide support.

"Starting low-rate production is a significant achievement for the FAB-T program," said Scott Whatmough, vice president of Integrated Communications Systems for Raytheon's Space and Airborne Systems business.

"Our focus during production will remain on delivering an affordable, reliable and capable solution that meets the requirements of this critically important mission."

DISPATCHES

McMurdo Bumps Up Satellite-Based Search + Rescue Ecosystem

McMurdo is extending its world leading Search and Rescue Ecosystem with the launch of the SARBE CommLink at the Dubai Airshow. SARBE CommLink is a next-generation digital wireless intercom system that helps emergency response/ rescue teams accelerate time-to-rescue with superior audio quality, long-distance communications range and unique programming capability.

With SARBE CommLink, the McMurdo SAR ecosystem, which has traditionally included distress beacons, satellite connectivity and mission control and rescue coordination systems, is now extended to include a military-grade communications solution as part of rescue operations. Rescue helicopters/aircraft, their crew and support teams can now use the next generation McMurdo communications tool in mission-critical applications across the globe including medevac, offshore transit, disaster recovery and SAR.

SARBE CommLink has been specifically designed for use in hazardous missions and environments. Rescue team members can maintain direct contact with remote support personnel, including hospital, law enforcement and other emergency staff, via SARBE CommLink's long-range communications, multi-group functionality and helmet-based design. This helps to streamline the entire rescue process, resulting in faster casualty analysis, expedited medical response and more lives saved.

SARBE CommLink adds mission aircraft solutions to McMurdo's unique ecosystem that encompasses distress beacons, satellite connectivity infrastructure, monitoring/ positioning software and emergency response management solutions.

- *Secure digital communications with clear audio quality, no loss VOX and Dual Band – VHF/UHF with option for direct communication via maritime VHF*
- *Multiple pre-programmed groups allows rapid simultaneous communication within operational teams*

1. A beacon distress signal is sent from aircraft, marine vessel or individual

2. Beacon positioning/location data is relayed by satellite communications to satellite ground stations or Local User Terminals (LUTs)

3. The Local User Terminal computes the location before sending alerts to the appropriate Mission Control Centers (MCC)

4. The Mission Control Center collects, stores and sorts the data received from LUTs and other MCCs and distributes alerts to associated Rescue Coordination Centers (RCC)

5. The Rescue Coordination Center notifies and coordinates emergency response/rescue teams 6. Emergency response/rescue teams engage in rescue operation using Mission Aircraft Solutions such as McMurdo's recently announced SARBE CommLink system.

- *Self-adapting, integrated, noise cancellation microphone improves audio clarity in the most challenging aircraft or operational environments, increasing efficiency of communication and the safety of response teams*
- *Built-in microphone allows SAR teams to communicate with on-scene personnel without having to remove helmets*
- *Fully ruggedized and certified submersible to IP68*
- *Integrated global positioning system and automatic identification system within the handset allows ground asset tracking*
- *Multiple operational modes – headset, walkie talkie, P2P*
- *Robust 10KM intercom range and long battery life, with automatic power adaption*
- *Remote keying of aircraft communications, aircraft VHF access extends speed and flexibility of operational communication*

» *Base station night vision goggles limit light impact where night vision technology is deployed*

» *Built-in AIS SART*

"The launch of SARBE CommLink is a major milestone. Now, we can provide rescue operators—whether in the military or other government agencies—with an innovative communications tool that saves precious time and will be a core element of the actual rescue, one that is backed by over 70 years of SABRE brand military industry excellence," said Remi Julien, McMurdo Presiden.

McMurdo was recently selected to lead development of next generation search and rescue beacons by the European Commission.

Search and Rescue (SAR) Helicopter:

CommLink's pre-programmed groups, with a choice of operational modes and remote keying to leverage aircraft communication, ensures operational teams can have unparalleled flexibility and confidence in their communication options. The digital handset's range of up to 10km, with superior audio quality via the built in microphone, no loss VOX, Press To Talk (PTT) and noise cancellation features, ensures optimal communication for teams on hazardous air missions.

Fire-fighting / Mountain Helicopter

For wild fire ground teams, mountain rescue or medevac crews separated from their aircraft, CommLink maintains contact with support teams through a robust range, dual band, long battery life with automatic power adaption and fully submersible rugged construction. The integral personalised Automatic Identification System and Global Positioning System of the CommLink handset also ensures both individual location clarity and crew tracking in the most demanding environments.

Military Teams

For helicopter deployed military teams the CommLink's four, pre- programmed groups allows rapid simultaneous or selective communication. The remote radio keying feature allows access to the aircraft's VHF radio, greatly extending the speed and flexibility of operational communications. The secure digital wireless intercom's superior audio, flexibility and ease of use continues SARBE's reputation for highly robust solutions designed to support tri-force operations.

Airport Logistics

The CommLink wireless intercom offers greater audio quality and versatile connectivity via the full duplex and dual band features, including self-adapting noise cancelation and microphone that allows advanced situational awareness in high noise environments or pressurised logistical operations. These are the scenarios where clarity between load masters, pilot, ground teams and control tower can save time and, potentially, lives.

mcmurdogroup.com/

DISPATCHES

Final GPS IIF Satellite Arrives @ Cape Canaveral Air Force Station

The final U.S. Air Force GPS IIF in a block of 12 satellites was delivered to Cape Canaveral Air Force Station, Florida, from Boeing's manufacturing facility in El Segundo, California, October 8 via a C-17 Globemaster III.

A crowd from the government and industry partnership, who will complete the satellite's final assembly, gathered on the Cape's 'Skid Strip' to watch the off-loading of the satellite they will prepare to launch aboard a United Launch Alliance rocket in 2016.

"This GPS IIF-12 satellite represents the end of a legacy, as it will be the last of the 61 GPS satellites processed here at CCAFS," said Brig. Gen. Wayne Monteith, 45th Space Wing commander. "This culminates an incredible 27-year legacy at our Area 59 Satellite Processing Facility. We are the Nation's premier gateway to space and are humbled to be a part of the team that provides GPS and its capabilities to the world."

Although there have been other models of GPS launched into space, the Airmen-led processing team at Area 59 is particularly proud to begin preparations to send the last IIF model satellite into orbit. They've been behind every launch of the series since the first GPS IIF launched here in May 2010.

"Our combined team's objective is 100 percent mission success--each and every time." said Col. Eric Krystkowiak, 45th Launch Group commander. "My Airmen work, in partnership, with Boeing and the

A quality assurance team from the 45th Launch Group receives an Air Force GPS IIF-12 satellite from an Air Force C-17 Globemaster III from March Air Reserve Base, Calif., that delivered the last model of the IIF series to Cape Canaveral Air Force Station, October 8, 2015.

U.S. Air Force photo/James Rainier.

System Program Office at the Space and Missile Systems Center throughout the final stages of satellite processing prior to launch. From spacecraft containerization, shipment from California, the arrival at the Cape Canaveral Air Force Station Landing Strip, final checkouts, fueling and encapsulation, the team is laser focused on identifying and mitigating any issues that could potentially jeopardize mission success."

The Boeing-assembled GPS IIF 12 that arrived at the Cape will undergo a series of pre-launch preparations, checks and rehearsals. These included functional checkout of the spacecraft, compatibility testing, battery installation, fueling, mating to the payload adapter and obtaining a final flight weight.

Members of the quality assurance team range from young military officers to career enlisted troops to seasoned civilians.

"Mission Assurance at the launch base is executed with our 'triad' of professionals," said Krystkowiak. "Our mission assurance technicians are enlisted personnel with many years of experience in missile maintenance who are fully engaged and observe the contractor's work with the satellite. They bring their hands-on experience, strict technical compliance and discipline to the satellite processing realm.

"Beside them are our company grade officers and civilian engineers who bring their engineering rigor and innovative ideas into the process.

"Lastly are our Aerospace Corporation partners who provide invaluable experience and legacy system insight to the team with their continuity of satellite processing. Many of these members have been here at the Cape since GPS first launched in 1989 and achieved full operational capability in 1995."

A field program manager for the team interfaces with 45th SW leadership, the Air Force Space and Missile Center (SMC) and the contracted partners throughout the months in between the satellite's delivery and its launch.

The Evolved Expendable Launch vehicle is used to launch GPS satellites from CCAFS into nearly 11,000-mile circular orbits. While circling the earth, GPS satellites transmit extremely accurate timing data on multiple L-band frequencies.

Design life across the satellite blocks range from 7.5 to 12 years, but many are lasting more than 20 years, with the oldest vehicle turning 25 in November of 2015.

The GPS Master Control Station, operated by the 50th Space Wing's 2nd Space Operations Squadron at Schriever Air Force Base, Colorado, is responsible for monitoring and controlling the GPS as a 24-satellite system, consisting of six orbital planes, with a minimum of four satellites per plane.

There are currently 39 vehicles in the GPS constellation.

Story by Christine Cuttita, 5th Space Wing, U.S. Air Force

DISPATCHES

Foxcom DSA Is Launched

Foxcom, a Global Invacom Company, has launched their new division—Foxcom DSA (Defense, Security and Aeronautics).

Leveraging more than 20 years of RF-over-Fiber experience, Foxcom's new and innovative technology is designed to meet the most rugged and demanding needs of the military and aeronautics markets.

Foxcom DSA's new offering spans a wide range of applications, such as:

» *Iridium & GPS Repeaters: This powerful solution enables users to stay connected to the world during an emergency while remaining indoors without requiring sky view to operate*

» *Military Radio Links: This versatile, strategic radio transportation system employs a standard antenna port on any HF/VHF/UHF radio to transmit radio signals to remote locations via fiber*

» *Timing and Reference Distribution: This system is an easy way to distribute timing signals from an accurate source, to various facilities using high performance, electrically-safe, fiber-optic media*

Foxcom's capabilities, which cover 1 KHz to 18 GHz, have been deployed around the world on numerous military platforms, whether fixed applications or mobile, land-based, airborne or maritime.

Since its establishment in 1993, Foxcom has positioned itself as the supplier of choice for leading satellite operators, broadcasters and integrators around the globe by constantly meeting the demand for high performance, increased bandwidth and reliability.

www.foxcomdsa.com/

WHY MILSATCOM'S FUTURE WILL BE COMMERCIAL

By Rick Lober, V.P. + GM, Hughes Defense & Intelligence Systems Divison, Hughes, + Senior Contributor

The current military satellite landscape continues to challenge defense agencies as they look for more practical methods to secure mission requirements, while dealing with limited budgets and evolving technology.

As commercial organizations continue to meet the lions' share of bandwidth requirements for the Department of Defense (DoD), there is a growing opportunity to move to commercially-managed services and entire platforms that would save the government money, boost security and improve operations.

Keeping pace in ground and space architecture today is essential given the growing volume of data and ubiquitous mobility requirements. The continuous introduction of new technologies by the commercial satellite industry means that the federal government must look for more effective ways to use commercial bandwidth as outlined in the USAF SMC Pathfinder initiatives.

Other factors driving the interest in commercial SATCOM options for military communications include the regular replacement of aging equipment, resiliency, increased capacity, efficient network management and the introduction of evolving solutions for protected (anti-jam) communication. Advocates such as the Defense Information Systems Agency (DISA) and increasingly, the Services, favor using commercial satellite communications to increase the availability, flexibility and resiliency of military communications.

SATELLITE BANDWIDTH FOR MILITARY COMMUNICATIONS

According to recent market research by Markets and Markets, the global military communications market is estimated to grow from $23 billion in 2015 to nearly $41 billion by 2020, at a compound annual growth rate (CAGR) of 12.1 percent from 2015 to 2020. The satellite landscape for military satellite communications (MILSATCOM) has shifted in recent years reflecting the core capabilities of commercial providers to effectively serve military SATCOM requirements. It is common wisdom that during the peak of the Iraq and Afghanistan wars, commercial providers were supplying an estimated 80 percent of space segment to the military.

The US Government currently operates several satellite constellations, but each of these is hampered by lingering issues limiting their use. The military owns and operates its Advanced Extremely High Frequency (AEHF) satellites, operated by the US Air Force Space Command to relay secure communications for the US and key allies.

AEHF is a very capable but expensive system that serves a great purpose in the event of a nuclear war; however, lower cost options that meet the majority of requirements for such a system are evolving. In addition, the system is hampered due to delays in the terminal segment (in particular the Family of Advanced Beyond-Line-of-Sight Terminals [Fab-T])—a common occurrence when the space, ground and terminal segments of a major DOD communications program are treated individually versus as an overall single system acquisition and design as is common in commercial industry.

Two additional examples of troubled military satellite programs include the Mobile User Object System (MUOS) and the Transformational Satellite Communications System (TSAT). MUOS was considered the next generation narrowband MILSATCOM system intended to support a worldwide, multi-service population of users in the ultra-high frequency band.

Although MUOS can operate in its legacy UHF mode, the system continues to lack an available terminal capable of operating in the improved modes that the satellite was designed for—even though the first MUOS satellite was launched more than three years ago. Additionally, the TSAT program was a DoD program sponsored by the US Air Force for a secure, high-capacity global communications network serving the military, NASA and the US intelligence community. Yet, TSAT was projected to overrun badly and was again hampered by the separation of the space, ground and terminal segments of the overall program and was ultimately canceled in 2009.

