Live Virtual Constructive Architecture Roadmap (LVCAR) Execution Management

J. Hollenbach

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List of Acronyms

ACE	Allied Command Europe
ADDU	Additional Duty
ALSP	Aggregate Level Simulation Protocol
AMG	Architecture Management Group
AMT	Architecture Management Team
CCTT	Close Combat Tactical Trainer
ConOps	Concept of Operations
COTS	Commercial, off-the-shelf (hardware or software)
CPM	Capability Portfolio Management
CRS	Congressional Research Service
CTIA	Common Training Instrumentation Architecture
DARPA	Defense Advanced Research Project Agency
DDR&E	Director, Defense Research and Engineering
DIS	Distributed Interactive Simulation
DISA	Defense Information Services Agency
DISR Online	DoD Information Technology Standards Registry Online
DHS	Department of Homeland Security
DMSO	Defense Modeling and Simulation Office
DoD	Department of Defense
DoE	Department of Energy
DSB	Defense Science Board
DSMC	Defense Systems Management College
EXCIMS	Executive Council for Modeling and Simulation
FAA	Federal Aviation Administration
FBO	FedBizOps (replaced Commerce Business Daily)
FI 2010	Foundation Initiative 2010
GAO	Government Accountability Office
HLA	High Level Architecture
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
IT	Information Technology
ITEC	International Training and Education Conference
JAT	Joint Analysis Team
JCIDS	Joint Capabilities Integration and Development System
JFCOM	Joint Forces Command
JMETC	Joint Mission Environment Test Capability
JNTC	Joint National Training Capability
JORD	Joint Overarching Requirements Document
JROC	Joint Requirements Oversight Council
LVC	Live Virtual Constructive
LVCAR	Live Virtual Constructive Architecture Roadmap
M&S	Modeling and Simulation
M&S CO	Modeling and Simulation Coordination Office (successor to DMSO)
M&S SC	Modeling and Simulation Steering Committee (successor to EXCIMS)
MOA	Memorandum of Agreement
MORS	Military Operations Research Society
MS3G	Modeling and Simulation Standards Steering Group

NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NDIA	National Defense Industrial Association
NIST	National Institute of Standards and Technology
OSD	Office of the Secretary of Defense
OUSD(AT&L)	Office of the Undersecretary of Defense for Acquisition, Technology, and Logistics
PBD	Program Budget Decision
PDM	Program Decision Memorandum
PE	Program Element
PEO STRI	Program Executive Office for Simulation, Training, & Instrumentation
PfP	Partnership for Peace
PM	Project manager
PPBES	Planning, Programming, Budgeting, and Execution System
RTI	Runtime Infrastructure (HLA middleware)
SACEUR	Supreme Allied Commander Europe
SBA	Simulation-Based Acquisition
SDO	Standards Development Organization
Si3	Service Integration/Interoperation Infrastructure
SISO	Simulation Interoperability Standards Organization
SSO	Standards Setting Organization
STOW	Synthetic Theater of War
T2 ESG	Training Transformation Executive Steering Group
TENA	Test and Training Enabling Architecture
TIJE SSG	Testing in a Joint Environment Senior Steering Group
TRMC	Test Resources Management Center
USD(A&T)	Undersecretary of Defense for Acquisition and Technology (later changed to USD(AT&L))
USD(AT&L)	Undersecretary of Defense for Acquisition, Technology, and Logistics
VMASC	Virginia Modeling, Analysis and Simulation Center
W3C	World Wide Web Consortium

1 Context

The Live Virtual Constructive Architecture Roadmap (LVCAR) identifies a set of actions to improve the cost-effectiveness of distributed simulation. Executing these actions will require effective management. Understanding the context in which management must function is a prerequisite for establishing an effective management approach. As the following paragraphs make clear, the context in which management must function is complex, involving both DoD and non-DoD stakeholders with varying ties to one another and many explicit and implicit interdependencies.

Each of the LVC distributed simulation architectures (hereafter LVC architectures) has its own constituency, objectives, funding source(s), and management structure. Grasping the complexity of these differences and understanding the forces that influence the use and evolution of these architectures is a prerequisite for crafting an effective execution management strategy.

Two of the architectures, TENA and CTIA, are managed by Components of the DoD. TENA is managed by the Test Resource Management Center (TRMC), a DoD Field Activity reporting to the Undersecretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)) in the Office of the Secretary of Defense (OSD). CTIA is managed by the Program Executive Office for Simulation, Training, & Instrumentation (PEO STRI), an element of the Department of the Army.

The standards defining the other two architectures of interest, HLA and DIS, are managed by a non-DoD entity, the Simulation Interoperability Standards Organization (SISO), a commercial standards development organization (SDO). Although many of SISO's 800+ members are associated with distributed simulation activities funded by the DoD, only 18% work directly for the DoD. One-third of the SISO membership is from other nations (*e.g.*, UK, France, Sweden). SISO also has members from other government departments (*e.g.*, NASA, DHS, NIST), commercial product vendors (*e.g.*, MaK Technologies, ViTech), and academia. Within SISO, the HLA and DIS architectures have overlapping but largely distinct constituencies that include representatives from these various communities. Some collaboration between the HLA and DIS communities occurs under SISO, but thus far SISO has not established any management mechanism to guide the evolution of DIS and HLA toward commonality where practical.

Whether or not to conform to one or more of the architectures is a decision that usually falls to the individual managers of live, virtual, and constructive representation assets (*e.g.*, ranges, laboratories, C4I systems, simulators, simulations). Various internal and external influences shape their decisions.

Similarly, managers of other software components used to compose LVC distributed simulation environments (*e.g.*, middleware such as an HLA Runtime Infrastructure (RTI); tools such as federation managers, data collectors, and gateways) must also decide which architecture(s) to conform to, when, and under what conditions. The managers of these software applications include government organizations, commercial-off-the-shelf (COTS) software vendors, and universities, which are also motivated by a wide range of factors that include such things as government policies, financial rewards, and personal relationships.

