Communications on-the-move in a satellite-denied environment

Radio communications have long been used in the battlefield to provide efficient, reliable communications, enabling soldiers and officers to stay in the know. However, in today's world, security is rapidly becoming a problem, as is bandwidth and usability. Here, Dr Rowan Gilmore, CEO of EM Solutions, outlines how the latest developments in antenna technology could change everything for mobile government users.

Radio communications is critical to the battlefield because it has the great advantage that one – or both ends – of the link do not have to be tethered, allowing freedom to roam.

Low frequency radio waves can propagate around the world under the right conditions, bouncing off the ionosphere to enable long distance communications. However, because of the low bandwidth, this type of communications does not support the increasing data transfer needs of the modern military. Satellite networks solve the problem of communications at distance by providing a 'relay' station in the sky, and because they operate at a higher frequency, they also support higher bandwidths and data rates.

For the remote user, either high throughput satellites (HTS) or microwave radios (which require line- of-sight) can provide the highest capacity channel. Millimetre wave frequencies offer massive bandwidths and therefore even higher throughputs. However, the challenge with these technologies that operate at microwave or millimetre wave frequencies is that antennas must be 'directional' to provide gain and achieve the radiated power (EIRP) required. For mobile users, this means that the antenna must be continually realigned, and the remote transmitter or satellite must remain within line-of-sight, to communicate.

State-of-the-art mobile satellite terminals, such as the Cobra 368A shown in Figure 1, transmit and receive in several microwave bands, and use sophisticated pointing systems to ensure the antenna is always pointed at the satellite, independent of the motion of the vehicle or ship. Most satellites in use today, including the WGS and Inmarsat GX systems accessed by the Cobra terminal, are geostationary (that is, at a fixed point in the sky relative to the user on Earth). For low or medium Earth orbits, the satellite can move slowly across the sky. Terminals such as Cobra typically support the highest data rate channel to or from a remote ship, plane, or vehicle, since communications is at high microwave frequencies and can thus support the higher bandwidths needed.

But how is a mobile user to communicate in an environment where there is no local cellular network (for instance, at sea or in the desert), and when the satellite is denied? Until now, the only fall back option would be to continue to use lower frequency VHF or UHF communications, but at these sub-microwave frequencies, achievable data rates are typically much lower than what the modern user requires, and rarely more than 1Mbps.

In the absence of a satellite, what if 'big data' could instead be exchanged with an alternative 'relay' station within line of sight of the mobile user, such as to a site on shore (from a ship) or to an aircraft or UAV (from another aircraft or vehicle on the ground) – and from there, relayed to the core network? In such a scenario, the relay station would perform a similar function to a satellite, and could communicate with a remote mobile asset at an equally high data rate.

To support this type of scenario, EM Solutions released its new Meerkat UltraBroadband Mobile Radio earlier this year. Now at TRL level 7 and recently tested in trials with a US Government agency, the Meerkat (so-named because of its nodding head as it looks for its partner radio in the distance) provides mobile line of sight communications at fibre-like speeds, providing a communications backbone for data traffic otherwise locked within an isolated geographical area.

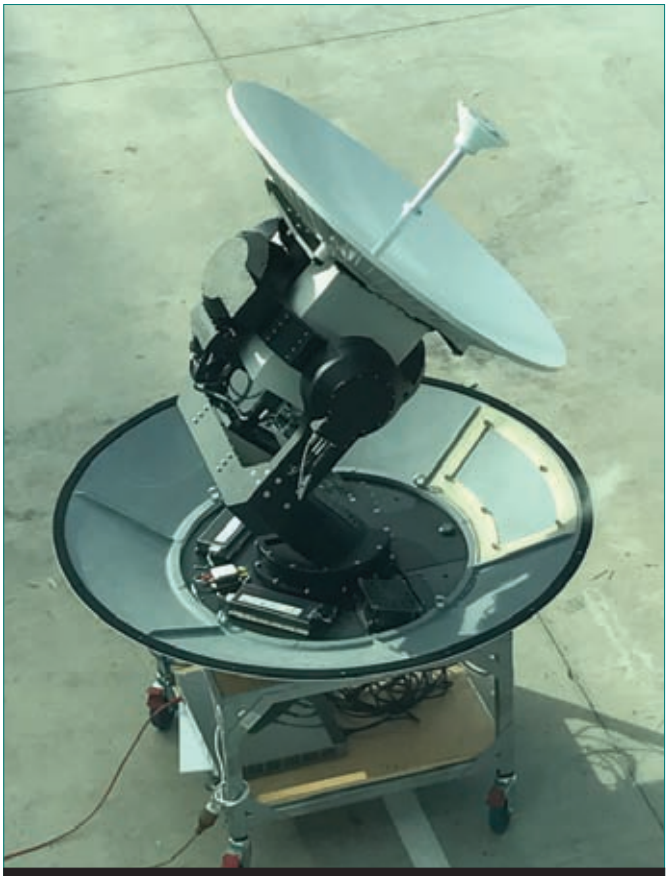

Figure 1: The Cobra 368A on-the-move satellite terminal enables high speed communications between a ship and the satellite even in rough seas, over both the military WGS or commercial Inmarsat GX satellite networks.