The Wideband Global SATCOM (WGS) satellites and program have been more successful, in part due to the commercial roots of the core spacecraft bus and a digitally transponded (bent pipe) versus fully processed payload. This has allowed numerous commercial providers to design terminals for the system which are then qualified by the DoD.

As we move to the future, multiple terminal providers will be able to add protected communications capabilities to their designs. This is one reason why commercial providers see COMSATCOM as the wave of the future for MILSATCOM. As we move forward, current evolving commercial capabilities include multiple terminal manufacturers building for open architectures, new levels of protection on commercial satellites and terminals, and dramatic increases in Ka-band capacity.

COMSATCOM SERVING MILITARY NEEDS

There are three areas where commercial satellites better serve military needs than dedicated DoD platforms.

The first is terminal availability. The commercial industry works on ground, space and terminal segments in parallel. There is much more coordination in the development phase, which is more iterative, in general, than MILSATCOM programs. The end result is a system roll-out in which the space, ground and terminal segments are concurrently available and the option to go to multiple terminal developers is available through an open standards based design and qualification process. This approach allows for advances in the overall system design through the upgrade of terminals or ground systems as compared to the satellite itself, a great example being upgrades for protected communications.

Secondly, commercial satellites provide a more resilient and inherently redundant capability for military users due to larger constellations (from various manufacturers) and designs that are predominantly transponded in nature thus allowing for a multitude of terminals and waveforms to operate on any satellite. The USAF recently released an RFP for airborne satellite communications that would rely on mixed satellite constellations from various operators using multiple inexpensive modems that would tie to each operators existing ground system—the end result being resiliency, redundancy, higher capacity and lower operating costs.

Thirdly, commercial providers are able to optimize network management and bandwidth efficiency much more effectively than the DOD since their bottom line profitability depends on it. In addition, the tools necessary for defense organizations to maintain the required degree of control for their applications are now available in many systems, a good example of this being VNO or Virtual Network Operations. For some DoD networks, moving to a complete managed services model will save the DoD in bandwidth acquisition costs and more importantly in manpower costs as commercial Network Operation Centers usually are staffed at 10 percent of the level of those in the DoD or in some cases as a "lights-out" operation.

CRUCIAL CONSIDERATIONS

The investment and innovation in commercial SATCOM technologies will continue to accelerate as illustrated by Silicon Valley's entry into this space and the DoD will likely be unable to keep up with these advancements. With the bulk of military spending going to major weapons platforms, such as the new Long Range Strategic Bomber which will cost the DoD more than $550 million each, dependencies on what commercial industry can supply in SATCOM must increase.

The ever increasing and unplanned needs for bandwidth by the DoD will continue to be met by commercial SATCOM providers. Future DoD requirements levied on commercial industry in the areas of security and protection are starting to and will continue to be met by COMSATCOM space and ground assets, as they will apply to both commercial and military customers.

While there will always be a need for specialized satellite systems such as AEHF that solely service the military for its unique needs in providing national security, there is little question that the bulk of military satellite communications can be provided by commercial industry in a manner similar to what has occurred in military terrestrial and cellular communications. Terminal availability and enhancements, satellite resiliency, redundancy, and capacity along with efficient network management will continue to be the major elements of why COMSATCOM best serves the military needs in this time of declining budgets.

Looking toward the future, there is no reason that protected tactical communications cannot be added to the growing list of why COMSATCOM will be the future of most MILSATCOM going forward.

www.hughes.com

SMALLER, LIGHTER + MORE CAPABLE REMOTES… THANKS TO NEW ASICS

By Karl Fuchs, Vice President of Technology, iDirect Government, + Senior Contributor

When speaking with very small aperture terminal (VSAT) end-users and obtaining their feedback on what's most important in next-generation technology, surprisingly, spectral efficiency and higher data rates do not top the list.

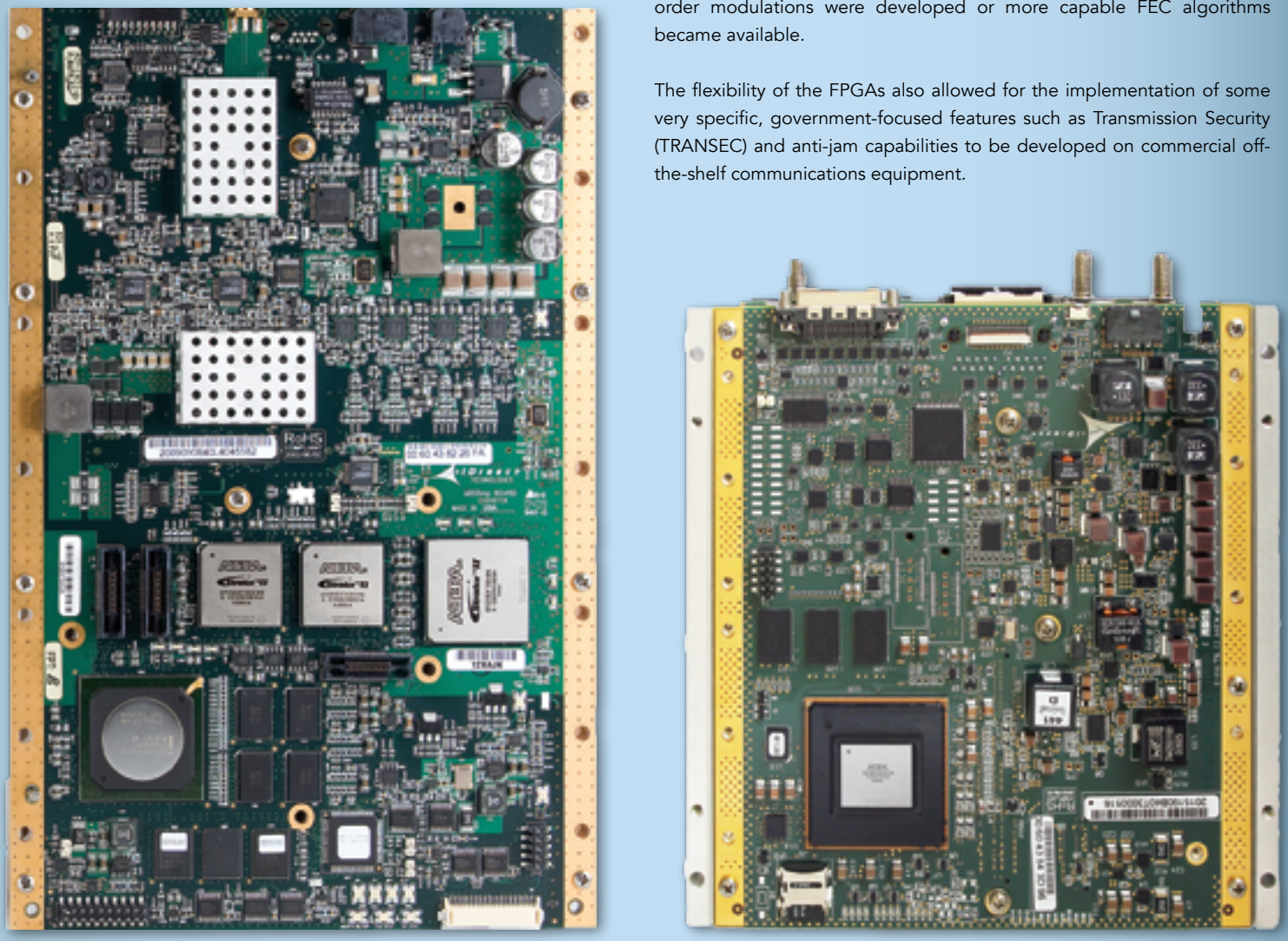
Almost universally, Size, Weight and Power (SWaP) are the biggest concerns. In fact, given the proliferation of man-portable terminals and the advent of Beyond Line of Sight (BLOS) communications on Unmanned Aerial Vehicle (UAV) platforms, reduction in SWaP has been the driving factor in all new VSAT modem designs. Of course, Moore's law has been our greatest ally in the battle to reduce SWaP.

As the density of electronics on any given chip increases, the footprint of the chip will decrease. Typically, the power consumption of the remote will drop as well. However, to make significant reductions in SWaP more quickly than Moore's law will allow, new modem architectures must be employed.

Historically, modems have relied heavily on Field Programmable Gate Arrays (FPGAs). These FPGAs serve primarily in modulating and demodulating waveforms as well as calculating Forward Error Correction (FEC). The modems, of course, needed packet processing and other capabilities so a central processing unit (CPU) was also needed in the design.

The use of FPGAs and a separate processor allowed for a very powerful and flexible modem design. FPGAs could be programmed to support any in-bound or out-bound wave desired whether standards based or proprietary. In addition, most of the FPGAs could be upgraded as higher order modulations were developed or more capable FEC algorithms became available.

The flexibility of the FPGAs also allowed for the implementation of some very specific, government-focused features such as Transmission Security (TRANSEC) and anti-jam capabilities to be developed on commercial off-the-shelf communications equipment.



ASIC technology is used in the iDirect 950mp, reducing the size of the original 850mp by 40 percent, as seen in this photo with the e850mp (left) and the 950mp (right).
The image is courtesy of iDirect Government.

These feature sets are tightly coupled to the waveform and therefore cannot readily be accomplished externally from the modulators and demodulators.

Such flexibility is a great benefit of FPGAs but unfortunately, they are very power hungry. The CPUs could be leveraged to perform any number of tasks. The price paid for all this capability and flexibility was SWaP and cost. Even today, FPGA implementations lead to very high cost of goods sold.

As standards-based waveforms, especially DVB-S2 as an out-bound carrier, became widely adopted, Application Specific Integrated Circuits (ASICs) manufacturers began developing DVB-S2 demodulators primarily for the broadcast TV market. The new DVB-S2 demodulator ASICs were produced in the millions. The DVB-S2 ASICs had hundreds of millions of hours operating in the field and therefore had proven their effectiveness and reliability. Later generation modem designs began incorporating these DVB-S2 demodulators but still relied on FPGAs for in-bound waveforms and separate CPUs for packet processing. Still the cost of goods sold for the remote dropped as did the power consumption.

The advent of System On a Chip (SOC) FPGAs, in which a processor is embedded in the FPGA fabric, eliminated the need for a separate CPU on the board. Eliminating the CPU from the design naturally enabled a decrease in board footprint. However this size savings was only a secondary benefit. By eliminating superfluous calls to a CPU and minimizing the time data spent on the buss dramatically decreased the power consumption of the unit.

In the world of SWaP, size and weight are important but power savings are paramount. This is especially true in the man-portable market. The true weight of a man-portable terminal is not in the terminal itself but the weight is in the batteries. As a point of comparison, a single BB-2590 lithium battery weighs in excess of 3 pounds. As a rough measure, single battery can power a standard terminal for 60 minutes to 90 minutes.

The latest innovation in modem design brings together all aspects of the system and integrates them into a single ASIC. The newest ASICs do not stop at just the demodulator. The newest ASICs incorporate a full RF front end as well as DVB-S2x demodulators and RCSv2 modulators in addition to a CPU and programmable memory.

The new ASICs, unlike the ASICs of the past, allow for programmability to support future feature enhancements and enable true Software Defined Radio (SDR) capabilities. The design and software development for these new ASICs is well under way, and smaller, lighter and more capable remotes will be available very soon.

The reduction in SWaP of satellite modems has been so dramatic over the past few years that a new type of terminal is emerging.

Currently, in most configurations we have an indoor unit, the modem and outdoor radio frequency transmission equipment including the antenna along with the block upconverter (BUC) and low-noise block downconverter (LNB). Improvements in SWaP have enabled a new configuration at the feed-horn. The latest generation of remotes incorporates the BUC, LNB and modem in a single package mounted directly on the antenna. This configuration vastly simplifies installation.

With the new configuration, only CAT 5 Ethernet with power of Ethernet needs to be run to the antenna. With so many architectural changes to satellite routers enabling smaller, more efficient and more flexible configurations, terminal designs are bound to evolve dramatically over the next few years. This coupled with the increased power and bandwidth available on the new High Throughput Satellites (HTS), the proliferation of geo-synchronous satellite communications will continue for years to come.

For additional information regarding iDirect Government's remotes:
www.idirectgov.com/product/next_generation_remotes

Karl Fuchs serves as Vice President of Technology for iDirect Government; kfuchs@idirectgov.com.

NSR ANALYSIS: MILSATCOM—WHERE ARE WE HEADED?

By Brad Grady, Senior Analyst, NSR, USA

As major Government and Military Satcom players gathered in London to discuss the industry and share ideas, what are the major issues still afoot in this turbulent sector?

With NSR's President Christopher Baugh chairing the conference during the event's second day and providing a keynote address of where we see the market, there are still numerous issues to be faced as government planners address enabling communications across their organizations.

Using NSR's *Government and Military Satellite Communications, 12th Edition* report, the key issues discussed included...

Does "Budget Certainty" mean "Smarter Acquisitions"?

