

## **Modeling and Simulation Synergies in Acquisition, Test and Evaluation, and Training**

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### **ABSTRACT**

Modeling and Simulations (M&S) capabilities are widely accepted tools which help manage risks and control costs in the acquisition, and Test and Evaluation (T&E) communities. The training community also benefits from M&S; however, the complexity of major acquisitions and a lower priority on their associated training systems often results in training tools which lag in realism, hardware and software versions as the system matures along the acquisition continuum. For obvious reasons then, these tools cannot be relied upon to advance the adoption of the emerging joint, live, virtual and constructive training environment for T&E of system upgrades, modifications or as new weapon systems join the growing joint interoperable, net-centric battle space. This paper briefly examines historical efforts of the T&E and training community's attempts to provide users with relevant M&S tools, and the policy and guidance which shape these activities. It then recommends a synergistic path that relies on the needs of the acquisition and T&E communities to develop an accurate, realistic and responsive virtual battle space accessible by all to achieve their respective goals. The end result is a training world capable of emulating the most current version of weapon systems hardware and software. This same environment will then support the development, and T&E concepts required to meet many of the needs of Service specific acquisitions as well as joint interoperability and net-readiness certifications, leading to a far more efficient, capable, net-enabled force.

### **ABOUT THE AUTHOR**

Major Rafael Vila is a Communications Officer in the United States Air Force recently assigned to the Joint Interoperability Test Command where he is responsible for ensuring joint interoperability testing and certification of major weapon systems. Prior to this assignment, he was stationed at the Warrior Preparation Center where he was instrumental in the development of senior level plans and guidance supporting Distributed Mission Operations and Joint National Training Capability initiatives. Major Vila brings 20 years of experience in telecommunications, networking, space, intelligence, fixed base and tactical communications in support of OPERATIONS SOUTHERN WATCH, IRAQI FREEDOM and ENDURING FREEDOM. From March 2001 to March 2005, he was assigned to the National Security Council's Situation Support Staff, the White House. In this capacity, he was responsible for day-to-day operations of communications in the Situation Room and the National Security Council's staff, including the President and Vice President. He led the design and implementation of many White House communication initiatives arising as a result of the attacks of September 11th. Major Vila is an Electrical Engineer with a Masters degree in Information Systems Management.

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## **INTRODUCTION**

Little doubt should be left within the Department of Defense (DoD) regarding the benefits of Modeling and Simulation (M&S). From the onset of a program—early in the acquisition lifecycle—through Testing and Evaluation (T&E), and to and beyond training, the impact of M&S can be illustrated by the myriad of references to the capabilities within directives, instructions, manuals and guides from the DoD to the component level. Unfortunately, the adoption of these tools and their evolution has by complexity, necessity, and/or public law, occurred in a disjointed manner.

The acquisition community understands M&S can yield valuable data early in a project during Analysis of Alternatives (AoA), mission thread modeling and the evaluation of materiel solutions, technologies, capabilities or prototypes. M&S can help assess risks associated with a particular acquisition strategy and influence the path towards program maturity or early termination. If the program matures beyond the first major acquisition milestone, T&E activities will be in line to benefit from M&S in support of Engineering & Manufacturing Development (EMD).

Developmental T&E (DT&E) activities rely on available M&S tools to analyze performance baselines, lower the risk to production representative test articles and reduce costs associated with these activities. A growing and critical aspect of T&E and M&S is tied to joint interoperability and Net-Readiness (NR) certification. Through a strategy of integrated testing, the Joint Interoperability Test Command (JITC) evaluates systems to certify joint interoperability and net-readiness requirements documented in the Joint Capabilities Integration and Development System (JCIDS). In addition to program documentation, JITC bases its evaluation on test results, exercises and validated M&S test tools and capabilities.

In the Operations and Support phase of a program, the training community takes advantage of virtual or constructive M&S trainers to aid in the qualification, team, or mission training events designed to employ the new capability. These training systems can range in complexity and realism depending on the weapon

system and employment strategy; from high fidelity, networked, virtual aircraft simulators to the emerging Live, Virtual and Constructive Training Environment (LVC-TE). This LVC-TE can bring in a single, instrumented soldier into complex operational-tactical-task level training events.<sup>1</sup>

This evolution of M&S along the acquisition timeline yields T&E tools and the Virtual-Constructive (VC) training capacity required for a LVC-TE. The process begins with a limited understanding of a proposed weapon system needed to fill a capability gap. Ideally, the system and its M&S are refined along the acquisition continuum culminating with the delivery of the weapon and a virtual or constructive replica good enough to train and qualify warfighters. In reality, a synchronized lifecycle strategy that ties M&S requirements of the acquisition, T&E and training communities along this maturity continuum is missing. This synchronized strategy can deliberately deliver the VC capacity needed for weapons employment training and T&E in a distributed manner. Thus, by focusing on the LVC-TE early in the acquisition timeline, we can, in the end, facilitate support to Systems/Families-of-Systems (SoS/FoS) along with their T&E and joint interoperability/NR requirements in the emerging, net-centric battlespace.

