Live Virtual Constructive (LVC) Architecture Roadmap (AR) Comparative Analysis of Business Models

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September, 2008

Cleared for public release (Distribution A) by the DoD Office of Security Review
(Case No. 09-S-2413) / M&S CO Project No. 06OC-TR-001

List of Acronyms

AMG	Architecture Management Group
AT&L	Acquisition, Technology and Logistics
CD	Compact Disc
COA	Course of Action
COTS	Commercial off the Shelf
DIS	Distributed Interactive Simulation
DOD	Department of Defense
DMSO	Defense Modeling and Simulation Office
DVD	Digital Versatile Disc
FOSS	Free and Open Source Software
GOTS	Government off the Shelf
HLA	High Level Architecture
HLA RTI	High Level Architecture Run Time Infrastructure
LVC	Live, Virtual and Constructive
LVCAR	Live Virtual Constructive Architecture Roadmap
M & S	Modeling and Simulation
M&S CO	Modeling and Simulation Coordination Office
MLS	Multi-level Security
OSD	Office of the Secretary of Defense
OSS	Open Source Software
OTD	Open Technology Development
TENA	Test and Training Enabling Architecture
USD	Undersecretary of Defense
WG	Working Group

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Executive Summary

The provision and management of Live Virtual Constructive (LVC) integrating architectures in support of Department of Defense's (DoD) various LVC user communities appears increasingly problematic as LVC employment[1] continues to expand in scale and scope. Sponsored and funded by the Modeling and Simulation (M&S) Steering Committee (SC), the Live Virtual Constructive Architecture Roadmap (LVCAR) Study is tasked to explore and assess a number of alternatives supporting simulation interoperability, related business models, and the evolution process of related standards. The goal of the LVCAR Study is to methodically and objectively develop a recommended roadmap (way forward) regarding LVC interoperability across three broad areas of concern: notional definition of the desired future architecture standard, the desired business model(s), and the manner in which standards should be evolved and compliance evaluated. This document serves to summarize the progress to date on the Business Model component of the LVCAR Study.

Few, if any, challenge the general value of LVC interoperability and distributed simulation. Likely, the value of LVC interoperability will grow significantly over the next several years. DoD is executing more complex and irregular missions in a vastly expanding mission space with increasingly complex systems of systems. Funding shifts, particularly during high tempo operations, are forcing trainers and testers to do more with less. Technology is advancing rapidly. Over the last decade, we have witnessed a tremendous growth in the internet, in information technologies, and communications. Large monolithic simulations are ill-equipped to keep pace with rapid operational and technical change. It's simply too expensive and too time-consuming to build new capability for every emerging need.

The value of interoperability accrues primarily at the corporate level. Interoperability provides a mechanism whereby M&S assets developed for a particular purpose are elevated above that initial purpose and made available to a much broader audience. This has the effect of reducing the cost of capability across the DoD enterprise. This presumes, of course, that programs, trainers, analysts, etc are making their assets available for discovery and application. However, the lower echelons find it more difficult to appreciate the value of interoperability and, more generally, reuse to them. Building capability that is interoperable and reusable adds cost to the development effort.

An absence of effective leadership has tended to foster incoherence in the marketplace. The current multiple-architecture situation is, at least in part, the result of inattention to DoD HLA policy by the Executive Council for M&S (EXCIMS) and the Defense Modeling and Simulation Office (DMSO). USD(A&T), in approving the "HLA for Simulation MOA" on 03 Nov 2000, included the following direction:

- "I direct [all Components] to aggressively transition their simulations to the HLA …consistent with their interoperability requirements and resources. I also expect the <u>[EXCIMS] to aggressively monitor and review the Department's progress in transitioning to HLA</u>. Lastly, I charge the EXCIMS chair with the responsibility to inform me if the commitment to HLA wavers."
- <u>"All exclusions</u> from HLA compliance shall be…justified by the DoD Component, and <u>reported</u> in <u>periodic HLA transition reports to the DoD EXCIMS</u>."

Yet no progress reviews were conducted nor transition reports submitted. Visible promotion of HLA ceased. This leadership vacuum left the M&S community confused and encouraged die-hard DIS users to halt transition to HLA. The EXCIMS took no action and did not notify the USD(A&T) when TENA changed course and emerged as a competitor to HLA in 2002. The goal of a single LVC distributed simulation marketplace, trumpeted by DoD for 5+ years, was effectively discarded, leaving DoD with the three distinct LVC marketplaces it has today.
DoD Modeling and Simulation business is conducted in an ecosystem. The organisms of that system include coordination offices at the OSD and Service levels, government labs and private firms that

1 These applications span all forms of live, virtual, and constructive (LVC) M&S-supported events which, as scoped by this study's proposal, may be composed of all or any subset of LVC capabilities (i.e., L, V, C, LV, LC, VC, LVC).

develop modeling and simulation assets; and, analysis, acquisition and training organizations that use modeling and simulation carry out their mission. M&S development and use is spread across a large number of program elements and authority for executing those funds is spread across and equally large number of organizations. Arguably by design, there is no single organization which controls both policy and funding under a single mission umbrella.

Leaders interested in modeling and simulation would like to spend millions to leverage the billions currently being expended within the Department. The central player in a healthy ecosystem is the keystone organism, which serves as the leader of the ecosystem. The keystone organism sets the direction of the ecosystem by creating value and sharing that value with their ecosystem partners.[2] The keystone organism need not control a significant portion of the revenue of an ecosystem. Microsoft has profound influence over the information technology (IT) ecosystem; yet in "both its revenue and number of employees represent about 0.05% of the total figures for the ecosystem." (Iansiti, 2004, 11) Taken the other way, a central M&S keystone with a budget of merely $35M could have a substantial effect on the $9B DoD M&S ecosystem. The limited central M&S funding in the context of the overall US government model makes the ecosystem strategy model so provocative for DoD M&S.

The Network Effect is the "phenomenon whereby a service becomes more valuable as more people use it, encouraging ever-increasing number of adopters." (Web Site, 23) Fundamentally, interoperable LVC assets exist on a network. The perceived value of interoperability, and hence the value of the interoperability architecture, will increase as the number of interoperable LVC assets increases. Stakeholders must, therefore, see value in linking their simulations with others and that value must be greater than the perceived cost of migrating to that architecture – and this must be true for the broadest number of stakeholders at all echelon levels. Maximum value from LVC interoperability will be realized when the network effect is a characteristic of the LVC economy. The network effect has to be the objective of the business model. The value of the network, both perceived and actual, will only reach the tipping point when a critical mass of LVC assets is compliant and available to the broadest possible user base. This is best accomplished by recognizing that an LVC business ecosystem exists and a cogent set of keystone strategies are adopted.

