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TTHQ-CG

MEMORANDUM FROM Commander, U.S. Army Transformation and Training Command

MEMORANDUM THRU Vice Chief of Staff, U.S. Army

FOR Chief of Staff, U.S. Army

SUBJECT: Training, Simulation and Experimentation Characteristics of Need

1. **Situation.** The modern character of war and the complex global threat environment are driving a continuous transformation of the U.S. Army across the domains of Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, and Facilities (DOTMLPF). This transformation necessitates the development, enterprise-wide integration, and acquisition of a persistent simulation capability that spans the Live, Virtual, and Constructive (LVC) simulation continuum. Such capability is critical for supporting Multi Domain Operation (MDO) training, systems design, testing, mission rehearsal and planning, experimentation, and analysis in an increasingly complex and contested world.

2. **Problem.** The current Army LVC capabilities, while offering significant potential for enhancing military readiness, face several deeply ingrained challenges that limit their effectiveness. These challenges often manifest as software and hardware systems that are siloed and costly, resource-intensive to execute, and rigid in their ability to keep pace with advances in technology and provide the agility and innovation required to support Mission Commander training requirements. They lack interoperability, scalability, and the ability to support Multi-Domain Operations in time and cost-effective manner.

A primary challenge plaguing LVC simulation is the tendency for systems to be developed in isolation, creating expensive, siloed simulation environments. This fragmentation stems from a lack of a unified approach to development, interoperability, and adoption of commercial industry software, gaming, and simulation standards, resulting in a collection of disparate systems rather than a cohesive whole. These limitations hinder the Army's ability to conduct cross-community collaboration, training, experimentation, and decision-making at the speed and scale required for modern warfare.

3. **Objective.** To effectively meet the demands of modern warfare, the U.S. Army seeks to establish a persistent LVC simulation environment built upon a foundation of composable services. This architectural approach will enable the creation of tailored

Army exercises where training occurs, seamlessly scaling from individual Soldier training to complex, collective combined arms maneuver, as well as supporting critical experimentation, analysis, and Test & Evaluation. Such a system is defined by its low cost and ease of use, providing Soldiers with ready access to complex simulation through intuitive interfaces. By ensuring that all components are connected systems, we can eliminate the legacy problem of siloed platforms and create a truly integrated simulation ecosystem that enables the reuse of simulation and data from concepts through sustainment. Ultimately, this evolution of LVC capabilities will leverage data and modern technologies, such as Artificial Intelligence (AI), gaming advances, and cloud computing, to deliver a flexible, adaptable, and data-driven relevant simulation, instrumentation and transport capability that prepares the force for the challenges into the future.

4. **Key Characteristics.**

a. **On Platform / Embedded Simulation.** Embedded sensing on weapon platforms is the critical enabler for modernizing the Army LVC environments. By integrating continuous data collection across all warfighting functions, the Army seeks modular and interoperable commercial solutions to capture the precise, real-world performance metrics of active weapon systems. This operational data is synthesized to produce high-fidelity digital representations, or digital twins, that accurately replicate the physical and functional warfighting capabilities of the platform. Within LVC simulation and instrumentation environments, these data-driven models should enable the warfighter to exercise the kinetic and non-kinetic platforms during training, mission rehearsal, testing and experimentation events.

b. **Games and immersive technologies.** The Army seeks commercial-proven gaming and immersive technologies that provide intuitive, scalable, and persistent simulation experiences across the LVC environments. These capabilities should support rapid scenario generation, realistic interaction with terrain and platforms, and accessible training from the individual to collective level at the point of need. They should leverage mature commercial technologies to reduce development timelines and lower total ownership cost. Immersive capabilities should enhance realism, improve repetition at scale, and increase soldier engagement within the operational environment without imposing excessive technical burden on units.

c. **Artificial Intelligence (AI) enabled Modeling.** The Army seeks AI-enabled modeling capabilities that accelerate the creation, adaptation, and employment of entities (individuals, units, vehicles, weapon systems, etc.), synthetic environments, behaviors, and outcomes across LVC events. These capabilities should improve fidelity, reduce manual workload, and support data-driven training, testing, experimentation, systems design, and analysis. AI-enabled tools should support rapid updates to scenarios, threat behaviors, and environmental conditions in response to changing operational demands in near real-time. These capabilities should also assist

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commanders, trainers, testers, product managers, and analysts in identifying trends, assessing performance, and informing decisions from large volumes of exercise data.

d. **Automation of data-centric plan, prepare, execute and assess.** The Army seeks automation across the exercise lifecycle to reduce time, manpower, and technical burden associated with planning, preparation, execution, and assessment. These capabilities should enable rapid exercise creation, orchestration, data collection, performance analysis, and After Action Review at echelon. Automation should minimize manual integration and configuration activities that currently slow exercise delivery and increase support requirements. It should also enable repeatable, scalable execution of simulation events and provide timely feedback to leaders and units to improve readiness. This includes leveraging authoritative data sets across the Army and Joint Force to more readily test, train, rehearse, and fight.

