New developments in antennas and terminals

Satellite communications have long been a vital component of military communications systems thanks to their ubiquity, security and speed. Antennas and terminals make up a fundamental part of satellite communications systems, providing a way for soldiers to communicate between different camps, and with headquarters. Accordingly, research into antenna and terminal technology has been continuous among both commercial and military groups, meaning that capabilities have come on in leaps and bounds over the years, never stagnating. This holds true today, with ever-advancing communications solutions coming to fruition.

Communications antenna and terminal technology has come a long way since it first came onto the market with the launch of the world's first satellites in the 1950s. The growing popularity of satellite communications for commercial, enterprise and military purposes has led to more and more satellites coming online, alongside the rapid development of increasingly advanced antenna and terminal technology to meet new demands.

Despite heavy pressure on defence groups to cut spending among tightening budgets, groups from around the globe continue to invest heavily in communications technology in the face of new threats. Today, is has become impossible to put a value on communications capabilities. After all, how can you put a price on the lives of soldiers or the defence of a nation, when the technology is well-tested and improving practically daily? Defence forces around the world rely heavily on commercial companies developing new, secure, communications equipment, thereby avoiding a lot of the development costs themselves.

Technology demonstrations

As new technology reaches the market, commercial manufacturers and service providers perform demonstrations to showcase the upgraded capabilities. Nowhere is this more important than in the military sector, where unproven equipment can lead to loss of lives. As such, technology demonstrations provide evidence of capabilities, reliability, and ease of use.

In March 2016, Intelsat General Corporation and L-3 Communications Systems-West (L-3 CS-West) demonstrated new automatic beam switching technology that allows UAS fitted with L-3 CS-West satellite communications packages to operate on the Intelsat Epic^{NG} HTS platform. With the new high throughout satellite (HTS) capacity and the upgraded software, users can enhance their throughout by a factor of 3-4 on antennas with apertures smaller than 30cm.

During the demonstration, which was conducted on three separate bandwidth segments of Intelsat's Horizons-1 satellite, a navigation simulator representing a UAS flew through three distinct HTS spot beams on a single Epic^{NG}-class satellite. Engineers used an L-3 CS-West hub and terminal modems to measure end-to-end performance of full-motion video and IP data between the UAS and the hub controller, as the system automatically switched the frequency and polarisation while the UAS moved between beams.

"Through our collaboration with Intelsat, both airborne and ground users will be able to upgrade the software on existing L-3 wideband modems to provide automatic beam switching capabilities for service on HTS like Intelsat's Epic^{NG}," said Andy Ivers, President of L-3 CS-West. "These results mark an important milestone in providing our customers with the ability to modernise their existing assets within today's fiscally constrained defence budget environment." Intelsat General and L-3 CS-West plan to conduct further tests with user platforms over the new Epic^{NG} IS-29 satellite.

Meanwhile, in June 2016, GetSAT, Hughes Network Systems, Klas Telecom and NexTech Solutions (NTS) partnered

Hughes completes operational demonstrations of military portable terminal. Photo courtesy Hughes

to demonstrate an integrated Communications-On-The-Move (COTM) SATCOM solution for HD video, voice and data connectivity in Virginia, USA.

The solution consists of a Klas Telecom Voyager 8 basebound kit running Acano HD video collaboration software, Sonus VX for voice optimisation and Riverbed Virtual SteelHead for data bandwidth optimisation. A GetSAT Micro Satellite antenna was connected to the Hughes HM200 COTM modem, which operates on the Hughes Scrambled Code Multiple Access (SCMA) waveform. A 1.8m antenna and HM100 modem at Hughes' facility in Maryland, USA, provided the hub and Internet connection.

The solution was first mounted on a fast-moving SUV to demonstrate an uninterrupted HD video call between six participants in different locations. The same facility was achieved on a fast-moving US Navy ship. "Both the land and maritime vehicles were manoeuvring at top speeds," said NTS Director of Engineering, Louis Pacheco. "We also experienced rainy and cloudy conditions and the system performed beautifully with high uplink and downlink speeds."

In other news, July 2016 saw Hughes' Defense and Intelligence Systems Division (DISD) complete the demonstrations of its HM300 portable terminal, which provides portable X-band communications, and was designed in partnership with Airbus Defence and Space and Tampa Microwave. The HM300 terminal was designed to meet the call to action from the US Army Special Operations Command (USASOC) G6 at the C41 Conference in 2015 for 'new capability' to improve satellite communications. Designed for long-range scout teams, early-entry units, forward deployed teams and executive communications, the HM300 meets the reduced size, weight and power (SWaP) demands of Special Operations Forces (SOF) missions.

Tests in December 2015 between an Earth station in the UK and Fort Bragg, North Carolina, and operating over Airbus' XEBRA service, showed that the HM300 demonstrated beyond-

Photo courtesy dvidshub/Tech. Sgt. Lauren Gleason

line-of-sight (BLoS) capabilities with data rates up to 512kbps symmetrically to transmit video, voice and data. A second scenario demonstrated autonomous operation transmitting to and from a 4.0m GATR antenna at Fort Bragg, providing VoIP and live video using an encoder. Later, in January 2016, the HM300 terminal was deployed during a Combat Airborne Training Operation. One paratrooper jumped the HM300 terminal while another jumped baseband equipment, demonstrating the terminal's SWaP benefits and earning it a 'jumpable' designation.