An LVCAR execution management strategy must account for this diversity of organizations, interests, motivations, and relationships.

2 Scope of the Management Challenge

As discussed in the Business Model section of the LVCAR, all of the above-mentioned entities are part of the distributed simulation business ecosystem. When trying to influence its evolution while preserving its health, all elements of the business ecosystem must be considered. Thus LVCAR execution management tasks are broad in scope. They include:

- Ensure accomplishment of the actions specifically described in the Architecture, Business Model, and Standards Management sections of the LVCAR.
- Oversee transition of DoD's live, virtual, and constructive representation assets (*e.g.*, ranges, laboratories, C4I systems, simulators, simulations) into conformance with the targeted LVC architectures as they emerge and evolve.

- Influence the actions of non-DoD entities that can impact LVCAR execution, either positively or negatively. These entities include:
    - Congress (*e.g.*, Defense Committees, M&S Caucus, CRS, GAO)
    - Defense industry
    - Standards development organizations (*e.g.*, SISO, IEEE, OMG, W3C, ISO)
    - Other U.S. Government departments and agencies with which DoD must interoperate in LVC distributed simulation environments (*e.g.*, DHS, FAA, NASA, DoE, NIST)
    - Allied nations & alliances with which DoD must interoperate in LVC distributed simulation environments (*e.g.*, NATO, PfP, Australia)
    - Academia active in simulation (*e.g.*, Georgia Tech, Arizona State)
    - Commercial vendors of software (*e.g.*, RTIs, other middleware, other tools) and services, (*e.g.*, M&S education)
    - Other commercial companies that influence standards and the COTS vendor base (*e.g.*, automotive, gaming)

In summary, the breadth of responsibilities and entities that must be managed is extensive.

3 Constraints

No organization charged with LVCAR execution management (hereafter, "LVCAR management") can have authority over all the elements of the business ecosystem listed above. Hence, it will be impractical for LVCAR management to direct each of the stakeholders listed above; most have a high degree of independence. LVCAR management may be able to exert authority in some circumstances, but it will primarily have to rely on influencing the various stakeholders so that they decide to follow the roadmap for their own benefit. This means LVCAR management must create value in its various forms (by applying the means of influence discussed in Section 5) in order to attract participants into the ecosystem and ensure its continued vitality.

Although significant funding will be needed to accomplish the LVCAR tasks in view, there is no possibility of persuading stakeholders solely by financial incentives. Some modest financial incentives may be possible, but in the current budget environment it is unrealistic to expect more. Only absolutely essential expenditures, for important things that demonstrably cannot be accomplished by other means, will have a chance of being funded.

In this context and under these constraints, LVCAR execution will be a management challenge of the first order.

4 Relevant History

George Santayana (1863-1952) observed, "*Those who cannot remember the past, are condemned to repeat it.*" In crafting an LVCAR execution management strategy, it is prudent to consider past attempts to get a broad range of stakeholders to align their efforts to improve DoD M&S. Particularly relevant lessons can be drawn from the Joint Simulation System (JSIMS) Program and the evolution and impact of the Department's policies regarding LVC distributed simulation architectures.

4.1 JSIMS

The mission of the Joint Simulation System (JSIMS) Program (1995-2002) was to build "*readily available, operationally valid, computer-simulated environments for use by… joint organizations and the Services to jointly educate, train, develop doctrine and tactics, formulate and assess operational plans, assess warfighting situations, define operational requirements, and provide operational input to the acquisition process.*" Aside from the technical challenges of satisfying such a broad set of requirements in a single simulation program, JSIMS management had many challenges similar to those the LVCAR faces: It had to coordinate the activities of many (eight) independent organizations to build the system; each

organization, including the JSIMS Joint Program Office itself, had different requirements, different management chains, and different funding sources; and the grand vision for JSIMS interoperability and broad utility was forged in a series of meetings and formalized in a non-binding document.

After spending approximately one billion dollars over seven years, the JSIMS program was cancelled. It had many impressive technical achievements but eventually succumbed to management flaws. The top three issues were:[1]

- No unity of command; the JSIMS PM had no direct control over other JSIMS Alliance members (his subordinate PMs)
- Fractured funding strategy; the funding was in nine separate budget lines, with the JSIMS PM lacking any effective means of influencing the funding of the other members of the alliance
- No unity of effort; in a competition among Service and Joint needs, Service needs took precedence

In light of the context and constraints discussions above, it is clear execution of the LVCAR will face these same three difficulties.

4.2 DoD Architecture Policies

The Department has repeatedly established DoD-wide policies regarding conformance to LVC distributed simulation architectures. A brief review explains how the current multiple-architecture situation arose and provides important lessons for LVCAR management.

4.2.1 Emergence of Interest in Distributed Simulation Standards

Interest in distributed simulation, by both DoD and Congress, arose circa 1988 with the advent of the DARPA's SIMNET (Simulator Network) Program. Over the next few years, this and several other events[2] fostered a realization that distributed simulation technology could yield great benefits to the DoD.

In 1991, the Department, with an impetus from Congress[3] and its own Simulation Policy Study,[4] established the Defense Modeling and Simulation Office (DMSO) to foster joint interoperability and reuse (vice duplication) among Service M&S efforts.[5] DoD concurrently established the Executive Council for Modeling and Simulation (EXCIMS) to improve the oversight and coordination of M&S across the Department, with the DDR&E as its chair and DMSO as its secretariat. Establishing standards to foster that desired interoperability and reuse was a key responsibility of the EXCIMS[6] and DMSO.[7]

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[1] Presentation by Ms. Laura Knight, JSIMS Alliance Executive, to the Summer Computer Simulation Conference, Montreal, Canada, July 2003

[2] These events included a 1988 Defense Science Board (DSB) study on "Computer Applications to Training and Wargaming," a 1989 DARPA-SACEUR Distributed Simulation Wargame (ACE-89), the ALSP linking of Service wargames, and the launch of DIS standards development activities.

