Mobile Data

Better bandwidth levels and innovative hardware are enabling SATCOM access to vital intelligence data for deployed operators in forward locations. **BY GERRARD COWAN**

SATCOM-on-the-move (SOTM) is an evolving dimension of an increasingly interconnected battlefield. The technology has advanced in a number of ways in recent years, with the aim of providing faster data rates in a robust, secure manner.

There has been a dramatic increase in data rates, said Rebecca Cowen-Hirsch, VP of Inmarsat's US government business unit.

This has been driven by increasingly sophisticated applications. As in the civil world, where consumers now use their mobile phones to do everything from booking a restaurant to hiring a car, so military users "are demanding those same type of readily accessible, highly agile applications that drive greater data rates."

This has been enabled by higher frequencies, Cowen-Hirsch continued. Inmarsat's new Global Xpress family of Ka-band satellites utilizes steerable spot beams, for example; this allows for higher speeds and for additional capacity to be directed in real time to wherever it is required.

Inmarsat operates a range of commercial satellites in L- and Ka-bands, with government and military users forming one of the company's largest customer bases. With regards to Special Forces users specifically, Cowen-Hirsch pointed to Wideband Streaming L-band, a service that was developed alongside SOF users.

The system provides data rates of up to 10Mbps x 10Mbps through very small antennas, which can be as small as 5in. It was designed initially to work with an airborne terminal, though the same capability is available for land, in order to provide SOTM at a very high throughput and small form factor.

Photo: General Dynamics

CONNECTED BACKDROP

The demand for SOTM is taking place against an increasingly interconnected backdrop, according to Richard Franklin, head of secure communications at Airbus Defence and Space, which operates a range of military satellite networks, including the UK's Skynet system.

"There is an increasing drive to have all assets connected, particularly vehicles, whether they be tanks, light armor, etc, because there's been a bigger push for longer-distance incursions at speed," he said.

This means that smaller groups of vehicles are being deployed further and faster from the main battalions, presenting them with new challenges, as they cannot effectively utilize their old radio networks and may not wish to stop and establish a communications hub by deploying antennas.

They may need SOTM to supply intelligence rapidly back to command, or to receive video transmissions from unmanned aerial vehicles (UAVs) to show them what lies ahead, for example.

"Everybody is starting to see this as much more than a luxury – they're actively looking to see how it becomes a part of the concept of operations," Franklin said.

Special operations users have been making use of such technologies for longer than others. But even then, "it was a relatively tactical solution, of quite low bandwidths… rather than a full solution, designed into a vehicle," he added.

There are a number of distinct challenges in the SOTM arena. Perhaps most notably, the antennas need to be placed on the roof of vehicles that must often travel at very high speeds over extremely rough terrain.

"You have to be able to design an antenna and a system that can cope with that. I think if you went back ten years that was probably quite a challenge," Franklin explained.

However, advances in flat-panel technology – resulting in a design that tends to be more robust – have boosted the durability of antennas. In addition, the applications are becoming better at adapting to varying levels of bandwidth, which "can become larger in capacity and smaller in capacity as you vary your terrain."

X-band SATCOM is not susceptible to rain fade and military users do not have to compete with commercial ones for bandwidth. (Photos: XTAR)

Franklin clarified that the precise antenna required depends on the platform and the operational needs: "If [users] want high bandwidth, they obviously need a larger antenna, which usually means a larger vehicle and a larger space on a vehicle… all of that needs to be taken into account in the solution design."

As well as antenna size, the user needs to consider the level of required throughput. A system like Skynet 5 provides highly protected waveforms at the military and government X-band frequency, providing resilient and secure capacity. However, users could alternatively opt for a more commercial capacity, which while less protected, might offer a higher throughput.

"Depending on your user requirement and the availability of protected capacity, different solutions get designed," he explained.

SHARED TERMINALS

Franklin also highlighted the development of broader networks where individual vehicles share a SOTM capacity across the group, which can make it unnecessary to place a terminal on every vehicle.

"Let's say you have ten vehicles: you might only put satellite terminals on three or four of them, but have them moving as one big, ad hoc network and distributing the information among them, knowing that one or two of them will always have a viable satellite link." This was very much the direction of travel in SOTM, he said.

"If you have three or four tanks, the chance of them all being under trees or out of line of sight at one point is much less, so your software can prioritize the one with the best signal and make sure that's the one that keeps going," Franklin continued.

