Future Construct/Architecture for Modeling and Simulation Support to Joint and Collective Training Across the Continuum of Military Operations

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ABSTRACT

NATO and our nations face an increasingly complex global security environment that requires training that reflects the current strategic environment, supports the span of military operations, and stimulates our forces to adapt and innovate faster than the enemy. However, current training capabilities like modeling and simulation lack the architectural framework and technological approaches to provide sustainable and agile capabilities to support these requirements. Advances in information systems technology demonstrate that more efficient, agile, and secure systems are possible. Legacy approaches of federating disparate tools require significant time and specialized contract labor to design, plan, and execute exercises or events. To respond to these challenges, the U.S. Joint Staff J7 is developing and transitioning to an enterprise service approach for joint training tools that will provide trainers the ability to replicate operational environments across the full spectrum of military operations, with an objective end-state of being able to do so with increased effectiveness and reduced cost during the design, plan, prepare, execute, and assess stages of an exercise. The architectural framework and technological approaches to provide sustainable and agile capabilities to support these requirements are currently in development. This paper will explore this approach that focuses delivering services that include: a single common user interface, web services, dynamic exercise flow and management, integrated scenario development, enhanced response cell operations, sharable data repositories, faster-than-real-time simulation, scalable cloud infrastructure, M&S configuration and management, and outcome assessment.

1.0 CHALLENGES FOR JOINT TRAINING

Today's military forces encounter evolving national threats, economic constraints, and a changing operational environment with a complex, multifaceted, and uncertain security landscape across a range of political, military, state and non-state actors. Advancing and sustaining the U.S. Department of Defense's (DoD) operational readiness for these threats require a portfolio of training capabilities that support a learning continuum from individual, staff, to collective training. This portfolio must create the training environment that prepares the total force to accomplish a diverse and complex set of missions that demand an ever-changing combination of military engagement, security cooperation and deterrence competencies.

However, the current training environment portfolio includes essential modeling and simulation (M&S) capabilities that lack the architectural framework and technological approaches that provide sustainable and agile tools to support these requirements. To meet Combatant Command, Service, and Agency (C/S/A) M&S-related training requirements that support development and sustainment of readiness, the next generation of capabilities must respond to the following challenges:

- Federated Architectures are outdated—vulnerable and inefficient. The current approach for simulation supported training is to establish a net-centric interoperable capability through the federation of multiple and diverse simulations. Today's tools and technical infrastructure are:
  - Predominantly monolithic (all or nothing)—limited/no ability to compose or tailor unique training environments to meet specific trainer/trainee objectives.
  - Built to differing standards that require significant time and specialized contract labor to integrate into useful federations that support exercises or training events.
  - Expensive to operate and sustain.
  - Lack the adaptability to reflect changing operational environment and emergent threats.
  - Are technically complicated, limiting the ability to make effective change to the synthetic representation of the operational environment.
  - Contain redundant capabilities.
  - Provide support for discrete events versus continuous on-demand (24/7) accessibility.
  - Are increasingly under pressure to meet growing infrastructure consolidation and cybersecurity compliance mandates.
- Advances in information systems technology demonstrate more efficient, agile, and secure systems are possible compared to our current capabilities.
- Growing demand for M&S supported training – currently impeded due to the complexity, time and cost required to plan, provision, and execute synthetic environment exercises.
- Reliance/dependence on "proprietary solutions" may limit innovation and increases licensing costs.
- Increased demand for M&S supported training at the tactical and operational force levels.
- Expanding demand for integration of partner nation M&S capabilities in support of multi-national training events and exercises.

2.0 VISION FOR RESOLVING CAPABILITY GAPS

The next generation of training tools must support trainers in preparing the total force to accomplish a diverse and complex set of missions that demand an ever-changing combination of military deterrence, security cooperation and engagement competencies. Commanders at all echelons are the primary trainers responsible for preparing their units to accomplish assigned missions. To assist Commanders in preparing for current and future conflicts, these tools must replicate and adapt to the operational environment.

2.1 Vision

A joint training synthetic environment (JTSE) toolset that enables accurate, timely, relevant and affordable education, training, exercises, and mission rehearsal in support of current and future Combatant Command and Service readiness priorities. These training capabilities shall:

- Support interoperability and integration among DoD and mission partner simulations. Mission partners are those with which the DoD cooperates to achieve national goals, such as other departments and agencies of the U.S. Government; State and local governments; allies, coalition members, host nations and other nations; multinational organizations; non-governmental organizations; and the private sector.
- Maximize ease of use—easy enough for direct use by military audience (trainers).

- Scale to support multiple simultaneous users/events
- Support "condition" based vs. "time" based phase transition during an exercise; "Faster than Real Time."
- Provide "on-demand" M&S services delivered via web-browser.
- Facilitate the development and delivery of distributed learning capabilities that meet the DoD and mission partners' joint learning and readiness objectives.
- Reduce the costs associated with development and support of new/improved functionality.
- Improve the interoperability and information sharing with allies, agencies, and non-government organizations in support of training.
- Simplify provisioning and use of training capabilities to both trainers and training event participants across the Joint training enterprise.
- Replicate the desired operational environment to allow warfighters to train for Joint and Coalition operations.
- Mitigate fair fight conflicts.
- "Plug" in user contributions to the JTSE as required.