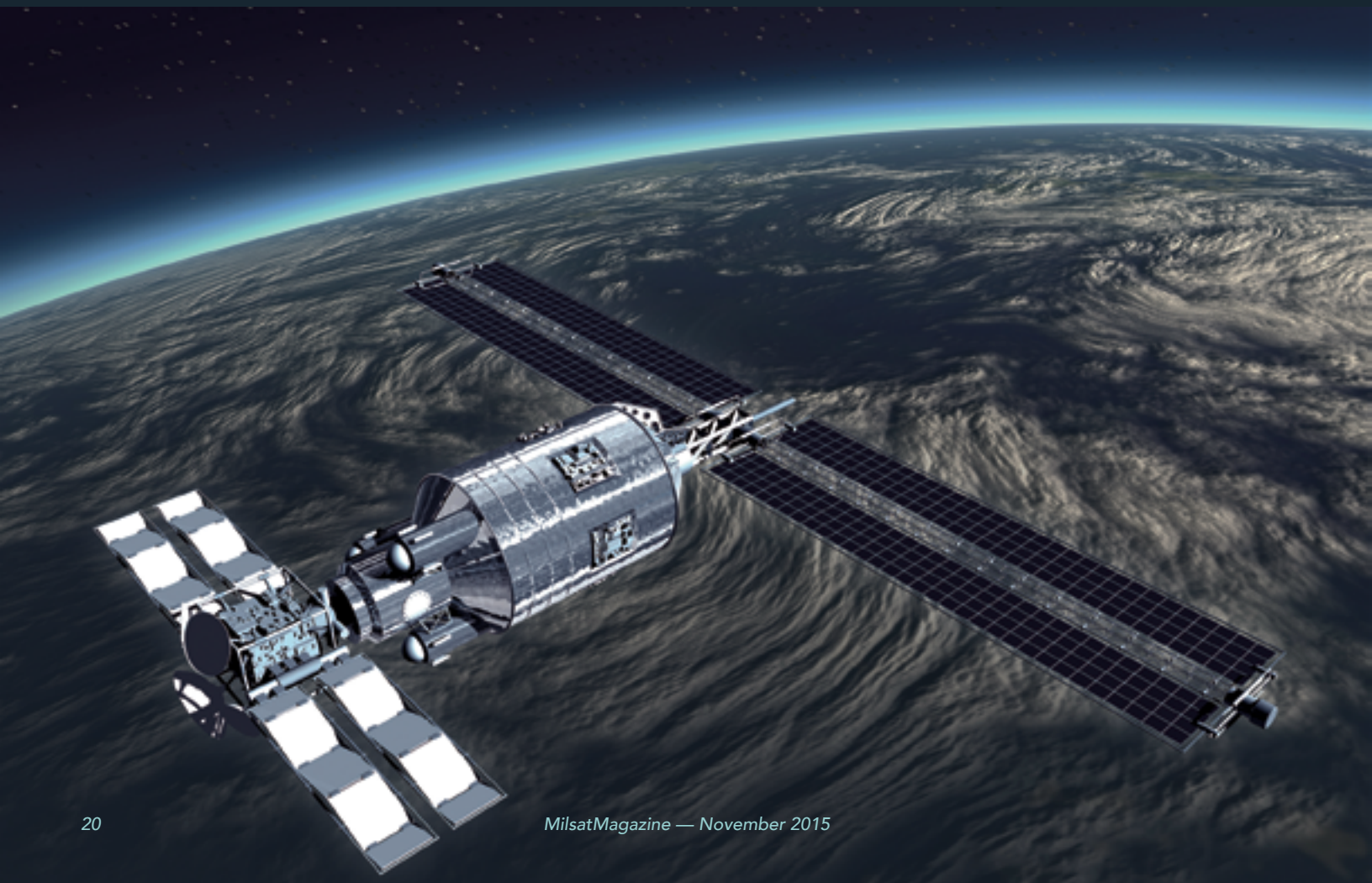
With a two year budget plan passed in the US, does that pave the way for these 'smarter acquisition' paths such as the Pathfinder Program or single purchasing entity consolidation, as it relates to COMSATCOM utilization? We remain skeptical, but at the least it might help enable action to develop a clearer picture of the how and what is being acquired, and where synergies might develop. Or, allow money to be allocated to study the issue per-GAO's recommendations.

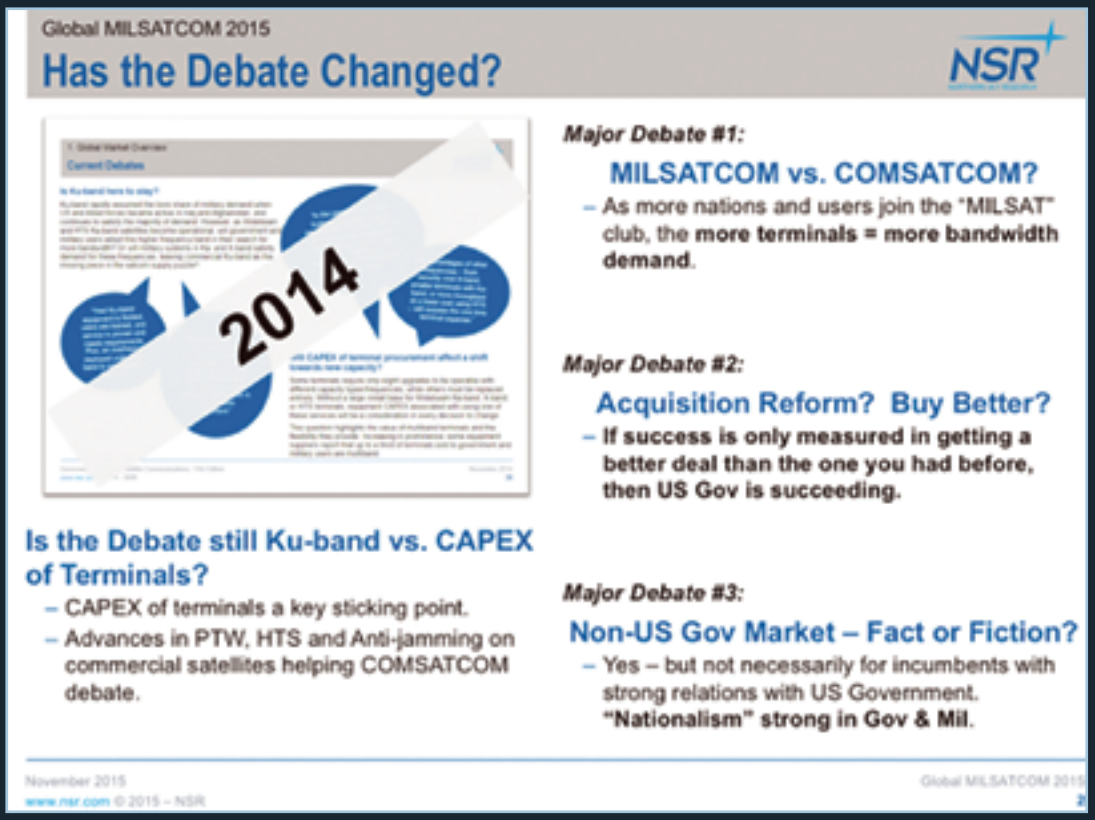
For industry, it might mean some relief of extreme pricing and competition pressures (and combined with the flare-ups in the Middle East, Europe, and Asia... there might be some new opportunities)— but we don't assume a change to the status quo…yet.

MILSATCOM Terminals are Expensive. Still.

A critical, often forgotten component of the MILSAT versus COMSAT debate, dedicated MILSAT terminals are frequently expensive, face significant production delays, and are only now providing flexibility in terms of their ability to connect to both COMSAT and MILSAT networks. For the vast majority of applications, a flexible approach to terminal programs that can leverage whichever frequency, source, or architecture available at the time provides the best service at the best price for government end-users.

In the growing UAS market, that is likely to remain a majority Ku-band play given the lead time for terminal certification and installation. For Maritime and Land-Mobile, other frequencies are easier to integrate into end-user platforms. As Ka-band offerings from GEO-HTS and MEO-

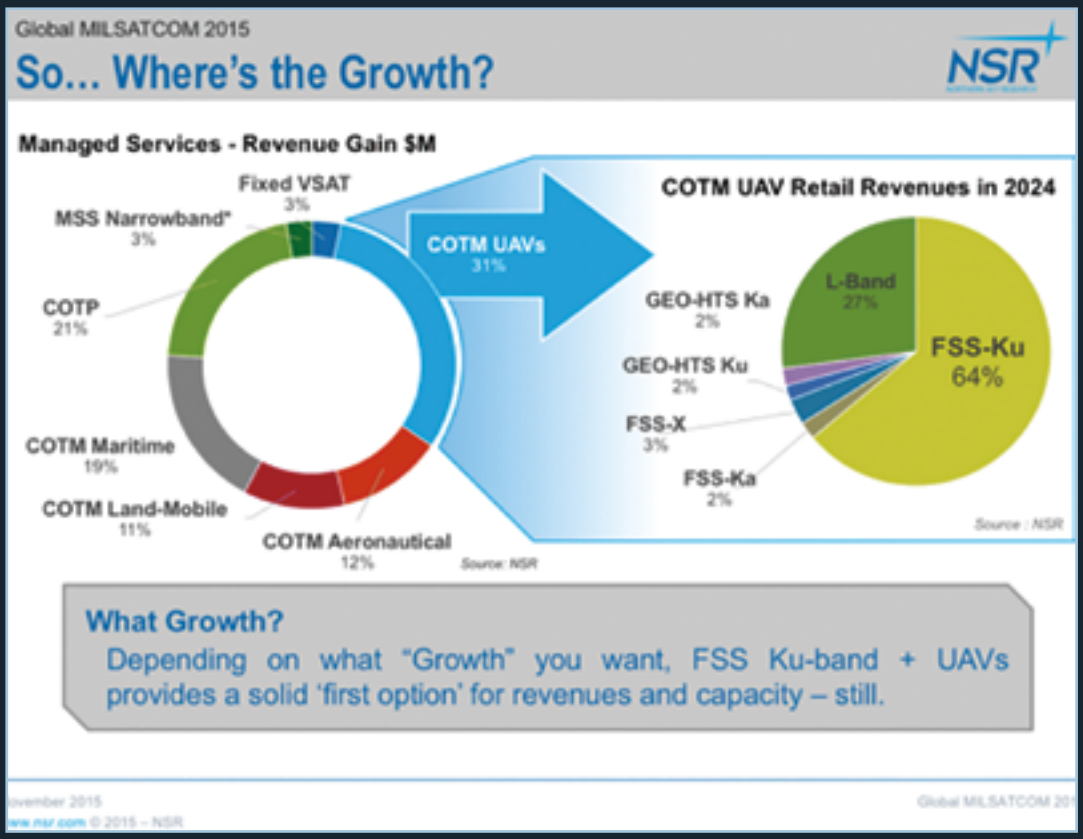




HTS expand and come online, they will provide a compelling value-proposition to government planners who have Mil Ka-band frequencies available to them, and help support costly terminal acquisition programs in a challenging budget environment.

Non-US/US-Partner Markets—Fact or Fiction?

More nations than ever before have joined the 'space club' in the past five years, most with a focus on providing support to their national security forces. For people in the 'building satellites' market, these national space programs have been more positive than negative in government markets—at least initially. Combined with a changing role of the US around the world, one might get the impression that there is 'easy money' in emerging markets.



However, elsewhere in the value-chain, these programs have created a complex operating environment of supporting national capacity and space programs, integrating commercial capabilities, and allowing industry to develop robust offerings at competitive rates. With the rising 'nationalism' movement within the Government and Military space sector, there might be opportunities outside US/US-Partner Nations. However, do not expect that incumbent players have a unique advantage simply because they provide services to the US DoD or US Partners.

"Us vs. Them" Attitudes Changing in MILSATCOM vs COMSATCOM Debates?

This is perhaps the most contended, heated debate in Government and Military circles. Beyond just the 'who's cheaper' arguments on the surface, it really gets to some of the core sentiments in satcom strategy; Does commercial count towards 'disaggregation', how secure or responsive can commercial really be, who do I partner with for my MILSAT systems, and, what applications can go where?

Although commercial capacity and commercial players are increasingly being considered 'part of the solution,' there will always be competition between them. And, at the end of the day, maybe some competition is a good thing for bringing better solutions at better prices to support government end-users in the field.

Overall, there remains a lot of skepticism and negativity as it relates to Government and Military SATCOM markets. With the changing face of military actions in the Middle-East, Europe, or Asia and the move from troops on the ground to eyes in the sky— is there a clear source of growth for industry going forward? Short answer—Yes.

"Clear Winners"

Mobility at a top-level, UAVs in general, and FSS Ku-band specifically will be key sources of growth for commercial players over the next ten years. Followed by COTP land-mobile opportunities across FSS, HTS and MSS; supporting Maritime networks, and then Manned Aero will be key revenue growth opportunities the industry needs to develop solutions to support.

"Less Winning" Options?

Fixed VSAT applications and MSS Handhelds or other form factors (MSS Narrowband segment in graphic) will be slower growth segments from a revenue perspective. Although they provide huge numbers of In-service Units, the changing face of US defense strategy continues to shift revenue growth towards mobility segments supporting high-bandwidth segments and applications.