e. **Enable Warfighting Functions (WfF) through convergence with Army and Joint Force Operation Platforms.** The Army seeks to converge the environment with Army and Joint operational platforms to train, test, and experiment as the force fights across all warfighting functions. These capabilities should enable interoperable data exchange, shared operational context, and integrated employment of mission command and warfighting systems within training, testing and experimentation environments. Convergence should allow operational and simulation systems to share relevant data and services without creating separate training-/test-/systems design/experimentation-only architectures. This approach should strengthen realism, improve training relevance, support the development of improved capabilities, and better prepare units to operate across echelon, domain, and formation boundaries.

f. **Realistic Threat Representation.** The Army seeks realistic, scalable, and continuously updatable threat representation across LVC environments. These capabilities should replicate contemporary and emerging threat doctrine, formations, signatures, tactics, techniques, procedures, and multi-domain effects to support relevant training, testing, mission rehearsal, systems design, and experimentation. The threat representation should be dynamic and informed by current intelligence, operational observations, and validated threat models to maintain military relevance. They should also support opposing force behaviors that are adaptive, credible, configurable and capable of challenging simulation users under contested and complex conditions.

g. **Universal Accessibility and Cybersecurity.** The Army seeks LVC capabilities that are universally accessible to authorized users while maintaining cybersecurity, resilience, and trust across the enterprise. Using proven commercial software security techniques, these capabilities should support secure use across distributed environments, reduce barriers to adoption, and protect systems, data, and training, test, and experimentation events from disruption or compromise. Accessibility should enable simulation access at unit home stations, in institutional settings, and across geographically dispersed networks with minimal specialized support. An integrated cybersecurity framework must be built into the architecture from the outset to protect data integrity, user access, system availability, and mission assurance.

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h. **Mission Partner Interoperability.** The Army seeks commercial standards-based interoperability with Joint, interagency, interorganizational, and multinational

mission partners across the LVC environment. These capabilities should enable secure simulation interchange, data exchange, and collaborative training, test and experimentation with mission partners at the appropriate classification levels. Interoperability should be achieved through common simulation, software, and hardware standards, interfaces, and governance paradigms that reduce custom integration and improve speed of coalition participation. These capabilities should allow the Army to train with partners in a manner that reflects real-world command relationships, information sharing constraints, and multinational operational requirements.

i. **Network.** The Army seeks to fully exploit modern Command and Control (C2) networks, specifically the Unified Network, to facilitate the transport of high-fidelity LVC data between geographically dispersed sites, including fixed, mobile, and expeditionary sites. The Army modern C2 networks will serve as the foundation for LVC integration. The Army strives to transition from siloed simulation events to a persistent, globally accessible training, mission rehearsal, testing, systems development, and experimentation architecture. This ensures that the network is not just a tool for communication, but a foundational platform for readiness and modernization.

5. **Technology Stack.** The Army seeks to consolidate the simulation and training portfolio into a single, integrated LVC simulation capability enabled by commercial-proven, data-centric architecture. This architecture should transition the Army from large, monolithic simulation systems toward open, modern simulation and software services across the instrumentation, transport, and LVC software layers. It should enable seamless data exchange across warfighting domains, support rapid insertion of emerging technologies, such as computer vision, 3D engines, and agentic AI, and simplify deployment during exercises, tests, mission rehearsal, experimentation, and analysis while evolving with emerging commercial technologies.

The Army further seeks an enterprise approach in which LVC services are modular, discoverable, and accessible through defined interfaces, open standards, and accessible Application Programming Interface (APIs). This environment should support continuous delivery, interoperability with Army Enterprise Services, and compliance with common data reporting standards, including data mesh, to improve scalability, usability, and long-term sustainment.

Figure 1 represents the Army's vision for an integrated enterprise LVC capability for the training domain, as an exemplar LVC implementation. The subsequent discussions decompose how the layers build upon each other to enable other LVC implementations, such as training, experimentation or test.