Maj (Ret.) Ronald V. Hanner, a former F-86/F-100 pilot with eleven years as an instructor questioned: “Are they still using those damn things?” after a brief explanation of my duties at the Warrior Preparation Center, Germany in 2005. Of course he was referring to simulators. Though not sure why his feelings were so strong, I knew by then that typical fighter pilots believe there is no substitute for the “real-thing”. Armed with this data, which captures a basic cultural roadblock,<sup>2</sup> I consider two examples to illustrate how the T&E and training communities have evolved M&S to meet their specific needs.

## **HISTORICAL PERSPECTIVE**

The following examples highlight M&S efforts which envisioned; 1) A T&E capability proven to benefit acquisition and training activities, 2) A distributed training environment to improve team and mission

training. Contrasts between the two illustrations emphasize the potential for divergence as different Services interpret and apply existing T&E, training and M&S policy and guidance.

First, consider a U.S. Navy (USN) project started in the early 1990's and its efforts to adopt an innovative M&S concept. They developed the Manned Flight Simulator (MFS) facility to "...provide a flexible simulation capability through the use of modular hardware and software designs that can handle almost all simulations required for T&E and training."<sup>3</sup> At the time, the facility implemented aircraft flight fidelity simulations and cockpits including the F-18, F/14, EA-6B, V-22, X-31, T-45 and the AV-8B. The USN also developed a 1553 bus interface for external computers to tie into mission systems for the purpose of T&E. Networking was implemented via distributed interactive simulation. A 1991 paper titled, *MFS and the Impact of Navy Weapon Systems Acquisition*,<sup>4</sup> touted benefits to the acquisition, T&E and training Communities of Interest (COIs).

Today the MFS provides real-time, pilot-in-the-loop, flight simulation supporting aircraft T&E activities throughout the system lifecycle. In addition, it is an integral part of the USN's Integrated Battlespace Simulation and Test (IBST) Facility (W. Hamel, personal communication, June 9, 2009). The MFS can operate in a standalone mode or be integrated with other capabilities and facilities such as; the Air Combat Environment T&E facility for Battlespace M&S, and the Electronic Combat Stimulation; the Integrated Battlespace Arena for weapons Research DT&E; and the Surface/Aviation Interoperability Lab to analyze interoperability between experimental or operational systems. The MFS and the complementing T&E capabilities are well suited for, and in some cases proven to support the management of USN Operational Flight Program (OFP) to mature weapon systems' software upgrades. However, as with other Services, the management of OFPs is left up to individual program managers and not all are open to this possibility, even if available.

Now consider a concept developed to meet the needs of a training community—the Air Force (AF) Distributed Mission Operations (DMO)—specifically Combat Air Forces (CAF) DMO. DMO was envisioned in the late 1990's as the AF considered networking their fleet of virtual simulators in a distributed training environment. CAF DMO focuses on fighters/bombers engaging in team training with essential Command, Control, Communications, Computers, Intelligence Surveillance and Reconnaissance (C4ISR) elements in the kill chain. To connect the simulators, CAF DMO relies on the

DMO Network (DMON). DMON is a commercial solution of leases, portals and network management designed to maintain a secure, interoperable, low latency, high-bandwidth, plug-and-train capability. CAF DMO is supported by a group of experts to ensure standards, configuration, integration and Information Assurance (IA) are effectively managed. In a 33 month study of DMO, a 2006 report<sup>5</sup> found that "...pilots become much more proficient on key aspects of combat mission objectives as a function of training within the simulators."

But this is just one AF community. DMO also comprises efforts by the Mobility, Training, Space, Special Operations and the Air Reserve Components, each with their own approach to meeting integration challenges related to their specific training needs. The AF understands these limitations. In a Broad Agency Announcement,<sup>6</sup> the Air Force Research Laboratory identifies major challenges to AF wide DMO as:

- Interoperability within the mix of protocols, standards and architectures in the environment
- Networks/applications performance in terms of latency, bandwidth, scalability, fault tolerance, and quality of service
- Interfaces to the Global Information Grid (GIG) and the effects of gateways, filters and layers of encryption on the current solution
- IA and accreditation issues on "live" networks along with multi level security and cross domain solutions

This list represents a small portion of the issues a single Service faces as it integrates M&S in distributed training environments. This should be relevant to the testing community because if they were to rely on these training tools for T&E and certification activities, they face at a minimum, the same set of problems. For example, think about the need to maintain a future Test and Training (T&T) federation populated with mirror images of operational systems in the inventory. Such a federation could support OFP upgrades and interoperability certifications for a system within a SoS/FoS throughout the system's lifecycle.

These few facts are a far cry from a historical framework to assess failures or identify areas to benchmark from. However, this assessment highlights challenges which have been validated by M&S studies<sup>7</sup> over the years:

- Culture/human issues inherent to changes
- Cultivating M&S experiences, learning from them, and institutionalizing lessons

- The need for a M&S infrastructure
- Technology and research

With this perspective in mind, I examine the governance that influences the activities just presented.