The Meerkat – Mobile ultra broadband communications

The Meerkat is shown in Figure 2, and shares some features common to its sister Cobra terminal – its pedestal, and its automatic pointing technology. Using a second Meerkat terminal at the remote link end as its reference, the terminal's monopulse pointing system stabilises itself against any motion of the vessel on which it is mounted, in the same way as Cobra does using the satellite as a reference.

The difference with Cobra, however, is revealing. Once self-aligned, two Meerkats can establish a high-speed point-to-point microwave or millimetre wave link between themselves, even when both ends are moving; for example, when one is on a ship and the other on a mobile station on land! Because they operate using a point-to-point millimetre wave radio link, a Meerkat link does not require a satellite and can communicate over line-of-sight at data rates as high as 10Gbps.

This is achieved using a state-of-the-art full-duplex radio that operates at 10Gbps in E-band, around 80GHz. The high frequency supports exceptionally high data rates over line-of-sight distances of up to 25km in clear air. The data interface to the radio is a 10G Ethernet cable with IP connectivity and that

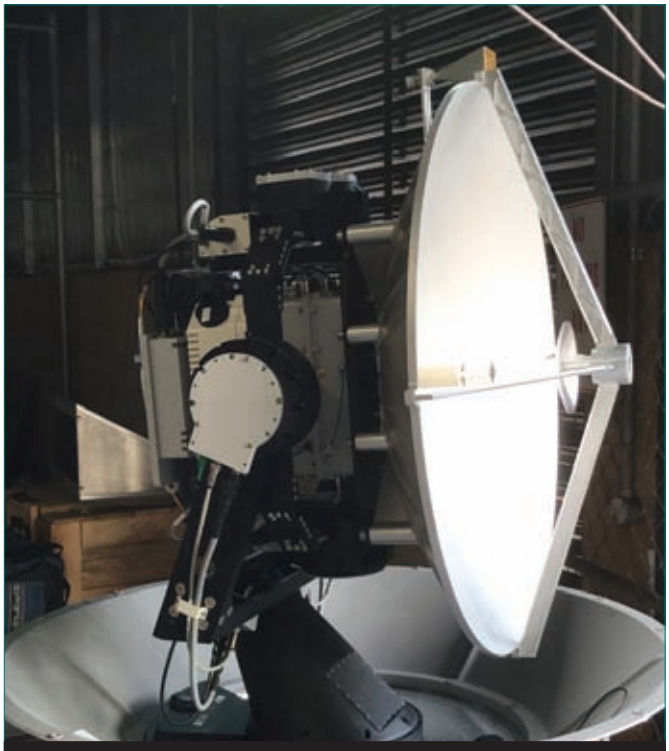

Figure 2: The Meerkat Ultra-broadband Radio Terminal is an on-the-move terminal that finds its partner terminal located on land, sea, or in the air. Two terminals automatically point their antennas to each other and enable a high-speed data communications link to be established between themselves in a satellite-denied environment.

concurrently supports the SNMP management interface, while the antenna control unit electronics, INU, and monopulse receiver are all self-contained within the unit itself.

Figure 3 shows the terminal directed skywards towards a second terminal. The high gain 750mm antenna provides over 50dB gain at E-band frequencies. With a beamwidth of less than ½ degree, the probability of intercept or jamming is very low; conversely, both antennas must be accurately steered towards their counterparts. This is achieved with a highly accurate 'monopulse' receiver in the Meerkat at each end that senses the remote unit and automatically drives the antenna motors to maintain lock on the remote boresight. An in-built INU provides additional pointing stability for faster response.

Applications

By merging two leading edge technologies from their satellite communications terminals and terrestrial microwave links product suites, EM Solutions is able to provide the fastest ever long-distance radio communications links between any two moving platforms.

As an adjunct to existing in-theatre communications assets connected by IP, the Meerkat provides a thick fibre-like backhaul route to offload or update massive data sets from any mobile vessel such as a ship, plane, or truck.

