The Evolution of Link 16

Across a rapidly evolving operating environment, the ability to quickly generate 360-degree battlespace awareness has become a critical requirement for armed forces.

Nowhere is this demand stronger than in the emerging Great Power Competition (GPC) where airborne, maritime and land-based forces must interoperate to ensure enhanced levels in situational awareness whilst operating against near peer and high capability adversaries in contested environments.

Link 16 Tactical Data Link (TDL) technology first emerged in the 1970s, employed by the US Department of Defense (DoD) and NATO in support of Cold War air intercept missions. Today, Link 16 has become the most widely used secure and jam resistant, Line of Sight (LoS) waveform with next-generation technologies set to further extend Link 16 capabilities to an even greater number of tactical edge end users.

With a rich history in the development of Link 16 TDLs dating back to the early1990s, global communications company Viasat continues to evolve the technology in support of the US DoD, Five Eyes and other international partners.

Having first been contracted by the US DoD in the late 1990s to produce Multifunctional Information Distribution System Low Volume Terminals (MIDS-LVT) (a program of record which remains in production to this day), Viasat now offers users an extensive and ever-increasing Link 16 capability set, designed to enhance the operational effectiveness of forces operating in the air, at sea, on the ground, and in space.

Reacting to the demand signals of customers around the World, Viasat continues to witness ongoing requirements for smaller Link 16 TDL technologies- a concept which the company has been able to execute thanks in part to developments in Field-Programmable Gate Array (FPGA) receiver designs.

As a result, Viasat has developed and fielded

ground-breaking solutions in the form of the KOR-24A Small Tactical Terminal (STT) and the PRC-161 Battlefield Awareness and Targeting System – Dismounted (BATS-D) handheld radio as well as TDL technology capable of being integrated on board a variety of unmanned systems.

"In the 2000s, Viasat witnessed emerging requirements for smaller terminals, especially for weapon guidance during flight," explained Viasat Chief Technology Officer, NGTDL Systems, Dr Pete Camana. "More work was needed to develop this use case so we decided to prioritize avionics solutions such as the KOR-24A STT, thousands of which are currently deployed on board high-valued Link 16 enabled U.S., NATO and coalition air, sea, and ground platforms.

In 2017, Viasat was contracted to supply Weapon Data Link L-Band Units to Lockheed Martin for the US Navy's AGM-158B Long Range Anti-Ship Missile (LRASM) program- part of the navy's Offensive Anti-Surface Warfare (OASuW) concept, designed to send target updates while in flight for secure, reliable weapons delivery, so as to significantly decrease the time in high-threat environments.

In 2016, Viasat extended the utility of Link 16 TDL yet further with the development of a handheld software defined radio (SDR), designed to bring similar networking capabilities down to the lowest tactical level on the ground.

Today, more than 2,500 Viasat AN/PRC-161 Battlefield Awareness & Targeting System-Dismounted (BATS-D) SDRs have been delivered to US DoD customers, providing Joint Terminal Attack Controllers (JTACs) with the ability to rapidly and digitally connect with close air support (CAS) assets in the air.

Despite these significant technology breakthroughs, Viasat continues to develop "Next Generation Tactical Data Link" (NG-TDL) technologies across its Link 16 TDL portfolio through the application of game-changing commercial solutions.

On 22 May 2019, Viasat was awarded a contract by the US Air Force to deliver the World's first Link 16-capable Low Earth Orbit (LEO) spacecraft which aims to extend the employment of TDL technology by enabling its usage beyond line of sight (BLOS).

The Air Force Research Laboratory's 'Space Vehicles XVI' program leverages commercial satellite innovation and military-grade communications to enhance the situational awareness of warfighters by extending the range of Link 16 networks, particularly useful to platforms and personnel operating in contested and congested environments.

Next Generation Tactical Data Links

As Viasat Vice President and Business Area Director for NGTDL Systems, Andrew Kessler described, the emergence of the company's NGTDL systems is the result of an evolution in commercial technology coupled with demand signals from end users.

