

Laser communications

LGS Innovations was established in 2006 to act as Alcatel-Lucent's sole sales and contracting channel for all classified and unclassified business with the US Federal Government. The company was acquired by Madison Dearborn Partners and CoVent in 2014, after which it continued to act as the exclusive reseller of Alcatel-Lucent products to the US Government. The company delivers a range of next-generation solutions that solve the most complex networking and communications challenges facing governments, critical infrastructure operators, and large commercial enterprises. Linda Braun, Sr. Technical Vice President of Photonics at LGS Innovations, talks about the company's latest activities with laser communications and other projects.

Question: In recent years, LGS Innovations has significantly expanded its areas of activity. Which markets are now key to the company's success, and how have they evolved over time?

Linda Braun: LGS Innovations continues to focus on developing advanced solutions in wireless communications, signals processing and analysis, optical networking, photonics, spectrum operations and management, routing and switching, and network assurance. Our focus is to give our commercial and government customers a technological advantage as they operate and execute missions in an increasingly crowded and complex communications environment.

One area that has expanded its activity is free space optical communications. LGS Innovations has publicly announced a number of recent wins with the National Aeronautics and Space Administration (NASA). We continue to expand our customer base and are currently working with NASA on three projects that will prove the viability of laser communications and open up the technology for more widespread adoption. We are building an optical modem for the Orion Capsule, an optical modem for the International Space Station, and the first deep space laser transmitter for the NASA Psyche mission.

LGS Innovations has also increased its market in custom lasers for sensing applications – we are a leader in high performance fibre-based lasers for communications and sensing applications. In an effort to arm our Department of Defense (DoD) customers with unparalleled detection and tactical mapping capabilities critical to situational awareness, we are focusing on building custom lasers for Intelligence, Surveillance and Reconnaissance (ISR).

Question: In October, LGS Innovations announced it was supporting NASA's Orion EM-2 Optical Communications (O2O) project by providing a modem



Linda Braun

Image: LGS Innovations

that will enable broadband data communications to and from the Orion Multi-Purpose Crew Vehicle, which is designed to take humans to lunar orbit. What can you tell us about the deal and the technology you'll be enabling?

Linda Braun: LGS Innovations will support the NASA Optical-to-Orion (O2O) project. For this pathfinder program, LGS Innovations will develop an optical modem for a free space optical communication system that will fly aboard the Orion mission. It will be the first demonstration of optical communication to and from a human spaceflight mission in lunar orbit. The O2O modem will leverage LGS Innovations' rich heritage in free space laser communications and fibre laser technology.

The O2O program will use lasers to encode and transmit data at rates ten to 100 times faster than today's communications equipment, requiring significantly less mass and power than equivalent radio frequency (RF) communications systems. The modem will transmit data from the Orion capsule in lunar orbit directly to ground. This new capability will greatly increase the amount of scientific data transferred from Orion, while supporting ultra-high-definition video to and from space.

Question: Laser technology is expected to revolutionize communications capabilities for passengers and crew on missions beyond low Earth orbit (LEO) in the years to come. What benefits will laser communications bring to these missions, in terms of both crew welfare and scientific advancement?

Linda Braun: Advanced laser communications technology facilitates a dramatic increase in

communication capacity. This leap in performance is accomplished while attaining significant reductions in size, weight, and power, in contrast to the prior generation terminal's RF-based approach.

The ability to share - on-demand - massive amounts of data with very low latency has the potential to enable new forms of highly interactive, adaptive and widely distributed real-time sensing experimentation. In terms of throughput and latency, this dramatically expands the capacity to support remote sensing payloads for LEO applications and beyond.

By increasing communications efficiency, LGS Innovations will help facilitate a faster exchange of data to the scientific community. LGS is proud to support NASA's mission and drive the evolution of photonics technology.

A step-function in the ability to monitor health based on additional communications capacity is an advantage when it comes to crew welfare. Given low latency, in addition to providing the expanded bandwidth needed to support ever increasing imaging modalities and augmented reality content, performance of emergency surgical procedures may become a viable option.

Similarly, an isolated crew may enjoy the advantages of immediate, on-demand, virtual connectivity for sharing and accessing information for social, entertainment, and educational purposes far beyond current capabilities.

Question: Laser communications technology is expected to have far-reaching implications, proving particularly useful in other sectors, including government and military applications. What can you

tell us about the potential in this area and others?

Linda Braun: Today's military missions require reliable access to mission-critical data in near-real time, regardless how remote the location or big of a file. MILSATCOM networks have to operate on smaller, lighter and cheaper platforms that are secure and difficult to jam. Those systems need to be capable of carrying more and more traffic in an increasingly congested radio frequency environment.

Traditional radio frequency infrastructure struggles to meet these demands. Laser communications links operate with significantly lower transmit powers and apertures but at much higher data rates than radio frequency links.