[3] The FY91 National Defense Authorization Act called for a joint office to "establish a coordinated DoD-wide approach to simulations and training devices for both acquisition and training..., to establish interoperability standards and protocols, and to develop a long-term plan to guide the development of simulators and training devices."

[4] Led by General Paul Gorman, USA (Ret.), former CINCSOUTH, and sometimes referred to as "the Gorman study"

[5] Col Ed Fitzsimmons, USA (Ret.) "The Defense Modeling and Simulation Office: How It Started," Simulation Technology Magazine, Vol. 2, Issue 2a, 29 June 2000 http://www.sisostds.org/webletter/siso/iss_51/

[6] DoDD 5000.59, "DoD Modeling and Simulation (M&S) Management," of 4 Jan 94, para 5.1.4.8, tasked the EXCIMS to "Foster programs to develop and, where applicable, implement DoD M&S interoperability standards and protocols."

[7] Ibid. paragraphs 5.1.10.4.2 and 5.1.10.4.3; and the FY 91 National Defense Authorization Act language cited above

4.2.2 Initial HLA Policy Established (1995-1999)

By 1994 it was recognized that DIS and ALSP were only providing islands of interoperability among subsets of DoD simulations and, with the emergence of a new generation of simulations (*e.g*., STOW, CCTT, JSIMS) in view, it was reasoned that DoD should develop a new distributed simulation architecture that would enable federating any combination of DoD simulations as a need arose and logic supported, regardless of the simulations' characteristics (*e.g.*, level of abstraction; live, virtual, or constructive representation nature; time management approach).

In early 1995 the EXCIMS decided to establish an Architecture Management Group (AMG) to develop the High Level Architecture (HLA). The HLA was a central aspect of the Oct 95 DoD M&S Master Plan, DoD 5000.59-P, which was coordinated with all DoD Components, both informally and via SD-106, before issuance. It called for "*a common high-level simulation architecture to facilitate the interoperability of all types of simulations among themselves and with C4I systems, as well as to facilitate the reuse of M&S components.*" The Master Plan also included an action, following HLA development, to review all DoD M&S projects and programs to either immediate adopt the HLA or establish the date by which each program shall comply, with reasons for any non-compliance to be reported by the Component to the DDR&E.

The HLA project was twice reviewed by DoD's Joint Requirements Oversight Council (JROC). Unconvinced that owners of legacy simulations would voluntarily transition to the HLA, in Jan 96 the JROC decided that two cut-off dates should be established regarding HLA compliance:

- A "*No Can Pay*" date, beyond which no further funding can be provided for the development/modification of non-compliant M&S. This would not affect the use of this M&S or provision of O&M funding. Funding to become HLA-compliant would be permitted.
- A "*No Can Play*" date, beyond which the use of non-compliant M&S must cease. No further funding of any sort would be permitted.

On 6 Sep 96, soon after the baseline HLA was developed,[8] the EXCIMS decided to set the "No Can Pay" date as 1 Oct 98 and the "No Can Play" date as 1 Oct 00. Based on the EXCIMS recommendation, the USD(A&T), Dr. Paul Kaminski, issued a strong HLA policy on 10 Sep 96 that included those No Can Pay & Play dates. For the next several years, HLA-compliance reviews were conducted cooperatively between the Components and the DMSO. The resulting transition reports, including waiver recommendations, were considered by the EXCIMS and forwarded to USD(A&T) for approval. In approving those recommendations, the Sep 96 HLA policy was explicitly reaffirmed by Dr. Kaminski's successor, Dr. Jacques Gansler, in Apr 98 & Nov 99.

In Dec 98 the NATO M&S Master Plan, committing to HLA as the NATO standard, was approved by the North Atlantic Council (NATO's highest body)[9]. This decision was based on recommendations by the NATO Military Committee and the NATO Conference of National Armaments Directors (CNAD). The plan was developed by the CNAD's Steering Group on NATO Simulation Policy and Applications, with strong US support.

In summary, from 1995 through 1999, DoD HLA policy was consistent and strong. Although characterized as an "unfunded mandate" (DMSO provided in-kind assistance to simulation owners, but not direct transition funding), it was a policy that had been openly developed and was well supported across the DoD, at least as indicated by DoD M&S Master Plan coordination and the above-cited series of decisions by the EXCIMS and JROC.

4.2.3 HLA Policy Relaxed (2000)

The most recent HLA Policy pronouncement by USD(AT&L) occurred 3 Nov 00 with his approval of the "Memorandum and Agreement (MOA) on the High Level Architecture (HLA) for Simulations" that had been signed by all EXCIMS members. This superseded the 10 Sep 96 policy. The MOA makes strong

[8] Version 1.0 of the HLA was unanimously approved by the AMG in Aug 96

[9] NATO Document C(INV)M(98)52 of 2 Dec 98

statements in several places, such as "*The High Level Architecture (HLA) shall be the standard technical architecture for interoperability among DoD simulations and where the potential for reuse exists…*", but it also relaxed the Sep 96 policy in significant ways:

- It appended the phrase "*any other alternative approach must be justified*" to the end of the statement quoted immediately above.
- It stipulated that transition of existing simulations to the HLA shall "*be based on DoD Component requirements, resources, and priorities.*"[10]
- Instead of requiring USDAT&L) approval of exclusions from HLA compliance, it delegated these decisions to the owning DoD Component, albeit with the requirement to report them to the EXCIMS in periodic HLA Transition Reports.[11]

In his approval of the EXCIMS MOA on 3 Nov 00, the USD(AT&L), Dr. Gansler, strengthened the MOA provisions by providing the following additional direction:

> *I direct each of the participants in this MoA to aggressively transition their simulations to HLA in the most expeditious and effective way, consistent with their interoperability requirements and resources. I also expect the DoD Executive Council for Modeling and Simulation (EXCIMS) to aggressively monitor and review the Department's progress in transitioning to HLA. Lastly, I charge the EXCIMS Chair with the responsibility to inform me if the commitment to HLA wavers.*

Dr. Gansler also requested "*each of the DoD Components report their progress transitioning to HLA as of December 31,2000, to the DoD EXCIMS Secretariat by January 15, 2001.*"

This policy was understood in various ways by interested parties. Many read it as "gutting" the HLA policy, but others saw it as a continuation of DoD's commitment to the HLA as the single architecture standard by which all simulations would interoperate.

