**Next Generation Command and Control (NGC2)**

**Findings Report from the Network Modernization Experiment (NetMod-X)**

**Purpose.** Describe the seven learning outcomes and actions taken from the 2024 NetMod-X.

**Background.** The electromagnetic spectrum is becoming more congested and contested as sensors proliferate our formations and our adversaries develop capabilities. The NGC2 program must overcome these challenges and ensure commanders have access to the mission critical data and services required to make better, faster, and more decisions than the enemy. To accomplish this, NGC2 provides a multi-layer technology stack that is highly adaptable, intelligent, and enabled by an integrated data layer. The integrated data layer is responsible for the synthesis of information across warfighting functions, and leverages a high capacity, low latency network as the backbone to enable its modular software solutions.

**Previous Demonstrations.** Previous demonstrations of NGC2 focused on the application layer and included digital workflows for a subset of prioritized domains.

**NetModX Experimentation Methodology.** NGC2 integrated with NetModX, DEVCOM C5ISR Center’s annual field experiment, to examine technologies for tactical operations in denied, degraded, intermittent, and limited (DDIL) environments. The experiment employed the same digital workflows across applications as the previous NGC2 demos, but the design added complexity with a compute layer a transport layer and networking solutions that automatically routed data packets to meet mission requirements.

**NGC2 Learning Outcomes (LO).** NetModX highlighted the importance of seamless interaction between the application, data, compute, and transport layers (full stack approach). The following LOs are supported by quantifiable data and the development, performance, and resiliency of the NGC2 ecosystem.

**NGC2 Application and Data Layers.** Although the experiment focused primarily on the compute and transport layers, it became apparent that the software and data load on the network required deeper analysis and attention. Peak functionality occurred when the software and network teams collaborated and had a thorough understanding of the architecture and its dependencies. The resulting approach effectively integrated the layers and highlighted the strain heavy software workflows have on a limited tactical network. The **first LO**, to optimize software for the tactical network, requires developers to code leaner software for use at the edge, and is an imperative for operating in challenging environments.

**NGC2 Compute Layer.** The loss of commercial cloud connectivity allowed us to test an *edge node architecture*, we transitioned the NGC2 ecosystem from *cloud-dependence* and experimented with *cloud-enabled* configurations when connected, and *cloud-independent* when disconnected. The cloud-independent iterations utilized high capacity, low size, weight, and power (SWaP) edge compute to increase resiliency and decrease latency within a decentralized mesh architecture. **The second LO**, to implement a *hybrid computing environment* that seamlessly transitions between *edge to cloud, cloud to edge, and edge to edge*, requires microservice orchestration and data distribution between nodes that reflect network availability. **The third LO**, to implement a network architecture tailored to the tactical network that dynamically adapts to external conditions and traffic load while providing automated selection of appropriate data links when congested. **The fourth LO** is to develop microservices at each layer that dynamically adapt to mission requirements via application programming interfaces for inter-layer orchestration.

**NGC2 Transport Layer.** The experiment demonstrated the importance of *low latency, diverse transport* and *data centric waveforms* to support data intensive applications and services and revealed the inability of legacy network systems to support the robust data requirements of the NGC2 ecosystem. **The fifth LO**, to provide *diverse, low latency transport* complements the **sixth LO**, to develop and integrate *data centric waveforms*. Both are necessary to support NGC2’s data rich ecosystem and workflows, which are an exponential increase to today’s program of record mission command information systems (MCIS). **The seventh and final LO** refers to a commander’s need for *real-time signature awareness, management, and response actions*.

**Actions Taken.** The results from NetMod-X were used to update the NGC2 Characteristics of Need (through a controlled release) to further refine the requirements at the application, data, compute, and transport layers, and to account for the entire technical stack as a singular ecosystem.

**Conclusion.** We are at an inflection point in our Army’s data centric transition. The future operating environment will be data rich and require a network that values low latency transport, a hybrid computing environment that prioritizes our warfighting formations at the edge, and an intelligent, SDN that is agile enough to maintain adequate levels of performance in the face of a technologically advanced enemy. The data derived from NetModX corroborates these learning outcomes as necessary to ensure our commanders have assured access to the NGC2 applications and services needed to maintain decision dominance.