Additionally, the bandwidth available for transmission is much greater. A Ka-band link might have 1GHz of bandwidth allocated, but the bandwidth available for laser communications, largely determined by the bandwidth where good amplifiers can be made, is almost 8000GHz. The need for bandwidth-efficient modulation is greatly reduced, leading to lower requirements for signal-to-noise. Furthermore, free space laser communications technology leverages the very large technology base of commercial optical fibre communication systems, where, for example, coherent modems handling 100 Gigabits/s/carrier are readily available for about \$25K.

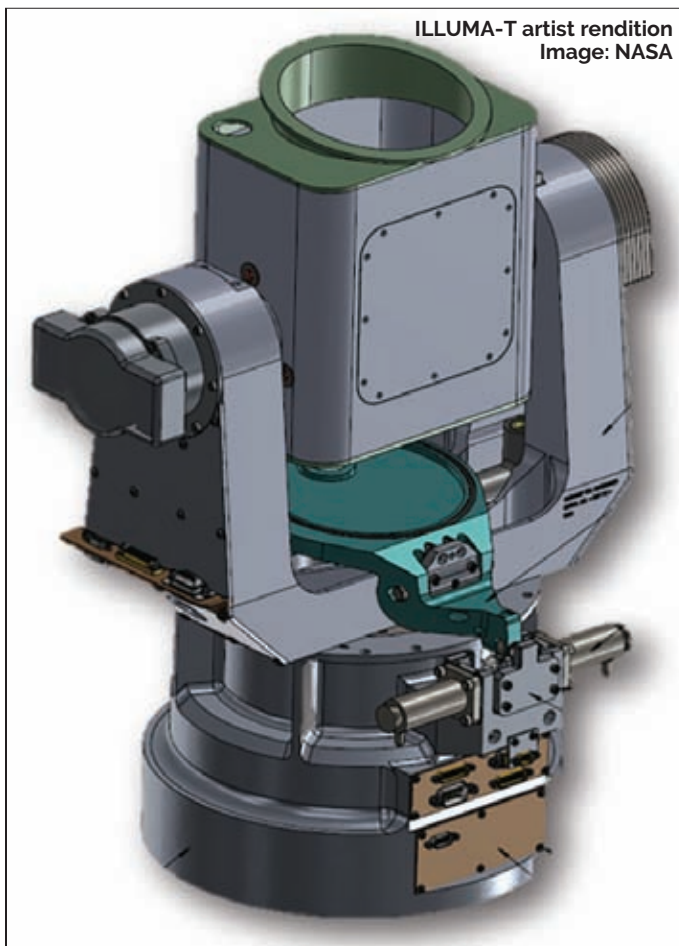
To deliver high-bandwidth communications capabilities to the warfighter, while keeping costs in check and providing higher security and anti-jam protection, it's clear that laser communications will become a part of future MILSATCOM networks.

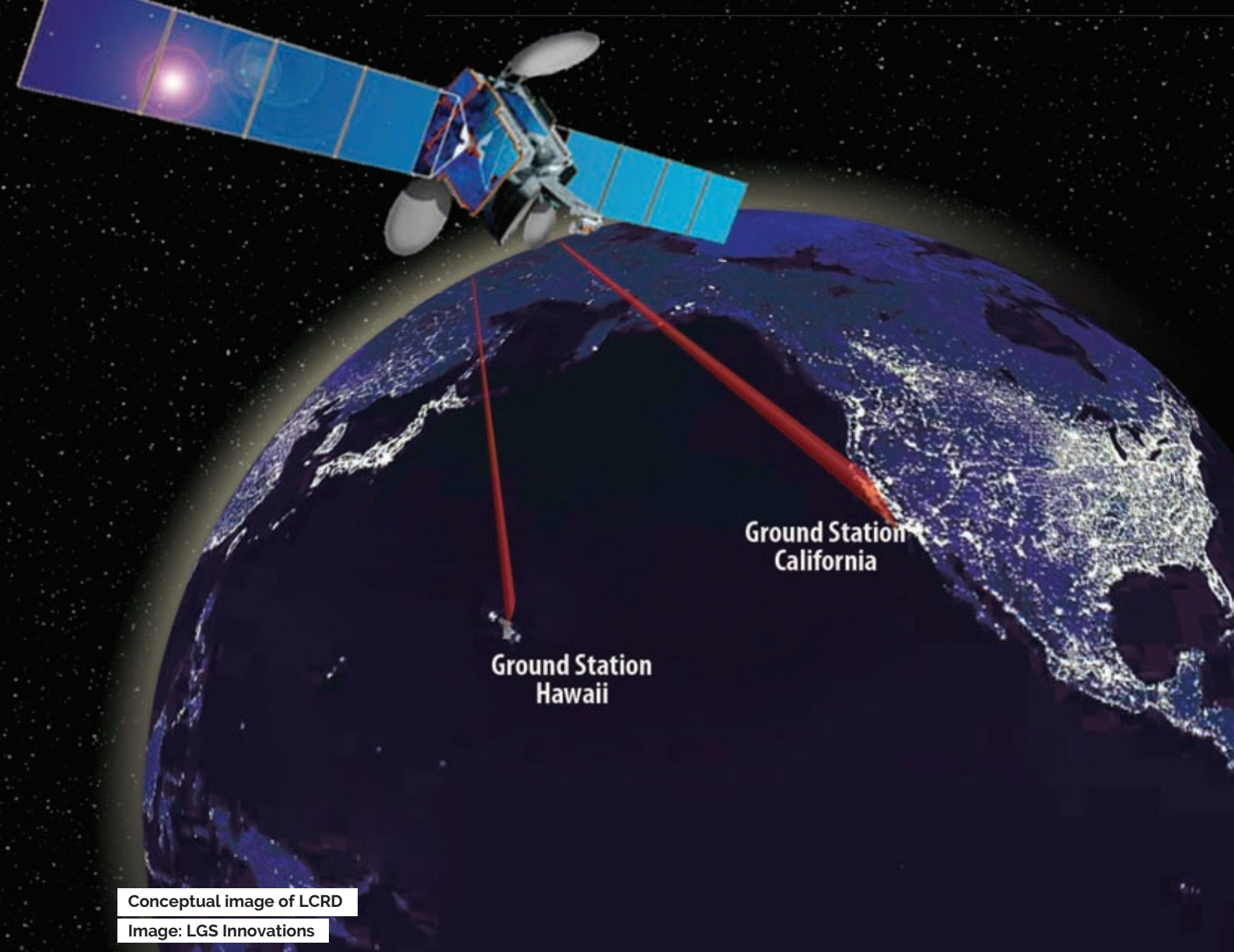
Question: Cybersecurity is a major concern amongst government, military and commercial sectors alike right now. How is LGS Innovations addressing these concerns, and what are the different priorities for each of these markets?