"The last 20 years has seen a migration towards software defined radios and demands to do more in smaller packages across the digital domain, enabling us to do things with handheld radios weighing just a couple of pounds. 20 years ago, we were talking about 300-pound racks of equipment measuring thousands of cubic inches.

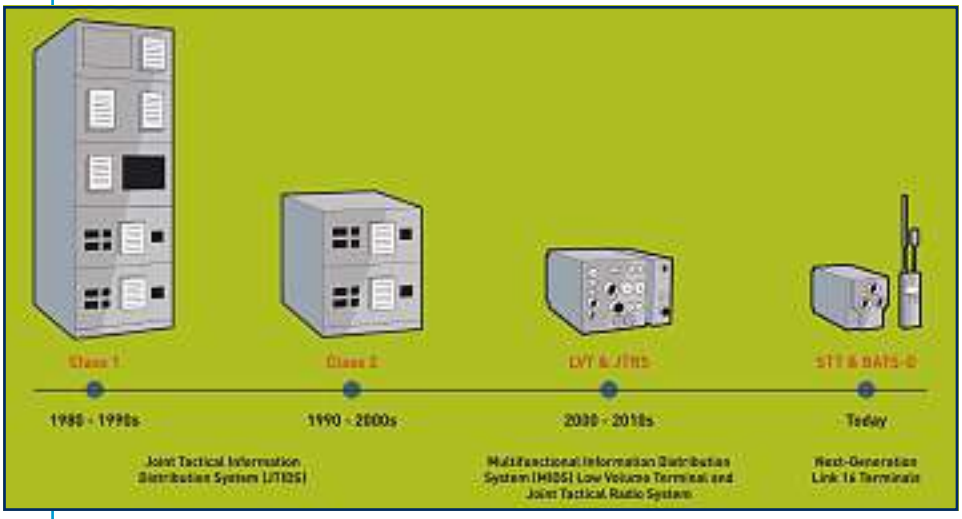
"The Art of the Possible has changed. Previously, it was impossible for small helicopters to access Link 16 information based on how big the radio had to be. Today, BATS-D can be carried on a tactical vest alongside other handheld SDRs. Viasat is at the forefront of the innovation cycle, allowing a greater spread of platforms and end users access to this type of technology," Kessler explained.

As a company, Viasat likes to find critical problems that need to be solved and then investing its own resources in the rapid development of products, bringing them to market far faster than traditional defense acquisitions can accomplish.

"Viasat is always very interested in being able to provide services to the underserved and our technology has enabled us to align what we see as urgent operational needs across the battlespace, identifying additional warfighter needs which could derive value from the inherent robustness of the Link 16 network."

As an example, Kessler described how BATS-D had first been designed on a napkin before being operationally assessed with JTACs and live aircraft at Nellis AFB within 18 months. "That kind of pace of development and bringing a much-needed capability to the warfighter rapidly is something that we strive to do every day," he urged.

As Dr Camana continued to explain: "We work with end users to develop software to do this alongside a lot of experiments and lots of concepts of operation. And then the customer sees the advantage and chooses Viasat as their Link 16 partner. We seek to apply commercial business models to the defense market, making Viasat more rapid and agile than our competition".



◄ Viasat continues to apply technological advances in size, weight and power in order to miniaturize Link 16 terminals.

Viasat's Link 16-capable LEO satellite is designed to fit the Viasat Hybrid Adaptive Network (HAN) satellite communications (SATCOM) concept.

According to Dr Camana, one of Viasat's most critical capabilities remains its commitment to achieving Link 16 interoperability between future and legacy systems.

Such an approach, he reiterated, allows integrators to incorporate the latest Link 16 TDLs into their inventory of platforms, thereby further extending their employment across the wider battlespace to ensure the reach and relevancy of Link 16.

"The U.S. Army AH-64E Apache and the U.S. Marine Corps' AV-8B Harrier fleets leveraged Link 16 capabilities to better coordinate their activities with other U.S. and allied aircraft in order to more rapidly engage enemy targets and to do so with reduced risk of fratricide or collateral damage.," Dr Camana highlighted.