"These tests successfully demonstrate the numerous scenarios of the HM300 terminal's operational flexibility with the XEBRA service as a reliable, durable and cost-effective communications solution," said Dan Losada, Senior Director of DoD programs at Hughes DISD. "Its rapid deployment capability, with only minimal training requirements and avoidance of high service cost, makes it an ideal fit for the evolving needs of the military."

Flat panel antennas: Leading the pack

Within the communications segment, the last decade has seen an overwhelming number of new antenna systems enter the market, most designed with mobility and Size, Weight and Power (SWaP) considerations in mind. Flat panel antennas, however, are garnering the lion's share of media coverage today, and for good reason.

Military customers have been testing flat panel antennas for more than a decade, but it is only now that they are coming onto the commercial market for wide-scale use. This commercial investment leads to more affordable flat panel antenna solutions being developed, much to the benefit of potential military users. Flat panel antennas are ideal for many mobile applications due to their low profiles, low weight, ease-of-use and reliability. With no mechanical parts, flat panel antennas are expected to slowly degrade in terms of functionality, rather than causing a total system failure at a vital moment.

Northern Sky Research (NSR) expects the flat panel antenna market to produce more than US$710 million in annual revenues by 2025, with the most prominent demand coming from aeronautical, maritime and land-mobile markets, in both the government and commercial sectors. Thanks to the lower price points and higher connectivity speeds, high throughout satellites (HTS) and flat panel antennas will provide mutually-beneficial market growth.

"Flat panel antennas have the potential to drive solid growth for the satcom industry, while addressing issues that traditional VSATs face in terms of efficiency, ease of use and installation," said Prateep Basu, NSR Analyst and co-author of the report. "But as the industry gradually migrates towards HTS-based services, and leverages the massive onslaught of capacity these will bring, flat panel antennas are expected to help customers find the right match between price and performance."

Despite the media attention lavished on Kymeta and Phasor and their electronically-steerable flat panel antennas, they're far from the only ones active in the flat panel antenna market.

Thales Group currently offers a range of tactical flat panel antennas under the SATMOVE family, designed for land, air and sea. The terminals are full outdoor integrated, ruggedized, designed for military and commercial frequencies, and offer high speed connectivity for both On-The-Move (OTM) and On-The-Pause applications.

In June 2016, Thales announced its SATMOVE Ka-band terminals following its earlier successful deployment of SATMOVE X-band terminals. The SATMOVE terminals use active electronically scanned antenna (AESA) technology to provide enhanced coverage and availability, with very high throughput speeds of up to 13Mbps, for mobile land, air and maritime applications. The first trials for the Ka-band SATMOVE terminal are due at the end of 2016.

C-COM Satellite Solutions is also entering the flat panel antenna market, having successfully tested its first Ka-band phased array antenna modules in May 2016, which were developed in partnership with the University of Waterloo, Canada. C-COM aims to deliver low-profile, low-cost, Ku, Ka or hybrid Ku/Ka-band antenna systems for the fixed and mobile markets.

The intelligent 4x4 Ka-band antenna modules tested showed that even when several of the 16 antenna elements were turned off, the module was still able to deliver results, without significant performance degradation. This is essential to ensure continuous communications capabilities.

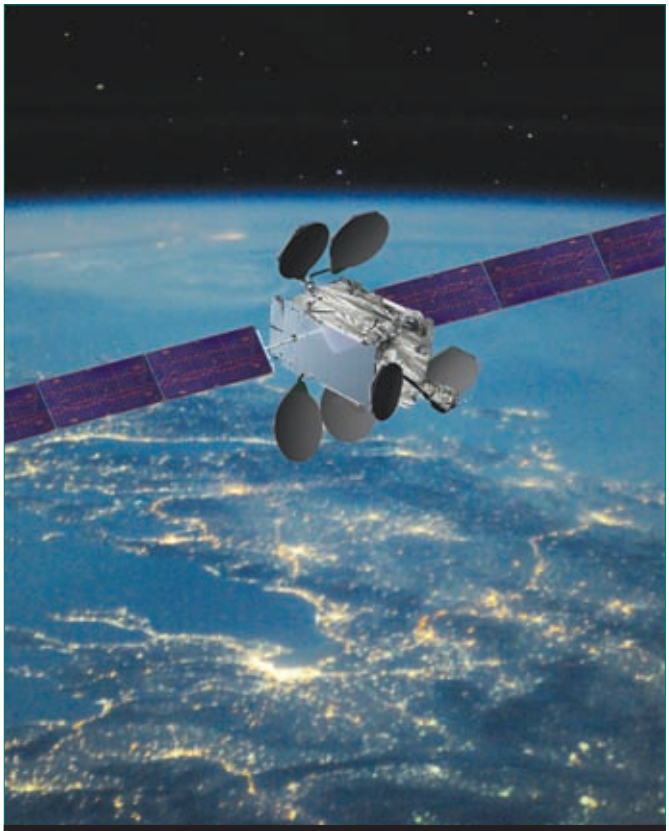
"We are very excited about this new Ka-band antenna technology development and its potential application to expand the addressable markets for electronically steerable flat panel satellite antennas," said Bilal Awada, CTO of C-COM. "The 4×4 phased array modular approach provides the basic building blocks required to manufacture new Ka-band antenna designs of various shapes and sizes for fixed and mobile applications. It is a potential game changer for the mobile broadband satellite market - whether land-based, maritime or airborne - as well as for next generation 5G mobile cellular communications."