Linda Braun: LGS Innovations prioritizes enhanced security for all types of networks and communications, both government and commercial. We develop capabilities for security assessments of complex, large-scale networks, assessing their vulnerabilities and associated mitigation approaches.

We continue to expand our research and development to ensure alignment with our customers' critical cybersecurity and cyber mission needs, building on our experience in network assurance, secure network integration, cyber support services telecommunications studies, and advanced cyber research capabilities. Key focus areas include network reconnaissance, supporting effective pen-test and analysis of the cybersecurity of customer networks.

Improved security is an additional critical advantage of laser communications over radio frequency links. Photonic technology uses a narrow laser beam. An eavesdropper can't detect a signal unless he's inside the beam. Similarly, a jammer can't effectively jam a receiver unless he's inside the field-of-view of the receiver. Both the transmitted beam spot size and the receiver field-of-view are reduced over radio frequency systems by the roughly 6400x ratio of the carrier frequencies. For example, even if a radio frequency aperture can be 10 times larger in diameter than an optical aperture, the footprint of the optical beam on Earth is 600 times smaller.





Question: We're hearing a lot about spectrum management these days; how are the needs and challenges of different users evolving, and what's the answer to the 'spectrum crunch?'

Linda Braun: With the proliferation of connected devices and 5G deployment around the corner, the already growing demand for frequency to transmit data will increase dramatically. Spectrum will become more crowded and managing this precious resource will become more complex, raising the risk of interference. For military customers, compliance with US spectrum allocations is only a small part of the problem. Military radars, communications, sensors, and weapon systems must manoeuvre within and around spectrum, which is allocated differently around the world.

There are no easy answers to the 'spectrum crunch'. We are focused on helping government agencies as well as critical infrastructure operators and telecom services providers manage this finite resource. We are implementing innovative solutions to monitor spectrum use in real time and identify violations. For example, LGS Innovations is currently supporting the National Oceanic and Atmospheric Administration (NOAA) with a radio frequency interference monitoring system to mitigate the risk of potential interference by commercial wireless carriers sharing the spectrum with NOAA satellite operations.

With the shortage of the radio frequency spectrum,

laser communications technology offers another advantage as optical spectrum is unlicensed and available at no charge.

Additionally, with the narrow beam, the problem of different users interfering with each other is greatly reduced.

Question: What's on the horizon for LGS Innovations in the rest of 2019? Which projects can we expect to hear more about?

Linda Braun: We will continue researching and investing in the technologies mentioned previously to develop solutions for today's communications issues, while anticipating those that have not yet surfaced. We are expecting to be involved in new contracts and develop more solutions in the Intelligent Spectrum Management, free space optical communications and cybersecurity markets.

We conducted hiring events across country this year and already added a few hundred highly talented people to the team. We are looking for more scientists and engineers who want to push the innovation envelope.

From propelling scientific exploration of space or enabling live video transmission the next time humans go into lunar orbit to making a life-transforming impact on people's lives, this is the kind of progress we want to enable with advanced communications technology. ■