However, the current LVC marketplace is incoherent. Differences in institutional investment and cost of entry for the users have resulted in marketplace where the array of possible key products – the various architectures and interoperability middleware – can not compete on technical merit alone. The situation is made worse by the lack of clear direction from the top. As a result, organizations participating in LVC exercises are compelled to maintain multiple interfaces in order to participate in the broadest possible array of revenue-producing exercises. This tends to suppress the perceived value of interoperability among practitioners. Separate architectures means that growth is compartmentalized making it more difficult to achieve the network effect at the Department level.

Specific actions that should be taken are summarized thus:

Establish a DoD LVC Interoperability Keystone. The central player in a healthy ecosystem is the keystone organism, which serves as the leader of the ecosystem. Leadership was/is a key component of the success of the existing business models. In order to successfully execute the LVC Architecture Roadmap, an OSD-level organization should be given the responsibility to function as the LVC Interoperability Keystone Organism. The Keystone is the ecosystem's value dominator and seeks to create and share value across the DoD enterprise as a means to foster broad participation in the Keystone's cogent LVC agenda. The Keystone should be a credible organization with appropriate technical and management personnel and sufficient authority to execute the requisite means of influence (e.g., policy, communication, direct sponsorship, and technical leadership) and structure actions to achieve the vision of the LVCAR. The LVC Keystone will be required to work with key partners in the

2 Wal-Mart, for example, entices suppliers into their ecosystem by providing broad-spectrum customer data that Wal-Mart collects as a matter of routine. Wal-Mart creates substantial value for their partners thereby enticing them to stay and participate. In turn, according to Iansiti and Levien in their 2004 Harvard Business Review article (Iansiti, 2004, 10), Wal-Mart's retail grocery business enjoys a 22% advantage because they are "better able to match supply and demand across the entire ecosystem increasing productivity and responsiveness for itself – and for its partners."

LVC Ecosystem to establish and maintain buy-in to the overall LVC strategy. The Keystone should be in a position to maintain situational awareness over the entire Department in all LVC matters so as to align ongoing activities and identify, understand and influence clearly redundant activities.[3] Furthermore, the Keystone will need to maintain cognizance of LVC-related activities outside the Department. Specific classes of organizations with which to develop strategic relationships include Standards Development Organizations, other Federal agencies, and coalition partners. The Keystone should have the capacity to obtain and maintain the necessary funding required to carry out Keystone responsibilities. This includes resources to maintain a technical staff that understands the challenges of LVC interoperability and have a vested interest in customer needs and requirements. Finally, the Keystone must have the long term view. They must be able to exhibit the strategic patience required to see the LVCAR to fruition.

Balance the Marketplace Using an Open Technology Development Paradigm. An Open Source solution provides a medium for government investment in architecture evolution while allowing private firms to align their businesses – in whatever way they see fit – to the Open Source solution. Further, it eliminates license fees as a barrier to entry to LVC interoperability. DoD should be about the business of the Warfighter. LVC interoperability is a means to an end not the end. By moving the source into the public domain for cooperative development by those so inclined, DoD focuses on establishing the requirements and needs rather than solutions. Over time, the cost and control of the architecture is moved into a shared innovation and development space. This opens up the core capability to innovation by other organizations, governments, commercial entities, and academia. Investment in development is pushed out to the community. OTD greatly improves the potential for innovation by spreading access and risk to a greater constituency. Barriers to entry are all but eliminated thereby encouraging investment from a broader range of interested parties.

Create Market Opportunities. The Keystone must work to tip the marketplace in favor of the ODT middleware. Tipping points are triggered by a few key players (i.e., connectors, salesmen and mavens) (Gladwell, 2001). By focusing resources on key players and leveraging them with existing resources, greater effect can be achieved. In an effort to foster expedient migration of federates and federations into the LVCAR, the LVC Keystone should large scale, issue-driven exercises as a market force for testing evolutions of the interoperability architectures. The LVC Keystone should identify important Federation Proponents (JFCOM, NCTE, large PEOs) and work with them (i.e., provide incremental funding, services, etc) to integrate emerging development by using the LVC OTD as a basis for their chosen middleware solution.

Establish Targets for Improved Interest and Participation in Developing and Shepherding Open Standards and Undertake Specific Actions to Meet Those Targets. The LVC Keystone must maintain vigilance across a broad user marketplace. They should stimulate interest in the broader community and establish a substantive government role in developing and vetting the interoperability standards. The primary target for standards development and vetting is the Simulation Interoperability Standards Organization (SISO) and is the right place to establish a presence. In so doing, members of the larger LVC marketplace will be able to maintain situational awareness of ongoing developments and will, as required, play a role in their evolution.

Define and Collect Business Measures. A business metric is any type of measurement used to gauge some quantifiable component of a company's performance. (Web Site, 20) Collecting, understanding and measuring progress against a cogent set of business metrics are essential to a successful and adaptive business strategy. The business model for the LVCAR is no exception. The keystone should undertake a cogent strategy of identifying measures, assessing progress and using performance measured against those metrics to adapt components of the business model.

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3 During the 2008 SBIR cycle, the Navy issued a topic seeking small business proposals "to provide an open architecture solution to interprocess communications between real-time simulation applications and services." [SBIR Topic N08-116 (Navy)]. Given SBIR topics are vetted through OSD, it's hard to understand how this made it through the selection wickets.

Finally, it is our sincere hope that this evaluation will bring “business thinking” into the LVC interoperability debate. We use the terms innovation/invention/creative interchangeably. However, there is an important distinction. As Jan Fagerberg wrote:

> *An important distinction is normally made between invention and innovation. Invention is the first occurrence of an idea for a new product or process while innovation is the first attempt to carry it out into practice.*

The attempt to “carry it out into practice” has “business model” written all over it. The invention of technology is a wonderful thing; however, only when the explicit concern on how the invention will be practically deployed will the concomitant return on investment be realized.

1 Introduction

Few, if any, challenge the general value of LVC interoperability and distributed simulation. Likely, the value of LVC interoperability will grow significantly over the next several years. DoD is executing more complex and irregular missions in a vastly expanding mission space with increasingly complex systems of systems. Funding shifts, particularly during high tempo operations, are forcing trainers and testers to do more with less. Technology is advancing rapidly. Over the last decade, we have witnessed a tremendous growth in the internet, in information technologies, and communications. Large monolithic simulations are ill-equipped to keep pace with rapid operational and technical change. It's simply too expensive and too time-consuming to build new capability for every emerging need.

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However, the lower echelons find it more difficult to appreciate the value of interoperability and, more generally, reuse to them. Building capability that is interoperable and reusable adds cost to the development effort. In the commercial world, this added cost would manifest itself in one of three ways: 1) the firm would absorb the cost to maintain competitive advantage, 2) the firm would raise the price of the offering or 3) the firm would make up for lower margin by increasing volume. In the government to government context, the situation is a little more complicated. To start, there's some question as to whether one government organization can sell unmodified capability to another government organization. Government organizations don't make a profit (i.e., they don't have margin) and so making up lower margin through volume isn't possible. Some government organizations (i.e., labs and warfare centers) generate overhead and could ostensibly use some of that overhead to build interoperability into their M&S assets; but why would they do that? Unless there is an opportunity to recoup that cost, convincing lower echelons to spend the extra money is difficult.