"We continue to advance this capability in the most efficient way possible, striving to avoid products coming back to the factory for hardware changes. Our products are all about adding new features via software upgrade which can be predominantly achieved in the field."

"In a recent demonstration, we were seeing F-16s designating targets and handing off targets via Link 16 to AH-64Es over the hill for immediate target engagement," Dr Camana highlighted. "This was a tactic not originally envisioned but because all platforms had Link 16 terminals on board, they were able to exchange digital information. Once a single end user witnesses such interoperability, then suddenly everyone across the battlespace wants that same capability."

Additional CONOPS being explored by Viasat include the employment of Link 16 TDL in support of small boat operations as well as indirect fire from artillery, rockets and mortar assets.

Problem Sets

According to Viasat Link 16 Technologist, NGTDL Systems, Jon Stearn, the company's NGTDL solutions are ideally suited to supporting US and coalition operations arising out of the GPC where armed forces face disrupted communications by near peer and high capability adversaries in congested and contested environments.

"Near peer adversaries are able to deploy significant electronic warfare [EW] capabilities against us so our customers are demanding more resilience and better communications in EW-challenged environments," Stearn stated.

"Traditionally, Link 16 was not designed to be employed in a Low Probability of Intercept/ Detection manner. Enemy forces may be capable of detecting 200W signals disseminated by omnidirectional antennas across the battlespace. But there are multiple ways to make a system more suitable by controlling transmission power," he added.

"We believe we are just scratching the surface with 'signals-in-space' as part of an overall network architecture. So, we continue to pursue multiple lines of effort making overall capability more resilient and dynamic with higher capacity. There is lots of runway left to support multi-domain operations in the information age."

As a result, Viasat continues to research dynamic control of power as well as the development of directional antennas to assist Link 16-enabled platforms operating in contested environments. "As we get more processing power and multi-apertures, this will open up plenty of ways to get directivity on 'Transmit and Receive' sides to allow Link 16 to operate in an even greater LPI/LPD manner".

Additionally, Stern suggested armed forces could "hide in plain sight" in the midst of a congested area of Link 16 signals: "It's hard to identify any specific user when they are surrounded by many others. So, we are working with end users to do that in order to try and figure out how to employ such a CONOP.

"We are also seeing significant opportunities for enhancements in receiver designs for continuous operation in challenged environments," Stearn described while highlighting emerging operational requirements arising out of the DoD.

Futureproofing Solutions

Viasat's family of NGTDL solutions have also been designed to be integrated into the company's Hybrid Adaptive Network (HAN) concept, which has been designed to maximize warfighter connectivity and resilience by providing simultaneous access to both commercial and military networks.

Such a CONOP applies to Viasat's KOR-24A STT, AN/PRC-161 BATS-D, and Link 16 LEO satellite which is due to be launched later in 2020. In addition, Viasat has designed its advanced Concurrent Multiple Reception (CMR) software and Link 16 Amalgamated Remote Management System (ARMS) to further enhance the operational effectiveness of TDL technology.

With more than 1,500 KOR-24A STTs already fielded across US and international armed forces, Viasat continues to upgrade the capability in response to ever-increasing

A JTAC operates the BATS-D during a close air support training serial. The BATS-D can be networked to the Android Tactical Assault Kit (inset).

demand signals from end users. Enhancements include the delivery of an encryption upgrade in response to Government mandates.

Similar upgrades are being applied to the AN/PRC-161 which has been designed to provide end users with more precise positioning data and reliable communications for CAS missions in order to reduce collateral damage and risk of fratricide across congested operating environments.

"We are about to release a software upgrade to deliver encryption modernisation to STT, allowing Link 16-enabled platforms and personnel to operate in future encrypted networks," Stearn highlighted.

Viasat's Link 16 LEO satellite could also lead to the launch of a wider constellation of spacecraft, capable of providing Beyond Line of Sight (BLOS) Link 16 connectivity to a wider variety of platforms including manned and unmanned platforms in the air, on land and at sea.