There is no more "easy money". As Intelsat's and other's annual reports point out, simply selling bandwidth to the US Government is not the money-maker it once was.

The one good thing? More terminals mean more bandwidth and if WGS is a valid case study—military capacity alone cannot support these emerging applications by itself.

Mr. Grady has been involved in the Satellite Communications industry since 2005, joining NSR in 2010. He is NSR's Energy market subject matter expert, and a core member of NSR's mobility research practice for both civil and government markets. He regularly provides his insights and analysis to NSR's single-client consulting practice, and is also a regular contributor to leading industry publications and forums.

Before joining NSR, Mr. Grady served as the Sustainable Development Projects Coordinator Intern with the Global VSAT Forum where he worked regularly with the GVF Secretariat and the Regulatory Working Group on many of the forum's initiatives. Working with the Regulatory Working Group, Mr. Grady helped develop and implement various RWG initiatives aimed at protecting satellite spectrum, increasing awareness of satellite services, and working to promote regulatory reforms across the globe.

Mr. Grady holds a Bachelor's degree in Economics from the University of Maryland, College Park where his research focused on renewable/alternative energies, Information Communication Technologies and the Satellite Communications Industry. He works in NSR's Washington DC office.

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HPA CORNER: HOSTED PAYLOADS FOR NAVIGATION AUGMENTATION

By Al Tadros, V.P., Business Development, SSL

In September of 2015, the first European Geostationary Navigation Overlay Service (EGNOS) payload went live, providing improved accuracy of satellite navigation signals in Europe.

Hosted on the SES-5 commercial satellite, navigation augmentation payloads such as EGNOS, GAGAN, MSAS and WAAS have been hosted on commercial spacecraft since the 1990's. While this hosted payload success is often overlooked, it can serve as an example for how other government services can make use of the assured schedule and shared launch cost of riding along with a commercial satellite.

Satellite-based augmentation systems (SBAS provide supplementary data, improving upon the measurements and information supplied by a global navigation satellite system. The US Federal Aviation Administration reports that using a navigation augmentation system "improves the accuracy, availability, and integrity (safety) of GPS-derived position information… GPS signal accuracy is improved from 20 meters to approximately 1.5 - 2 meters in both the horizontal and vertical dimensions."

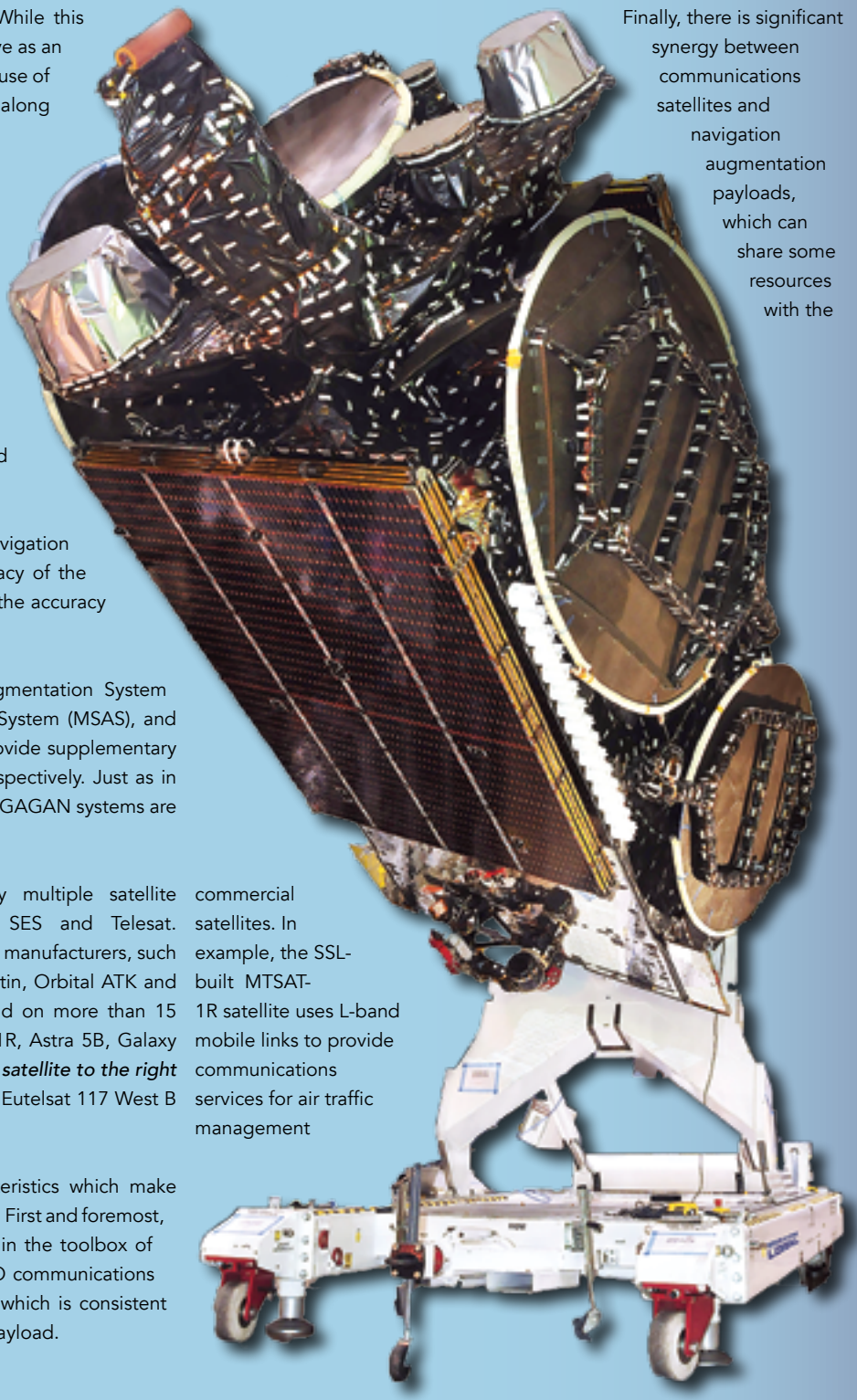
One such system is the European Geostationary Navigation Overlay Service (EGNOS), which improves the accuracy of the GPS, GLONASS and Galileo systems by reporting on the accuracy of satellite navigation signals in Europe.

Similar to the EGNOS system, the Wide Area Augmentation System (WAAS) and Multi-functional Satellite Augmentation System (MSAS), and GPS Aided Geo Augmented Navigation (GAGAN) provide supplementary navigation data to North America, Asia and India, respectively. Just as in the case of the EGNOS system, the WAAS, MSAS and GAGAN systems are currently on-orbit as hosted payloads.

SBAS navigation payloads have been hosted by multiple satellite operators, including Eutelsat, Inmarsat, Intelsat, SES and Telesat. Integrated on commercial spacecraft by major satellite manufacturers, such as Airbus Defense and Space, Boeing, Lockheed Martin, Orbital ATK and SSL, navigation augmentation payloads can be found on more than 15 commercial satellites. These satellites include Anik F1R, Astra 5B, Galaxy 15, four Inmarsat satellites, SES-5 (***photo of the SES-5 satellite to the right is courtesy of SSL***), as well as the recently announced Eutelsat 117 West B and SES-15.

GEO communications satellites possess key characteristics which make them ideal hosts for navigation augmentation payloads. First and foremost, the payload technology used in SBAS is already within the toolbox of the GEO communication satellite business. Also, GEO communications satellites provide a large, predictable coverage area which is consistent with the requirements of a navigation augmentation payload.

GEO communication satellites also have the benefit of enabling navigation augmentation payloads to provide coverage over large bodies of water, where ground-based coverage is not possible.



Finally, there is significant synergy between communications satellites and navigation augmentation payloads, which can share some resources with the commercial satellites. In example, the SSL-built MTSAT-1R satellite uses L-band mobile links to provide communications services for air traffic management

while additionally hosting a WAAS navigation augmentation payload which uses the same frequency range and provides a combined solution for air traffic control.

With governments around the world deciding to put navigation augmentation payloads on commercial satellites, the benefits of the hosted payload model have been proven and many perceived obstacles have been overcome.

This column's question for HPA Members is…

From your perspective as members of the Hosted Payload Alliance, why are navigation augmentation instruments so well suited to be hosted payloads and what can we learn from those successes?

"The most widely used precision navigation system in the world today is the global positioning system or GPS. This system enables users with a GPS receiver to determine their current location by detecting beacons broadcast from Earth orbiting GPS satellites. Real-time awareness of where you are and where you want to go within a standardized global position coordinate system enables precision GPS-based navigation. Additionally, there are opportunities to solve problems and create value by enabling stakeholders beyond just the GPS receiver user access to this data. Hosted payloads provide a powerful tool for unlocking this value.

"Augmentation instruments for GPS navigation services are particularly well suited for deployment as hosted payloads. Two specific examples are the Harris designed and produced hosted payloads that provide real-time global detection of ship and aircraft location data. The resulting real-time global air transportation and maritime domain awareness services provide significant benefits to individuals, industries, and governments worldwide including improved safety, lower fuel costs, and more efficient traffic management. Harris is currently producing these hosted payloads in support of air traffic management services offered by Aireon, as well as maritime domain awareness services offered by Harris and exactEarth.

*"The instruments (receivers) that collect location data for ships and airplanes are particularly well suited for deployment as hosted payloads. The payloads only receive the RF beacons from ships and airplanes—they do not have to transmit. Therefore, electromagnetic compatibility risks with the host platform are significantly reduced. Also, detection of these terrestrial location beacons in Oceanic and remote regions is not practical without space based receivers. The use of hosted payloads provided an affordable, robust, and mission compatible solution for fielding this capability with greater than 12 years of mission life."—**Sid Stewart**, Senior Program Manager, Responsive ISR, Space and Intelligence Systems,* **Harris Corporation.**

*"Part of SBAS system architecture consists of ground uplink stations that relay information to the repeaters on GEO spacecraft. Commercial operators already have networks of fiber-connected teleports which can be leveraged to perform this function. Additionally, while the payloads provide vital services to PNT users (government and civilian), operations of the host spacecraft do not need to be conducted from within a classified control environment which allows further sharing of existing facilities. GEO owner operators already provide trusted services to governments across the globe and reliability of their commercial platforms is very high. With a predictable satellite replacement plan stretching into the next decade, PNT stakeholders can feel confident that SBAS services from commercial platforms will continue well into the future."—**Bryan Benedict**, Senior Director, Innovation and Satellite Programs,* **SES Government Solutions.**

During the recent ***Global MilSatCom 2015***, the HPA presented a preconference workshop that was led by:

- *Nicole Robinson, Corporate Vice President of Government Market Solutions and HPA Chair*
- *Rick Skinner, Director of Business Development for Northrop Grumman Aerospace Systems*
- *Catherine Dargeou, Business Development in Commercial & Military Markets for Thales Alenia Space*
- *Rich Pang, Senior Director of Hosted Payloads at SES Government Solutions*

The workshop explored current examples of successful, commercially hosted government payload programs and where those successes could help accelerate adoption of similar programs for global government customers. The experts from HPA member companies offered an unbiased view with a diverse base of satellite owner-operators, launch providers, payload and satellite manufacturers and others, who brought forward lessons learned from their respective hosted payload programs. Also offered was an open dialogue about technical considerations, procurement and funding challenges as well as opportunities for industry and global governments to collaborate to further leverage these time and cost reducing means of accessing space. This workshop served as a targeted discussion regarding hosted payloads as well as a forum for open dialogue between the government and industry participants.

For additional information regarding the HPA, please visit:
www.hostedpayloadalliance.org/

AN INTELSAT GENERAL POINT OF VIEW
DOD NEEDS COMMERCIAL INNOVATION IN SPACE

By Kay Sears, President, Intelsat General Corporation

A recent visit by Defense Secretary Ashton Carter to Silicon Valley focused a lot of attention on the government's role in fostering technical innovation.

This visit reminded me about how the money invested in the Apollo Program in the 1960s that got American astronauts to the moon also fostered a wide range of technical innovations of benefit to mankind, including improvements in kidney dialysis, water filtration, monitoring hazardous gasses and flame retardant materials.

Now, the DoD wants to pick the smartest brains in the nation's most successful high-technology companies. Dr. Carter went to Silicon Valley in Northern California to announce that the DoD would invest $75 million in a consortium of 162 companies, called the Flexible Hybrid Electronic Institute, which specializes in wearable electronics. He also visited the Pentagon's new Defense Innovation Unit – Experimental, which was launched in April to scout promising technologies.

Commercial innovation isn't just located in Silicon Valley—it can also be found much closer to home. Historically, the Pentagon has presented specific technical problems that commercial contractors then strived to solve. This approach has been used with satellites as well to develop such constellations as MUOS and WGS, where the Pentagon defined the capabilities the spacecraft needed and let private industry create the end product.

But in today's budget climate, such government constellations are no longer affordable, and the DoD is now looking to the commercial space industry to deliver the highly advanced communications capabilities needed by troops in the field and ships at sea.