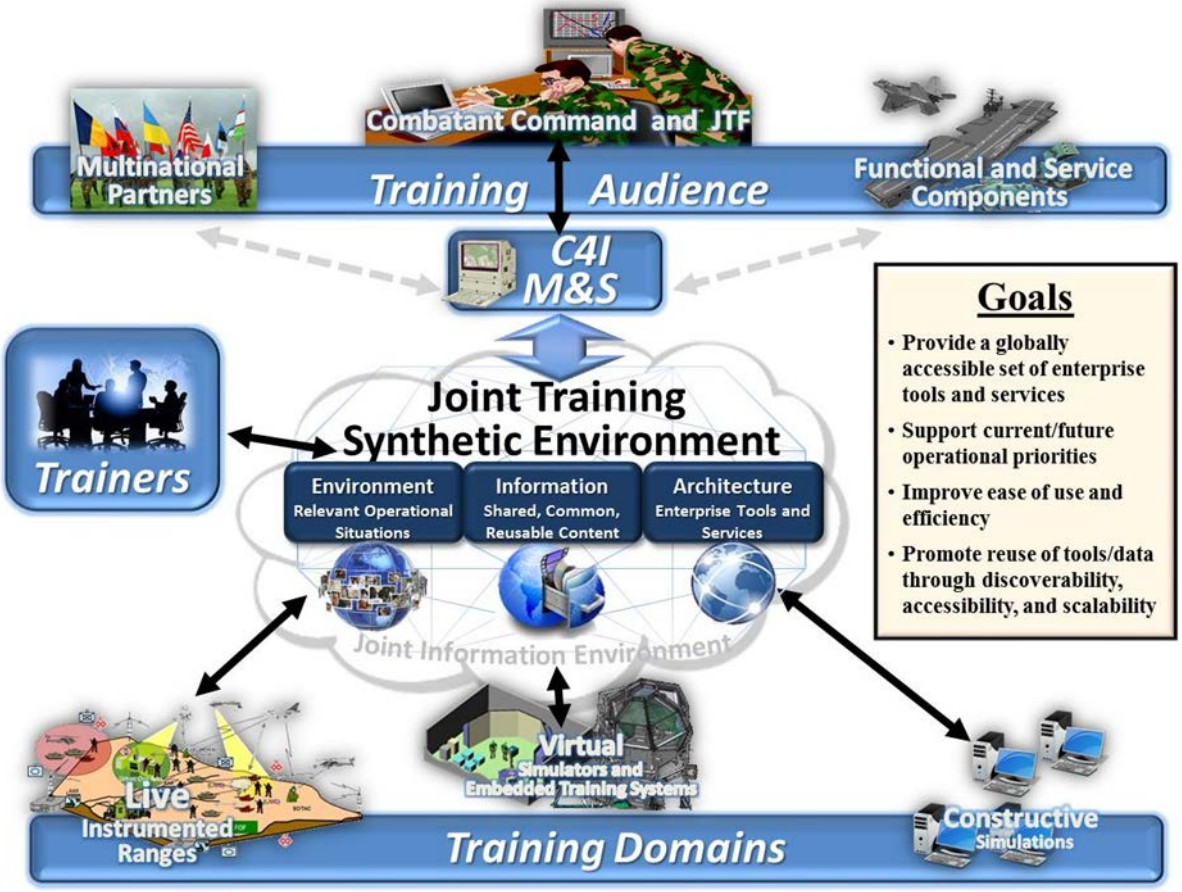

Figure 1 JTSE Operational Viewpoint - 1 (OV-1)

2.2 High-level Concept and Desired End-State

The JTSE Operational Viewpoint (OV) illustrates how future trainers will replicate training domains that meet the needs of Combatant Command (CCMD), Joint Task Force (JTF) and Service component training audiences (see Figure 1). JTSE leverages a Joint Information Environment (JIE) compliant training network to deliver capabilities. JIE is a DoD information technology mandate to transition toward common networks and data centers, enterprise services, and a single cyber security architecture, in order to gain efficiency, reduces redundancy, and improves security. The JTSE will provide trainers a distributed set of enterprise tools and services accessible at the point of need and transparently integrate across the LVC training domains. The domains are defined as: live (human participants using operational systems and platforms in the physical environment), virtual (human participants operating simulators, emulators and operational systems in a synthetic environment), and constructive (human participants are stimulated by and provide stimulus to simulated forces in a synthetic environment). These three enablers may be combined to create a common training domain where units can interact. An integrated JTSE readily enables the stimulation of operational Command, Control, Communications, Computers, and Intelligence (C4I) systems and provides three primary capabilities:

- Environment—Integrated capabilities that enable training across the full range of military operations when and where needed by accurately replicating complex operational context at the necessary levels of detail to meet readiness objectives.
- Information—Shared, common, reusable data and content capable of supporting training scenarios.
- Architecture—An enterprise structure of design elements, standards, relationships, and principles that promote synchronized capability development and facilitates training across U.S., bilateral and multinational geographies, environments, and missions.