Phasor and Kymeta represent the next step in technology with their electronically-steerable flat panel antennas. Unlike the flat panel offerings currently available, the Kymeta and Phasor solutions have no mechanical parts, providing extremely low-profiles and impressive lifetimes.

Both Phasor and Kymeta plan to commercially launch their first products to market in early 2017, and both are working with partner companies to tailor solutions for different markets. Phasor is collaborating with Intelsat, OmniAccess and Harris Caprock to provide solutions for the super- and mega-yachts, aviation, and cruise markets, respectively. Meanwhile, Kymeta has partnered with Intelsat, Inmarsat and Panasonic Avionics for connected cars, aviation and maritime applications.

New material applications enable new communications solutions

As military antennas become more lightweight, efficient and portable, military communications capabilities will continue to evolve and improve. However, the real game-changer for military groups will be the next-generation innovative ideas that are



Intelsat EPIC^{NG}. Photo courtesy of Boeing

Photo ourtesy Defense Imagery Management Operations Center

turned into truly ground breaking feats of technology. The key link between the three outstanding ideas from 2016 discussed below is that they all depend on new material applications which enable new approaches for vital communications technologies.

At the Intelligence and National Security Alliance summit in September 2016, Larry Holmes, Principle Investigator at the US Army Research Laboratory (ARL), outlined how 3D printing could be used in the battlefield to enhance military communications capabilities. In addition to producing spy cameras, biometric communications, and ballistic missiles, 3D printing could also be used to make plastic satellite antennas.

Since plastic is non-conductive, such antennas could operate 'above or separately' from the electromagnetic spectrum, helping to keep communications operational in a congested or contested zone. Instead of relying on being made from a conductive material, the antenna would function via the dielectric properties designed into its geometric composition. Research is ongoing at the University of Texas to make this possible.

Aside from maintaining communications, the benefits of manufacturing antennas in the field include not having to transport bulky parts, which would, according to Holmes: "Help us reduce logistics and the logistics trail, but also help with signature management."

Also in September 2016, reports of a new anti-sonar antenna technology emerged from Russia. According to local media, Russian submarines will be fitted with piezoceramic coating antennas which will be able to intercept and distort enemy sonar signals.

OceanPribor and the Krylov Research Center are developing the technology under the Foundation for Advanced Research Projects, for the 'Korsas' project. Essentially, with the new technology, a polymer membrane comprised of piezoceramics will cover the entire hull of the vessel. An incoming sonar signal is transformed to electrical energy, prompting a measurable change to the piezoceramic antenna which is analysed by the antenna's control system. The sonar signal is then distorted, and sent back towards the source.

An unnamed source, allegedly from inside the Russian Defense Ministry, told Russian newspaper Izvestia: "The work is at final stage, and trials of particular elements will start in the nearest future. It is the polymeric film based on oxides of zirconium, titanium and lead. The film is able both to absorb external radio signals and conduct them. In fact, the piezorubber coating applied on a submarine turns the whole hull into a hydroacoustic antenna."

The new technology is expected to be installed on existing and future submarines and submersibles in the Russian Navy once research and development is completed in 2017. Piezoceramic antennas might one day replace the passive rubber anti-sonar coatings currently in use by many submarines around the world.

Meanwhile, in October 2016, Bluewater Defense and Vorbeck Materials launched next-generation, high-performance wearable antennas featuring multiple communications bands, including LTW capabilities, for military, tactical and commercial use. The antennas are discrete, conformal printed graphene embedded in military apparel and backpacks. The partners highlighted the following benefits:

- Increased existing cell phone coverage by up to 200 percent;
- Significant upload and download speeds improvements;
- Omni-directional coverage through the deployment of array of antennas;
- Supports wide frequency range from 800-3000Mhz;
- Durable, flexible, washable and non-corrosive; environmentally friendly; and
- Increased battery life by reduced operating power.

"We expect that our military and defence leaders will appreciate a high-performance, wearable antenna with little or no silhouette, therefore better protecting the warfighter," said Vorbeck's CEO, John Lettow. "Two additional benefits of this technology are that it delivers real-time, 'on-the-go' communication capabilities because there is no need to deploy an external antenna, and they also interface with traditional electronics, making them very easy to field." **GMC**