4.2.4 Other Architectures Emerge Amid Policy Confusion (2001-Present)

Regardless of one's reading of the Nov 00 HLA policy, M&S community leaders subsequently signaled they were not very interested in carrying it out.

- The EXCIMS did not meet between Feb 01 and Sep 03, an unprecedented lapse of 31 months.[12]
- No Component policies on HLA transition were published.
- No HLA Transition Reports were submitted to the USD(AT&L).
- The EXCIMS did not monitor the Department's progress in transitioning to HLA.
- DoD M&S leaders, previously vocal HLA advocates, largely went silent on this issue. The DMSO reduced its involvement in the Simulation Interoperability Workshops, where the commercial HLA standards (IEEE 1516 series) were developed. Other forums in which the DMSO had been a prime advocate for HLA also witnessed a decreased DMSO role.[13]

The sum effect of the above actions was to sow doubt about DoD's commitment to HLA. It was in this *de facto* policy vacuum that TENA and CTIA emerged, and DIS survived, as viable alternatives to HLA.

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[10] This was restated later in the MOA (para 4.4) as "*DoD Components shall establish their own policies and processes for transitioning their simulations to HLA or excluding them based on based on requirements, resources, Component priorities, or security.*"

[11] The MOA states, "*All exclusions from HLA compliance shall be documented, justified by the DoD Component, and reported in periodic HLA Transition Status Reports to the DoD EXCIMS*"

[12] The reasons for this are unclear, but do not appear HLA-related. The lapse coincided with a change of EXCIMS chairmanship to Dr. Charles Holland in Jul 01 and a rapid turnover in DMSO Directors, averaging 19 months during the period 2000-2004.

[13] DMSO leadership in NATO M&S activities decreased, as did participation of the DMSO Director.

Foundation Initiative 2010 (FI 2010) requirements documents direct TENA to be HLA-complaint.[14] As late as May 01, the FI 2010 Technical PM described TENA as services riding atop HLA, stating "*HLA & TENA are complementary in purpose, design, development, and implementation."*[15] But soon after that, TENA diverged from HLA, not because HLA couldn't provide the needed functionality, but because (a) a belief TENA developers knew a superior way to provide it and (b) an aversion to having users buy COTS RTIs.[16]

Jun 03 saw the issuance of a USD(P&R) memo stating "*Ensure all new range instrumentation is compatible with the Test and Training Enabling Architecture (TENA)."*[17] This policy would have been fine had TENA not changed from being a range-interoperability augmentation of HLA to being a simulation interoperability alternative to HLA, but given that change, it conflicted with the DoD HLA policy.

Amid an increasingly unclear DOD architecture policy, transitions from DIS slowed.[18] Other architectures emerged (*e.g.*, CTIA) and projects using proprietary architectures were funded by DoD.[19]

Contrary to the Nov 00 HLA policy, no justification for the use of these other interoperability architectures were ever provided and the EXCIMS Chair never informed the USD(AT&L) about this obvious wavering in DoD's commitment to HLA.

Contradictions in LVC architecture policy have continued. Still-current indications of a US commitment to HLA include:

- The Aug 06 US ratification of STANAG 4603 regarding HLA (IEEE 1516), committing to implement it as the standard by which the US would interoperate its simulations.[20]
- The DISR Online listing of HLA (IEEE 1516) as a mandatory standard for programs under the JCIDS process, while DIS is listed as an emerging standard and TENA is not mentioned.

The new directive on DoD M&S Management, DoDD 5000.59, released in Aug 07, does not mention the STANAG or DISR policies. It makes a passing reference to standards but does not name any. Likewise, although the "Strategic Vision for DoD M&S" signed out by the M&S SC that same month calls for "*standards, architectures, networks and environments that promote the sharing of tools, data, and information across the Enterprise,*" it doesn't mention HLA or any other LVC architecture.

4.3 Conclusions from History

Several conclusions can be drawn from this historical review:

- LVCAR execution will be a high risk endeavor because management will face the same problems JSIMS did: no unity of effort, no unity of command, and fractured funding. To be successful, LVCAR management must find a way to be effective despite them.
- The current multiple-architecture situation arose not because of divergent requirements, but because the EXCIMS Chair, the EXCIMS members, and the DMSO failed to follow the 2000 HLA policy they had advocated.

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[14] Joint Overarching Requirements Document (JORD) for Foundation Initiative 2010 (FI 2010), 31 Oct 98 (see Annex 2, pg. 2); Test Capabilities Requirements Document for Foundation Initiative 2010 (FI 2010), 12 Sep 99 (see Sections 1.2.1, 3.2.1, and 7.3)

[15] "Interoperability Efforts in M&S and in T&E," G. Rumford and P. Zimmerman presentation to the 3rd NDIA Simulation-based Acquisition Conference, "Enabling the 21st Century Acquisition Enterprise," Springfield, VA, 13 May 01

[16] FI 2010 Requirements Documents, op. cit., and J. Hollenbach discussion with G. Rumford, 22 Jul 05

[17] Page 1 of attachment to USD(P&R) memo, "Guidance for Fiscal Years 2006-2011Sustainable Ranges Programs," 26 Jun 03

[18] For example, the Aug 04 FBO #0986 Solicitation Notice for USAF Distributed Mission Operation Center (DMOC) Technical Support indicated a continuing commitment to DIS.

