Division Tactical Network Architecture for LSCO

Optimization

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Current conflicts in large-scale combat operations (LSCO) prove that the old standard of large, static command posts (CP) with high electromagnetic signatures cannot survive in austere environments. Legacy Army network equipment is not sufficient to support agile, dispersed CPs required for division operations.

The rapid proliferation of commercial satellites in low earth orbit (LEO) has revolutionized the satellite communications (SATCOM) landscape, with operational satellites skyrocketing from approximately 1,500 to over 13,000 over the past decade. This growth has created an opportunity for the military to leverage commercial communications solutions to overcome the limitations of its legacy networking equipment.

The 1st Infantry Division's (ID) National Training Center (NTC) Rotation 25-03 provided the Army with a successful example of how to use commercial solutions to address critical shortfalls in its traditional networking capabilities. 1st ID's success demonstrates the potential for commercial technologies to enhance military communications and drive modernization efforts. The Army must continue using commercial solutions to improve tactical capabilities and keep up with technological advancements.

Department of Defense Information Network (DoDIN) Operations planning for NTC Rotation 25-03 began with guidance from 1st ID's Commanding General, Maj. Gen. Monté Rone:

> *"… the division will train with multiple command post configurations during NTC 25-03 to prepare for future combat operations. [Task Force] Danger command posts must be grounded in four fundamentals. Command posts must be* ***distributed, survivable, functionally integrated, and redundant*** *in their functions…"*

Based on this guidance, the division established planning priorities for the tactical network architecture:

1. Integrate smaller and more dispersed division nodes into the tactical network with corps headquarters, NTC, Home Station Mission Command (HSMC), brigade elements, and other supporting units to enable distributed command and control (C2).
2. Optimize tactical network nodes by reducing the physical footprint and shifting computer-intensive functions away from the tactical edge to improve network reliability.
3. Leverage commercial equipment to cover legacy Army network architecture shortfalls, minimize bandwidth friction points, and enable a complete network contingency plan.

To address these priorities, 1st ID employed a multi-faceted approach. Enabling CP dispersion would require each CP to operate independently while allowing the staff to maintain a common operating picture. 1st ID's HSMC network, with its Tactical Hub Node (THN), acted as the central point for all CP connections to limit inter-node dependencies. 1st ID limited bandwidth utilization by distributing critical services between their HSMC network and the division's tactical edge; they distributed processing power by experimenting with virtualizing Mission Command Information Systems (MCIS) to be used remotely. Additionally, they leveraged commercial network infrastructures and the Armored Formation Network-On The Move (AFN-OTM) system to take full advantage of the strategic transport agnostic capability of the Global Agile Integrated Transport (GAIT) team's internet virtual private network (iVPN) technology. By doing so, 1st ID could reduce its electromagnetic footprint, blend into the electromagnetic operating environment, seamlessly exercise network contingency plans, and tactically distribute communications assets to enhance resilience and survivability.

Home Station Mission Command

The 1st ID HSMC network played a crucial role as the central hub for the division's primary server stack, connecting all nodes on Fort Riley, Kansas, including the Mission Training Complex and Division Headquarters, as well as forward nodes on Fort Irwin, California. Likewise, the 1st ID THN acted as the central point for route distribution, processing all network traffic using HSMC servers. This centralized architecture enabled the division to streamline network management operations and improve network security by centralizing network monitoring. By hosting common services (such as SharePoint, chat, and email exchange) on HSMC servers and placing only select services forward, 1st ID reduced the amount of deployed equipment required, minimized the physical footprint, and lessened the logistical burden associated with deploying and maintaining these systems. This approach also allowed the division to optimize

resource allocation, ensuring that critical systems and services were always available and accessible to those who needed them.

1st ID's experimentation with virtualizing mission command systems further amplified the success of the HSMC network. By creating a virtual desktop hosted on the HSMC network with pre-configured Joint Automated Deep Operations Coordination System (JADOCS) client software, the division could provide users with secure and reliable access to critical systems and applications from any 1st ID CP. This innovation enabled JADOCS users to process fire missions remotely, leveraging the processing power of the HSMC network to perform complex calculations and data analysis. The benefits of this approach were twofold: not only did it reduce the amount of equipment required at forward command posts, but it also significantly decreased bandwidth utilization by offloading client and server processing to the HSMC network. 1st ID conserved bandwidth by only passing remote desktop traffic through the wide area network, ensuring efficient and effective completion of critical communications and data transfers.

In the future, 1st ID will virtualize additional mission command systems, leveraging the HSMC network's processing power and scalability to support a broader range of applications and services. This approach will enable the division to reduce its physical footprint further, minimize logistical complexity, and enhance overall operational agility.