Intelsat General Corporation (IGC) is a leader in delivering continuously improved spacecraft that benefit both commercial and government customers. One example is the "digital payload" technology incorporated into Intelsat's new EpicNG satellites, the first of which will be launched next year. Intelsat EpicNG's digital payload represents the latest generation of high performance technology initially developed by Boeing Co. for use on the DoD's WGS satellites. This technology is also provided exclusively for commercial use on the Intelsat EpicNG satellite platform.

The digital payload will be instrumental in allowing flexible and efficient use of spectrum, resulting in a dramatic increase in the amount of throughput we can deliver on the satellites. In addition to efficiency, the technology also increases our ability to mitigate interference and purposeful jamming.

Antenna technology is another area where we are making great strides to deliver commercial applications that will also benefit our government customers. Intelsat has partnered with Phasor Inc. to co-design and produce an ultra-thin, active phased array, Ku-band satellite antenna. When used in conjunction with Intelsat EpicNG Ku-band satellites, the Phasor antenna technology is expected to enable unprecedented broadband speeds to civil and military jets of over 15Mbit/s to the aircraft and 5 Mbit/s from the aircraft.

Intelsat is also working with Kymeta, another new antenna company, to produce a flat, thin, light and low-cost satellite tracking antenna designed to provide connectivity for a wide range of ground and maritime transportation applications, civil and military.

IGC technicians have vast experience gained over the past half-century of operating one of the world's largest satellite fleets. We've developed a number of proprietary automation tools that allow just a few operators at a single location to simultaneously control more than 75 spacecraft orbiting the earth, in a range of orbit planes. This expertise benefits our commercial customers today, but could also benefit the US government, which is currently considering ways to shift the operation of military satellites over to commercial operators.

The US government plays a leading role in driving technical innovation by funding R&D at universities, through its Defense Advanced Research Projects Agency (DARPA), and now in Silicon Valley. This approach, and a new openness to true collaboration with the commercial space industry, will lead to new technologies that will benefit many industries. And it will better support the security of the United States in space.

intelsatgeneral.com/

Artistic rendition of an Intelsat EpicNG® satellite. Image is courtesy of Boeing.

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TRANSFORMING THE GROUND ENTERPRISE… AN RT LOGIC PERSPECTIVE

SpectralNet™ from RT Logic, a Kratos subsidiary, is a technology that digitizes and transports IF spectrum over IP networks in a way that preserves both frequency and timing characteristics, allowing the original signals and data to be recorded, broadcast, or processed at another location. SpectralNet brings analog IF data to the IP network world, as shown in *Figure 1 on the following page*.

This simple ability to perform long-haul network transport and reconstruction of any signal brings disruptive innovations to the ground segment architecture and enables significant benefits. These include the following:

- *Centralization of ground system assets (Hubs, Modems, Crypto HW) to simplify operations and lower costs*
- *Robust site diversity capabilities for rain fade mitigation that provide guaranteed service over high frequency satellites*
- *Increased flexibility in antenna placement to lower costs and space requirements*
- *Flexibility in the location of customer premise equipment or specialized processing equipment to enable new services for network customers*
- *Enabling new backup and disaster recovery scenarios to meet stringent Service Level Agreement (SLA) requirements*
- *Virtualization of the ground segment signal processing to lower costs and increase operational flexibility*
- *Transporting RF with noiseless signal distribution*

TECHNICAL OVERVIEW

TCP/IP is reliable but unsuited to IF data transport. SpectralNet™ algorithms provide both data reliability and determinism over IP.

The explosive improvement in IP network capabilities in recent years, driven by the Internet revolution, enables the next step forward for ground data processing: a technology called "Packetized IF," described in *Figure 2* on the next page.

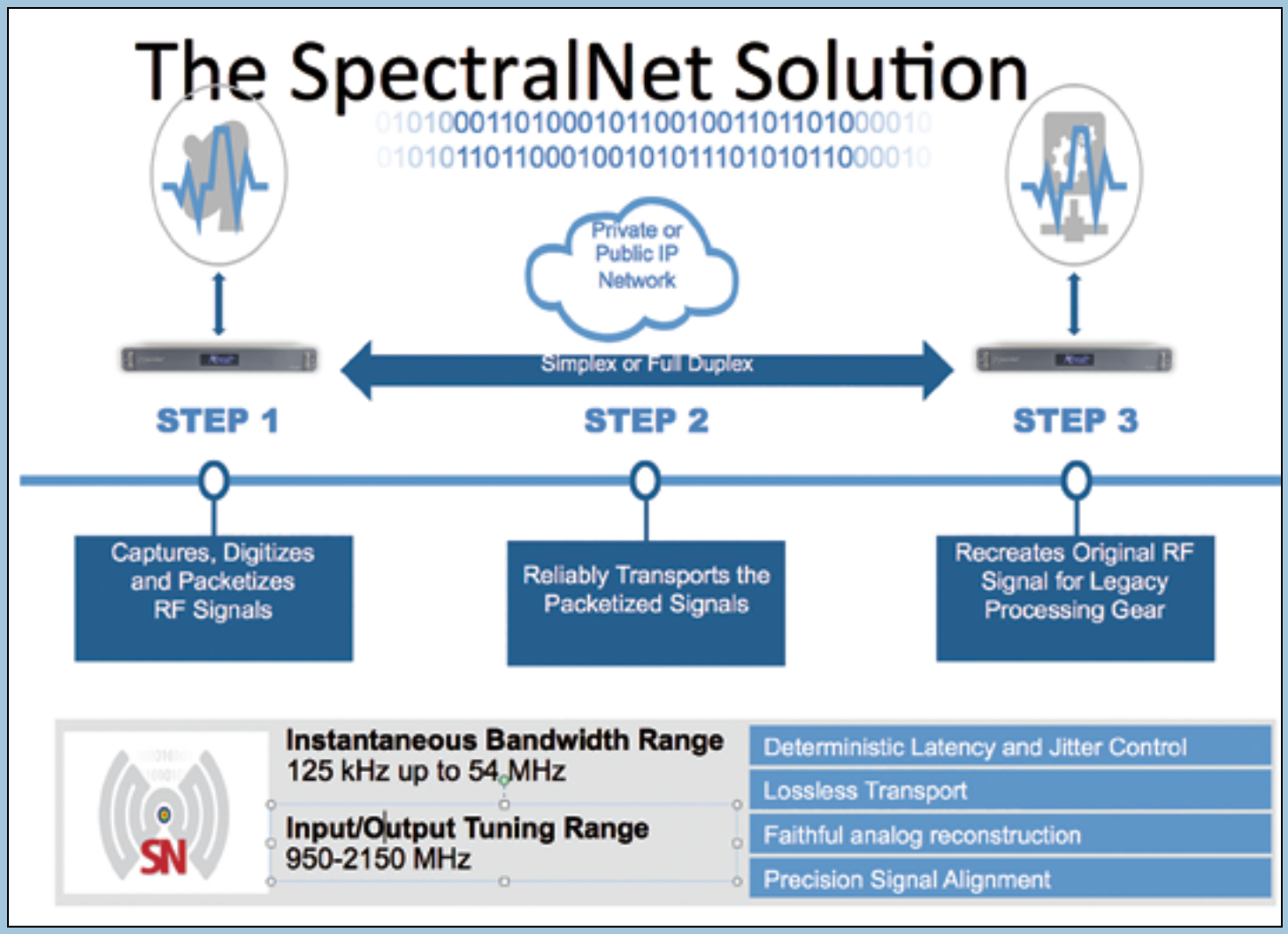

Figure 1. Bridging analog IF/RF with IP networks using SpectralNet.

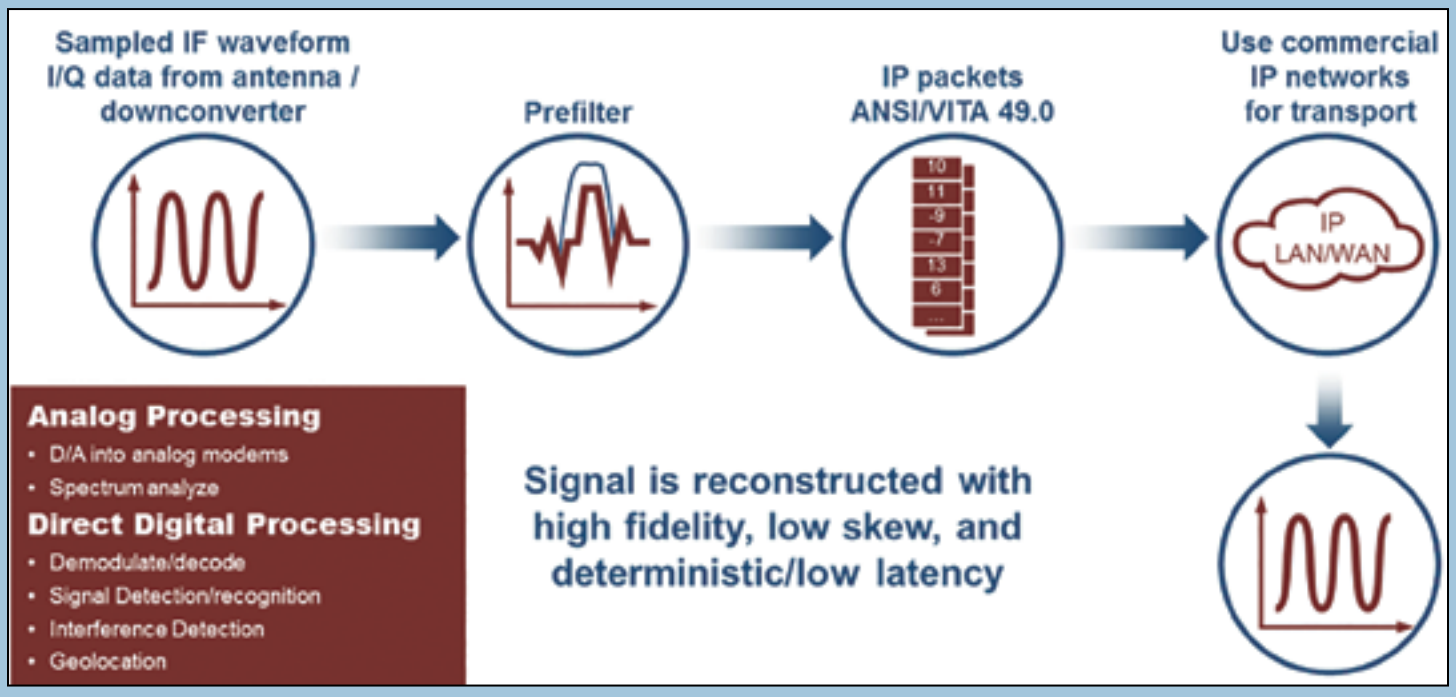

Figure 2. Packetized IF decouples transport and processing from receive/transmit.

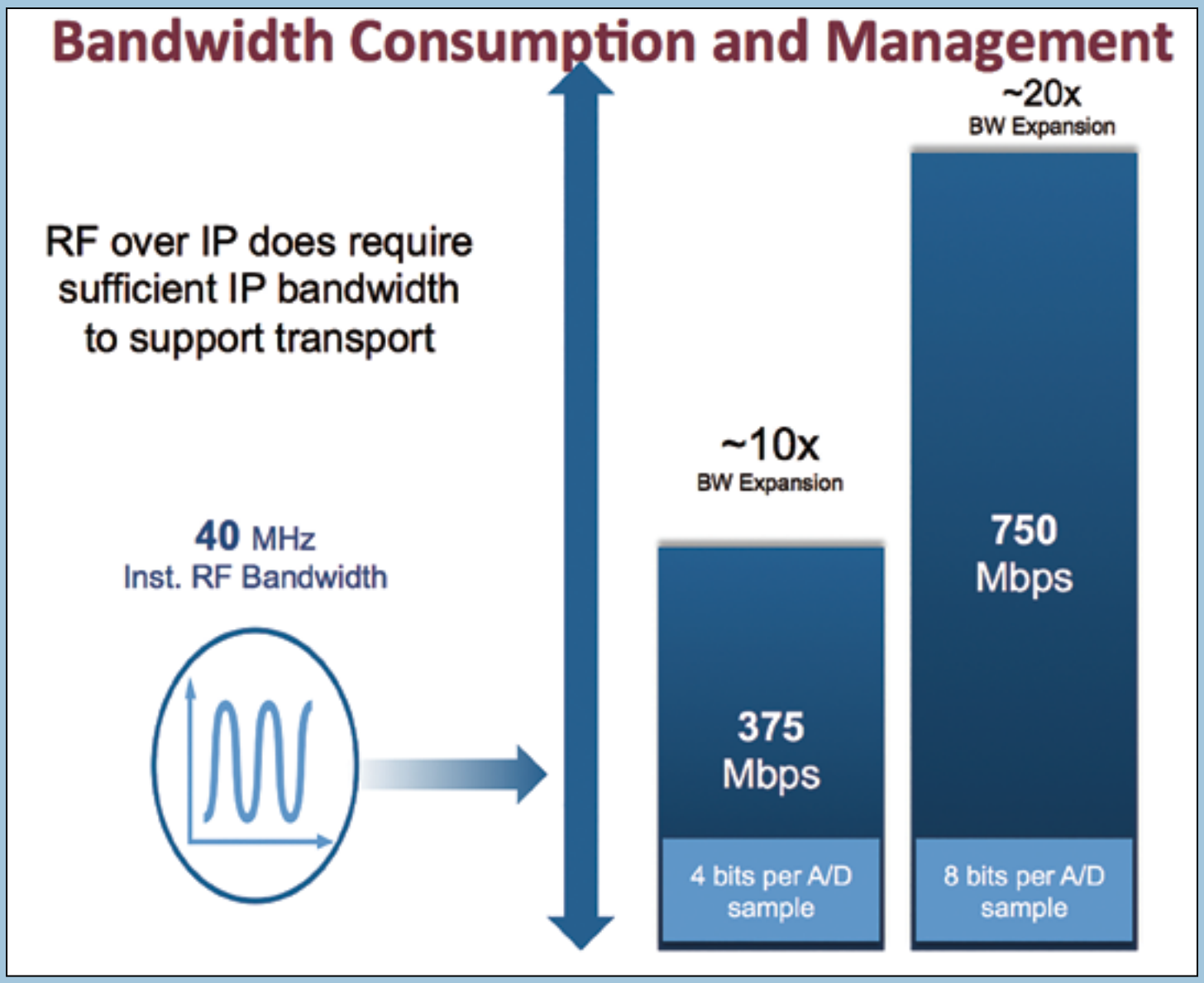

Figure 3. Network throughput can be adapted based on individual needs.