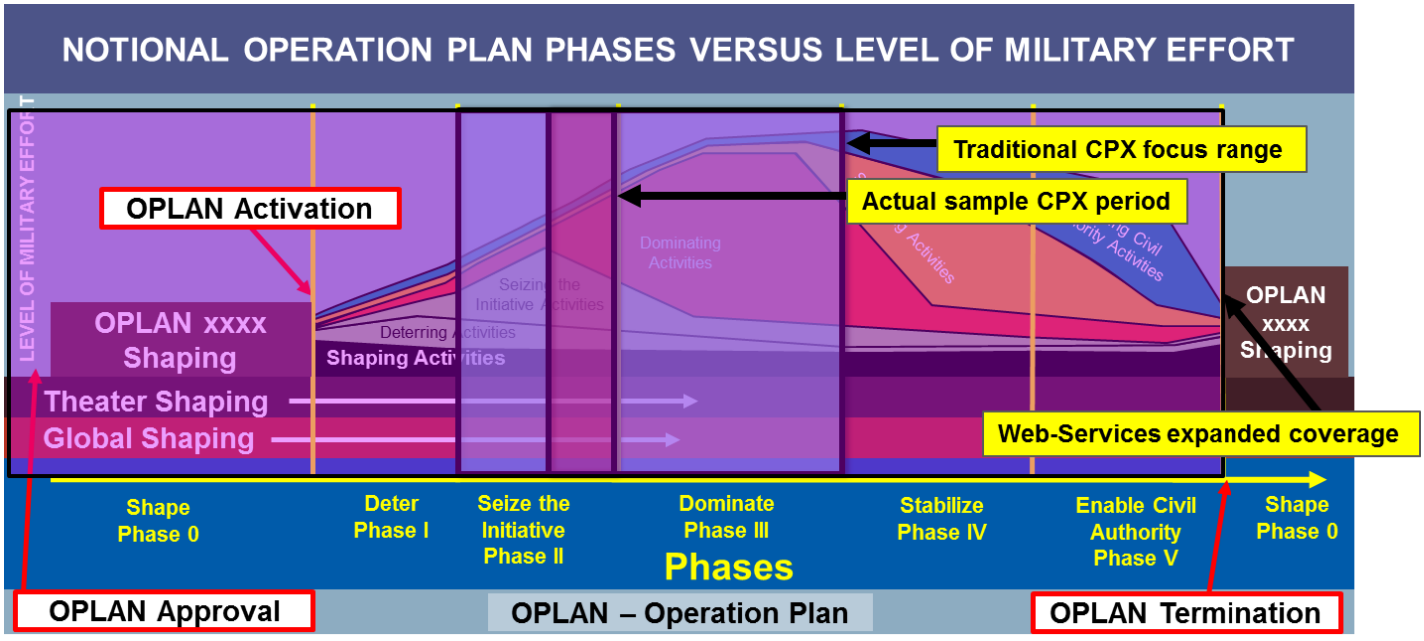

Figure 2 Joint Operations and CPX Focus for JTSE

2.3 Operational Outcome

Commanders and trainers will develop, maintain, and assess readiness by using the JTSE to:

- Facilitate training to support the full spectrum of Joint, interagency, and multinational operations necessary to contribute to maintenance and development of readiness.
- Enable the rapid and efficient execution of Joint Event Life Cycle (JELC) activities. The JELC is the DoD Joint Training System sub-process for the design, planning, preparation, execution, evaluation and reporting stages required to successfully execute discrete training events.
- Enable Combatant Commands/Services/Agencies (C/S/A) and partners (individuals, staffs, and units) to exploit their organic capabilities and collaborate within and across LVC training domains to conduct events in the same battle space regardless of physical location.
- Expand the scope of the command post exercise (CPX) for joint operations beyond the traditional coverage of Phase II (Seize the Initiative) and Phase III (Dominate) phases of joint operations (Figure 2).
- Preserve the "art" component of people training people.
- Promote functional Interoperability with mission partners in support of Joint training

2.4 Capability Requirements

In 2011, the Joint Staff conducted a capability assessment study and subsequent C/S/A focus group meetings in 2012 and 2013. The study identified 14 JTSE gaps in the Environment, Information and Architecture capabilities:

Table 1 JTSE Capability Gaps (CG)

Environment: Focus on the trainer's ability to use JTSE tools to replicate the operational environment	
Gap #	**Capability Gap Description**
CG 01.1	Collaborative – Enable multiple, geographically dispersed trainers and units the ability to coordinate, collaborate, and conduct training.
CG 01.2	Accessible – Facilitate trainer access through direct-use JTSE services.
CG 01.3	User Friendly – Provide intuitive interfaces for the trainer.
CG 01.4	Automated – Reduce manual processes to aid training collaboration, planning, execution, and data collection for After Action Review (AAR) and assessment.
CG 01.5	Operational Relevance – Provide functional capabilities supporting current and emerging operational requirements.
CG 01.6	Agile – Provide LVC environments that quickly adapt to operational need.
CG 01.7	Assessable – Provide tools that capture event data.
Information: Focus on the trainer's ability to prepare and manipulate data:	

Gap #	Capability Gap Description
CG 02.1	Efficient – Minimize the time and resources required to produce and manipulate scenario data.
CG 02.2	Trustworthy – Provide safeguards for secure, current, and relevant data.
CG 02.3	Discoverable – Provide search capability and access to information and services (e.g., tools, services, data, and documentation).
CG 02.4	Flexible – Dynamically manipulate data and data services to match training objectives.
Architecture: Focus on the developer's ability to build enterprise tools	
Gap #	**Capability Gap Description**
CG 03.1	Enterprise-based – An enterprise service that is persistently available via common-use networks (NIPRNet, SIPRNet, and multinational enclaves).
CG 03.2	Integrated – Enable a common JTSE to support C/S/A requirements by aligning as a reference architecture under the DoD Information Environment Architecture.
CG 03.3	Sharable – Provide sustained access to share information with mission partners.

3.0 APPROACH

3.1 Method and Technologies

The JTSE will be developed leveraging the following methods and technologies:

- **Automated information technology**— where feasible and appropriate, automate labor intensive, repetitive tasks to allow trainers (at all levels) to increase their focus on the art of designing, planning, preparing for and executing training.
- **Web-services**—deliver training capabilities as scalable enterprise services to the point-of-need. Exploit "cloud" technologies to increase trainer accessibility and involvement in the planning, provisioning and execution of M&S. Reduce demand on co-location of exercise planners and operators for conduct of an exercise.
- **Collaborative information management—**Promote system interoperability and integration to the training data level (i.e., data elements) through a centralized data repository, authoritative sources, and automated program interface (API) specifications.
- **DoD training architecture based design**—deliver an operationally focused and relevant capability that supports the Joint Training System (See Figure 3).
- **Common, open, net-centric standards**—adopt, adapt or recommend development of standards that support interoperability and integration among U.S. DoD and mission partner simulations.

- **Composable, scalable modular simulation architecture**— use standardized software modules, application program interfaces, and architectures to provide common tools, data, and services for Joint training; promote reuse; and simplify interoperability and integration requirements among training aids, devices, simulators, simulations, and embedded training systems. Promote the organizing, developing and managing of the integration and hosting of LVC capabilities on data centers (location agnostic) that aligns with DoD IT enterprise architecture—supports delivering training enablers as enterprise services while leveraging common DoD IT infrastructure.
- **Common data**—discoverable, standardized, and correlated from authoritative sources.