1st ID will achieve a balanced hybrid network by actively assessing which services to keep at the tactical edge and which to virtualize, thereby providing the benefits of both centralized and distributed capabilities. This hybrid approach will enable the division to maintain the benefits of centralized network services while providing forward-deployed units with the autonomy and flexibility they need to effectively operate in dynamic and unpredictable environments.

As the division continues to push the boundaries of what is possible with virtualization and centralized networking, the HSMC network will remain a critical component of 1st ID's network architecture, enabling the division to stay ahead of the curve and maintain its operational edge.

Armored Formation Network

NTC Rotation 25-03 served as a validation event for the AFN-OTM solution, which features a compact, low-SWaP (size, weight, and power) design installed on select tactical vehicles and provides a multi-transport network architecture for armor formations by integrating geostationary (GEO) and low LEO satellites, Fifth Generation (5G) Long-Term Evolution (LTE), and mesh radio capabilities.

With an experimental application for bandwidth virtualization, the AFN-OTM network was able to load-balance network traffic amongst every transport option. The AFN system also includes a variable height antenna for line-of-sight retransmission capabilities and stand-alone LEO terminals as "kick-out dishes" for dismounted connectivity. As the capability evolves, 1st ID expects to enable system emplacement on inconspicuous vehicles, allowing command posts to reduce their visibility and avoid detection by enemy forces.

During NTC Rotation 25-03, 1st ID successfully utilized five AFN trucks to support the division's mission. With the AFN-OTM's mobility, the division could support dispersed, independent command posts (CPs). Two trucks were dedicated to the Division Tactical Action Center (DTAC) node and were tethered to an "Expando" van for the Joint Air Ground Integration Center (JAGIC) and current operations CUOPS to conduct operations. Although the AFN trucks can work OTM, the division benefited most at-the-halt or short-halt, with the ability to rapidly establish a stable and secure connection to the 1st ID High Speed HSMC network.

The remaining three AFN trucks supported other critical functions. Two trucks supported the targeting cell and mobile command group (MCG), providing them with the necessary connectivity to conduct their operations. The fifth truck, meanwhile, played a crucial role in supporting the analysis and control element (ACE) from the rear CP, providing them with the bandwidth they needed to function effectively. This support was a significant win for the ACE, as there were no other tactical systems available that could meet their bandwidth requirements aside from a fiber connection. The AFN truck's ability to provide reliable and high-bandwidth connectivity made it an essential asset for the ACE, and its success in this role was a key factor in the overall success of the rotation. The combination of LEO, GEO, and LTE technologies offers a significant enhancement to traditional beyond-line-of-sight (BLOS) Ultra High Frequency (UHF) Tactical Internet (TI) capabilities.

Unlike traditional military satellite (MILSAT) systems, which rely on GEO constellations and are characterized by high latency (typically 650 milliseconds or greater) and low bandwidth, the AFN solution provides a much more robust and responsive communications capability. With data speeds reaching an upwards of 250 Mbps, the AFN system far surpasses the limited bandwidth of traditional MILSAT equipment, which typically ranges from 512 Kbps to 16 Mbps. The limitations of traditional MILSAT systems become even more pronounced in congested environments, where bandwidth availability per terminal or

unit decreases as more forces enter the theater. In contrast, the AFN system's ability to leverage LEO, GEO, and LTE technologies enables it to provide a more reliable and high-bandwidth solution, even in environments with high demand for SATCOM. By addressing the limitations of traditional MILSAT systems – including latency and congestion – the AFN solution enables commanders to receive, process, and send critical data promptly and effectively.

Successful integration of emerging technologies, including the AFN-OTM package, during 1st ID's NTC rotation has yielded significant outcomes and lessons learned. Notably, the division could complete its rotation without relying on fiber connections for any of its CPs, demonstrating the effectiveness of commercial LEO terminals as a primary SATCOM system.

The Army should prioritize the rapid procurement of commercial LEO terminals for every formation and invest in researching ruggedization and anti-jam capabilities for future LEO terminals. Additionally, the Army must allow divisions to invest in their HSMC networks with regular upgrades and life-cycle replacements to remain current with emerging technology and security requirements. These upgrades will enable units to maintain a high network uptime and support level, as demonstrated by 1st ID's impressive uptime during the NTC rotation.

The 1st ID Network Operations section's success in supporting the division's network priorities has laid the foundation for future missions. It is a model for how units can leverage innovation to enhance their capabilities. Virtualized mission command systems and commercial LEO SATCOM are prime examples of how the unit of action can use emerging technologies to improve operational effectiveness.

As the Army continues to evolve and adapt to new challenges, it is essential that units are empowered to innovate and adopt new technologies and that the service prioritizes investment in the infrastructure and capabilities needed to support these efforts. By doing so, the Army can ensure that it remains at the forefront of technological innovation and is well-equipped to meet the demands of future operations.

About the authors

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