[19] For example, the Service Integration/Interoperability Infrastructure (Si3) has been used by the Army, Air Force, and Navy (Northrop Grumman "Si3 Contract Experience" presentation, Mar 08)

[20] Defense Standardization Program Office letters DSPO 20006/01 and 2006/02 of 10 Aug 2006 (JD 20060222). This STANAG was promulgated (official decision by the NATO Standardization Organization to announce a STANAG) in Jul 08.

- It takes a long time, perhaps 10 years, to transition an LVC user community to a new architecture. Consistency, effective communication, and strategic patience (persistence) over the long term are essential.
- The high-rate of leadership turnover within DoD, with its attendant political motivations, loss of corporate memory, and desire to establish new initiatives, makes persistence unlikely absent extraordinary efforts.
- M&S leaders should not only publish a policy but also document the rationale for it. Providing an effective "pass-down" should be seen as one of their responsibilities.
- Every incoming leader should be given more than an explanation of what the current policy is. They should be given the rationale for the policy and the need for persistence to accomplish the desired goal should be stressed. The M&S community likewise needs to be continually educated.

5 Means of Influence

To learn from these lessons, overcome the obstacles LVCAR execution faces, and effectively discharge its responsibilities, the organization entrusted with LVCAR management must function as the keystone organization of the LVC distributed simulation business ecosystem (as discussed in the Business Model section of the LVCAR). Fulfilling this role will require comprehensive, persistent, and discerning application of the following means of influence by LVCAR management. These were developed iteratively with inputs from LVCAR Workshop 4 participants.[21]

5.1 DoD Policy

Clear policy declarations will be needed so that the M&S Community, the DoD as a whole, and others impacted by DoD's course understand what the Department expects to happen regarding LVC architectures. LVCAR management could be involved in establishing that policy in the following ways:

- Proposing the policies to be established by the USD(AT&L) when he/she responds to the M&S SC's submittal of the LVCAR for approval. (Among other things, this policy statement would formally charter the organization responsible for LVCAR execution management, enumerate its duties and authority, and direct any other actions necessary to its establishment and operation.)
- Recommending follow-on policies to be issued by USD(AT&L)
- Submitting change recommendations to ensure that that the above policies are reflected in other DoD guidance (*e.g.*, DoD M&S issuances; the M&S SC's "Strategic Vision for DoD M&S;" DoDI 5000.2, "Operation of the Defense Acquisition System;" the Defense Acquisition Guide)
- Advocating and coordinating PPBES actions based on policy adherence. Policy and funding need to be aligned.

5.2 Communication

LVCAR management can influence the success of the LVCAR by effectively communicating with the various stakeholders identified in Section 2. This must be two-way communication. As the keystone organization, LVCAR management has to understand each stakeholder's situation, listen to their concerns, and provide them information they consider valuable. LVCAR management should explain the roadmap and point stakeholders to opportunities where they can advance their own interests by participating in the roadmap's activities and leveraging its products and services. LVCAR management should maintain situational awareness over the entire department in all LVC matters and keep all parties informed of progress as the plan executes.

[21] LVCAR Workshop 4 was held on 24 Jun 08 at the Virginia Modeling, Analysis and Simulation Center (VMASC) in Suffolk, VA. Participants affirmed all the means of influence except awards, which they did not think would be relevant to LVCAR execution. That means of influence has been modified and is included here as a reinforcing complement to the others.

For optimal effectiveness, these communications would be regularly repeated until LVCAR execution is complete. The venues in which these communications should occur include:

- Liaison (*e.g.*, office calls, *ad hoc* "walking around" meetings, correspondence) with the various stakeholders identified in Section 2 and other organizations that may assist LVCAR execution
- Participation in relevant conferences (*e.g.*, I/ITSEC, SIWs, ITEC, NDIA, MORS) via keynote addresses, tutorials, papers, and invited presentations
- Articles and interviews in professional journals and newsletters
- Congressional testimony
- Press releases
- Education courses (e.g., Continuous Learning Modules, DSMC classes, guest lectures)

5.3 Business Model Facilitation

The organization entrusted with LVCAR execution management will play a critical role in establishing the business model envisioned by the LVCAR, functioning as the keystone organization of the distributed simulation business ecosystem that DoD relies on to deliver value. LVCAR management would influence execution of the LVCAR by performing business model-related activities such as:

- Advocacy for, and coordination of, any required changes within the DoD PPBES
- Advocacy for the evolved business model with users
- Advocacy for any required changes with COTS vendors
- Open source software development solicitation preparation, proposal evaluation, and source selection (in coordination with the government's Contracting Officer)
- Service as the Contracting Officer's Technical Representative (COTR)
- Team with "capstone event" sponsors to foster a viable marketplace (see Section 5.7)
- Tracking business model adoption (and adaption) by all parties
- Assessment of business model effectiveness

5.4 Cross-Architecture Technical Management

The LVCAR proposes to shepherd the evolution of the various architectures to minimize future divergence and achieve convergence to the maximum extent practical. Operating within its charter, LVCAR management should work collaboratively with all interested parties to influence the evolution of the various architectures through the following actions:

- Understanding the issues with which the architecture developers and architecture users are grappling
- Tracking requirements and validating requirements that affect convergence or are duplicative
- Executing LVCAR recommended technical activities, to include:
  - Solution concept development, including experimentation
  - Analysis of alternatives (AoA), to include the design and execution of experiments
  - Prototyping selected concepts
  - Dispute arbitration
  - Configuration management of common architecture elements and cross-architecture interfaces (*e.g.*, wire protocol, common object models)
  - Implementation tracking and assessment
- Identifying other needed technical activities, with execution as above
- Assessing mixed architecture federation performance, possibly complemented by gateway development, procurement, and/or management

- Tracking user and vendor migration to evolved standards (in cooperation with managers of the individual architectures)

5.5 Standards Organization Participation

To wield influence regarding the evolution of the various architecture standards, the organization entrusted with LVCAR management should be an active participant in the standards development processes of the relevant SDOs (*e.g.,* SISO, TENA AMT). This is necessary not only to stay abreast of emergent issues, but to effectively advocate for those changes it views as the optimal evolution path.