### **POLICY AND GUIDANCE INFLUENCING THE COMMUNITIES OF INTEREST**

The effectiveness of our military inventory hinges on the acquisition system, upgrades to the weapons systems inventory, T&E, certifications and ultimately the training of our forces. Synchronized governance is essential to actions that bind T&E and training requirements into a common M&S maturity strategy. Though sorely needed, a detailed examination of policy and guidance which addresses roles, responsibilities and reliance on M&S for the COIs is not possible within the limits of this work. Such an examination would probe into Service specific governance and resulting initiatives. Instead, I provide a quick review of the relevant documents from the DoD and Chairman of the Joint Chiefs of Staff (CJCS), which support potential M&S synergies in the acquisition lifecycle.

#### **Acquisition**

The DoD follows fundamental principles and procedures to rapidly acquire quality products that satisfy user needs with measurable improvements to mission capability, at a fair and reasonable price.<sup>8</sup> DoD Directive (DoDD) 5000.01 and DoD Instruction (DoDI) 5000.02 provide this guidance. DoDD 5000.01 references the concept of M&S within the context of integrated T&E as follows: “The conduct of test and evaluation, integrated with M&S, shall facilitate learning, assess technology maturity and interoperability, facilitate integration into fielded forces, and confirm performance against documented capability needs and adversary capabilities...”<sup>9</sup> Thus, we can presume reliance on M&S throughout the acquisition continuum. The directive only mentions training within the context of developing a professional acquisition workforce.

DoDI 5000.02 provides clearer M&S guidance. The instruction ties M&S activities to testing efforts such as OT&E and Live Fire T&E (LFT&E), FoS interoperability and IA testing. The concept of testing in LVC environments is introduced. References to training are prevalent throughout the instruction, along with embedded training system concepts and their potential use in T&E, instrumentation, individual, team and joint training requirements. Furthermore, the instruction states the training system “shall fully

support and mirror the interoperability of the operational system.”<sup>10</sup>

CJCS Instruction (CJCSI) 3170.01, JCIDS<sup>11</sup> and the Manual for its Operation<sup>12</sup> address the acquisition system designed to identify joint military capability needs. While larger in volume and more specific, the manual makes very few references to M&S. The context is limited to lessons learned from the EMD phase, and as an analysis tool to be considered in support of doctrine change requests. The Manual however, addresses the concept of LVC capabilities within the “selectively applied” System Training (ST) Key Performance Parameter (KPP) in the right context; the need for LVC to augment live training due to costs, environmental or safety considerations.

Furthermore, under Enclosure B, item 2.d.(1), Training KPP, the JCIDS Operations Manual states; “...ensure system training is addressed in the AoA and supporting analysis for subsequent acquisition phases and ensure projected training requirements and associated costs are appropriately addressed across the program life cycle. Embedded training and net-centric enabled training shall be considered the first alternative for cost effective delivery of instruction. The training capability requirements should be on par with operational systems capability...” The analysis questionnaire of the ST KPP, also references LVC training along with the interoperability of envisioned training systems. While T&E activities are abundant in the Manual, they are mostly used in support of traditional DT&E functions with little consideration for M&S and emerging LVC capabilities.

This glance at the most fundamental policy and guidance available to the acquisition community begins to paint an incomplete picture of what, when, where, who and how to synchronize M&S along the acquisition timeline. However, common themes emerge:

- Rely on M&S throughout a system’s lifecycle
- Rely on the LVC-TE to achieve training efficiencies and to facilitate T&E activities
- Training systems mirroring interoperability requirements of operational systems
- Interoperability of M&S in the LVC-TE

Acquisition guidance is overarching and influences how the COIs develop their individual governance to meet JCIDS requirements. As such, we should expect to find similar themes echoed as we consider the next logical activity in the acquisition timeline, T&E. Thus, conceptually we moved from a valid need requiring

Materiel Solution Analysis/Technology Development to EMD/Production and Deployment.

### **Test and Evaluation**

For the most part T&E activities differ among military departments. As such, each Service “grows” their testing centers, range complexes, policy and guidance. Most of this Service specific T&E governance is developed to meet requirements imposed by the acquisition guidance just examined.

Under DoDD 5141.02,<sup>13</sup> the Director of Operational Test and Evaluation (DOT&E) ensures, among other things, that military components comply with OT&E/LFT&E requirements. The DOT&E approves or co-approves the T&E Master Plan (TEMP), the T&E strategy and LFT&E strategies or waivers. DOT&E also manages the Joint T&E (JT&E) Program and efforts to improve interoperability and IA. The document identifies 5 Operational Test Agencies (OTA); one from each of the Services, and the JITC as the only joint OTA. Furthermore DOT&E monitors and advises on the development of the Information Operations (IO) Range and oversees implementation of testing in a joint environment roadmap.