An absence of effective leadership has tended to foster incoherence in the marketplace. The current multiple-architecture situation is, at least in part, the result of inattention to DoD HLA policy by the Executive Council for M&S (EXCIMS) and the Defense Modeling and Simulation Office (DMSO). USD(A&T), in approving the "HLA for Simulation MOA" on 03 Nov 2000, included the following direction:

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The goal of the LVCAR study is "to methodically and objectively develop a recommended roadmap (way forward) regarding LVC interoperability across three broad areas of concern: definition of the desired future integrating architecture(s), the desired business model(s), and the manner in which standards should be evolved and compliance evaluated". Currently, our interpretation of the term "desired business model(s)," assumes that our recommendations should provide for the set of factors that will achieve the maximum amount of compliance with the recommended set of architectural standards, thus maximizing

interoperability. The goal of the business model portion of the study is to identify a coherent business path within which to execute the LVC Architecture Roadmap.

2 Business Model Defined and Its Scope Delineated

A business model is a conceptual tool that allows a firm to explain how it operates and expects to stay in business. Business models are characteristics of organizations and not particular products. A product can embody the results of applying the business' core competency, sales of the product earn revenue for the firm, and the method by which the product contributes to the firm's cost structure. However, the product itself is not the firm's strategy nor is it the firm's approach to staying in business. As illustrated Figure 2.1, aspects of the business model concept can be imported directly into government organizations, notably the descriptions of principal activities and core competencies. A firm is just one kind of organization: a privately owned, profit-seeking organization that uses market relationships and contracts to create value, earn revenue, and pay costs. Government organizations instead are granted authority through legislation or executive order, enforced by the government's coercive powers, and constrained by the constitutional and legal procedures that give citizens democratic representation. Government organizations generally do not seek profits but rather are given various public missions (e.g., providing public goods that the market would fail to offer to willing consumers). Nevertheless, all organizations, including government ones, have principal activities or missions, and all organizations make claims about what they are good at – their core competencies – to justify their continued existence.

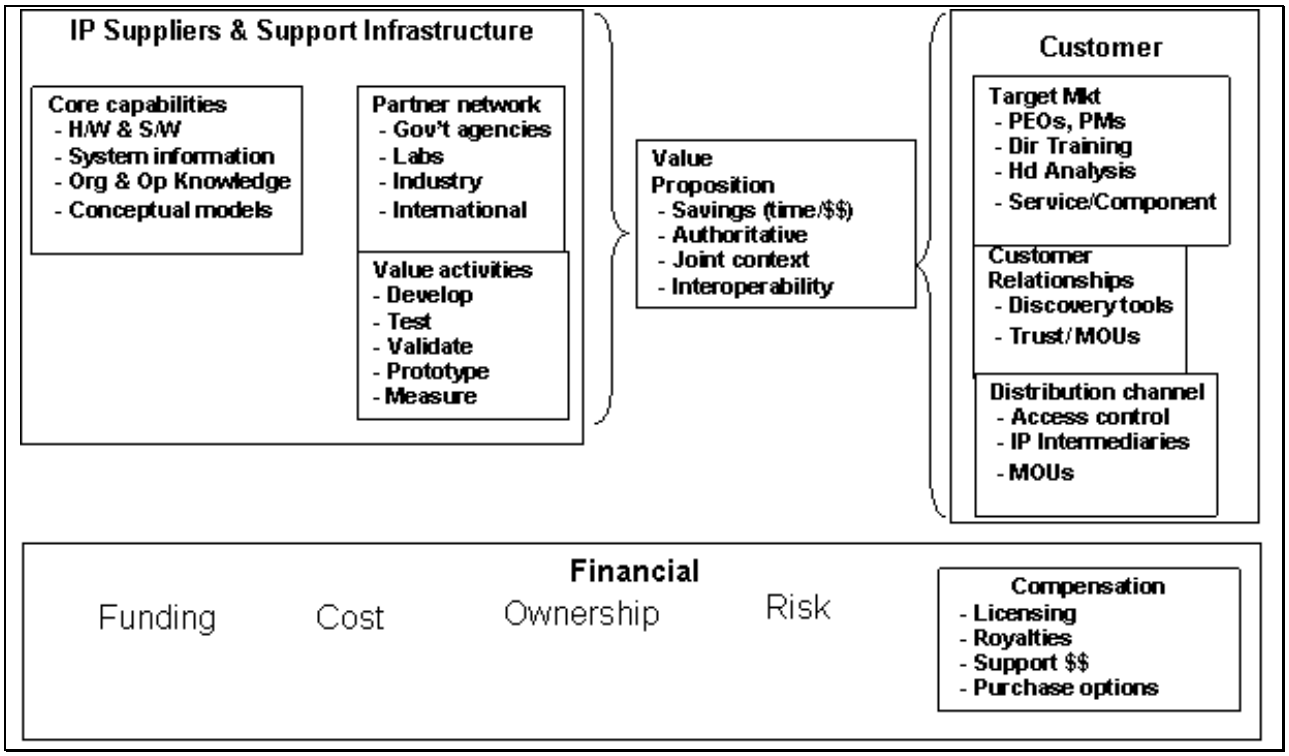

Figure 2.1 Modified Reuse Business Model Components (Shea, 2007)

In the world of modeling and simulation (M&S), some government organizations run exercises or experiments (e.g., various laboratories or ranges); some sponsor larger, distributed M&S events that link a variety of federates (e.g., United States Joint Forces Command (USJFCOM) in its roles as a sponsor of experimentation and training); and still others guide or fund the development of infrastructure (e.g., Central Test and Evaluation Investment Program (CTEIP) that provides funding for the Test and Training Enabling Architecture (TENA) architecture, software, and standards that enable some distributed M&S events). Each of these organizations has its own mission and justification. For example, a laboratory that contributes to torpedo development and testing has core competencies in understanding the science and technology of how torpedoes work, how they interact with their physical environment, and how to interpret

data from torpedo experiments. If torpedoes became unimportant as military assets or if the science and technology of torpedoes changed so radically as to undermine the value of past knowledge, the laboratory's justification would be threatened, because the core competency part of its business model would have lost its value.