This activity is complementary to the cross-architecture technical management tasks discussed directly above. The requirements tracking, analyses, experiments, and prototypes performed there will inform and accredit the LVCAR management's proposals to the SDOs regarding standards evolution and/or the need to develop new standards.

LVCAR management should also encourage other DoD organizations to participate in SDO operations and track this. By inviting these other representatives to periodic DoD-only meetings, LVCAR management could refine and build consensus for the proposals it intends to make to the SDO and thus facilitate their approval. It could also use these meetings to solicit critiques of SDO operations and so be able to provide a unified DoD voice offering constructive criticism to improve SDO operations.

Because of the impact of such organizations on the rest of DoD, LVCAR management should also participate in the deliberations of DoD standards setting organizations (SSOs), such as the Navy's M&S Standards Steering Group (MS3G) and the M&S Technical Working Group under the DISA's IT Standards Committee, which controls the DoD Information Technology Standards Registry Online (DISR Online). As an example of the benefits to be realized by SSO involvement, inclusion of the evolved LVC architectures standards in the DISR Online, as either emerging or mandatory standards, would inform potential users of the appropriateness of employing these standards.

5.6 Direct Assistance

LVCAR management providing direct assistance to stakeholders would influence their behaviors in proportion to the perceived value of the assistance. That assistance could take the form of funding assistance for:

- Architecture change implementation
- SDO operations support
- Representation asset compliance with the evolved LVC architectures
- Open source software development (*e.g*., funding government organization involvement as a complement to the open source activities discussed in Section 5.3 above)

LVCAR management could also provide in-kind assistance via mechanisms such as training, technical advice, software tool distribution (*e.g*., to facilitate use of the evolved architectures), or providing compliance certification services in support of SDOs and those representation asset owners and tool vendors seeking to become compliant with the evolved architectures.

5.7 Capstone Events

Architecture convergence can be facilitated by leveraging on-going multi-Service / Joint distributed simulation activities such as the Joint National Training Capability (JNTC) and Joint Mission Environment Test Capability (JMETC). They federate large numbers of live, virtual, and constructive representations from across the DoD for important purposes such as training a joint force, evaluating new operational concepts, or testing a system's performance under operationally-representative conditions. These events are the culmination - the capstone - of much time, investment, and effort by a military unit or acquisition program and the decisions informed by these events have major implications for DoD's future.

As such, these capstone events have an influence beyond their immediate purpose. For a military unit or acquisition program being evaluated, these events are akin to competing in the Olympics. Just as athletes want to train under conditions as similar as possible to those in which they will compete, unit

commanders and program managers will want the LVC environments they use to prepare for such events to be as close as possible to the LVC environment in which they will be evaluated. If LVCAR management is able to persuade and assist capstone event program managers (*e.g.*, JNTC and JMETC PMs) to comply with the evolving LVC architectures, this will in turn influence many other programs and federate owners across the DoD to also comply.

5.8 Awards

Because people appreciate being recognized for their work, LVCAR management could help influence LVC distributed simulation stakeholders by presenting awards for actions that are particularly helpful in executing the LVCAR. Such recognition could range from laudatory mention in newsletters, to letters of appreciation or commendation, to physical mementos such as plaques. Besides issuing awards, LVCAR management could also nominate individuals or organizations for the annual M&S awards managed by the M&S Steering Committee. Perhaps a special LVCAR award category could be established to draw attention to the importance of roadmap execution.

6 Management Organization Considerations

The following sections identify considerations that must be weighed in deciding the organization to be entrusted with LVCAR execution management responsibilities. These considerations are informed by (1) the above-established understanding of the means of influence that this organization must exert, and (2) the need to align responsibility, authority, and accountability (management basics) to the extent possible within the LVCAR execution context.

6.1 Organization Structure

The organization will need to function at both an executive and a technical level, and so must be structured accordingly. It will require two executives (director and deputy) who can comfortably interact with decision makers who are general or flag officers; Presidentially-appointed, Senate-confirmed executives; members of the Senior Executive Service (SES); or leaders of industry. They would handle policy and funding matters, many of the communication tasks (*e.g.*, conference keynotes, interactions with Congress), interact with Congressional staff, advocate the LVCAR business model, establish direct assistance guidance, serve as the final authority for major award selection, forge agreements regarding use of the evolved standards for capstone events, etc. They would also oversee all other LVCAR management activities.

The organization will need a technical staff of about six people.[22] The bulk of their duties will be performing the cross-architecture technical management tasks identified above and participating in the standards organization activities described in Section 5.5. They will handle the critical external communications at the working level, to include observing LVC events. They will be deeply involved in the open-source software development efforts associated with the new business model. The technical staff will also alert the organization's executives about emergent issues and otherwise exercise all necessary support tasks.

Table 1 identifies the role of the executive and technical levels regarding exercise of the various means of influence identified in Section 5.

Table 1 Allocation of Responsibilities

Means of Influence	Executives	Technical Staff
DoD Policy	Lead	Support
Communication	High level	Working level
Business Model Advocacy	Lead	Open-Source Support

[22] Per LVCAR Workshop 4 participants and weighed against required tasks

Cross-Architecture Technical Management	Oversee	Lead
Standards Organization Involvement	Oversee	Lead
Direct Assistance	Approve	Propose
Capstone Events	Advocate	Support
Awards	Approve	Nominate

6.2 Personnel Qualifications

The executives should be selected based on the following criteria:

- Business acumen
- Leadership skills
- Communication skills
- Familiarity with LVC distributed simulation
- Credibility with stakeholders
- Expected longevity in the position

Members of the technical staff should be selected based on the following criteria:

- Technical competence in distributed simulation
- Experience in standards development
- Expected longevity in the position
- Inter-personal skills

6.3 Funding

It will take significant and sustained funding, notionally $10-$15M per year, to successfully execute the LVCAR. As discussed in the Business Model section of this report, the potential benefits of a more capable and cost-effective LVC distributed simulation business ecosystem justify such an investment. Nonetheless, obtaining the required funding will be a contentious matter.