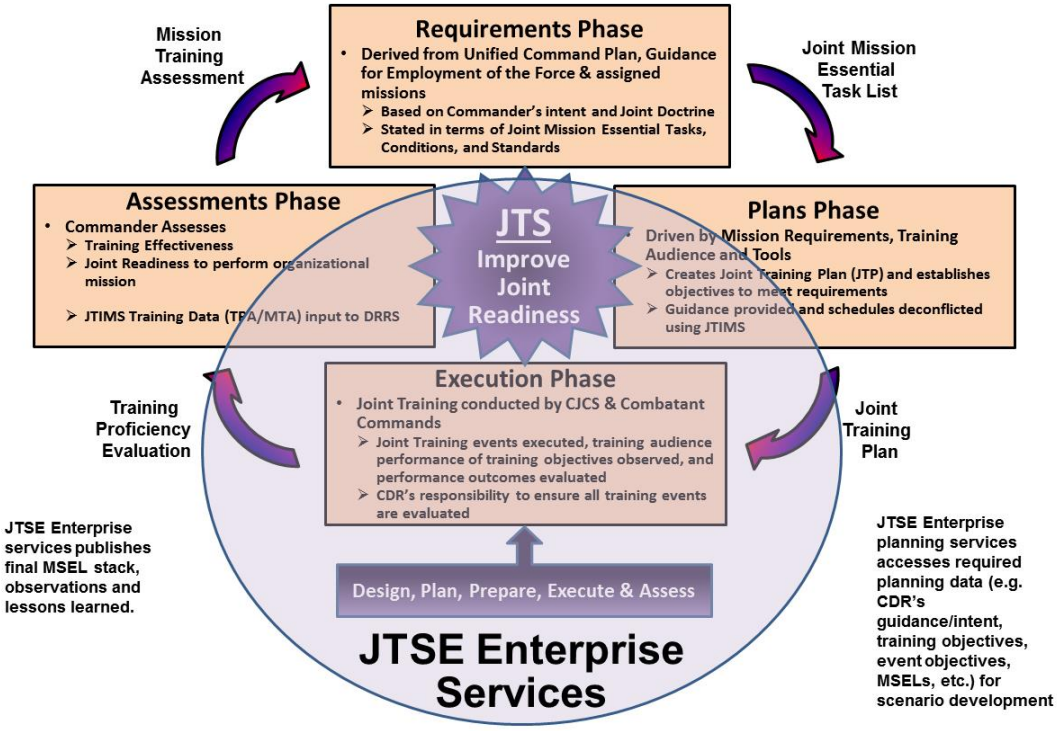

Figure 3 JTSE Relationship to the Joint Training System (JTS)

3.2 Conceptual JTSE Future Use

3.2.1 Data repositories

JTSE will maintain repositories (location agnostic) of configuration-managed simulation-ready data, master scenario event lists (MSELs), and scenario-specific data. Based on authoritative sources, the corrected data mitigates the numerous data correlation problems associated with source data. The data repositories will be accessible and searchable by trainers and will store the corrected data that services will need during execution. It is recognized that the data repositories cannot resolve all data-related issues; since training objectives, mission requirements, classification and releasability requirements, and a myriad of other variables cannot be totally accounted. However, maintaining corrected terrain and order of battle data greatly reduces redundant database production and the time required for generation.

3.2.2 Operational concept

The conceptual use of JTSE is illustrated in Figure 4. Users achieve access through a common user interface. Users design, plan, and prepare for training events, exercises, and mission rehearsal, then transition to execution and performance data collection for after action review, leveraging user friendly (i.e., reduced technical knowledge and expertise dependencies) information systems (IS) and tools. The system supports and maintains interoperability standards for the integration of Service and Agency capabilities supporting events that makes home station or point of need M&S supported/driven training routine. Authorized users are intended to access JTSE services via web browsers, through a secure network connection and appropriate identity and access management (IdAM) authentication processes, and role-based permissions. The following are JTSE enterprise service descriptions:

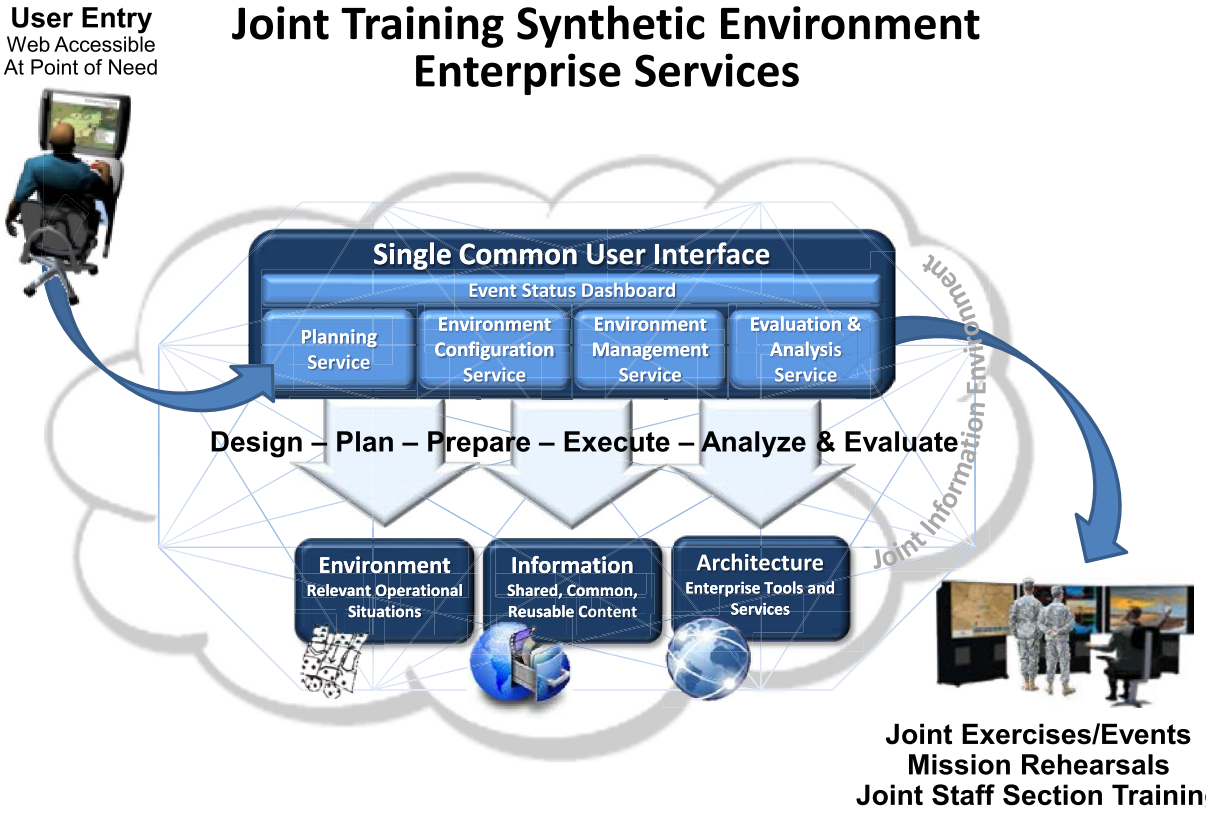

Figure 4 JTSE Operational Concept

- **Single Common User Interface:** Enables access to a collection of services through which all human to machine interactions will occur, excluding Command and Control (C2) devices and interactions with live ranges and virtual simulators. The interface allows access services via a component called the "Event Status Dashboard".
- **Event Status Dashboard:** Provides a visual timeline of scheduled JELC actions and events analogous to a "common operational picture." Deliverables (e.g., Road to War/Conflict, scenario products, Master Scenario Event List (MSEL), manning documents, floor plans, and exercise control plans) associated with

these scheduled events will be depicted as displayed icons and show status visually (e.g., color coding). These icons would also be selectable and allow document reference or editing as required. Documentation would be configuration managed by the system with user permissions to maintain a record of changes. The dashboard would also include a map display showing placement and disposition of scenario forces depicted in standard symbology.

- **Planning Service:** Scheduling, design and planning for Joint training begins with this service. It provides a question-driven user interface to assist the planning process. Choices made in planning service will serve as a primer to help users input or import the correct data based on event objectives, and will identify the starting point for other services and modules to begin. Shortcut options will be available for experienced users. Collected data common to multiple tools within the planning service will auto-populate to those tools, ensuring that the data is handled only once to reduce errors. Timing data on scheduled JELC activities entered into the planning service will auto-populate to the event status dashboard for a visual event timeline, and to other services and modules to coordinate timing and resource allocation. Collected data automatically generates reports or deliverable event documentation using standardized or customizable formats.
- **Environment Configuration Service:** Prepares and deploys the technical infrastructure (i.e., virtual domain) necessary to support Joint training. It facilitates the technical planning process by:
  - Selecting user and access parameters to support configuration of resources
  - Identifying simulation services required to support the training objectives.
  - Preparing the technical infrastructure by: 1) Allocating resources (processors, memory, and storage), 2) Provisioning virtual machines, 3) Component and virtual network development and management.
- **Environment Management Service:** Refines and synchronizes the event scenario by providing:
  - MSEL, Order of Battle (OOB), and scenario information management tools.
  - Ability to display, check, and synchronize event OOB with master scenario events.
  - Event execution monitoring and management tools that provide the ability to update, synchronize, and display real-time changes to MSEL and OOB during execution.
- **Evaluation (Outcome Assessment) and Analysis Service:** Collects event data and assists analysis in support of facilitated after action reviews (AARs) and the Commander's readiness assessment. This service:
  - Identifies and publishes the standards, Commander's intent, and training objectives in a Collection Management Plan.
  - Documents the AAR concept of operations processes and products during event planning.
  - Monitors human activity and compares against the established training objectives.
  - Captures information pertinent to the exercise AAR process.
  - Generates post-event reports, assessments, and other products for analysis of outcomes.

3.3 Key Supporting Capabilities

The JTSE relies upon both existing and nascent approaches to achieve sufficient LVC interoperability and compatibility:

- **International Standards:** The Joint training enterprise requires a common set of open, net-centric, national, international standards, and protocols that promote interoperability, data exchange, open system architecture, and software reusability. Common standards and an enterprise approach will enable the

organization, development, management, and integration of DoD capabilities that provide effective and efficient information exchange between each other.

- **U.S. Joint Information Environment (JIE) Architectures and Standards:** The JTSE will make full use of the DoD's common-use networking capability called the DoD Information Network (DoDIN). The DoDIN is built to the JIE architectures and standards. The JTSE capabilities are being built to comply with same specifications to maximize interoperability, information availability, and mission effectiveness. Leveraging the JIE networks, single security architecture, enterprise services, and data centers gains efficiency, reduces redundancy, and improves cyber security. Training requirements that dictate unique training solutions will operate within JIE parameters and follow current cybersecurity policy and guidance. Compliance with JIE mandates further facilitates integration with partner nations, in that the capability to interoperate with partner nations is included as a requirement within the environment performance objectives.
- **Joint Training Enterprise Architecture (JTEA):** Provides the technical framework that further defines standards and technologies for building the future JTSE. JTEA will provide a reference architecture and management framework to modernize the delivery of Joint enablers to Combatant Command/Services/Agencies (C/S/A) and mission partners, while meeting mandated requirements for aligning information systems and technology infrastructure within the JIE.
- **Data Center Consolidation (DCC) Initiative:** DCC is a U.S. federal mandate to improve efficiency and reduce unnecessary spending on Information Technology (IT) by reducing the number of data centers across the federal government. Objective is to reduce Data Centers by 40 percent.
- **Mission Partner Environment (MPE):** A mission network based on common standards, operational concepts, and tactics, techniques, and procedures among nations, commanders, and components for operations and warfighting, with information-sharing flowing naturally from effective command and control. MPE is similar to and aligned with NATO's Federated Mission Network (FMN). JTSE needs to leverage the MPE in becoming a strategic tool for cooperative engagement that enables mission partners to train with common simulations and stimulate each other's compatible command and control (C2) systems. Mission partners are essential to today's globally integrated operations where partnerships are built and enhanced through shared training and combined exercises. A JTSE objective is to interoperate with our mission partners within the Mission Partner Environment as well as stimulate their compatible command and control (C2) systems.
- **Modeling & Simulation as a Service (MSaaS) Technical Activity (MSG-136):** NATO M&S Group activity focused on 1) evaluating the use of MSaaS to improve simulation interoperability and credibility, 2) analyze MSaaS from the organizational perspective to establish a sustainable and efficient management construct to deliver and manage M&S services in NATO, and 3) develop, test and experiment with an MSaaS Reference Architecture and associated services. MSaaS is an essential enabler for delivering an enterprise-based JTSE that is web-accessible, scalable and collaborative.