Unlike private firms, government organizations generally do not earn revenue directly from their customers; government organizations receive budget allocations through a political process. If a government organization's customer really appreciates the organization's performance, it rarely has the ability to shift resources to buy more of the organization's product. On the other hand, if the organization's customer is dissatisfied with the organization's performance, the customer rarely has the opportunity to shift its operations to another organization, because customer relationships and command hierarchies among government organizations are established in authorizing legislation. At best, the customer can try to influence the budget process by noting the organization's allegedly poor past performance, especially if it has caused the customer to have performance problems. The problem from the perspective of customer feedback is that a complaint in the political appropriations process might yield either an increase in budget allocation (a resource infusion to remedy the problems) or a decrease in budget allocation (as punishment). In the world of M&S, the customer feedback process is even more attenuated, because many of the participants are too small or have too many other jobs to register a complaint on the political radar screen that affects budget allocations specifically for M&S.

On the cost side, government organizations generally use a broader definition of costs than private firms do. All organizations need to consider traditional financial costs. Like private firms, government organizations need money to pay personnel costs and suppliers with whom they have contracts. The complication in the government context is that government money is not quite as fungible as private sector money. Different kinds of costs must be paid for with money from different sources (different line-items in an appropriation), meaning that money cannot be reprioritized or easily shifted from areas that have resulted in a cost savings to areas that face unexpected cost overruns. As a result, even the simple dollars-and-cents side of the cost structure component of a government organization's business model is unusually complex.

2.1 Business Ecosystems

We propose that the DoD M&S business environment is best described as a business ecosystem. A business ecosystem, an economic web, is a community of organizations and stakeholders operating within a particular business environment that collaborates and competes in an economic web of relationships. These relationships co-evolve through time subject to the general forces in the business environment and the specific moves made by the web of players. (Web Site, 21)

An ecosystem is a system whose members benefit from each other's participation via symbiotic relationships (positive sum relationships). It is a term that originated from biology and refers to self-sustaining systems. As it applies to business, an ecosystem can be viewed as a system where the relationships established across different industries become mutually beneficial, self-sustaining, and (somewhat) closed. (Web Site, 22)

The term Business Ecosystem is credited to James Moore in the Harvard Business Review in a May/June 1993:

> *[A Business Ecosystem is an] economic community supported by a foundation of interacting organizations and individuals--the organisms of the business world. This economic community produces goods and services of value to customers, who are themselves members of the ecosystem. The member organizations also include suppliers, lead producers, competitors, and other stakeholders. Over time, they co-evolve their capabilities and roles, and tend to align themselves with the directions set by one or more central companies. Those companies holding leadership roles may change over time, but the function of ecosystem leader is valued by the community because it enables*

members to move toward shared visions to align their investments and to find mutually supportive roles. (Moore, 1993)

Principles often used in the analysis of organizations as systems include:

- Open system—Organic systems exist in a continuous exchange with their environment, characterized by a continuous cycle of input, internal transformation (throughput), output, and feedback.
- Homeostasis—Self-regulation and the ability to maintain a steady state achieved through processes that regulate and control system operation on the basis of "negative feedback", whereby deviations from some standard norm initiate actions to correct the deviation.
- Entropy/negative entropy—Closed systems are entropic in that they have a tendency to deteriorate and run down. Open systems seek to sustain themselves by importing energy – they are characterized by negative entropy.
- Structure, function, differentiation, and integration—Relationship between these concepts is crucial to understanding living systems as they are closely intertwined.
- Requisite variety—The internal regulatory mechanisms of a system must be as diverse as the environment with which it is trying to function.
- Equifinality—In an open system, there may be many different ways of arriving at a given end state.
- System evolution—The capacity of a system to evolve depends on an ability to move to more complex forms of differentiation and integration. (Morgan, 1997)

The central player in a healthy ecosystem is the keystone organism, which serves as the leader of the ecosystem. The keystone organism sets the direction of the ecosystem by creating value and sharing that value with their ecosystem partners. Wal-Mart, for example, entices suppliers into their ecosystem by providing broad-spectrum customer data that Wal-Mart collects as a matter of routine. Wal-Mart creates substantial value for their partners thereby enticing them to stay and participate. In turn, according to Iansiti and Levien in their 2004 Harvard Business Review article, Wal-Mart's retail grocery business enjoys a 22% advantage because they are "better able to match supply and demand across the entire ecosystem increasing productivity and responsiveness for itself – and for its partners." (Iansiti, 2004, 11)

Additionally, the keystone organism need not control a significant portion of the revenue of an ecosystem. Microsoft has profound influence over the information technology (IT) ecosystem. Its operating systems and software applications are nearly ubiquitous. However, "[d]espite Microsoft's pervasive impact, for example, it remains only a small part of the computing ecosystem. Both its revenue and number of employees represent about 0.05% of the total figures for the ecosystem." (Iansiti, 2004, 11) Taken the other way, a central M&S keystone with a budget of merely $35M could have a substantial effect on the $9B DoD M&S ecosystem. The limited central M&S funding in the context of the overall US government model makes the ecosystem strategy model so provocative for DoD M&S.

Applying the ecosystem metaphor to government business presents at least one systemic challenge, namely system evolution, including "organism death", which in the government context is largely controlled by coercive (e.g., policy, funding) sources. Therefore, cogent leadership, ostensibly provided by the keystone organism is essential to the ecosystem's health.

2.2 The Network Effect

When it comes to networked capability, the goal must be to maximize the number of nodes in the network. The Network Effect[4] is the "phenomenon whereby a service becomes more valuable as more

4 We should say upfront, there is some disagreement as the actual network effect value function. Regardless, it's an important principle that drives the motivation to increase the number of interoperable LVC assets.

people use it, encouraging even-increasing number of adopters." (Web Site, 23) Robert Metcalf, formerly of 3Com and the inventor of the Ethernet, explains how the term "Network Effect" was born:

> *I argued* [see Figure 2.2] *that my customers needed their Ethernets to grow above a certain critical mass if they were to reap the benefits of the network effect. 3Com sold $1,000 cards that connected desktop computers into a network. Here was the payoff: The cost of installing the cards at, say, a corporation would be proportional to the number of cards installed. The value of the network, though, would be proportional to the square of the number of users. Multiply the number of networked computers by ten and your system-wide cost goes up by a factor of ten but the value goes up a hundredfold.*
>
> *Why should that be so? The network effect says that the value of that Ethernet card to the person on whose desk it sits is proportional to the number, N, of other computer users he can connect to. Now multiply this value by the number of users, and you have a value for the whole operation that is roughly proportional to* N^2. (Metcalf, 2007)