This technology extends the transport of analog IF data to IP-based networks, *e.g.*, the Internet.

Using specialized techniques, Packetized IF can move digitized spectrum deterministically anywhere over an IP network, and reconstruct it at the destination so it can be processed by either digital or analog equipment. The specialized techniques achieve this with minimal added latency and no lost data all while being agnostic to the spectral content. As IP network protocols provide neither deterministic data transport nor minimal latency, the implementation of Packetized IF required several innovations to achieve these objectives.

Overcoming The Limitations Of TCP/IP

IP networks use the Internet protocol stack to isolate the users of the network from the physical details of data transport. Data is grouped into packets (typically 1500 bytes long). Because of network congestion, traffic load balancing, or other unpredictable network behavior, IP packets can be lost, duplicated, or delivered out of order.

The TCP Internet protocol achieves reliable transport in the face of these errors by requiring that the receiver acknowledge correct or failed packet receipts. This additional reliability, however, comes at a heavy price in network efficiency.

When network transport is unreliable, such as over long-haul shared WAN links, TCP/IP can perform excessive retransmissions and acknowledgements, making latencies high and unpredictable. If error density and latency gets too high, a phenomenon called "NACK implosion" can occur, where effective throughput crashes due to excessive retransmissions.

These factors make TCP/IP unsuitable for the deterministic, low-latency transport requirements of Packetized IF. In contrast, the User Datagram Protocol (UDP), which provides low-overhead and latency but unreliable packet transport, is a more effective foundation for IF transport, so long as occasional packet losses and out-of-order delivery can be overcome.

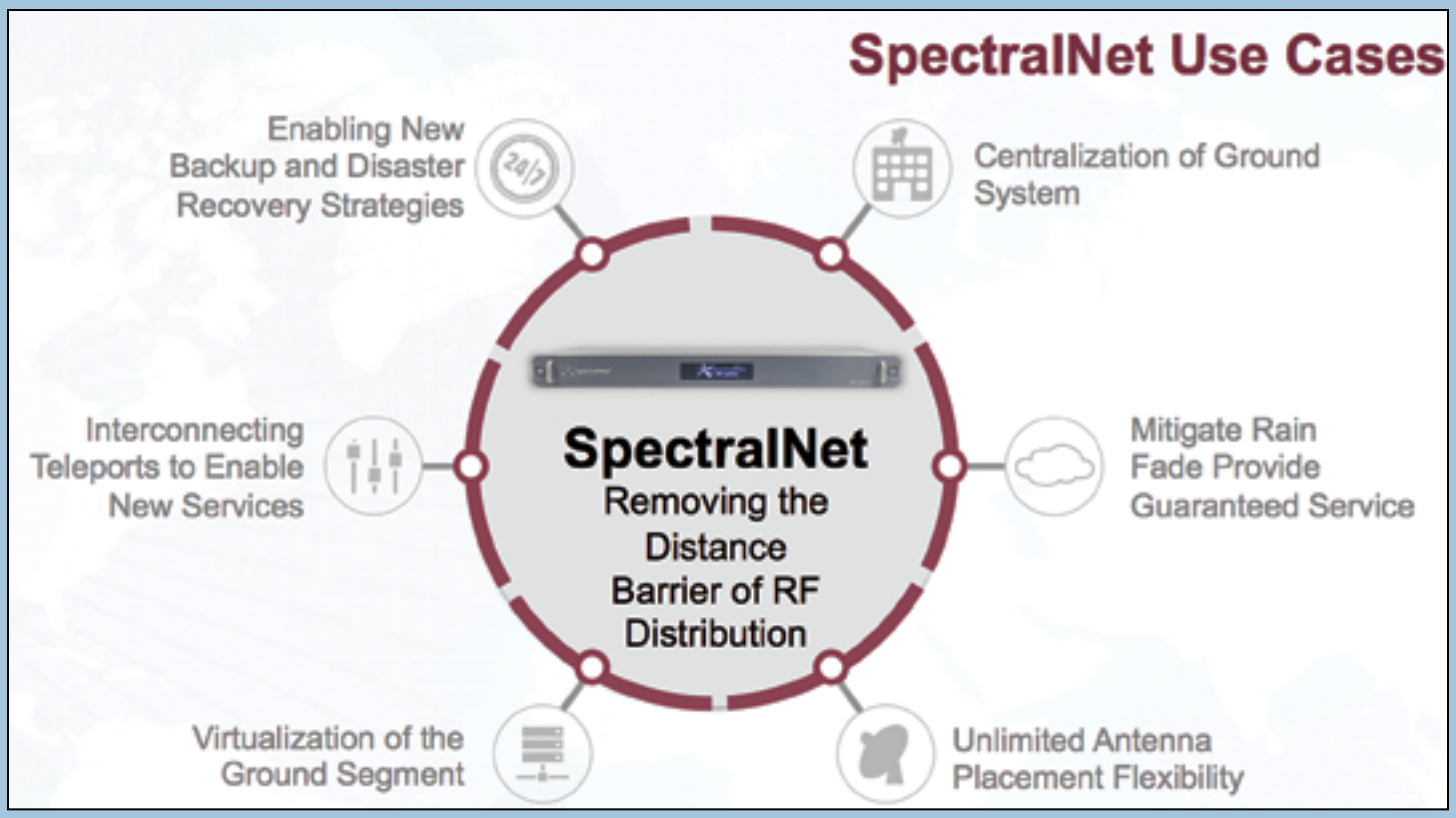

Figure 4. Packetized IF opens many new applications in the ground segment.

To enable accurate regeneration of the analog spectrum at the destination, Packetized IF schemes must overcome the packet loss problem. Traditional Forward Error Correction (FEC) codes, such as Reed-Solomon codes, provide no protection against IP data loss. If a bit error occurs within a packet, the IP checksum fails and the entire packet is lost, providing no opportunity for the user's FEC algorithm to repair it.

As a result, error correction must be performed at the packet level. RT Logic has implemented an algorithm within SpectralNet called Packet Forward Error Correction (P-FEC) that treats successive packets in a digital IF data stream as data elements subject to loss/repair. If a packet is lost, the error-correcting code information available in nearby packets allows the reconstruction of the lost data, just as a traditional error-correction code can reconstruct lost bits from nearby encoded received bits. This allows the P-FEC method to improve effective data rate greatly over straight UDP, without incurring the two-way traffic impacts and high latency associated with TCP/IP protocol.

SpectralNet's P-FEC algorithm has operationally proven that lossless, low-latency transport of Packetized IF data is feasible even in the presence of severe burst packet losses.

Deterministic latency is another key requirement needed for the accurate regeneration of the analog spectrum at the destination end. SpectralNet leverages precision time references at either end of the link as well as data handling algorithms to ensure accurate time-release of data to its output D/A converters. This allows modulation and coding schemes that rely on precise timing, such as TDMA and frequency-hopping waveforms, to be correctly processed after WAN transport.

IP Network Throughput

Even in modern networks, data throughput is a precious resource. Due to Nyquist Theorem, any A/D sampling process used to capture and digitize an input RF source requires minimal network throughput to achieve sufficient data transport and spectrum regeneration. The amount of required network throughput is directly related to the A/D sampling rate used (dictated by the instantaneous RF capture bandwidth), and the amount of sampling resolution in the number of sample bits per A/D sample. This relationship is shown in *Figure 3* on the previous page. As seen in the figure, a 10-20x factor is applied to the capture bandwidth in MHz when determining the resulting network throughput requirements in Mbps.

To help minimize the impact of its network loading SpectralNet includes technology that allows the desired signal center frequency and instantaneous capture bandwidth to be sub-band tuned from the input RF spectrum source so that no unneeded data (***i.e.***, unoccupied noise floor region) is sent over the network. This spectral channel capability also allows multiple signals of interest to be selectively tuned and distributed to different destinations for either digital or analog processing. The bit resolution setting of the A/D sampler is also adjustable from 4-12 bits to optimize the network loading while preserving signal integrity for modem processing.

Applications Of Packetized IF

SpectralNet introduces a paradigm shift in the operations, maintenance, security, and logistics associated with managing ground segment missions. The use of IP network transport and reconstruction of any waveform brings fundamental changes to overall architectures for antenna facilities, operations centers, and the communications network ground segment enterprise as a whole.

As shown in ***Figure 4*** on the previous page and highlighted in the following paragraphs, these changes permit major paradigm shifts in the operations, maintenance, security, and logistics associated with managing ground segment missions. The application of Packetized IF can enable many high-value use cases that can minimize costs, maximize operational efficiency and flexibility, and generate additional revenues.

Centralization To Simplify Operations + Lower Costs

The SpectralNet technology enables RF data from an antenna at any location to be digitized, transported to, and faithfully reconstructed at a centralized operations facility. This enables teleport and satellite operators to centralize processing and operations (Communications and/or TT&C).

One example is how the technology enables significant reduction in required equipment at a ground antenna site. This can greatly reduce facility, personnel, and equipment spares costs, especially for ground sites at austere or remote locations, as shown in ***Figure 5*** below.

In addition to lifecycle cost-savings achieved through equipment and personnel reduction, SpectralNet also enables centralization of expensive commercial, EAR-restricted or sensitive cryptographic equipment and software, thus improving overall risk posture and allowing lower protection-level security approaches to be used at teleport sites.

Moving ground modems/hubs and other processing equipment away from the antennas allows this equipment to be shared among multiple antennas and allows multiple ground sites to work with the same data.

SpectralNet can be used to extend the capabilities of VSAT Hub equipment to new markets at very low costs. To enter a new market, the VSAT provider only needs to provision or lease a new antenna in the market of interest and then connect the hub and antenna through SpectralNet. This saves the cost of new hub equipment and the cost of managing a new site.

This data architecture improves resilience of the enterprise in the event of a site failure, adversary action, rain fades, or test activities. Since the site footprint is smaller and non-sensitive, it becomes much simpler to provision new teleport locations to support regional surges or changing mission needs.

Effective Rain Fade Mitigation

SpectralNet enables users of high frequency satellites (Ka-/Ku-) to mitigate rain fade concerns by now being able to geographically disperse two smaller, low-cost antennas with SpectralNet and then transport the Digitized RF signal to a central facility equipped with a SpectralNet unit.

The SpectralNet at the central facility then precisely aligns the data from the two sources and makes a best source selection. The best source is then converted back to RF and fed to the downstream equipment.

SpectralNet can seamlessly switch between sources with very minimal data loss to the downstream equipment, ensuring modems remain locked and services remain active.