Based on the above DOT&E requirements, this section looks into three more documents to assess the M&S relationships under consideration. These documents are; the recommended format for the TEMP,<sup>14</sup> the JT&E Program Handbook<sup>15</sup> (in lieu of DoDI 5010.41, the JT&E Program) and CJCSI 6212.01,<sup>16</sup> Interoperability and Supportability of Information Technology (IT) and National Security Systems (NSS). While 6212.01 provides acquisition guidance for IT/NSS, I discuss it here because it establishes procedures for JITC joint interoperability/net-ready T&E and certification.

The TEMP begins its journey in a program’s lifecycle prior to Milestone B, before low rate production items are available for testing. The main purpose of the TEMP is to provide top-level documentation required by different test organizations to develop integrated test plans and strategies throughout the system’s lifecycle. Reliance on M&S during T&E is evident in the TEMP authoring guidance. Even more evident is the requirement for the Verification, Validation and Accreditation (VV&A) of all M&S to be used during tests events along with rationale for their use. References to training systems are absent as the TEMP is authored to meet T&E requirements.

The JT&E Program Handbook provides more details on M&S. The document includes a 10 page Annex (I)

which emphasizes VV&A, the challenges of building LVC federations, interoperability and other planning and management issues. Annex I, concludes with the following summary; “A JT (Joint Test) can use M&S for test concept evaluation, data analysis extrapolation, isolation of test design effects, representation of complex operational environments, and overcoming inherent limitations in testing. The use of M&S can help validation of test findings and conclusions, increase confidence levels, and may reduce overall test costs. However, it may take time and extensive funding to build the M&S federation to the point that it is not useful for test purposes.” This level of uncertainty regarding the use of M&S in T&E is not limited to this summary, but its wording is telling of the problems confronting the COIs. The handbook has many references to training in the context of relying on operational training exercises to conduct JT&E activities, along with the inevitable conflicting priorities of such arrangements.

CJCSI 6212.01 establishes procedures for joint interoperability test certification from JITC. This is relevant because one of the main themes from the acquisition guidance is that M&S will mirror operational systems in capability and interoperability. With regard to interoperability and the Net-Ready KPP testing and certifications, the instruction states: “All IT and NSS must be evaluated and certified by the Defense Information Systems Agency (DISA) JITC. All systems – Acquisition Category (ACAT), non-ACAT, and fielded systems – must be evaluated and certified prior to (initial or updated) fielding, and periodically during their entire life – as a minimum, every 4 years.” This statement extends to what the instruction refers to as “Simulators/Stimulators and Training Systems” in two different contexts; first the applicability and validity of relying on M&S and training systems in T&E and, second, the certification of the said systems (in the same manner as an operational one) as long as they have Joint Staff J-6 Interoperability and Supportability Certification. This potential JITC certification does not validate/verify the accuracy of the model, but can address interoperability from a standards conformance perspective or the assessment of joint interfaces.

One of the main purposes of T&E is to reduce risks in the decision making process. The T&E community has spent years experimenting and determining the best statistical methods required to achieve an absolute minimum level of effort (time and resources) that yields a maximum level of certainty of outcomes. While the use of M&S is one of those proven approaches, potential reliance in the emerging, ad hoc LVC-TE brings about complexities that disturb an

already difficult, inexact science. Based on these facts and the highlights of the T&E policy and guidance, three takeaways surface:

- Interoperability is a major concern of the T&E community, as more systems join the net-centric environment
- Emerging, net-centric capabilities must be mirrored by training systems, which raises similar interoperability challenges
- VV&A essential to the adoption of LVC capabilities in realistic T&E and training environments

It is now time to move into the Operations and Support phase of the lifecycle timeline to address training systems in the context of the JLVC-TE and their potential use in T&E.

### **Training**

Training is the most specific, Service driven activity of our armed forces. As a result, this analysis is limited to a brief examination of the Strategic Plan for Transforming DoD Training,<sup>17</sup> DoDD 1322.18, Military Training<sup>18</sup> and CJCSM 3500.03, Joint Training Manual for the Armed Forces of the U.S.<sup>19</sup>

The vision for the Strategic Plan for Transforming Training (T2) foresees the following concepts:

- A dynamic training environment, adaptable to changing opportunities and technology
- Capabilities-based, joint training that mirrors the top-down approach to DoD planning
- Integrated training, across all instruments of national power, government agencies and partner nations

Reliance on M&S, specifically the U.S. Joint Forces Command's (JFCOM) Joint National Training Capability (JNTC) and the JLVC-TE are central to this vision. These enablers are envisioned to:

- Increase realism of live training environments for future weapon systems
- Improve the cycle of Doctrine, Organization, Training, Material, Leadership, Personnel and Facilities analysis and change
- Support training anywhere, anytime
- Aid with encroachment and environmental issues associated with live training in ranges

The plan calls for the JNTC to "Develop and enforce LVC open net-centric interoperability standards and

architectures for training and exercise activities that directly support the distributed joint training requirements of combatant commanders, JTFs, Services and defense agencies." The plan does not overlook T&E, as the JNTC is also charged with collaborating with the "...Joint Mission Environment Test Capability and IO Range to develop solutions to common requirements and to leverage activities associated with the testing in a joint environment roadmap to further develop realistic joint mission environments and a persistent connectivity and interoperability between training and test ranges, instrumentation, and models." Lastly, T&E is acknowledged as a capability that must be "composable, agile, net-capable, adaptive, interoperable, persistent and robust."