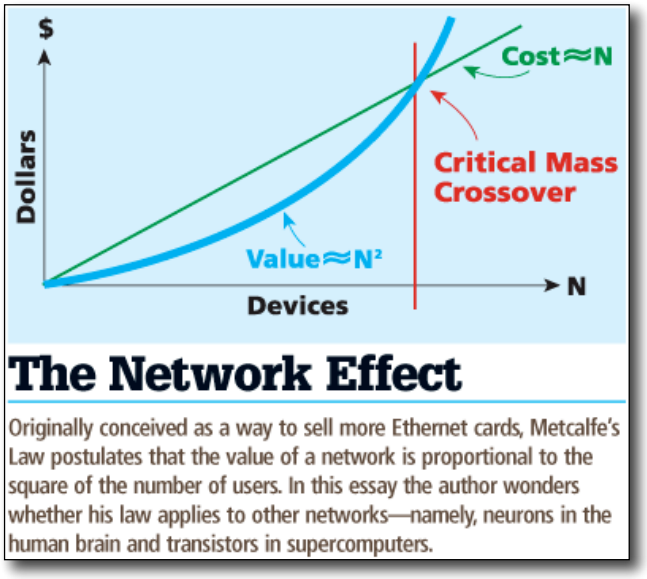

Figure 2.2 The Network Effect (Metcalf, 2007)

In the simulation interoperability context, the Ethernet card is a metaphor for the interoperability architecture. The metaphor suggests that the perceived value of interoperability, and hence the value of the interoperability architecture, will increase as the number of interoperable LVC assets increases. Stakeholders must see value in linking their simulations with others and that value must be greater than the perceived cost of migrating to that architecture – this must be true for the broadest number of stakeholders at all echelon levels. The Network Effect has arguably eluded past/current proponents of simulation interoperability.

Finally, in light of the dot com bubble, many have started rethinking the accuracy of Metcalf's law at truly predicting network value. A paper in the Institute of Electrical and Electronics Engineers (IEEE) Spectrum Magazine states:

> *The fundamental flaw underlying both Metcalfe's and Reed's laws is in the assignment of equal value to all connections or all groups. The underlying problem with this assumption was pointed out a century and a half ago by Henry David Thoreau in relation to the very first large telecommunications network, then being built in the United States. In his*

famous book Walden (1854), he wrote: "We are in great haste to construct a magnetic telegraph from Maine to Texas; but Maine and Texas, it may be, have nothing important to communicate." (Briscoe, 2006)

Indeed, if the value of networks followed Metcalf's Law, there would be an overwhelming motivation to merge disparate networks – Metcalf's Law leaves little room for isolated networks to grow up.

2.3 Strategic Patience

The DoD has historically lacked the strategic patience to allow for the slow dynamics of market penetration. DVD players were introduced to the consumer market in late 1996. In their review of 1999 consumer electronic sales, the Consumer Electronics Association named the DVD player the "fastest-selling consumer electronics product in history" because DVD players were in 5% of American households in only 3 years. By 2004, DVD players were in 50% of American households and still retained the "fastest selling" title. The sales performance of the DVD player was extraordinary. Normal market penetration is generally 10 years. New Distributed Interactive Simulation (DIS) was in its first formal state in 1990. The Aggregate Level Simulation Protocol (ALSP) emerged on the scene in 1990. Work on High Level Architecture (HLA) began in 1994 with its first stable release in the 1996 timeframe. TENA was started in 1994[5] with a major re-direction of effort in 2000. In the span of 10 years, the DoD invented three simulation interoperability standards. Each, ostensibly, represented an improvement; however, the the federal government's Planning, Programming, Budgeting and Execution System (PPBES), stakeholder consumers of interoperability have difficulty responding fast enough to the changing landscape.

2.4 Commercial Products, Standards[6], Policy and Public Law

Surrounding the discussion of the LVC Architecture business model are the laws governing government agency activities and Department of Defense regulations. Several are directly pertinent to the review of existing business models and the vision state business model(s).

The Federal Acquisition Regulation (FAR) Part 12 Paragraph 102 states:

> *Agencies shall—*
>
> *(a) Conduct market research to determine whether commercial items or nondevelopmental items are available that could meet the agency's requirements;*
>
> *(b) Acquire commercial items or nondevelopmental items when they are available to meet the needs of the agency; and*
>
> *(c) Require prime contractors and subcontractors at all tiers to incorporate, to the maximum extent practicable, commercial items or nondevelopmental items as components of items supplied to the agency.*

The Department of Defense is dependent upon a strong industrial base to support its needs. In order to control cost, maintain a technological edge, and share benefit with the rest of the American economy, working with industry – and not just "defense industry" – is essential. According to the DoD Handbook on Assessing Defense Industrial Capabilities, cost efficiencies and technological innovations can be gained by leverage commercial development. International cooperation provides access to a larger industrial base, financial leverage, and global technological innovation. DoD 5000.60-H (**A DoD Handbook:**

5 This date was given to the author by TENA's first program manager — Mr. Peter St. Jacques of the Office of Naval Research and the Naval Undersea Warfare Center

6 The specific issue of standards and standards bodies is addressed in the Comparative Analysis of Standards Management – Final Report. Our primary motivation for including a discussion here is to address standards and standards bodies in light of the Federal laws and regulations governing the conduct of Department of Defense business.

Assessing Defense Industrial Capabilities) lays out a strategy that supports a healthy DoD industrial base. (DoD 5000.60-H, 1996)

Finally, the National Technology Transfer Advancement Act (NTTAA) – Public Law 104-113 – states the following:

> ***PUBLIC LAW 104-113***
> *(d) UTILIZATION OF CONSENSUS TECHNICAL STANDARDS BY FEDERAL*
>
> *AGENCIES; REPORTS.—*
>
> *(1) IN GENERAL.—Except as provided in paragraph (3) of this subsection, all Federal agencies and departments shall use technical standards that are developed or adopted by voluntary consensus standards bodies, using such technical standards as a means to carry out policy objectives or activities determined by the agencies and departments.*
>
> *(2) CONSULTATION; PARTICIPATION.—In carrying out paragraph (1) of this subsection, Federal agencies and departments shall consult with voluntary, private sector, consensus standards bodies and shall, when such participation is in the public interest and is compatible with agency and departmental missions, authorities, priorities, and budget resources, participate with such bodies in the development of technical standards.*
>
> *(3) EXCEPTION.—If compliance with paragraph (1) of this subsection is inconsistent with applicable law or otherwise impractical, a Federal agency or department may elect to use technical standards that are not developed or adopted by voluntary consensus standards bodies if the head of each such agency or department transmits to the Office of Management and Budget an explanation of the reasons for using such standards. Each year, beginning with fiscal year 1997, the Office of Management and Budget shall transmit to Congress and its committees a report summarizing all explanations received in the preceding year under this paragraph.*
>
> *(4) DEFINITION OF TECHNICAL STANDARDS.—As used in this subsection, the term "technical standards" means performance-based or design-specific technical specifications and related management systems practices.*

2.5 Key Terms

Several key terms will be used in this analysis. **Stakeholders** are those organizations that have a role or interest in the business model. Examples of stakeholders are federation developers, acquisition program managers, and Service resource sponsors. During our work with the Expert Team and the workshop participants, it was difficult to get consensus on a single list of important stakeholders. In the hope of getting beyond this debate, we reduced the specific stakeholders to classes of proponents. A **proponent** is someone who argues in favor of something: an advocate. In our case, we have grouped stakeholders into five proponent groups that would argue or support their particular perspectives. The five proponent groups are:

- **ARCHITECTURE PROPONENTS.** This group of stakeholders develops requirements, funds, and/or develops the interoperability architecture in question. The architecture proponents for TENA, for example, would include the Test Resource Management Center (TRMC), CTEIP, and the TENA prime contractor.