Advances in software mean that the system can switch between different services, depending on how much bandwidth is available.

"If you've got a video conference going on, the picture requires a lot of bandwidth, but the voice requires a lot less," he explained. "As the available bandwidth decreases, the software can automatically cut the picture but allow the voice to keep going. And then as you get better bandwidth, the picture will come back again."

General Dynamics has reduced the size of its antennas to make them compatible with smaller vehicles. (Photo: General Dynamics)

The X-band frequency has itself evolved considerably in recent years, according to Philip Harlow, president and COO of XTAR, a provider of X-band satellite communications and other services for government and military users.

He argued that X-band has a number of advantages over other frequencies: X-band satellites are required to maintain at least four degrees separation from one another, which reduces interference from adjacent satellites and "means we're able to transmit and receive much higher power densities, which translates into a higher data rate".

In addition, Harlow asserted that X-band is not susceptible to rain fade, which refers to the interference of weather phenomenon with signal transmission, while there are no commercial users of the band that could potentially interfere with the signal. "On the operational side, it's a very quiet frequency band and it's very controlled," he said.

Harlow confirmed that there have also been a range of changes on the industry side in the seven years since his appointment to the top role in XTAR. Eight new X-band satellites have been launched worldwide as part of the US Wideband Global SATCOM satellite system, with more planned, while terminal manufacturers are now producing X-band equipment on a far larger scale than in the past.

Much of this is designated for use by the US DoD in its satellites, but the by-product is that the equipment is now far cheaper overall.

"The availability of X-band has gone up, the utility of X-band has gone up, and the equipment has come down in price, so now we"re talking about an environment where X-band is competing with every other frequency band on an equal footing," Harlow said.

"That has been the biggest change over the past seven years."

POWER CONSIDERATIONS

A key challenge for SOTM is around size, weight and power (SWaP), said Allen Griser, business manager for SOTM at General Dynamics. The company's Generation IV SOTM antenna lowered the weight and power consumption versus Gen III, he said, to make it more applicable to a range of vehicles, including smaller land vehicles. "The challenge is always around the size of the antenna and the throughput needed for voice and data, as well as obviously the weight, because you don't want something that's 500lbs on a small vehicle." A lighter system also uses less power, he said.

General Dynamics takes a number of approaches to keep the weight down. A key area of focus is the type of materials that are used in the construction of the antenna. For example Gen IV uses composite materials as opposed to the aluminum alloys used in Gen III.

Additionally, the electrical cable assemblies have moved from copper to small, ribbon-style cables. "The Gen III bundle is made of wires in a protective sleeve, typically referred to as a wire harness," Griser explained. "The Gen IV assemblies are flex prints, which are typically called ribbon cables. The flex prints are much lighter in weight than a wire harness."

Harlow also highlighted the importance of SWaP considerations. "These guys have got to pack in as much as they can into as small a space as possible so that they've got room to carry the other things that are essential to the mission: that could be weapons, that could be sensors, that could be people – that could be any number of things."

FLAT PANELS

Comms gear therefore needs to be very compact, and sometimes even covert. He pointed to the growing momentum behind flat-panel antennas, which provide key advantages from a SWaP point of view.

"The antennas themselves are becoming more efficient, they're becoming more lightweight, they're becoming easier to install on odd-shaped platforms," he said. "Once we get to a flat-panel antenna that is cost-effective and technically effective then we're going to see an explosion in the use of satellites."

The use of flat-panel technology has advantages in other areas, too, said Alfie Brand, deputy head of land and special project sales at Airbus Defence and Space.

When SOTM first rose to prominence the vehicles used the type of rotating antennas that are found in ships or aircraft. However, these were not just big and bulky, but have to rotate in order to track the satellite.

"Rotating antennas are gyro-stabilized to track the satellite, so as the vehicle bounces and moves and vibrates, the antenna senses that movement and autocorrects very, very rapidly," he added.

"But bouncing a system like this around in an armored vehicle requires robust technology, so a flat panel is a better solution for a vehicle."

The satellite is tracked electronically on a flat-panel system, so there are fewer moving parts and the antenna retains contact with the satellite more efficiently.

The bigger challenge for ground vehicles is terrain, Brand emphasized: dealing with obstacles like bridges, tunnels, hills and trees. Again, this is where the use of networked solutions is particularly convenient, as a meshed ground network can simply rely on the antenna on one vehicle if another is temporarily blocked.