3.4 Capability Development Management Construct

JTSE capabilities are expressed as seven interdependent Lines of Effort (LOE) that logically group technical solutions that support the objective JTSE endstate, and one semi-independent LOE that is focused on maintaining the current LVC architecture viable as the future architecture is realized.

3.4.1 Guiding Principles: Four principles for developing LOE:

- Production of the new training system should not harm existing capabilities already available in the Joint Live Virtual and Constructive (JLVC) Federation.
- Development should first address services that have common use across the JTE (e.g., terrain and OOB services).
- Development of Joint modular capabilities will adopt a use case-based, incremental approach.
- Future capabilities would be consistent with the Department's objectives for JIE and Data Center Consolidation Initiatives.

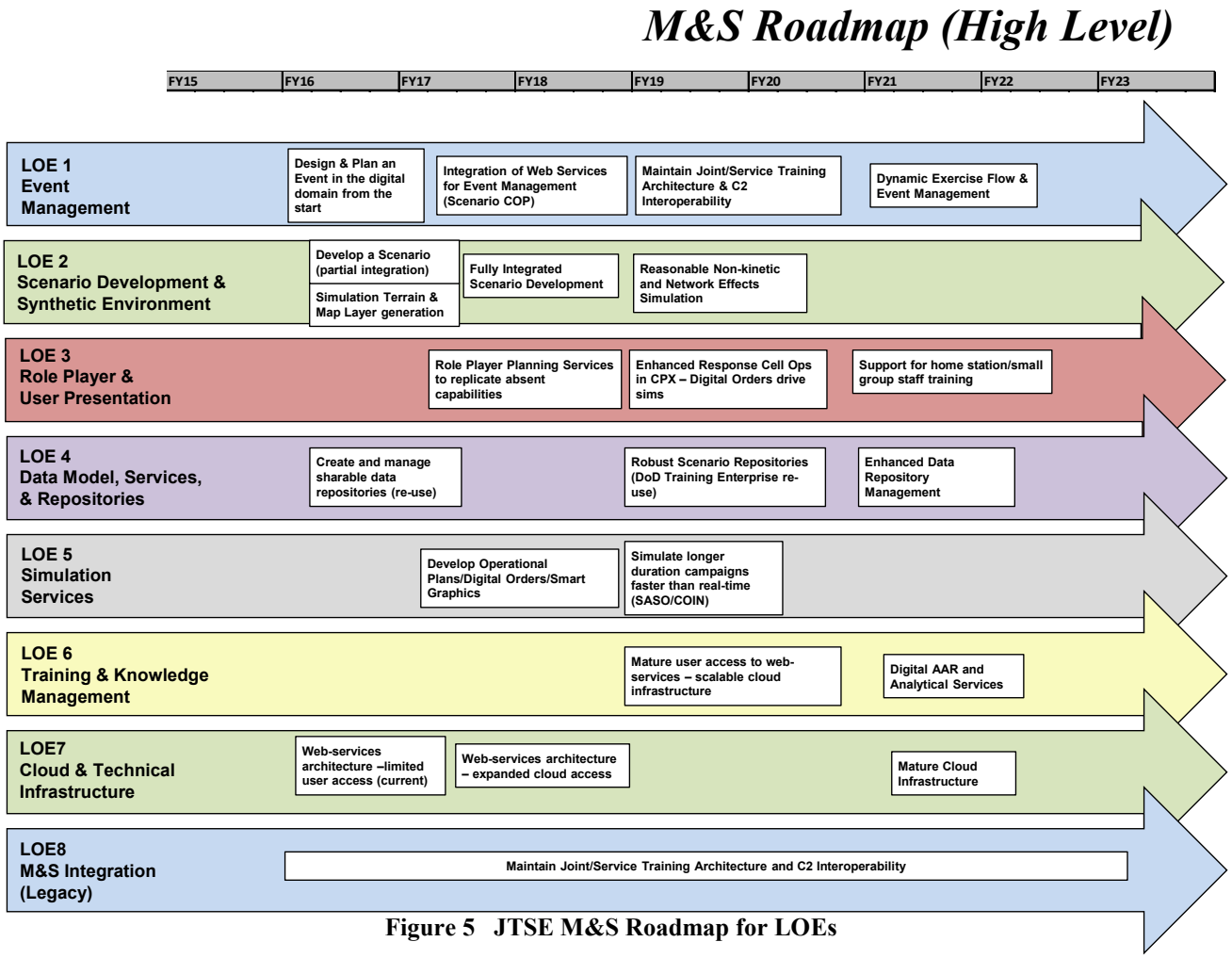

Figure 5 JTSE M&S Roadmap for LOEs

3.4.2 Capability Lines of Effort (LOE): Provides descriptions, focus areas and roadmap (See Figure 5) for the JTSE capability development.