Unlike the T&E community, DoDD 1322.18, acknowledges the need for sharing infrastructure resources, ranges, maneuver areas, and other facilities and devices, to the maximum extent possible, using a scheduling and priority rule set that balances the requirements of the training and T&E communities. The directive encourages the Under Secretary of Defense for Personnel and Readiness [USD (P&R)] to collaborate with the DOT&E and USD for Acquisition, Technology, and Logistics [USD (AT&L)] on policy to promote interdependent development, architectures, and standards for training and testing. LVC guidance is just as prevalent assigning responsibilities to USD(P&R), the Service secretaries and to JFCOM. JFCOM is charged with management of the JNTC and the JLVC-TE, the development and maintenance of open, net-centric, interoperable standards for JLVC training systems, and the certification of joint training instrumentation, models, federations, and tools.

The salient points of the 310 page Joint Training Manual can be summarized as follows: JFCOM is the CJCS lead agent for joint training in support of Combatant Commanders (CC). While Joint Mission Essential Tasks cover the spectrum of warfare from strategic to tactical, the focus of JFCOM's role is on strategic national, strategic theater and operational level of warfare. References to M&S are numerous but more directly applicable to Constructive M&S designed to represent aggregations of the battlespace. This is not to say JFCOM's role is limited, but to bound efforts and minimize overlap with the Services' responsibilities to organize, train and equip. T&E is only referenced within the context of the IO Range to meet CC or Service IO needs.

From the training guidance, the following particulars stand out:

- The vision for T2 relies heavily on M&S and the JLVC-TE
- JFCOM's training and experimentation role is pivotal to the exploitation of M&S synergies between the COIs
- The training community seems more "open" to teaming with T&E for exploiting M&S and JLVC synergies

I finally consider policy and guidance from the M&S perspective to try to bring together the acquisition, T&E and training governance.

### **Modeling and Simulation**

The DoD manages M&S through Directive 5000.59.<sup>20</sup> It does this mainly through a steering committee under USD(AT&L) with participation from the Service Secretaries, and representatives from USD(P&R) for training, USD(DOT&E) for testing, CJCS and the Commander, JFCOM. A key responsibility under the directive is one of oversight of VV&A, standards and protocols. M&S goals are to be achieved by "...promoting visibility and accessibility of M&S; leading, guiding, and shepherding investments in M&S; assisting collaborative research, development, acquisition, and operation of M&S; maximizing commonality, reuse, interoperability, efficiencies and effectiveness of M&S, and supporting DoD Communities that are enabled by M&S." One of the contrasting points of this brief assessment is that JFCOM's role in the steering committee is limited to representing the experimentation community.

Guidance for the VV&A of M&S activities is provided through DoDI 5000.61, DoD M&S VV&A.<sup>21</sup> This instruction applies to all M&S developed by DoD Components to include those used in support of OT&E, joint training and exercises. The instruction delegates DoD Components responsibility to validate M&S representing their forces and capabilities. It designates the DoD M&S Office [known today as the M&S Coordination Office (M&S CO)] as the "DoD VV&A focal point" and the central source of DoD VV&A information. Validation and verification is mandated through the lifecycle management process of all M&S. This includes resource programming for VV&A activities, as the M&S are developed or upgraded.

CJCSI 8510.01,<sup>22</sup> Joint M&S Management, focuses on the role of Joint M&S (JM&S) in training activities. JFCOM's role is once again prominent—specifically the Command is charged with identifying, gathering and integrating all joint training M&S requirements. However the oversight of C4I JM&S is delegated to the Director, Joint Staff J-6, which acts as the primary

interface for DISA and other C4I Centers. While it is not clear if this role is limited to T&E and/or joint training M&S, it is significant because it is through DISA the JITC performs its interoperability T&E and certification role, also in direct support of the J-6 staff. VV&A roles and responsibilities are expanded upon, along with direction for Service interaction with the DoD M&S Resource Repository (MSRR).

