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Connecting the dots: AI and 5G in tactical communications

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As expeditionary forces consider how best to enable and maintain tactical communications in complex and contested environments, industry is exploring how next-generation capabilities such as AI, ML, and 5G connectivity can support emerging signal demands. *Andrew White* reports

According to Viasat's 'State of Military Communications Technology' study, published in December 2020, 97% of respondents from across the US Department of Defense (DoD) experienced a "complete loss in connectivity" in a military working environment last year.

Having questioned more than 300 personnel from the US Air Force, US Army, and US Navy, 60% of respondents felt the DoD was "on par or lagging" behind near-peer adversaries such as China, while 50% believed that the DoD should pursue next-generation military communications technologies, including artificial intelligence/machine learning (AI/ML) and 5G.

Speaking as the report was published, Viasat President of Defense Ken Peterman described the technology being employed by the DoD as "stale and tired" that is not suitable for supporting operations against near-peer adversaries associated with great power competition.

Describing the report findings as "important and compelling", he said, "I think this is a call to arms to do something different. We have a problem and everybody across the DoD and warfighter communities sees it clearly."

Moreover, he argued, "There is an enormous opportunity by moving toward more sophisticated technologies. It blows open the door for the warfighter and these platforms to now leverage cloud connectivity and cloud empowerment in ways that have never been possible before."

Meanwhile, there are similar concerns in Europe about optimising tactical communications in expeditionary environments, with defence sources telling *Janes* that AI/ML algorithms could be used to support the tactical communications requirements of armed forces in all domains. However, the sources warned that such upgrades would require additional power consumption levels and new microchip technologies.

Moreover, European commanders have raised concerns about a potential cognitive overload for end users. According to one commander in the French Army, "AI is a facilitator for soldiers but if we want to use neural networks to improve the communications performance of software-defined radios [SDRs], there is a danger of making them more complex and less understood by the end user." Crucially, "We really have to think about explaining to the armed forces how it will improve capability," he emphasised.

Similarly, as concerns continue regarding the security of Chinese telecoms giant Huawei's network, the US military, NATO, and partner forces are also considering the best means to integrate 5G infrastructure into tactical communications plans.

Industry enablers

According to Shane Eisenman, senior scientist for communication systems at L3Harris, AI has been enhancing warfighter communications for "many years, albeit in specific tasks".

Pointing to an example in the electromagnetic environment, Eisenman said, "At a fundamental level communication relies on the electromagnetic spectrum as its key resource [and] being aware of channel conditions, identifying contested spectrum, tracking link status, and evaluating network performance are all ways current tactical communications solutions can optimise the best use of the electromagnetic resources available."

Describing how this technology is advancing, he added, "There's been an increasing level of sophistication applied to these as processing and SDR resources have grown. Now, our modern waveforms can proactively sense channels, adjust frequency, move between bands, adapt data rates, and collaborate with nearby radios to accomplish this without any operator input."

Examples of this include L3Harris' AN/PRC-163 and AN/PRC-167 multichannel handheld and manpack SDRs, which feature integrated signals-based threat warning/situational awareness (SBTW/SA) technology that 'senses' other energy and identifies and classifies signals of interest.

"This is an area ripe for future research and development, especially as we look towards aggregating sensor data across tactical networks in the 'sensor-to-shooter' construct," Eisenman noted.

According to L3Harris, the greatest capability gap for integrating AI and ML into tactical communications is meeting the requirement to operate within a self-supporting and dynamic system, often with the limitations of using battery power.

"For dismounted [operations] we provide everything in a technically challenging small form factor and make it valuable enough that soldiers want to add it to their carry burden," Eisenman explained, noting that, while sophisticated AI processing is well established in large infrastructure and desktop applications, the same technology for portable equipment is in its infancy with more specific tasks such as biometric security.

"New mobile processors are just starting to feature neural processing engines so I expect these barriers will slowly be overcome," he said, adding, "The perennial issue with ML is having enough appropriate training data; refining a neural net to be useful can take a large amount of characterised data. Beyond real-world data collection, the use of synthetic training data will also play a role in bridging this gap."

Looking to the future, Eisenman said, "I could foresee a future where dismounts could each have something approaching a general AI on their person, assisting with a myriad of complex tasks." Moreover, he suggested that warfighter effectiveness has much to gain from AI, including reducing cognitive load with increasingly relevant and streamlined information managed by AI. "Much has also been said about supporting synthetic training environments where simulations can more closely mimic real-world threats," the scientist noted.

Meanwhile, PacStar, Viasat, and Digital Barriers are also working to optimise AI/ML and 5G connectivity into tactical communications networks. The three companies displayed an integrated solution at the US Army's CyberQuest event in September 2020, which featured software from Viasat and Digital Barriers operating on board PacStar hardware.

According to Charlie Kawasaki, chief technology officer for PacStar (part of Curtiss-Wright Defense Solutions), many of the potential benefits of AI in advanced network architecture or monitoring activities are nascent today.