- **PRODUCT PROPONENTS**. This group of stakeholders capitalizes on the market created by the product. In the case of interoperability architectures, these could be growers (those who build original capability based on the defined standard), frosters (those that add functionality to the product core), and accessorizers (those who build tools to support the core product). Product

proponents bear the full risk of development in the hope of recouping investment and making profit through the marketplace; this distinction is very important for the following discussion. HLA product proponents include, for example, commercial providers of object model tools and runtime infrastructures (RTIs).

- **STANDARDS PROPONENTS.** These are the standards bodies that conform to the definition of voluntary consensus standards body defined in Office of Management & Budget (OMB) Circular A-119:

> *Voluntary consensus standards bodies" are domestic or international organizations which plan, develop, establish, or coordinate voluntary consensus standards using agreed-upon procedures. For purposes of this Circular, "voluntary, private sector, consensus standards bodies," as cited in Act, is an equivalent term. The Act and the Circular encourage the participation of federal representatives in these bodies to increase the likelihood that the standards they develop will meet both public and private sector needs.*

- **FEDERATE PROPONENTS.** This group of stakeholders contributes federate (or simulation) assets to a distributed simulation exercise. These include acquisition program managers (a very important member of this group from a business model perspective), government labs, and service contractors.

- **FEDERATION PROPONENTS**. This group of stakeholders is responsible for requiring, funding and developing distributed simulation exercises. Examples include the Joint National Training Capability (JNTC), the Partnership for Peace (PfP), and Distributed Mission Operations Center (DMOC).

Individual stakeholders may have multiple roles in the business model discussion. For the sake of simplicity, we will look at the broad stakeholder and proponent categories and not at particular organizations in an effort to get at key value/cost statements.

3 Comparative Analysis of the Existing Business Models

Our comparative analysis is on DIS protocols, HLA, and TENA; although, these are not business models, they are product (interoperability architectures) components of business models. For simplicity, we will refer to the business model built around TENA as the “TENA Business Model” and likewise for HLA and DIS. The specific technical specifications of the products will have a bearing on how they are bought and sold. There are many aspects of the respective business models/theories that can be interchanged among DIS, TENA, and HLA.

A government organization’s business model requires four components: description of the organization’s principal activities, core competencies, revenue stream, and cost structure. As in the case of private firms’ business models, these four categories aggregate a number of other important issues, including dependencies on other organizations (notably suppliers, customers, and resource providers). The most important adjustments required to apply the business model concept to the government context involve accounting for non-financial costs and the inflexibility of the politically determined revenue stream.

In this analysis, each business model will address the following:

- Principal Activities – the activities performed by the various proponents within the ecosystem.
- Cost Structure – specific costs and where costs are borne.
- Revenue Stream –where the money comes from and how it is executed.

- Primary Elements of Influence – specific influential elements contributing to the relative success of the particular business model.
- Implications – an analysis of the pros and cons, as function of the degree to which each model leads to the network effect for the business model product (i.e., interoperability architecture).

3.1 The DIS Business Model

3.1.1 Principal Activities

Table 3-1 is a simplified representation of the principal activities associated with the DIS Business Model as it stands today.

Table 3-1 Principal Activities Associated with the DIS Business Model

	DIS				
Proponency	**Architecture**	**Product**	**Standard**	**Federate**	**Federation**
Eco-System Role			Keystone Organism		
Standards Development	There is no architecture proponent	Participates	Predominant Responsibility	Participates	Participates
Middleware		There is no middleware.			
Tools		Total responsibility			
Middleware Integration				Total responsbility (note 1)	
Federation Development					Total responsibility

The highlighted activities are the lead activities for each DIS element. The activities highlighted in green are owned and are clearly dominated by one proponent.

DIS was born out the DARPA SIMNET program of the mid-eighties. Following a successful demonstration of the SIMNET interoperability protocols, the Defense Modeling and Simulation Office (DMSO) initiated the DIS Workshops – held semi-annually with several smaller working groups meeting throughout the year. The result of this activity produced IEEE 1278 – Distributed Interactive Simulation Protocols. Today, the DIS protocols are still widely employed, particularly in the Air Force.

3.1.2 Cost Structure

The cost of maintenance and evolution of the DIS standards is borne by the participants of the Simulation Interoperability Workshop (SIW) – the successor to the DIS Workshops.

3.1.3 Revenue Stream

Cost of maintenance and evolution is minimal. Required modifications to the standards are generally discovered and fleshed out in its application during development of distributed simulation exercises. DIS is locally extensible through a generic DATA Protocol Data Unit (PDU). The modifications are issue-driven and are therefore seen as an integral part of capability development. As modifications are identified and tested, they are brought into the workshop and vetted in the broader community. The costs for this activity are paid in the form of SIW registration fees that amount to about $500.00 per participant.

3.1.4 Primary Elements of Influence

Figure 3.1 illustrates DIS's Business Model primary elements of influence. The elements of influence in this model are relatively weak. Modifications are generally driven by a specific local need and then vetted in the broad community. The cost, as mentioned earlier, is reasonably small and considered part of the cost of developing a distributed simulation application. Despite evidence that DIS is not a scalable protocol, DIS satisfies the needs of a large number of users. The cost associated with moving from DIS to other architectures is deemed too large in relation to the perceived benefit.