The guidance within the last three documents does not provide as comprehensive a look at M&S as the information gleaned from the acquisition, T&E and training communities. This is telling in its own way for the following reasons:

- While some of the guidance is as current as Jan 08, references to, and the influence of M&S on the LVC environment are absent
- As seen so far, LVC is essential to the COIs; this gap can lead to conflicting guidance, approaches and duplication of efforts
- M&S definitions seem weak, dated or independent from those already examined

It is not all bad news however. The emphasis on VV&A is significant, just as references to the M&S CO, the MSRR, and DISA's oversight role for C4I JM&S. Even more relevant is the DoD's Research and Engineering M&S Corporate and Crosscutting Business Plan, which identifies standards, interoperability and visibility as three strategic objectives required for the long-term improvement of efficacy of DoD M&S capabilities. How this plan influences DoD, CJCS and Service governance will be essential to achieving full spectrum M&S support of DoD activities and operations

### **THE CURRENT ENVIRONMENT**

The governance just examined influences how Services implement programs to achieve M&S efficiencies; I present the next examples to illustrate "how well". First we will look at a "legacy" process developed to support weapon system upgrades and the required T&E activities that go along with it. Next we explore M&S training initiatives attempting to navigate the JCIDS process to be able to mature as joint, interoperable and net-ready M&S—a potential parallel to the actual weapon systems they will support.

#### **The Force Development Evaluation (FDE) Process**

The AF relies on the FDE process to validate modifications to their weapon systems once they enter the Production and Deployment, and Operations and Support phase of the acquisition continuum. The

process centers around OT&E events designed to bring together AF systems deemed necessary for the said validation. Per AF Instruction (AFI) 99-103, Capabilities-Based T&E, an FDE may be used for:<sup>23</sup>

- Verifying resolution of previously identified system deficiencies or shortfalls
- Evaluating software modifications under the OFP supporting upgrades/improvements
- Evaluating operational systems against foreign equipment, or new or modified threats

While AFI 99-103 leaves the door open for reliance on M&S, it partially closes it based on guidance within public law. In essence three additional AFIs are referenced, to point-out the limits on the use of M&S for realistic testing... “M&S and Digital System Models (DSMs) must receive sufficient VV&A according to AFI 16-1001, AFI 16-1002, and AFI 14-206.” The definition of “sufficient VV&A” is absent.

As Maj (Ret.) Hanner would prefer, the FDE program hinges on live flying. Take a recent OFP evaluation<sup>24</sup> as an example. The evaluation spanned 18 months of developmental T&E activities, hundreds of flight hours, hundreds of contractor/DoD personnel dedicated to direct and indirect test support, analysis, reporting and joint certification. It should be evident that in a not so distant future, such a process is likely to collapse under its own weight. As more systems join the net-centric battlespace, bringing together “relevant” players in multiple test events not only becomes an expensive proposition, but a scheduling nightmare.

### **M&S Programs and JCIDS**

The JITC recently reviewed two key M&S training programs making their way through the JCIDS. The Air Warfare Simulation (AWSIM) and the Army’s LVC-Integrating Architecture and Infrastructure (LVC-IA), are examples of programs specifically focused on maturing M&S concepts to support the training community. Additionally, the Mobility AF (MAF) DMO program is considering the potential of documenting their efforts through JCIDS. The most salient points of these efforts follow:

1) AWSIM: According to the Capability Development Document (CDD) Executive Summary, “AWSIM will be the AF’s next generation synthetic environment for air and space operational weapon system control exercises and rehearsals that stimulates critical command and control and collection management systems, providing the Joint Forces Air Component Commander with decision quality information.”<sup>25</sup> A quick scan of the associated operational system

Information Support Plan (ISP) identifies AWSIM, amongst others, as a stimulator used to facilitate initial, mission and continuing qualification training of command and control crews. The AWSIM CDD addresses requirements for supporting the T&E and acquisition community. Consideration for VV&A requirements, however, are absent from both the CDD and associated operational system ISP.

2) LVC-IA: “...The goal of the LVC-IA increment one is to enable a LVC-TE that approximates the operating environment and thus provides realistic training and mission rehearsal capabilities for units, leaders, and staffs.”<sup>26</sup> The Army’s approach is to define how battle command systems will interact within the LVC-TE (architecture) along with the means to communicate (infrastructure). Just as AWSIM focuses on the Air and Space Operations Center-Weapon System, one of the goals of LVC-IA is to provide the medium to stimulate the Army Battle Command System in training exercises. Not addressed in the document is the potential integration of the LVC-IA concept with existing Army laboratories which operate and maintain operational C2 federations for software management, configuration control and T&E. While the CDD does not mention VV&A, LVC-IA simply seeks to facilitate the interaction of M&S with live, operational systems.

3) MAF DMO: This effort has to mature beyond a Roadmap<sup>27</sup> to move into the JCIDS process, if the AF and the Joint Staff believe a joint designator is applicable to the program. It is certain many will question the need for interoperability requirements, not to mention certification. However, unlike its CAF DMO cousin already discussed, MAF DMO is weighing the following options:

- JLVC-TE concepts to include the potential of joint interoperability certification
- Integration across multiple networks not just the DMON
- Development of an operationally realistic environment to support FDE T&E events
- Use of the GIG as a transport

Once again, there is no consideration for VV&A requirements within the Roadmap.