“Those technologies today are not widespread in terms of adoption; they’re more in the labs or in early pilot programmes,” he said. “On the other hand, the use of AI is much more mature and developed in video analytics for things like identifying objects or facial recognition so it’s very dependent on the use case,” he added.

Kawasaki noted that the adoption of AI/ML in tactical networks is in the very early stages “and we’re just beginning to scratch the surface across many different use cases, whether it’s assisting with robotics in an unmanned vehicle, doing predictive maintenance, cyber security, or conducting electronic warfare”.

Meanwhile, the director of advanced networking at Viasat Government Systems, David Schmolke, described how AI/ML could support robust networking throughout tactical communications networks while conceding that the technology is still “relatively new”.

“The tactical communications network has a wealth of data derived from devices, including querying radios on the network for their [radio frequency] signal levels and areas of frequency blockage; querying cyber sensors for indicators of compromise or cyber activity; or looking at environmental analytics, for example location and weather, and based on that information [determining] what sort of terrain [is being dealt] with [or whether there are] potential frequency blockages,” Schmolke explained.

“The traffic itself produces metrics and combining all of this data with AI/ML brings a powerful capability that can be used to make decisions on how to set up, manage, maintain, and route data,” he added. Moreover, he noted that AI/ML “brings a power capability in understanding the [electronic warfare] environment and potential countermeasure”. This requires additional data collection but AI/ML is optimal for tackling those problems. “The application of AI/ML to tactical communications is driving towards the self-forming and healing network, [which is] critical to highly dynamic tactical networks,” he argued.

Senior Vice-President of Digital Barriers Mark Patrick told *Janes* that one of the typical requirements for effective AI is the availability of high-performance computing. “That has not been available until recently within the battlespace edge and so has required transmitting the data and processing centrally, [which reduces] the number of sensors that can be effectively deployed in a congested and contested communications environment,” he said.

However, he added, “What is changing now is the wider availability, notably with the PacStar products, of those processing architectures within vehicular and body-worn deployment, which is bringing new opportunities for AI to be explored for enhancing the effectiveness of the warfighter.” An example of this, he continued, is “bringing facial recognition to the edge so allowing facial recognition to confirm the target”.

According to Schmolke, AI/ML can enable the automatic set up, maintenance, and management of tactical communication networks across a battlespace by leveraging data across the network and combining it with emerging smart networking technologies.

“This provides a robust network that will rapidly react to dynamic conditions, including on-the-move communications, a wide range of wireless users and battlespace sensors, varying wireless networks, environmental conditions, and adversary effects including electronic warfare and cyber attacks,” he explained, adding, “This capability also enables automated PACE [primary, alternative, contingency, emergency communications], which brings the ability to autonomously manage multiple communications links as a primary, alternate, contingency, and emergency.”

Schmolke further noted that a robust network “is critical to delivering real-time situational awareness across the battlespace and enables the warfighter to focus on the mission”.

Additional capabilities include the ability to bond and aggregate multiple communications paths together, meaning AI/ML can automatically detect and predict changes across beyond-line-of-sight (BLOS), long-term evolution (LTE), free space optics (FSO) communications systems, Mobile Ad Hoc Networks (MANETs), and 5G networks. Moreover, traffic can be tagged and prioritised, especially across classified networks.

Referring to the collective solution demonstrated at the US Army's CyberQuest exercise in 2020, the companies described how it had developed small form factor networking and computer solutions optimised to run these technologies.

Moreover, the companies supported a casualty evaluation vignette featuring combat medics providing initial evaluation and triage of injured warfighters in support of battalion medical staff stationed at a tactical operations centre (TOC). To demonstrate the capability medics wore augmented-reality (AR) headsets with integrated cameras that sent high-definition video over a local soldier wireless network.

Meanwhile, at the TOC, Digital Barriers AI-based image recognition software and Viasat NetAgility networking software were hosted on a PacStar platform. The software performed facial recognition against emulated patient records that enabled the rapid retrieval of patient data by the TOC medical staff and the remote medic via MANET radio.

Wireless connections were made available through Viasat's NetAgility SDN bonding router located at the TOC and the tactical edge.

According to company sources, "NetAgility simultaneously managed traffic across two Silvus Technologies MANET radio networks, a Viasat satellite communications (satcom) link, and VPNs over three different public infrastructure LTE networks, [while] Viasat's portable multimission terminal provided High Capacity Ka (HCKa) satcom BLOS transport."

The networking software "bonded and aggregated the data across all available links and managed a network tunnel across multiple MANET radio networks". As the links changed state, NetAgility automatically adjusted to maintain the quality and robustness of the connection. As a result of the successful performance, the team was invited to participate in the US Army's Multi-Domain Operations Live event later this year.

According to Kawasaki, "We're taking advantage of continual advances in these technology spaces, leveraging commercial-off-the-shelf development and making it consumable for the tactical communications networks." Looking to the future, he added, "We will continue to very aggressively develop new products in that product family, partnering with leading companies like Viasat and Digital Barriers to integrate their software into our hardware so that we can offer it as an integrated solution that we can stand behind." This, he said, will ensure those technologies have a route to market and a route to be delivered into existing customer systems.