Now being demonstrated in defence but also available for trial in commercial markets such as oil and gas, the new Exomux mobile platform at either end of a line-of-sight link automatically finds its partner at the other end, and remains locked to it so that data at speeds of 10Gbps can be passed in both directions between the two ends.

Operating at E-band where there are no spectrum or bandwidth restrictions, a pair of Meerkat terminals provides direct line of sight communications in a satellite-denied environment. With a range of 25km in clear weather, and potentially hundreds of kilometres in free space where there is no atmospheric absorption, the radios provide a huge 10Gbps pipe accessed

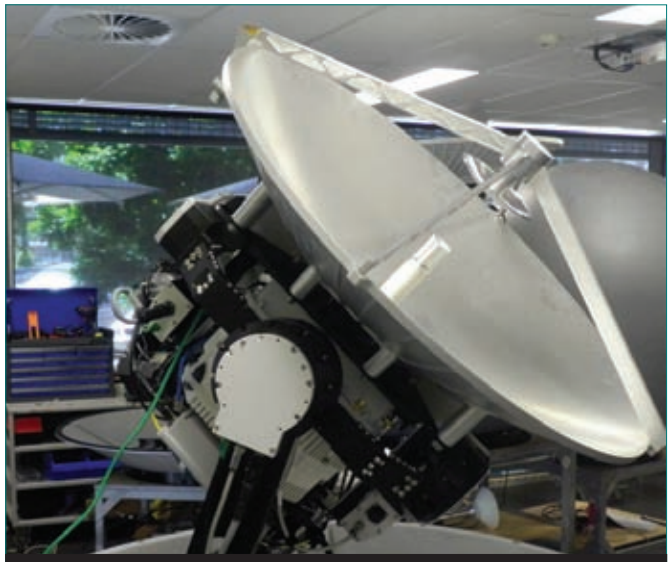

Figure 3: The Meerkat Terminal orients itself using a monopulse antenna feed (coincident with the data feed) that detects and locks onto a remote terminal, before establishing communications using its 10Gbps E-band radio (in white) mounted directly behind the antenna. The antenna is mounted in a three-axis gimbal system to point anywhere within the upper hemisphere.

through an optical gigabit Ethernet IP input. This ability to backhaul big data comes with a very low probability of intercept since the beamwidth is so small, and the terminals automatically compensate for motion at either end. **GMC**

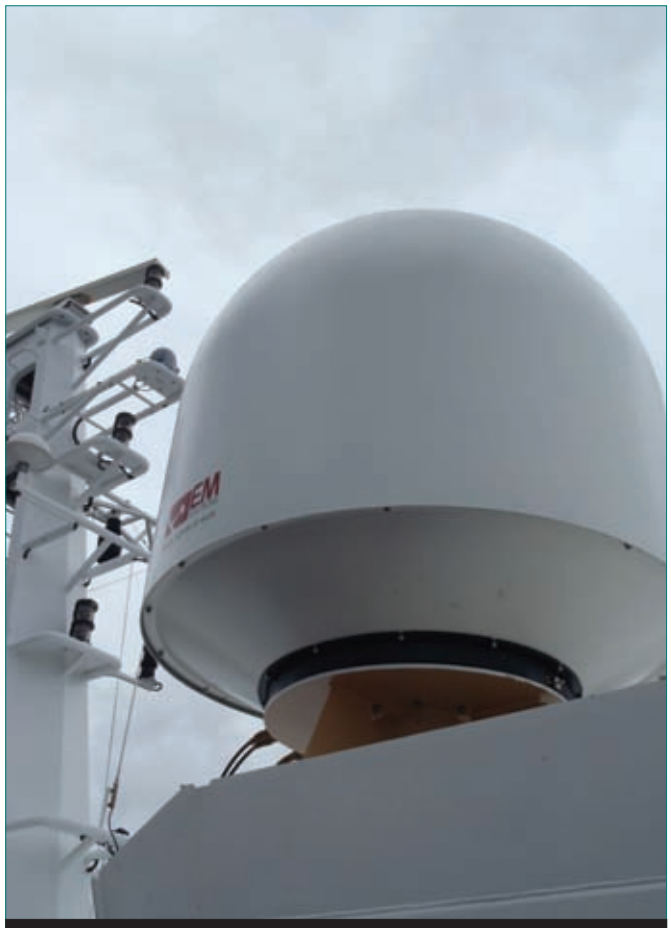

Figure 4: The Meerkat Terminal can be ship mounted in a similar way to an existing maritime satellite communications terminal