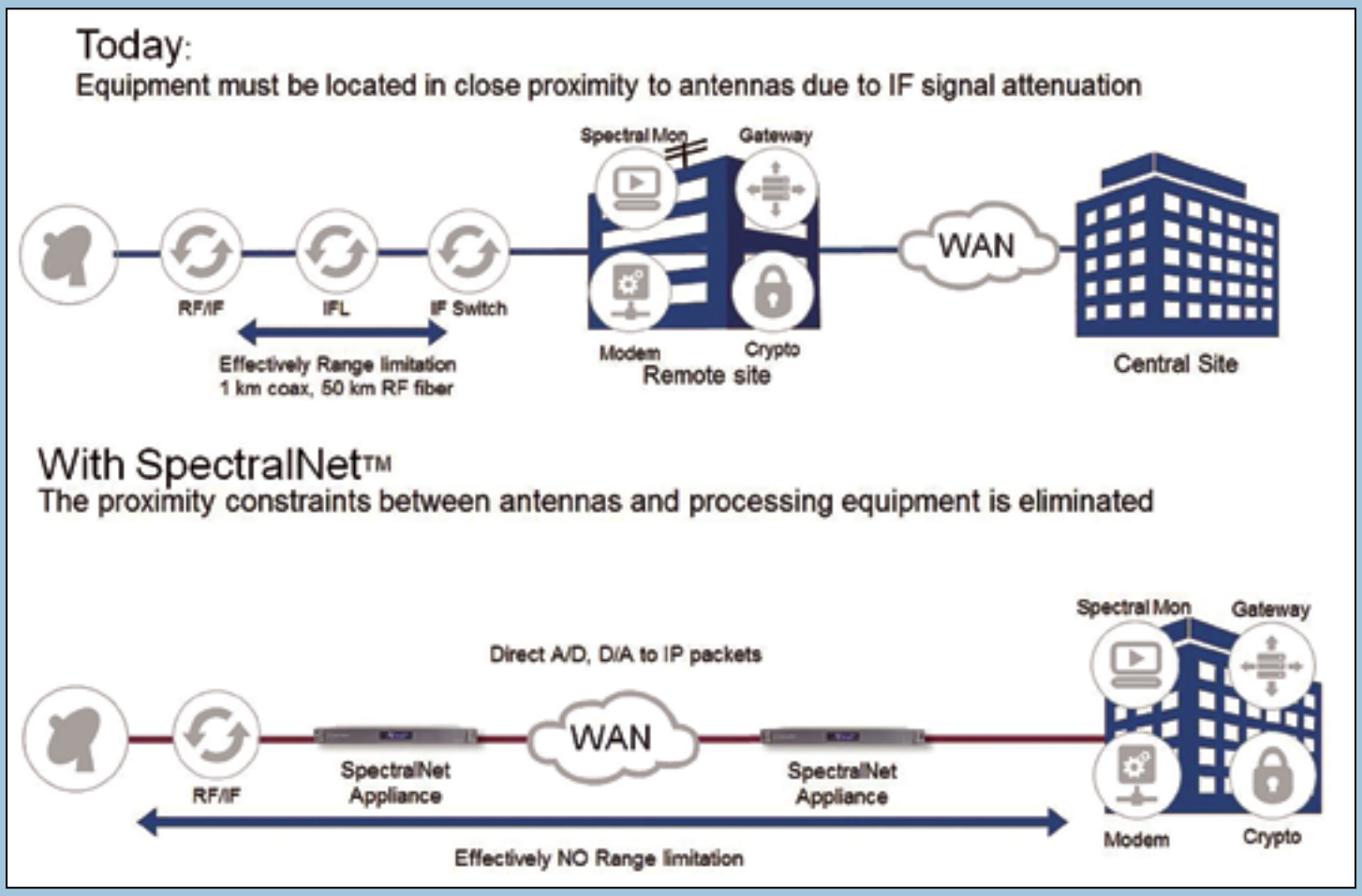

Figure 5. Packetized IF reduces needed equipment footprint at ground sites.

Unlimited Antenna Placement Flexibility to Lower Costs + Space Requirements While Enabling Revenue

With SpectralNet, antennas are now freed from the constraints of being located near processing equipment. Antennas can now be placed at the the optimal location based on costs, real estate availability, and signal reception. SpectralNet thus enables the reuse or sale of high-value property that is currently required to provision antennas. With SpectralNet, antennas can be relocated to lower value property or consolidated at a local teleport freeing up valuable real estate to other uses or sale.

Backup + Disaster Recovery To Meet Stringent SLA Requirements

SpectralNet provides teleport operators or content originators with new options to provide backup and path diversity options to meet stringent SLA requirements. SpectralNet digitizes and provides lossless transport of RF across public or private IP networks and reconstructs the RF for ingest by standard processing systems. This adds multiple new options for managing back-up and disaster recovery scenarios.

Lower The Cost + Impact Of Maintenance Operations

SpectralNet provides antenna operators new options to manage maintenance operations. When an antenna is down for maintenance, its reception responsibilities can be shifted to a backup antenna at any location. The received RF can be digitized and transported by SpectralNet to original antenna processing equipment. This greatly simplifies the scheduling and execution of maintenance operations.

Flexibility In The Location Of Customer Premise Equipment Or Specialized Processing Equipment To Enable New Services For Network Customers

SpectralNet enables your network to be extended without the need to provision or locate processing hardware in new geographical areas. Services provided by expensive processing equipment can be extended to a new geographical area by simply transporting the RF signal to a new antenna in the new area of service. Customer premise equipment can remain with the customer shortening the time required to provision new services.

Virtualization Of The Processing Portion Of The Ground Segment To Lower Costs + Increase Operational Flexibility

SpectralNet is a key enabler for software modem and virtualized ground processing and brings RF data into the IP network environment. RF data can be processed using much less expensive, more flexible, software-based methods. For example, a purely software-based modem application becomes feasible, where modulation, coding and framing algorithms are performed using commodity server hardware in a centralized cloud processing center.

If the modem algorithms are changed, no equipment changes are required at the ground antenna site, and software-only modifications to the modem application can adapt to the changes within a virtualized processing environment. This allows lower overall cost and flexibility in reusing the ground equipment as space platforms and waveforms change.

RT Logic has demonstrated a completely software-implemented modem that supports symbol rates in excess of 10 Msym/sec in a standard Linux server environment. The use of digital data and software-defined processing also allow multiple functions to be performed on the same data. For example, a spectral monitoring application, channel simulator, or a channel/transponder characterization program can be run to ingest the digital IP data in parallel with normal processing without requiring special-purpose hardware.

Spectral Record/Playback

The ability for Packetized IF systems to record and playback raw I/Q data has several uses in both test and operations. During system test, recorded IF data can be used to provide repeatable test cases for integration, test, and verification of the communications paths between a satellite bus (such as in a high-bay) and the ground processing equipment.

Coupled with IP data transport, this allows the high-bay and ground equipment to be physically separate from each other while still permitting end-to-end testing. After launch, the recorded IF data can be used to assist early on-orbit test and to provide trusted regression test cases for verification of new versions of ground software.

An IF recorder can also be used as an online 'black-box' recorder. Like an airliner's black-box recorder, such a system continuously records link IF data during normal operations, retaining a rolling window (such as the last few hours) of data on disk. In the event of an anomaly or on-orbit event, the data is then retrieved to allow detailed analysis and troubleshooting.

For cases where problems occur rarely or under unusual conditions, such a black-box recorder greatly improves the ability of system engineering experts to diagnose and fix issues. For LEO satellite systems, the black-box recorder allows recovery from downstream processing errors, such as those due to incorrectly configured ground equipment or operator error. After the missed contact, the IF data is played back into the ground string to recover data that would have previously been lost to the contact failure.

The Benefits

The ability to perform digital conversion, IP network transport, and reconstruction of any waveform brings significant benefits to the satellite ground communities for both commercial and government applications. These benefits include lower costs, more flexible software-based processing, improved resilience, improved test and troubleshooting, and reduced vulnerability at remote ground sites. Sustained IP transport at up to 40 MHz instantaneous bandwidth has been operationally proven (TRL 9) and is currently available commercially. This capability can provide zero packet-loss, deterministic latency, and spectral reconstruction even over severely impaired wide-area networks. RT Logic's internal investments are increasing both the achievable bandwidth and the processing capabilities of digital IF.

www.kratosdefense.com/
www.rtlogic.com/

For more than 30 years Kratos has been the acknowledged leader in the development and integration of ground segment solutions that are key to providing secure management, delivery and distribution of data and information from space and terrestrial-based platforms into networks for defense, intelligence, government and commercial satellite and communication service provider partners.

Kratos offers turnkey enterprise-grade ground system solutions encompassing Command & Control, integrated RF management solutions, including signal monitoring, geolocation and mitigation; satellite and terrestrial communications, network monitoring and control, service quality management and a broad array of sophisticated, yet cost effective, antennas. Kratos products and services are used by more than 75 percent of the world's commercial satellite operators and 90 percent of US-based space missions.

RT Logic, a Kratos subsidiary, is the leading supplier of ground-based equipment for space/ground communications. SAT Corporation, also a Kratos subsidiary, is the leading provider of RF management solutions.

HUMANITARIAN + GOVERNMENT SECTORS NEED TAILORED SERVICES FROM MSS PROVIDERS

By Amal Ezzeddine, Senior Director, Government Services, Thuraya Telecommunications Company

In October, Thuraya Telecommunications Company—under the umbrella of the EMEA Satellite Operators Association (ESOA) and the Global VSAT Forum (GVF)—signed a Crisis Connectivity Charter in Geneva.

This Charter was signed with the global humanitarian community represented by the UN Office for Coordination of Humanitarian Affairs (OCHA) and the Emergency Telecommunications Cluster (ETC).

The agreement embodies a commitment from the satellite community to provide connectivity during the response to humanitarian crisis, and beyond. It formalizes terms and protocols designed to accelerate the ability of emergency response teams to access satellite-based communications at times of disaster in 20 high-risk countries identified by the ETC within Thuraya's coverage area.

This Charter takes Thuraya one step further towards educating and working with governments and NGOs to deliver secure, reliable, portable, easily deployable and user friendly solutions in the event of any disaster. As an end-to-end satellite-based response, the door is now opened for more coordination among satellite operators, government and humanitarian agencies. This charter will allow the humanitarian community to plan more effectively—refining and improving the NGO response to disasters.

The intent at Thuraya is to create dependable solutions based on a deep understanding of military operations, Search and Rescue (SAR) requirements and the environment out in the field. It is critical for those deployed in remote and often dangerous locations to be able to make timely and informed decisions regarding operational capabilities, emergency management, situational awareness and SAR activities. The mission is, after all, to save and improve lives.

A well-known fact is that, during an environmental or manmade crisis, terrestrial networks become unreliable for a number of reasons, including broadband congestion or infrastructure destruction. In these situations, NGOs and governments frequently turn to MSS operators for the provisioning of what could be their only means of communicating with the outside world and for coordinating relief and appropriate responses. Satellite communication in these situations is more reliable. Thuraya is often the first deployed provider of communication services during such crises.

Developed in partnership with TrustComm, the Thuraya solution allows customers to benefit from a fully managed end-to-end service with a US demarcation point for all voice and data traffic. Thuraya's implementation of a five year investment program in the firm's well-configured network has enhanced all capability and redundancy features.

Starlight was built to improve performance and offers land or sea-based communication solutions and is shaped to add enhancements that specifically fit government and commercial users and offers guaranteed access to the network, thereby serving as a pivotal resource for users in remote locations.

Thuraya deployed vital communication links in the Central African Republic to connect SOS Children's Villages and extended their outreach to foreign aid donors.

The Central African Republic (CAR) ranks 185th (out of 187) in the United Nations Human Development Index, which assesses health, education, standard of living, child welfare, and other factors. One of the world's poorest countries, the CAR is heavily dependent upon foreign aid.

The country has more than 935,000 Internally Displaced People (IDP)—most are women and children. Food insecurity is rampant, access to water and sanitation is limited, and there is a high risk of diarrhea, typhoid, cholera and AIDS.

Nearly 50 percent of the population is younger than 14 years of age. The ongoing civil war has made conditions extremely unsafe for young people. More than 370,000 children are now orphans. The majority of them are kidnapped and forcibly recruited to fight for armed militias. In 2013, some 650,000 children were unable to attend school, due to the closure and occupation of schools by fighting groups.

SITUATION

SOS Children's Villages has been supporting and sheltering children in the CAR since the early 1990s. In a country deeply affected by child poverty, a high infant mortality rate and dysfunctional family structures due to AIDS and political strife, the work of SOS Children's Villages is of critical importance. In 2013, the group commenced emergency relief operations in the cities of Bangui, Bouar and Bossangoa. To date, their programs have covered the needs of more than 65,032 beneficiaries.

The SOS Children's Villages' activities currently involve health, nutrition, WASH (Water, Sanitation and Hygiene), education and the protection of women and children. The villages provide family based, alternative care to 258 orphans. There are two medical centers that deliver primary healthcare assistance to women, children and chronically ill patients.

The NGO has also established kindergartens and child friendly spaces, in addition to launching mobile education services to ensure children who are trapped in the violence can continue their education. Their volunteers work directly with families and communities to effectively protect and care for their children. More than 1424 parents and children benefit from these programs.

Thuraya's commitment to support security operations, as well as SAR activities, is also highlighted in an end user portfolio of highly capable terminals (voice and data). These are portable, easily deployable, reliable and effective in meeting the requirements of disaster management responders, SAR agencies, military, NGO, and civil service sectors.

Similarly, the company's recent launch of the DigiMed solution bridges an information gap by allowing real-time teleconferencing to occur between doctors and patients at the scene of an emergency. This solution provides critical voice communications for relief teams, weather, and mapping services—all crucial elements for those working in disaster areas.

The introduction of High Throughput Satellites (HTS) has increased available capacity against legacy satellite systems. HTS has significantly helped to drive down costs for end-users and has enabled Thuraya to create services normally offered over terrestrial networks. Cutting edge products, such as the SatSleeve+ to enable iPhone and Android users to convert their smartphones into satellite phones in areas that don't have terrestrial cellular connectivity, have been introduced.