Cowen-Hirsch said that terminal size and power were important in other regards as well, to support the data rates required to accomplish the mission, yet at a size that does not make the vehicle a more obvious target for the enemy.

She determined that a communications vehicle that "has large, fixed satellite antennas designed for broadcast" consequently become a target. Inmarsat "works with our military users to ensure that power is efficient and that the terminal does not take away from the main function of that vehicle. We focus on reducing the antenna size while increasing the amount of throughput".

Jamming is a major challenge for SOTM platforms. Cowen-Hirsch said that Inmarsat systems are designed to support highly mobile users, and that Global Xpress spot beam architecture supports a uniform distribution of power and allows for consistent, uninterrupted connectivity.

Additionally, the use of steerable spot beams enables greater jam resistance, as they can be directed to respond to jamming or denial of service or to provide additional capacity in surge spots – something that was useful "not only for our commercial users but specifically for our military and our special operations users."

PAUSE BUTTON

While SOTM has grown as an area of focus, other uses of the technology are prevalent among Special Forces users.

This is often referred to as "SATCOM-on-the-pause", and involves the use of a portable antenna that can be set up in a stationary position. For example, General Dynamics has taken one of its antennas and made it mobile for SOF users.

Instead of mounting the antenna on a vehicle, it is placed in a case and can be easily used on the ground. "We've made some special adaptations for Special Forces operators in those kinds of environments where they're not mounting it to a vehicle, they just want a portable antenna," Griser said.

SATCOM-on-the-pause has also been a focus for Airbus, whose Xebra solution is designed "very much with tactical missions in mind," Franklin said.

This military SATCOM service was launched in November 2015, and uses a Hughes compact X-band terminal and the Skynet satellite network, according to the European aerospace, defense and space giant. It uses small terminals that weigh 5.1kg and measure 23x25x8cm in size.

While Xebra is designed to be used in a stationary position by ground patrols, it could potentially be attached to a vehicle for rapid deployment when the vehicle comes to a pause. Trials of this capability recently took place with the British Army during Army Warfighting Experimentation 2017.

SWaP considerations are just as important in on-the-pause systems as for their SOTM counterparts.

To address this, the US company GATR has developed deployable inflatable SATCOM terminals, which can provide a 90%-plus reduction in the logistical size of conventional rigid antenna systems. The inflatable design allows for the deployment of high-bandwidth terminals in two cases the size of airline checkable cases, said Cyrus Wilson, GATR USSOCOM program manager.

The inflatable products have been used by the US for several years, Wilson said. The company was founded in 2004, and its technology was transitioned to USSOCOM in 2008 for evaluation. The inflatable antenna was made an evolutionary component of the SOCOM Deployable Node family of SATCOM terminals.

"In many instances, our users require a stationary, 'SATCOM-on-the-pause" terminal that will allow them to provide high bandwidth, stationary communications," Wilson explained.

"Additionally, during those times in which our communicators are deployed to a fixed area for a short- or long-term period, our terminals can easily be set up or taken down within minutes of arriving onsite."

The biggest challenge is "getting people to see past the obvious perception of an inflatable antenna," Wilson said:

"Most people view it as a beach ball that couldn't possibly hold up the rigors of satellite communication," he said. However, once they realize the potential of a flexible parabolic system, with reduced weight and pack-out volume, "the light bulb goes off and the sceptic turns into avid supporter."

HIGHER THROUGHPUT

Looking forward, Franklin said that antennas would continue to improve, allowing higher throughput through smaller antennas that in turn leads to more connected assets. A major focus is on antennas that can receive data from multiple bearers, whether that be satellite or a radio network, so that if a satellite link is unavailable, "we will at least give them connectivity via something else."

Brand pointed again to the developing focus on dispersed networks. He said this was often termed "puddles" – one terminal receives data and passes it around to the other users in the puddle.

"Within each of those puddles they have this mesh network that allows them to pass everything out and about to each other, and that's really the future where everything's going: it's that meshing."

Griser again highlighted the demand around SWaP, with continuing requests for lighter systems that are lower profile on a vehicle.

"There's no one-size-fits-all SOTM antenna. It is very unique to the mission," he said.

"The vehicle and the bandwidth requirements of that mission are really what drive the design of the antenna. I think what'll happen more and more in the future is you're going to see faster vehicles, faster boats, faster land vehicles, and SOTM antennas have to be fast enough to respond to those style of vehicles." ■