Today, Link 16-enabled end users on the ground must have Line of Sight (LOS) to aircraft in order to coordinate CAS fire missions. With Link 16 LEO, this capability will be extended into BLOS operations.

As Stearn explained, the Link 16 LEO satellite is "another example of Viasat seeing need and taking steps to increase network capacity, resiliency and relevancy, particularly in terms of near peer and high capability adversaries in contested environments.

"The biggest issue with Link 16 is LOS. But when bouncing off a LEO altitude, this can be extended beyond 300 mile range. We are working with the USAF to identify various CONOPS benefiting from that BLOS extension in range," he added while suggesting similar capacity could benefit surface vessels operating at sea.

"First, we must build one and get it into space in order to start building these CONOPS. We have to prove we can do it but once we've done that, there will be plenty of momentum to put up constellations of Link 16-enabled satellites in areas that need it."

Evaluation of Viasat's Link 16 satellite will see it operating at an altitude between 500 and 700km above ground level above the Continental United States.

Capable of being integrated into Viasat's HAN concept, the Link 16-capable LEO satellite will allow end users to leverage the resilient and global connectivity capabilities of the HAN and share information with other platforms and end users around the world.

The LEO satellite will also augment Viasat's existing geostationary satellite constellations and provide interoperability with the company's next-generation Viasat-3 constellation, providing higher broadband capacity globally.

"LEO satellites can only cover a small portion of the Earth due to their low orbit but connect them to a constellation of GEO satellites and that limitation vanishes. Meanwhile, the lower orbit enables connection to handheld terminals on the ground," Stearn explained.

Due to be deployed in support of end users later in 2020, Viasat's advanced CMR solution has also been designed to enhance communications and reduce network congestion while enabling Link 16 radios to receive multiple messages simultaneously.

"CMR is vital to support manned-unmanned teaming (MUM-T) missions where unmanned aerial vehicles (UAVs) cooperate with manned helicopters and air frames," Kessler explained.

"This will facilitate more users onto existing Link 16 networks, allowing users to consume multiple information exchanges instead of choosing a single output like voice or data," he added.

The CMR was designed following the emergence of urgent needs from the US DoD calling for the means to enhance communications capacity and reduce network congestion across Link 16 networks.

CMR features have been updated into the latest version of the KOR-24A STT; AN/PRC-161 BATS-D; as well as Viasat's Move out / Jump off (MOJO) expeditionary tactical gateway system. Such a capability, developed by Viasat as a non-developmental item, will allow network planners to optimise network performance to accommodate the maximum number of platforms in order to share maximum levels in information to support operational requirements.

Viasat's proven NDI business model is designed to deliver new capabilities significantly faster, at lower lifecycle costs and with lower risk to the customer when compared to traditional acquisition programs and timelines.

Finally, Viasat's ARMS software will support extended utility of Link 16 networks, allowing end users to plan, manage, modify and troubleshoot tactical data link networks over wide areas of operation. Embedded directly into Link 16 SDRs and terminals, ARMS software optimises end user management of bandwidth as well as streamlining decision making processes.

As Kessler explained: "We continue to explore enhancements in every area, including size, weight and power. A big thrust is the dynamic network management and entry/exit into and out of the network."

As a result, Viasat's distributed approach provides a multi-viewpoint solution to network management, connecting operations centers with multiple Link 16-enabled platforms and personnel including MIDS-LVT, STT and BATS-D over an IP-based Wide Area Network.

"ARMS obtains the tactical picture as seen at each location, accepting all transmissions and receptions as well as status from each terminal. From this information, it creates a multi-terminal database that is analyzed for discrepancies and anomalies," Stearn explained.

ARMS retains the capacity to directly host more than 30 Link 16 terminals simultaneously, while also operating in tandem with existing Command and Control (C2) systems with zero footprint integration, providing a single and consolidated tactical feed for all hosted ground systems.

Conclusion

As more and more is demanded of armed forces operating at the tactical edge, the future growth potential of Link 16 technology is clear to see, providing US, Five Eyes and coalition partners with secure, survivable, jam-resistant waveforms enabling enhanced coordination and communication across contested battlespaces.

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