### **A SYNERGISTIC ENVIRONMENT**

Looking back at the historical perspective and in the author’s opinion, the USN’s IBST federation of M&S, stimulators, hardware in-the-loop, and Research DT&E tools represents one of the closest examples of some of the capabilities a future, net-centric battlespace will require in support of lifecycle T&E, certification, and

training. As net-centricity matures, SoS/FoS will grow as unforeseen interdependencies give way to desired, emergent behaviors and capabilities. With this growth, it is prudent to expect limitations on the ability to exercise, train and test in live environments. Thus, the need to develop the JLVC “playground” required to train our forces to exploit the net-centric advantage. This playground must also function as a “virtual range” in which to test changes within the SoS/FoS that may affect desired behaviors, new capabilities or test against new threats. Essential to this environment are verified, validated and accredited M&S, stimulators, T&E tools, and system trainers which mirror operational capabilities.

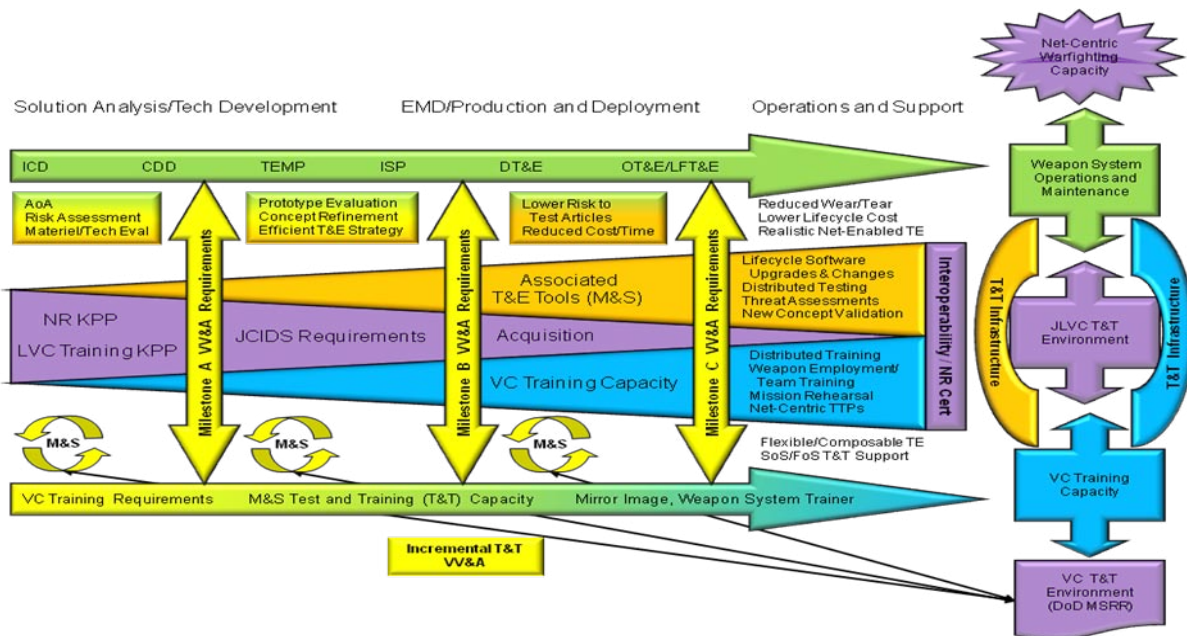
**The Mandatory LVC Training KPP**

Imagine an Integrated Defense Acquisition, Technology, and Logistics Lifecycle Management System that begins to address the use of M&S within the Initial Capabilities Document (Figure 1.). This could be accomplished by mandating DoD Architecture Framework (DoDAF) products, in support of a Mandatory LVC Training KPP. This new KPP would replace the current “Selectively Applied System Training KPP.” Under this concept the T&E and training communities are forced to work together the minute a capability is envisioned. M&S would evolve

incrementally along with narrowly focused VV&A documentation required as entry and exit criteria for each milestone. As a result, VV&A’d T&E and training tools could begin to take shape and aid in the evolution of the weapon system itself, through experimentation in the JLVC T&T Environment. Given the parallels between an envisioned JLVC-TE and an operational, net-centric one, DoDAF products for the LVC Training KPP could mirror those in support of interoperability and net-readiness.

In other words, the LVC Training KPP can benefit from the architectural analysis already being performed in support of interoperable, net-centric systems—the challenge is to translate the information to a LVC “plane.” This translation will require consideration for, and an understanding of, existing LVC architectures, infrastructures, tools and VC systems required for individual, tactical, team, operational and joint training. The focus however would be on VV&A, standards, interoperability and visibility of M&S evolving into an emergent JLVC T&T Environment.

Once the requirement for defining LVC training capacity is available early-on in the lifecycle of a capability, it will be easier to plan and fund M&S activities. This emphasis should increase the demand for access to M&S repositories, standards and VV&A



**Figure 1, The M&S Synergistic Acquisition Life Cycle**

resources. References to these products and resources would be required as JCIDS documentation matures. A catalog of M&S along with VV&A efforts, beginning with AoA, mission thread modeling and threat assessments would provide a foundation for the early refinement of future M&S efforts in support of a new capability. Cooperation, education and understanding of mutual requirements between COIs will begin as soon as Service specific M&S representatives begin to work with their respective OTA and training communities in support of the LVC Training KPP and mandated VV&A efforts.