There are four conceivable funding sources for LVCAR execution:

(1) The organization entrusted with LVCAR management could volunteer to fund it from its own resources.

(2) Existing M&S SC funding[23] could be allocated to LVCAR execution.

(3) The M&S SC could gain the additional funding required for LVCAR execution by (a) developing a comprehensive, plan for improving M&S support to the Department's operations, (b) proving that its existing funding is inadequate to accomplish that, (c) having the DDR&E or USD(AT&L) initiate a PPBES action (PDM or PBD) to obtain the additional funding, and (d) prevailing in the PPBES issue adjudication process.

(4) Congress could identify funds for LVCAR execution, with that action having to be repeated each year unless Congress directs the Department to begin budgeting for LVCAR execution. One rationale for Congressional action is that the LVCAR impacts other government departments besides DoD.

Allocating existing M&S SC funding appears the least difficult course, but the organizational home chosen will certainly affect the viability of these various funding options. This will be weighed in Section 7 below.

[23] Program Element 0603832D8Z, "Joint Wargaming Simulation Management Office," $38.15M in FY09 President's Budget

6.4 Location within DoD Organizational Structure

Section 3 noted LVCAR management will not have authority over all elements of the distributed simulation business ecosystem, or even all its DoD elements. Hence the location of LVCAR execution management responsibility within the DoD organizational structure should be decided based not on positional authority, but rather on the strengths and weaknesses associated with each alternative.

The following criteria are relevant to that choice (these are identified by letter here to facilitate referencing them in the Section 7.2 analysis):

a. Location compatible with existing roles and missions, and acceptable to USD(AT&L), the head of DOD M&S per DoDD 5000.59

b. Independence and responsiveness to apply the means of influence to maximum effect

c. Credible stature/position in relation to LVC distributed simulation ecosystem stakeholders

d. Organizational stability (persistence; ability to exercise "strategic patience")

e. Ability to provide or obtain, and maintain, required funding

f. Ability to provide or obtain, and maintain, required personnel billets

g. Ability to attract and retain personnel with the required qualifications (per Section 6.2 above)

7 Management Organization Options

7.1 Options

The following options for assigning LVCAR execution management responsibility have been identified by LVCAR participants.

Option 1: Assign this responsibility to the **M&S Coordination Office**, under M&S SC oversight

Option 2: Establish a special **M&S SC Task Force**

Option 3: Establish a new **Capability Portfolio Management (CPM) Office**

Option 4: Establish a new **USD(AT&L)-chartered Joint Analysis Team** (JAT)[24]

Option 5: Assign this responsibility to the **Joint Forces Command** (JFCOM)

Option 6: Assign this responsibility to an **existing M&S Community governance body** with strong involvement in distributed simulation (*i.e.*, the TT ESG, SE Forum, or TIJE SSG)

Option 7: Assign this responsibility to **a DoD Component**, designating them an M&S Coordination Agent[25]

7.2 Analysis

Arguments pro and con for each of the above options are as follows.[26]

Option 1: Assign this responsibility to the **M&S Coordination Office**, under M&S SC oversight

- Pros (a, d, e): No new organization required; as noted in Section 4.2.1, this office was founded as a cross-DoD organization to establish standards that foster interoperability and reuse; funding available from current PE

[24] USD(AT&L) Source Document "Blueprint for the Future, Dec 07, slides 15-16

[25] DoDD 5000.59, "DoD M&S Management," paragraphs 4.4, 5.1.3.6, 5.4, 5.7.5, E.2.9

[26] Drawn from Expert Team observations and comments by participants in LVCAR Workshop 4

- Cons (b, c, f, g): Current M&S SC ConOps is very cumbersome, so M&S CO would need a special charter to provide requisite authority and responsiveness; M&S SC and M&S CO are currently perceived as being largely uninterested in LVC architectures; five of the original six M&S CO billets have migrated elsewhere in OUSD(AT&L), so it has none available for this task; DDR&E has directed the M&S CO to not manage technical projects and that new role has been insufficient to retain or attract personnel with needed skills; the M&S CO in its current form is not well postured to execute the proposed responsibilities.[27]

Option 2: Establish a special **M&S SC Task Force**

- Pro (a, e): Although a new organization, it would exist within M&S management structure established by DoDD 5000.59; funding available from current PE
- Con (b, c, d, f, g): Current M&S SC ConOps is very cumbersome, so Task Force would need a special charter to provide requisite authority and responsiveness; M&S SC is currently perceived as being largely uninterested in LVC architectures; can't assign government billets to an M&S SC task force, so would have to assign executives from other organizations on an additional duty (ADDU) basis, inviting the JSIMS problem of no unity of command; lack of permanence of Task Force would inhibit recruitment of personnel with needed skills

Option 3: Establish a new **Capability Portfolio Management (CPM) Office**

- Pro (b, c, d, e, f, g): CPM is intended to manage related projects that together provide a capability, so this is a good fit for LVC architectures; a CPM Office would have great credibility
- Con (a): DoD is still early in applying the CPM concept and LVC architectures are too small an issue relative to issues address by CPM thus far;[28] USD(AT&L) is skeptical of the PFM concept[29] due to the additional management layer is imposes

Option 4: Establish a new **USD(AT&L)-chartered Joint Analysis Team** (JAT)

- Pro (a, b, c, e): John Young's favored alternative to CPM;[30] subjects addressed so far include some at a lower-level than CPM;[31] JATs are composed of teams of stakeholders, similar to an IPT; funding could come from a M&S SC or USD(AT&L)-initiated PPBES action

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[27] LVCAR Workshop 4 participants lamented the current situation and suggested "putting DMSO back together."