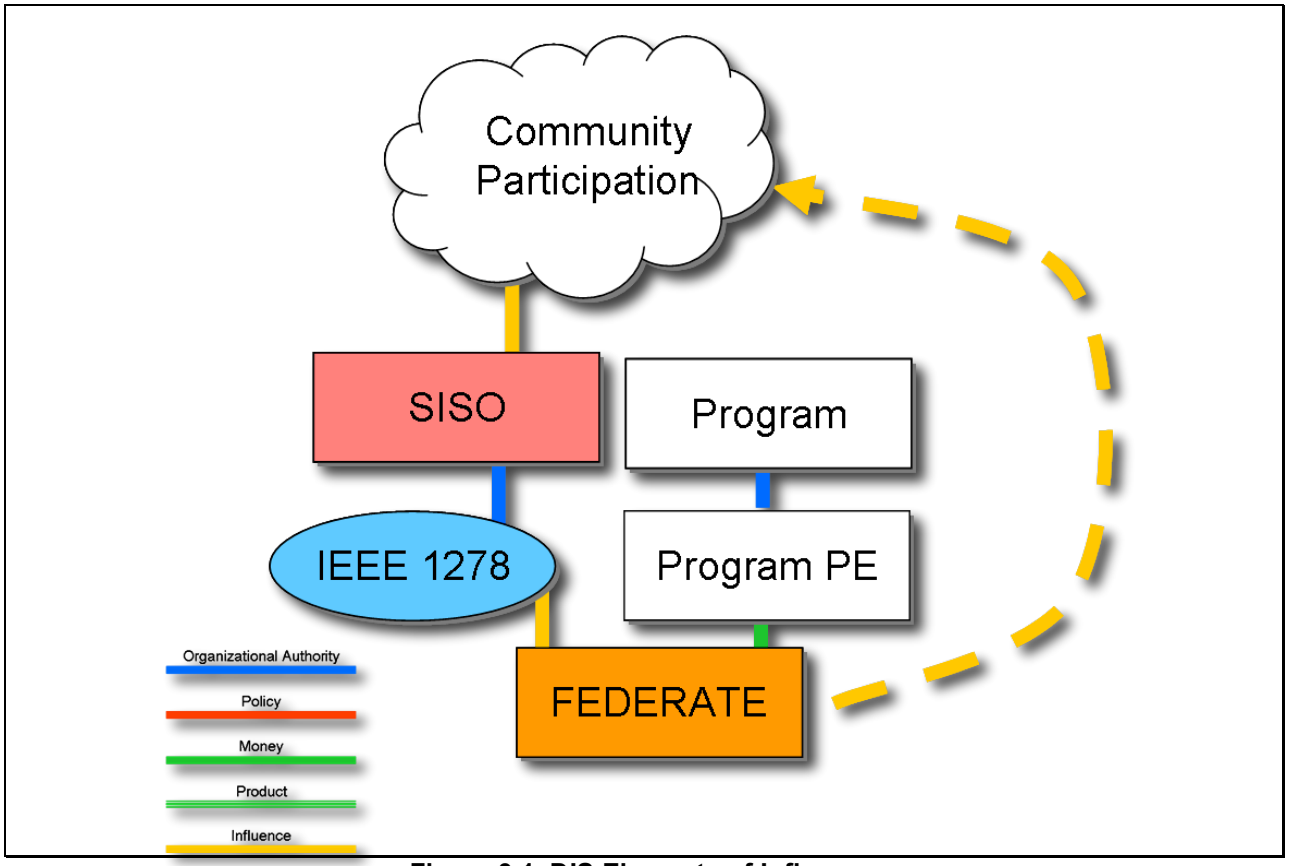

Figure 3.1 DIS Elements of Influence

3.1.5 Implications

The following are specific implications of the DIS Business Model:

- **Technical Inertia**. If something works, people generally stay with it. This is evidenced by the fact that so many organizations continue to use DIS.
- **Cost.** Costs are low for everyone and are seen as part of development. Those who use DIS have taken "ownership" of it. Costs for maintenance and evolution are seen as the cost of doing business.
- **Scalability.** By distributing the transactional workflow, maximizing participation in the architecture's evolution and involving the commercial and international sectors to the maximum extent possible, the DIS Business Model provides a high degree of scalability. As the DIS ecosystem grows, producers will organically respond with more producer choices and greater producer flexibility.
- **Stability of the Specification.** Because the DIS standard (IEEE 1278) is under SISO stewardship, there is an articulated due process for reviewing, changing, and evolving the standard. Changes to the standards process itself are onerous and so the likelihood of major procedural swings is very low.
- **No Flag Bearer.** There is no one at the vanguard for DIS development. There is no one looking at "what next". The closest thing to a DIS flag bearer is the Air Force's Distributed Mission Operations proponents.

3.2 The TENA Business Model

3.2.1 Principal Activities

Table 3-2 is a simplified representation of the principal activities associated with the TENA Business Model.

Table 3-2 Principal Activities Associated with the TENA Business Model

	TENA				
Proponency	**Architecture**	**Product**	**Standard**	**Federate**	**Federation**
Eco-System Role	Keystone Organism	Producer	No Appreciable Role	Consumer	Consumer
Standards Development	Predominant Responsibility	Reviews and provides opinion through AMT	No Appreciable Role	Reviews and provides opinion through AMT	Reviews and provides opinion through AMT
Middleware	Predominant responsibility; builds the middleware.	Opportunities to add capability (frosting) to the middleware.		Acquires	
Tools	Builds/maintains the LVT.	Opportunities to build other tools		Acquires. Opportunities to build tools.	Acquires. Opportunities to build tools.
Middleware Integration	Will assist integration. Provides online resources.			Predominant responsibility	
Federation Development	Participates			Participates	Predominant Responsibility

Apart from Federation Development, the Architecture Proponent plays a role in all aspects of the transactional workflow of TENA. Also of note is the lack of any involvement of a Standards Proponent such as ISO, IEEE or SISO.

3.2.2 Cost Structure

Apart from Federation Development, the Architecture Proponent bears the vast majority of costs associated with TENA requirements, development, integration, and compliance testing. Federation Development costs are borne by the Federation Proponent primarily. Costs borne by the Federate Developers includes costs to participate, as desired, in deliberations of the Architecture Management Team (AMT), and costs to develop federate interoperability requirements and prepare federate software for middleware integration.

3.2.3 Revenue Stream

The CTEIP has been the primary sponsor of TENA. CTEIP is executed by TRMC of the USD (AT&L). According to the TRMC website:

> *CTEIP is focused on proactively identifying test requirements of the future and developing the test capabilities needed to address them. The program seeks to provide a coordinated and integrated approach to test investment that builds synergy between its projects and seeks to leverage its individual efforts to achieve its vision of providing a global test and evaluation infrastructure to support the warfighter.*

The TRMC Mission is to:

> *Plan for and assess the adequacy of the…MRTFB…[and] to provide adequate testing in support of development, acquisition, fielding, and sustainment of defense systems; and, maintain awareness of other T&E facilities and resources, within and outside the Department, and their impacts on DOD requirements.*

TRMC is the "Steward of the DoD Test and Evaluation Infrastructure." As such, its mission is to satisfy test and evaluation (T&E) infrastructure requirements. The funding for TENA is aligned with DoD T&E and therefore TENA must be substantially aligned to meet/support test and evaluation requirements.

Funding for TENA also comes from the Joint Mission Environment Test Capability (JMETC), a TRMC-sponsored activity, for addressing their requirements.

As most of the TENA-compliant federates are brought into compliance in support of T&E, it is likely that some funding for Federate Proponents would come from T&E sources. At a minimum, some of the Federate Proponent technical labor (particularly maintenance and operations) would be subsidized by the Major Range and Test Facility Base.

Finally, TENA receives funding from USJFCOM's JNTC. The JNTC funding allows TRMC to surmount JNTC training requirements and to test and maintain TENA from the training perspective.