- LOE 1—Event Management: Enhances and automates the planning, management, and synchronization of a joint training event.

  - Distributed event planning - The ability for users to perform many of their planning functions via the network.
  - Synchronized Master Scenario Event Lists (MSEL), MSEL injects, scenario, M&S objects, storyline, as well as simulated sensor stimulations that populate C4I systems.
    - Modify once, synchronize the change across many databases and documents, plus retain what was done for evaluation and reuse.
    - Easily and automatically adjust, change, and re-synchronize data real-time across the event flow.
  - Simplify the configuration management (CM).
    - Update all exercise databases and documents.
    - Account for C2 stimulation of Mission Command Systems.

- LOE 2 –Scenario Development and Synthetic Environment: supports event planning; story line, MSEL and other database information for automation of scenario development and synthetic environment, control and movement. Specifically, this requires the creation of a road to crisis, development of the scenario files required by the simulation, and subsequent loading (i.e., simulation ingestion) of these files in preparation for the start of the exercise or event (STARTEX). Characteristics of these files include:
  - Scenario generation by trainers at Tier 1 through Tier 4 sites to include home station.
  - Create realistic terrain; correlated from authoritative sources within hours.
  - Create force flow based on Task Organization that is synchronized within the Concept of Operation.
- LOE 3 – Role Player and User Presentation: supports establishing player roles and the user presentations that allow the military training audience (TA) to directly use automated tools and simulation throughout the JELC. Supports providing access for planning, training, and learning on demand via the web. Specifically this requires the TA generation of training by-products that can be linked to operational planning. Following are by-product exemplars:
  - Generate digital orders and plans (e.g., Air Tasking Orders (ATOs) and Time Phased Force and Deployment Data (TPFDD)), and keep the orders up to date based on scenario changes.
  - Allow for TPFDD flow, then assess impact (e.g., port supportability).
  - Make simulation available during exercise planning via the web.
  - Enable longer stimulation period (i.e., longer duration) force flow and Intel play outside the event execution days. Stimulate decision-cycles outside 5-10 day CPX cycle.
  - Eliminate simulation specific orders – Provide trainers, planners, and other users with easy to use interface.
  - Directly link the TA actions/decisions to conditions in the simulation.
- LOE 4—Data Model, Services, Repositories: supports JTSE data creation and management that enables the automated ingestion of data from a range of "authoritative" sources, correct or fix it, correlate it, manipulate for purpose, and make it usable (i.e., simulation ready). This is "behind the scene" system work the planners/trainers/users normally do not see. Specifically this requires:
  - A large repository of correlated simulation ready data.
  - Synchronization of the data exchanges that directly connect to scenario, mission command systems, synthetic environment data, and processes in both planning and execution with dynamic variable time scale.

  - Translation of standard orders and graphics from operational to simulation use.
  - Data markup for discovery.
  - Data editors to automate data content creation and generation.

- LOE 5—Simulation Services: provides "simulation as a service" using a loosely coupled architecture of simulation services that are designed to be available on demand via a web Application Program Interface (API). Services will be implemented incrementally as new information is obtained. These services are expected to be modular for ease in updating/improving while reducing redundancy. In-work are the services required to simulate Tier 1 & 2 training situations where the context is at the Joint campaign level, and the ability to enable Tier 3 & 4 training. Specifically this requires:

  - An ability to simulate longer duration campaigns and scenarios (i.e., faster than real-time).
  - Long term modularity making simulation cheaper to sustain and easier to replace.
  - More consistent outcomes when executing the same scenario.

- LOE 6—Training & Knowledge Management: Delivers after action and analytic functions that support the trainers' need to provide evaluation and assessment of training, in parallel with requisite knowledge management and lessons learned. This LOE includes Joint training services and select capabilities required to support Joint force development (JFD). Specifically this requires:

  - Tools to measure some performance against metrics; enhance ability for simulation supported AAR reports/tools/products.
  - Tie in for doctrine development process and feedback loop; ensure doctrinal representation is accurate within tools.

- LOE 7—Cloud and Technical Infrastructure: Provides capabilities required to move toward a modern technical infrastructure. This LOE includes "cloud" and web technologies, which enable M&S and associated tools for virtual cloud environment use. Specifically this requires:

  - Web-enabled access at the point of need for stakeholders.
  - Users to reduce the system's physical footprint and hardware costs.
  - Scalable simulation resource support synchronized with need of the users (elasticity).

- LOE 8—M & S Integration: promoting JTSE interoperability and integration with the Joint, Service, Agency, CCMD, and Coalition training architectures and C4I interoperability. LOE 8's primary focus is to maintain Joint/Service training architecture interoperability and integration. It includes the development and management of LVC interoperability specification and standards; joint interoperability, as well as M&S and C2 integration. Specifically this allows users to:

  - Maintain/integrate current JLVC federation and provide support to the CCMD exercise program.
  - Identify, develop, and maintain M&S standards.
  - Integrate new JTSE services to enhance capabilities and improve efficiencies/ effectiveness when coupled with essential non-materiel solutions.

4.0 CONSTRAINTS FOR PROGRESS

Even with validated requirements and a documented approach to developing and delivering the JTSE capability, there are several factors we will continue to work through to keep this effort on schedule and successful.