Technology bridges the digital divide and is often used as a route to improving education, health, economic status and security. In Guatemala, for example, mobile phones inform mothers as to how they may experience healthy pregnancies. In Kenya, women receive financial services via their mobile phones. In Nigeria, citizens use BudgIT, a mobile app, to assess whether governments are keeping to their spending promises. The link between relief and government sectors and the life-saving equipment developed for those working in these sectors must continue to serve those facing dangerous, life-threatening situations.

Government and relief users require technology that is simple and seamless and which can function in the dusty terrains of North Africa or in the rainy tropics of the Philippines. Such sectors rely on the commercial satellite industry to provide the best service at the best price, and we, as mobile satellite service operators, are duty-bound to deliver on this.

www.thuraya.com/

Thuraya's DigiMed (left) and SatSleeve+ (right).

The SOS teams operate within troubled regions where the ICT (Information Communications Technology) is weak. Even the slightest delay in the delivery of emergency services could spell disaster for thousands of children and parents for whom SOS is the only lifeline. In such an unstable environment, SOS Children's Villages needed a reliable communications network to coordinate and survey relief operations and logistics as well as monitor the whereabouts of their field workers. In addition, they also need a steady communications channel to reach out to foreign donors to create ongoing awareness regarding their humanitarian work.

SOLUTION

SOS Children's Villages represented by its Gulf Area Office approached Thuraya to deliver satellite connectivity to their villages. Thuraya donated a number of Public Calling Office (PCO) units, SatSleeve+ satellite adapters and IP satellite broadband terminals. The PCOs deliver voice, fax, data and SMS services in remote locations that are beyond the coverage of terrestrial GSM networks. The SatSleeves are combined with iPhones and Android smartphones to make calls in satellite mode when local telecom networks fail. The IP mobile satellite terminals can be deployed anywhere within Thuraya's coverage area for Internet connectivity.

"Thuraya equipment facilitates communication between all of our sites at any time, especially where Internet service by local operators is impossible," said Julie Begbia, National ICT Coordinator at SOS Children's Villages CAR.

RESULTS

Thuraya has enabled daily coordination among SOS Children's Villages and other relief organizations in the CAR.

"We now have safety and autonomy everywhere when we are on the ground, even where cellular networks do not work," said Elie Koyela Ngnindou, Family Strengthening Program Coordinator and focal point of Emergency Response Program for SOS Children's Villages in Bossangoa.

Thuraya IP terminals are regularly used to share pictures of damages sustained during attacks by armed guerrillas. They also dispatch documents and reports to international funding partners to raise appeals for emergency relief; and they create awareness about SOS Children's Village activities, infrastructure and communities.

Thuraya SatSleeves and PCOs have united families and brought communities closer. They have also expedited emergency response, connecting people in times of emergencies and distress, when communications is needed most, to help save lives.

Nicole Nasser, Gulf Area Office Managing Director for SOS Children's Villages appreciates the contribution. "We thank Thuraya for their generous donation as we nurture the children and families in these remote communities. Thuraya's satellite equipment and services will benefit our teams providing vital care in terms of education, development and community building. We are also coordinating efforts between the communities to ensure they are prepared for any emergencies. Every bit of support we receive will enable us to build sustainable communities for the future."

FROM STEM TO EMPLOYMENT

By Major General John F. Wharton, Commanding General, RDECOM

Growing the next generation of Army scientists and engineers through an education and research continuum

The Army Operating Concept dictates that "future forces conduct operations consistent with the tenet of adaptability, anticipating dangers and opportunities and adjusting operations to seize, retain, and exploit the initiative."

The Army is arguably the nation's foremost leadership training institution, and one of the roles of the research, development and acquisition communities is to develop leaders who can innovate and adapt on the science and technology fronts so that we can deliver the capabilities Army leaders need on the battlefield.

The U.S. Army Research, Development and Engineering Command (RDECOM), on behalf of the Army, is committed to growing the next generation of scientists and engineers to deliver the decisive overmatch the nation needs to win in a complex world. As a community, we must develop a national strategy to ensure America's future security through a robust continuum of science, technology, engineering and mathematics (STEM) education and research.

RDECOM has the mission to deliver this competitive advantage and the programs, investments and partnerships needed to drive the critical educational fundamentals. The command's 13,800 civilians and military constitute one-third of U.S. Army Materiel Command (AMC) manpower. Approximately 10,000 of our personnel are scientists and engineers. With that workforce, RDECOM executes 74 percent of the Army's science and technology budget. We also have more than 1,000 agreements with industry and more than 1,500 with academia. These agreements, in a variety of forms, further the Army's specific goals in research and development (R&D), scientific investigation, innovation and education.

Furthermore, RDECOM already invests more than $100 million annually along a continuum that begins with our K-12 outreach efforts and extends through undergraduate scholarships to sponsored postdoctoral research. On behalf of the assistant secretary of the Army for acquisition, logistics and technology and AMC, RDECOM serves as the executive agent for STEM outreach and the Army Education Outreach Program, which reaches 42,000 students annually.

Major General John F. Wharton, RDECOM CG, discusses students' projects at the culmination of the eCYBERMISSION National Judging and Education Event.

US Army photo by Conrad Johnson, RDECOM Public Affairs.

RDECOM is increasing its investment with historically black colleges and universities (HBCUs) and tribal colleges and universities, as well as institutions serving minorities such as the Hispanic community and Pacific Islanders. RDECOM has ongoing relationships with a number of HBCU institutions, funding an average of $43.5 million a year in R&D contracts, grants and cooperative agreements.

Dr. Asha Hall, a materials science engineer with the U.S. Army Research Laboratory at APG, works on the Keithly four-point probe station measuring capacitance of a light and flexible multifer-roic material in a crystalline charge transfer material. Hall is a DA civilian who represents the ultimate goal of RDECOM's STEM education and research continuum: to provide the Army with the R&D workforce it needs to win in a complex world.

US Army photo by Conrad Johnson, RDECOM Public Affairs

We are now designing a program to bring together and strengthen these programs. Our goals are far-reaching but can be stated simply: Gain visibility on all the programs we offer, manage and publicize these programs, and develop a strategy to connect the dots from program to program so the Army and those in the academic community who engage with us get the most out of our time, effort and money.

The Army's vision of winning in a complex world drives this effort. RDECOM's global presence through forward-element commands and international technology centers in locations such as Japan, Singapore, Argentina, Chile, the United Kingdom and France informs our understanding of the scientific and technological challenges we face. What we and others see is not promising.

REGAINING SUPERIORITY

Expanding global interest and investment in scientific knowledge have empowered potential adversaries that are threatening our superiority in key areas. According to the National Science Foundation (NSF), America's ratio of R&D to overall gross domestic product in 2011 was 2.8 percent, which ranked 10th in the world. The United States ranked eighth in R&D intensity in the data for 2007.

Vincent Filary, an electrical engineering student from the University of Michigan and summer hire with the U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC) Ground Vehicle Robotics team, demonstrates his project to a TARDEC employee Aug. 13 during the 2015 Summer Hire Expo. The expo culminates TARDEC's Summer Hire Program, through which it seeks high school graduates, undergraduate- and graduate-level college students who are interested in working on science and engineering programs such as the development of hybrid-electric vehicles, fuel-efficient energy modules and advanced robotics.

US Army photo by Doug Halleaux, TARDEC Public Affairs.

The NSF states that America's R&D intensity"has been gradually slipping in the world rank for this indicator in recent years." In contrast, China and South Korea exhibited the greatest percentage increases. The pace of growth from 2001 to 2011 in China's overall R&D remains high at 20.7 percent annually, according to NSF data. South Korea's R&D rate of growth averaged 10.9 percent annually over the same period.

In its study of trends in R&D spending, the Organisation for Economic Co-operation and Development (OECD), whose membership includes 34 countries, finds that while America remains the world's largest R&D investor, China's total R&D funding is expected to surpass that of the United States by about 2022 if the current rates of growth and investment continue. According to the OECD, China is projected to hit $600 billion in R&D spending by 2024, while the United States will stand at about $475 billion.

With respect to innovation in military science and technology, America's adversaries have attempted to dissect our R&D efforts during the past 14 years of war with the goal of harming our warfighters. For example, Iraqi insurgents developed improvised explosive devices (IEDs) to destroy America's High-Mobility Multipurpose Wheeled Vehicles. This led to the expedited development and fielding of the Mine-Resistant Ambush-Protected family of vehicles.

At the same time, countries around the world are investing significantly in military programs amid growing tensions and conflicts in Eastern Europe, the Middle East and the Pacific. In 2014, the Chinese government released its official defense spending of $131.57 billion, an increase of 12.2 percent from the previous year. On March 4 of this year, China announced

Jyuji D. Hewitt, executive deputy to the RDECOM commanding general, shows a student how to use a Meal, Ready to Eat June 17 during the eCYBERMISSION National Judging and Educational Event.

US Army photo by Conrad Johnson, RDECOM Public Affairs,

that it would raise its defense budget by approximately 10 percent. The announcement marks China's fifth consecutive year with a double-digit percentage increase in official military spending figures.

THE PROGRESSION CONTINUES

U.S. Army leaders now face critical decisions about how to address the joint warfighter's anticipated needs for Force 2025 and beyond. In the R&D and acquisition communities, it is understood that the technological capabilities that will power Force 2025 are already about 85 percent designed and engineered. At RDECOM, we are compelled to look further into the deep future. We are committed to developing the next generation of scientists and engineers who will design and build the capabilities we field in 2040 and beyond.

Bringing visibility and coherence into our programs will also enable us to better influence our partners and thereby optimize our investment with the academic community. The Army must foresee vulnerabilities and develop unmatched capabilities as the academic disciplines and technology change.

We must cultivate our relationships with universities to help them produce graduates who can meet that challenge. Ensuring diversity in the Army R&D workforce is inherent in the need to present our adversaries with multiple dilemmas. To that end, we will make proportional distribution among academic institutions a priority as we continue to engage institutions serving minorities.

We will match this effort with the development of leaders who are knowledgeable about crucial capabilities, because Army leaders are the competitive advantage that technology, advanced weaponry and other platforms cannot replace.

Combining this with the technical expertise we are fostering through academic engagement, plus the products that an innovative workforce creates, will present our adversaries with multiple dilemmas. Successful leader development programs incorporate accountability, engagement and commitment; create agile and competent leaders; produce stronger organizations and teams; and increase expertise by reducing gaps. Adapting Army training and leader development programs to efficiently support changing requirements will enhance scientific and technological innovation.

Suzanne Procell, a supervisory chemist with the US Army Edgewood Chemical Biological Center, explains how to build a spectroscope to identify all the wavelengths of white light, to ninth-grade students attending the APG STEM Expo, November 18, 2014. These students represent the rising generation of scientists and engineers that RDECOM is making a concerted effort to nurture, in part through events such as this one.

US Army photo by Conrad Johnson, RDECOM Public Affairs.

This is particularly important in light of the aging workforce now in place. The largest portion of the RDECOM workforce falls within the range of 49 to 63 years old. Seventeen percent of the RDECOM workforce is eligible to retire. By 2025, 45 percent of the current workforce will be eligible for retirement. At three of our seven centers and laboratories—the Aviation and Missile Research, Development and Engineering Center, Army Research Laboratory and Edgewood Chemical Biological Center—less than 20 percent of the workforce is younger than 34.

The Army must be prepared for new threats that demand a workforce well versed in rapidly emerging fields such as synthetic biology and cybersecurity, as well as the leadership qualities and experience necessary to eventually run the organizations they join. Young college graduates are a prime source for this agility and these necessary skill sets. Without a strategy to recruit, develop and retain bright professionals, the Army places Soldiers' technological advantage on the battlefield in jeopardy.

By providing a platform of awareness surrounding existing education programs and opportunities, we are bridging the gap for our next generation of scientists and engineers. (See the Army Educational Outreach Program website at ***www.usaeop.com/***, for example.) We will continue to encourage our nation's youth to take advantage of opportunities in continuing education, but we will also light the path for future opportunities. Likewise, we will continue to develop the leaders that the Army community needs. It is deeds, not words, that will enable RDECOM's goals to take root.

As leaders, we are responsible for the current security of our nation, but we must be equally responsible for ensuring that there is a STEM pipeline to support future U.S. military technology requirements. Our community must drive the conversation on how we build relationships and develop a cohesive national strategy. Doing this ensures our ability to win decisively in the complex world of the future, as we have shown we can today.

Editor's Note
This feature and the included imagery are offered to our readers with the permission of ***Army AL&T Magazine****, their October-December 2015 issue, and by the author,* ***Major General John F. Wharton.***

MG JOHN F. WHARTON has been the commanding general (CG) of RDECOM, Aberdeen Proving Ground, Maryland, since September 2014. He leads more than 14,000 researchers, engineers and support personnel assigned to RDECOM, a major subordinate command of AMC. Previously he served as CG of the US Army Sustainment Command and Rock Island Arsenal, IL, and as the senior commander for US Army Garrison – Rock Island. He has also commanded at the company, battalion and theater-support-command levels and held Army and joint staff positions in logistics.

He holds an M.A. in national security and strategic studies from the Naval War College and a B.S. from the United States Military Academy at West Point, and studied at the US Army Command and General Staff College. He also completed the Quartermaster Officer Basic and Advanced courses and the Inspector General's Course.