[28] CPMs approved by DepSecDef 07 Feb 08 memo are Force Application; Battlespace Awareness; Command and Control; and Net-Centric. Experiments with CPMs for Force Support; Protection; Building Partnerships; Logistics; and Corporate Management and Support are ongoing thru FY10.

[29] Carlo Muñoz, "Young Favors Joint Analysis Teams Over Portfolio Management," Inside the Pentagon, June 5, 2008. Excerpt: "Young expressed concern that the department's capability portfolio management (CPM) process could add another cumbersome layer to an already complicated capabilities-development process."

[30] Ibid. includes following statements:

> "Young advocated the use of "joint analysis teams" to convey the services' capability needs, as opposed to the CPM construct." "I feel more strongly about that" Young said of the joint analysis teams, noting the fondness he had for the approach as head of the Pentagon's Defense Research and Engineering shop.
>
> Significantly smaller, the joint analysis teams would consist of "teams of stakeholders within the department, across the services and into the requirements community, and into the resources community" tasked with developing development roadmaps for a given capability, according to Young. Those roadmaps would outline the short- and long-term development and acquisition strategies needed to bring a given capability into the field.
>
> "These tools are the right tools," Young said of the joint analysis teams. "These smaller teams that attack certain technical areas in our portfolio and assure that we have a joint, coordinated and collaborative development approach or set of programs to address our [acquisition] gaps and needs. I feel pretty strongly about that. "

[31] USD(AT&L) Source Document, op. cit., lists JATs for Inter-Service Depots, CRAF Operational Concept; and Joint Container Management

- Con (d, f, g): JATs may not provide the required persistence; it appears personnel would have to be assigned ADDU; USD(AT&L) would have to direct organizations to provide personnel on a long-term basis; ability to attract needed personnel uncertain

Option 5: Assign this responsibility to **Joint Forces Command** (JFCOM)

- Pro (b, c, e): JFCOM is well-respected and active in distributed simulation; funding could come from the M&S SC or Congressional action[32]
- Con (a, d, f, h): USD(AT&L) will probably not wish to see this responsibility transferred outside OSD; not all M&S Communities represented (*e.g.*, Acquisition); billets hard to get; JFCOM not desirous of additional tasking; persistence questionable

Option 6: Assign this responsibility to an **existing M&S Community governance body** with strong involvement in distributed simulation (*i.e.*, the TT ESG, SE Forum, or TIJE SSG)

- Pro (a, d): No new organization; all Services represented; already dealing with LVC standards issues
- Con (b, c, e, f, g): Not all M&S Communities represented, so independence and respect beyond current community doubtful; no billets, so would have to rely on ADDU personnel; existing tasks absorb all current resources, so funding would have to be allocated from M&S SC PE

Option 7: Assign this responsibility to **a DoD Component**, designating them an M&S Coordination Agent

- Pro (a): Conforms to management concepts in the DoD M&S Management directive
- Con (b, c, d, e, f, g): Level playing field concerns; billets hard to obtain; unlikely to maintain strategic patience and funding for the long term due to emergent competing priorities

8 Conclusions

8.1 Billets and Personnel

Obtaining government billets will be very difficult. The alternative of government personnel serving in the management organization on an additional duty or rotational assignment basis will not provide the needed stability and persistence.

Considering the responsibilities involved, the paucity of government billets available, and the limited numbers of government personnel with the qualifications listed in Section 6.2, it will probably only be possible to obtain two government billets: one at the executive level and one at the technical level. The second executive position could be filled by a person from an FFRDC, UARC, or academia. The remaining technical positions could be filled by persons from an FFRDC, UARC, academia, or industry. A few of the technical positions could be filled by personnel on rotational assignments, but the majority should be long-term, permanently-assigned personnel.

Anyone with the requisite qualifications is likely to have experience tilted towards one of the architectures affected by the LVCAR. For this reason, the LVCAR management team needs to be reasonably balanced.

8.2 LVCAR Management Organization

Successful LVCAR execution requires management responsibilities be assigned to a persistent organization equipped with vision (*i.e.*, a sound roadmap) and the requisite authority and means of

[32] Two prominent members of the Congressional M&S Caucus, Representatives J. Randy Forbes (R, VA-04), its chair, and Robert C. "Bobby" Scott (D, VA-03) represent the Tidewater area of Virginia where JFCOM is located.

influence. With these things the organization can overcome the several risks identified in the context, constraints, and history discussions. Without them, LVCAR execution will fail.

Option 4, establishing an LVC Distributed Simulation Joint Analysis Team is the best option, but it is contingent on USD(AT&L) support for (a) establishing a persistent (5-10 years) JAT, (b) directing organizations under his control to assign two government persons, with the requisite skills, to the JAT long-term; and (c) approving contracting out for the services of the other needed personnel.

The second best option is to assign these responsibilities to the M&S CO, contingent on (a) the M&S SC granting the M&S CO sufficient authority to freely exercise the full means of influence, (b) the DDR&E ensuring at least two of the five government billets that migrated elsewhere in OUSD(AT&L) are returned to the M&S CO, and (c) the M&S CO hiring personnel meeting the criteria listed.

8.3 Funding

Obtaining new funds for LVCAR execution, via a DDR&E or USD(AT&L)-initiated PPBES action, is desirable and should be pursued. As noted previously, this will be facilitated by development of a comprehensive, plan for improving M&S support to the Department's operations and proving that existing funding is inadequate to accomplish this.

Having to fund LVCAR execution from the existing M&S SC-controlled PE is less desirable but most likely. This should be anticipated and the required $10-$15M annual funding set aside. As discussed in the Business Model section of this report, the potential benefits of a more capable and cost-effective LVC distributed simulation business ecosystem justify such an investment.