4.1 Establishing a Cooperative Development Culture

Each of the U.S.'s Services (Army, Air Force, Navy, and Marines) are responsible to "organize, train, and equip" their forces to contribute their unique service capabilities to our joint force commanders. These are large organizations with separate funding resources to meet their readiness objectives. Consequently, they develop their own training tools and depend on the Joint Staff J7 (JS J7) to provide the integration framework that allows these capabilities to interoperate. For the last decade, this framework has been based on a federating architecture that requires cost prohibitive integration testing across the Service capabilities. These costs erodes JS J7's Research Development Test and Evaluation (RDT&E) budget and thereby reduce the capacity for new Joint capability development. The current culture for capability development is "cooperative integration" versus "cooperative development" and therefore more conducive to building federations versus transitioning toward a web-services based architecture. To help transition the Joint training community toward a cooperative development culture, the JS J7 will pursue the following courses of action:

- **Demonstrate Relevant and Useful Capabilities:** Build trust in the proposed architecture by building capabilities that perform well. Currently JS J7's M&S Roadmap (Figure 5) focuses on delivering capabilities to support Training Tiers 1 (National Level and Combatant Command) & 2 (Joint Task Force) and integrating Tier 3 (Functional and Service Component). By demonstrating that the technological framework performs well and delivers a better and more sustainable capability than is currently available, the expectation is that C/S/A enterprise partners will adopt this framework as they replace their legacy systems supporting their Tier 3 and Tier 4 (Individual Organization or Tactical) training.
- **Establish JTSE Technical Standards:** Currently, JS J7 delivers federating standards through a Federation Integration Guide. On 3 Jun 2016, the Joint Staff Director of Joint Force Development invited training capability developers to partner through cooperative development by collaboratively developing and evolving toward an agreed-upon set of technical standards for joint training. Joint Staff J7 has published and offered to their DoD components for consideration a set of standards and protocols that are being used for building the JTSE new modular services and tools. DoD components contribute invaluable expertise and perform a critical role in the development of U.S. training requirements, standards, architectures, and capabilities. As with any technology construct, the need to modify and evolve is understood and expected, but the codification of a set of standards is viewed as necessary to at least initiate the conversation.

4.2 Keeping Pace with the Information Technology Mandates

As the training community tries to keep pace with the technological innovation that offers opportunities to deliver more relevant and efficient training tools, higher headquarters is also responding with mandates and initiatives that both support and hinder JTSE development. As mentioned in para 3.2, JIE, Data Center Consolidation, and MPE are key enablers that can help in building the JTSE. However, they can be hindrance if they develop in a direction that does not consider Joint training specific requirements. If JIE does not deliver common-user networks that can support the current simulation requirement for multi-cast traffic or the security constraints for stimulating a C2 system on an operational network, it will only delay the transition to JIE as well as the delivery of training enablers on a network with greater accessibility to the trainers/trainees. Therefore, the JS J7 must continue to engage and ensure that leadership for each mandate are cognizant of the mission and requirements of the training community.

4.3 Identifying and Adopting Standards

Para 4.2 already highlights the need for collaboratively establishing technical standards for joint training with the DoD. However, to make well informed decisions on the identification and timing of adoption, the Joint training community needs to connect to international organizations that formulate and govern international standards (e.g.

SISO, IEEE, NMSG, and OGC) for M&S, IT and data. And where appropriate, actively participate in their efforts to ensure the Joint training community has a voice in their development.

4.4 Cyber Security

Complying and satisfying cyber security mandates is starting to consume a large portion of our RDT&E resources. It has become the primary limiting factor for delivering and sustaining training tools on time and on-budget. In May 2016, the DoD adopted National Institute of Standards and Technology's (NIST) Risk Management Framework for DoD IT. This transitions the DoD from a compliance-based checklist-driven process to a risk based approach, which applies reciprocity in order to reuse resources and/or accept other DoD organizations assessed security posture. This process has greater documentation requirements in the beginning of the process but is expected to be a more agile as it moves the DoD from periodic compliance to continuous compliance. The small and discrete nature of the JTSE modular architecture will be easier to secure and isolate vulnerabilities.

5.0 CONCLUSION

The Chairman of the U.S Joint Chiefs of Staff has articulated that the Joint Force will face an increasingly complex global security environment, one in which both state and non-state actors will seek to challenge the current international order. In doing so, these actors will use new technologies and asymmetric approaches to avoid our strengths and exploit perceived vulnerabilities. These conflicts will take on an increasingly transregional, multi-domain, and multi-functional nature, which is a departure from the methods of armed conflict of the past. Changes are needed.

This increasingly complex global security environment he describes, will change the manner in which training will be conducted. Combined with decreasing fiscal and man-power resources and warfighting co-dependencies across the Alliance, collectively we have the right ingredients that give us the impetus for the change in how we, the technical community, provide the tools and capabilities that support advancing and maintaining readiness across the force. But, it is advancements in Information Technology (i.e. Cloud technology, Data Exchange, Machine to Machine interactions, Processing Speeds, etc.) that make this the time to change the M&S provisioning paradigm.

Our current Live Virtual and Constructive training capabilities have served the community well for several decades. This paradigm shift is not looking to change the "what" we provide. Training will continue to be the effective stimulation of people in the art of warfighting, to make appropriate decisions and provide proper direction in response to those stimuli. What we are looking to change is "how" that stimulus is designed, planned, provisioned and ultimately delivered. Without a targeted effort over the coming decade toward modernization of LVC capabilities that take advantage of those advancements, the "status quo" technology of the last century will impede our ability to provide effective and efficient stimulation of the warfighter, and as a result impact his/hers ability to develop Knowledge, Skills and Abilities needed to fight and win the wars of today and tomorrow.

DISCLAIMER

The views and conclusions contained in this document are those of the author(s) and should not be interpreted as representing the official policies, either expressed or implied, of the US Joint Staff or the US Government.

This paper or presentations associated with it, are not to be construed as an official agreement to share technical solutions at this time. Approaches presented are being explored and are in the early stages of being realized. As maturity level of the effort increases, partnerships and mutually supporting efforts will be explored and solicited.

The methods to share and distribute functionality associated with the modular services/capabilities concepts has not been determined. Determination on the ability and authorities to enable the services/capabilities to be provisioned from a common "cloud" environment had not been started. The authors suspect that this change in how training environment tools can be provisioned will require a corresponding change to the Foreign Military Sales processes and concepts, to allow for nations/alliance to be self-sufficient in the use of future tools.

6.0 REFERENCES

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