The TEMP and ISP will have to address how the new capability will rely on M&S and the JLVC T&T Environment to manage lifecycle hardware and software changes. VC training systems will represent the most current software and hardware version required to support the operational system. As net-centricity takes hold and SoS/FoS capabilities emerge, this concurrency will be essential to OT&E activities of systems operating in the joint battlespace, legacy or new, with common information exchange requirements.

This concept does come with an increased level of complexity for programs already struggling to meet objective capability requirements. Nevertheless, if the DoD is committed to exploiting the benefits of a true net-centric revolution in military affairs, M&S policy, guidance and processes must be coherently aligned to achieve that goal. While the proposed approach is partly supported by current policy and guidance, there are areas of overlap, conflict and gray which foster Service specific interpretations. Unfortunately, these interpretations will always follow Service driven governance, concepts, and priorities. As a result, the DoD must embark in an effort to “herd” M&S activities into a synergistic approach with assertive actions, but without stifling Service level innovation.

### Enabling Initiatives

In addition to the proposed concept based on the LVC Training KPP, the author contends DoD’s action needs to come in the form of two major initiatives. First is the design and implementation of a T&T Infrastructure for Net-Centric, GIG enabled systems. Today, study groups are exploring this possibility<sup>28</sup>—however when one considers:

- Current network challenges associated with large scale M&S/LVC training federations
- Complexities brought about by multiple protocols, architectures and technologies

- IA and accreditation requirements on the operational GIG
- Flexibility to support new concepts/systems
- Lessons regarding simulated missile warning data flowing into operational systems<sup>29</sup>

The need to determine how to best consolidate the myriad of networks in the DoD “inventory” in support of JLVC T&T activities should be obvious. This solution will be essential to the refinement of future, net-centric tactics, techniques and procedures.

Regardless of how good the infrastructure, it will not serve its purpose if the communities continue to define their own VV&A processes. An environment in which one Service’s apple is another Service’s orange must be avoided. VV&A can be used to define common standards, architectures and application performance in addition to Service responsibilities to represent their forces and capabilities. Under the proposed approach, VV&A is the glue that binds early consideration for VC training capacity to T&E efforts required to support a weapon system along the acquisition continuum. Without comprehensive, common guidance in support of incremental VV&A activities, there will never be a “sufficient amount” to build realistic M&S centric testing federations. As a result, the second action is the commissioning of a VV&A Summit to:

- Prioritize VV&A issues which impact the three M&S Strategic Objectives of Standards, Interoperability and Visibility
- Catalog Service specific, best-of-breed VV&A efforts
- Propose joint VV&A processes from which Services can build
- Define an M&S lexicon for use by the COIs and Service specific governance

Professionals in VV&A circles deal with some of the toughest M&S problems in the community. Exploiting their knowledge, expertise and experiences is essential to empower DoD with M&S capabilities that “effectively and efficiently support the full spectrum of the Department’s activities and operations.”<sup>30</sup>

### CONCLUSIONS

History has shown varying levels of success as Services continue to evolve their own interpretations of M&S, T&E, and the JLVC-TE. While existing policy and guidance support a coherent, synergistic strategy for the institutionalization of M&S, it is not without conflict, overlap and uncertainty. Along with

synchronized governance, processes are needed to reign in divergent M&S approaches envisioned by each of the Services and their specific needs.

This paper presented arguments to support a concept that brings together M&S requirements for the testing and training communities during the acquisition of new weapon systems. The approach will require early consideration for the delivery of VC training capacity associated with new, network-centric weapon systems. A parallel to the NR KPP was drawn to illustrate the potential to mirror existing JCIDS processes and products to the VC one.

The concept is centered on a Mandatory LVC Training KPP to influence the evolution of M&S from the earliest possible stages in the acquisition lifecycle. This early focus on M&S will also bring to the fore T&E activities required in support of VV&A and a realistic LVC-TE. Consequently, operational system maturity will directly tie to the M&S representing its behavior in the VC realm. The goals are to validate future capabilities in a JLVC T&T environment, and support the development of VC weapon system trainers representing mirror images of the operational system.

These training systems will be essential to future warriors. Increases in speed, complexity, and amount of information required to be processed before pulling a trigger, must be matched with similarly fast, complex, networked and immersive training systems. The future warrior must be able to manage the limits of information overload on one extreme, to the most basic instincts of survival and communications if networks fail, on the other. That in itself is one of the biggest challenges the training community will face; thus the need to elevate training to a higher tier in the acquisition continuum.

The hope is that the recommended policy changes and resulting VC training capacity, will in-turn facilitate a future JLVC T&T environment capable of meeting the needs of OTAs and weapon systems lifecycle requirements. These environments must be capable of representing realistic, interoperable and responsive operational environments that address restrictions in public law and the DoD governance that embodies it.

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