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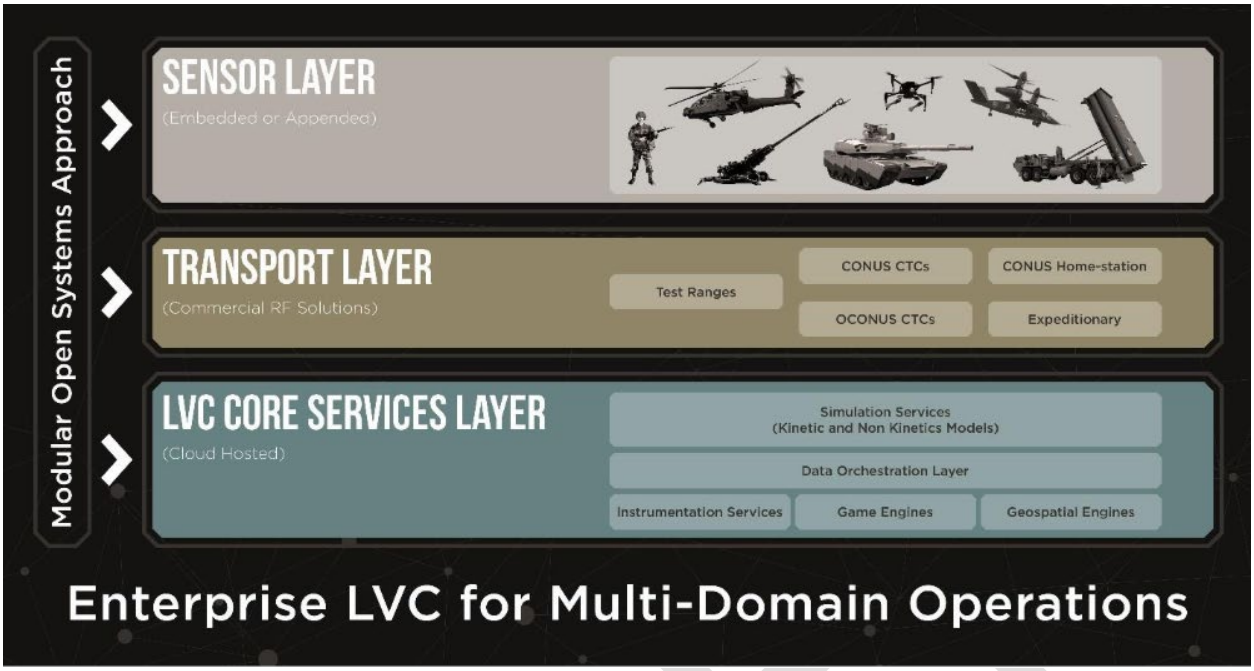

Figure 1. LVC Enterprise Architecture for Training Multi-Domain Operations

a. **Sensor/Instrumentation Layer.** The Army seeks an instrumentation layer composed of modular sensing capabilities developed and embedded across BLUFOR and OPFOR weapon systems and related training devices. Moving away from single-product solutions, this layer should collect data for simulation, feedback, experimentation, and analysis across training environments. These capabilities should support the digital representation of live warfighting systems and provide the foundational data needed for persistent, integrated LVC environments.

Examples of opportunities for evolution of instrumentation capabilities include tactical engagement systems, OPFOR sensors, live fire targets, observer controller (OC) tablets, player unit devices, immersive devices, simulators, weapon platform sensors, and transmitters. Looking ahead, the Army seeks to collect data organically from operational platforms, including C2, counter-C2, and aviation systems, with solutions that minimize size, weight, and power while accurately representing live capabilities in the digital space.

Embedded sensing on operational and training platforms should enable continuous data collection across warfighting functions, improve fidelity, support performance feedback, and contribute to high-value readiness data. This instrumentation layer should serve not only current training needs, but also the broader Army-Verse objective of establishing a persistent simulation environment capable of supporting training, testing, rehearsal, experimentation, and analysis.

b. **Transport Layer.** The Army seeks a transport layer that serves as the communications infrastructure for moving high-fidelity LVC, simulation, and instrumentation data at speed from sensors and operational platforms to simulation engines, instrumentation services, and enterprise data environments. This layer should fully exploit modern Army and commercial networks, including the Unified Network, to enable globally accessible and persistent training and testing capabilities across fixed, mobile, and expeditionary sites.

The Army envisions the transport layer as a catalog of services tailored to spectrum, geography, bandwidth, resilience, and cost considerations. It should maximize commonality with C2 and counter-C2 efforts, reduce duplication, support secure and resilient distributed operations, and enable transition from isolated training events to a persistent, accessible LVC architecture.

c. **Core Services Layer.** The Army seeks a core services layer representing the convergence of program product lines into a single LVC environment powered by instrumentation, sensor data, and simulation services. Using modern data and software practices, this layer should enable the composition of software instances at the point of need to support wargaming, Combat Training Center rotations, homestation training, applications, operational tests, mission rehearsal, experimentation, systems design, and analysis. The core services layer must be able to enable transport layer and sensor / instrumentation layer capabilities specific to this broad and diverse set of uses.

Core services should include data fusion services, gaming and simulation engines, digital terrain and geospatial services, and modeling technologies. This layer should be data-centric and AI-enabled, enabling soldiers and leaders to instantiate simulation instances based on mission objectives that initialize LVC simulation environments and in connection with Army enterprise services.

The core services layer should be modular, standards-based, and governed to support multi-developer collaboration, rapid technology insertion, and continuous improvement. It should enable best-of-breed contributions from government, commercial, and other technology providers while reducing integration burden and delivering military simulation capability at scale and speed of relevance.

6. **Amendments.** This Characteristics of Need Statement is a living document and will be updated as required based on technological observations and lessons learned.