3.2.4 The Primary Elements of Influence

Figure 3.2 illustrates TENA's Business Model primary elements of influence.

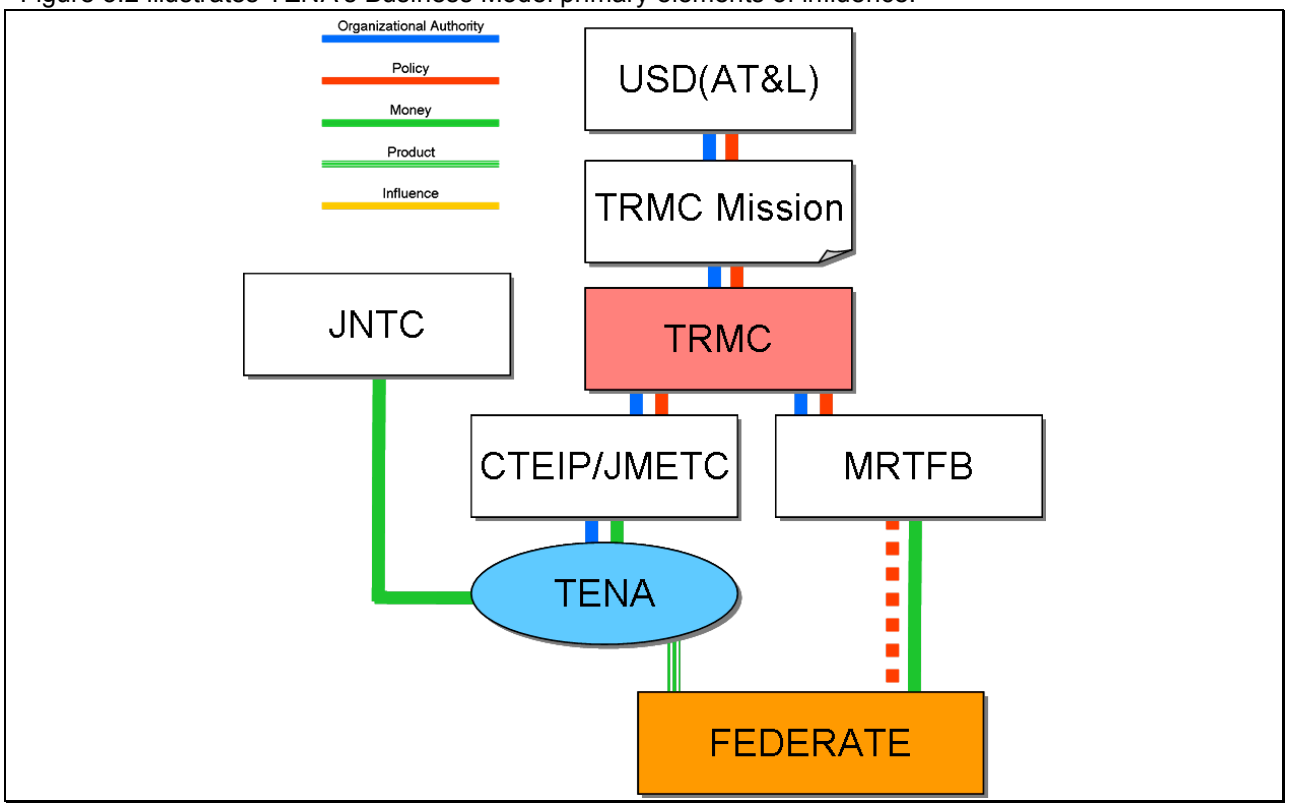

Figure 3.2 TENA Elements of Influence

The two elements of influence that make the TENA Business Model a compelling one are:

1. Substantive centralized funding
2. Policy potential

Centralized funding aligns TENA costs to the organizations whose missions best align with its goals . As the stewards of the DoD T&E infrastructure, TRMC has a vested interest in improving T&E enterprise efficiency and reducing enterprise costs. Funding coming from JNTC ensures that TENA will align with training requirements, and therefore the training community will benefit as well.

DoD Directive 3200.11: Major Range and Test Facility Base provides the policy base. DoD 3200.11 provides authority to issue, as policy, supporting DoD instructions. These are powerful motivators for those in the T&E community.

3.2.5 Implications

There are several important implications of the TENA Business Model. Principally they are:

- **Low Cost to Federate Proponents.** The costs of compliance are aligned with those gaining the most value from employment of TENA. Federate Proponents required to bring their assets into compliance do not pay for middleware. Furthermore, since the Major Range Test Facility Base (MRTFB) subsidizes labor, it is likely that some Federate Proponent labor costs are also significantly reduced. This should have the effect of moving required assets into compliance quickly. The downside to this is that loss of single source resources will have a profound effect on the Architecture Proponent's ability to evolve and maintain TENA. It should also be noted that the US, and DoD in particular, are bearing the full cost of ownership.
- **Clear Understanding of Cost.** Because TRMC oversees most of the funding for TENA, they have significant knowledge of the costs of TENA. Costs associated with developing federations are well understood by the owning organization.
- **Clear Understanding of Market Penetration.** Middleware is integrated at compile time. Therefore, the Architecture Proponent should have near perfect knowledge of all of the assets that are TENA compliant. They should also have significant understanding of most of the assets available to the T&E community and therefore should be able to assess market penetration. This situation is likely to change in the future as Product Proponents develop TENA-compliant interfaces.
- **Clear Leadership.** TRMC is the primary TENA stakeholder. As such, they define tactical and strategic direction for TENA. They define requirements, with input from the broader community, and develop the product.
- **Limited Market Size.** The chain of command and revenue flow, while beneficial in some ways, clearly works against the efficacy of the TENA Business Model's in other ways. With TENA's focus, and indeed the Architecture Proponent's focus, on T&E and training, the potential market size is significantly curtailed. As JNTC funding continues, training community interests are addressed and therefore training should be considered part of the TENA market space, albeit as a lesser partner to T&E.
- **Lack of Scalability.** Because Object Model Developers are required to submit object models to a web-based code generation mechanism where the OM is reviewed by TENA staff, it is unlikely that the Architecture Proponent will easily adapt to fluctuations in federate demands. Additionally, TENA knowledge is vested with TRMC and their contractor(s). As knowledge is not spread over a broad community, risk associated with a change in prime contractor or loss of key personnel is substantial.

3.3 The HLA Business Model

3.3.1 Principal Activities

Table 3-3 shows the principal activities for the HLA Business Model.

Table 3-3 Principal Activities for the HLA Business Model

	HLA				
Proponency	**Architecture**	**Product**	**Standard**	**Federate**	**Federation**
Eco-System Role	Observer	Producer	Keystone Organism	Consumer	Consumer
Standards Development	Reponsibility for Initiating. Continues to participate in evolution.	Participates	Predominant Responsibility	Participates	Participates
Middleware	Tests Compliance of Middleware Solutions	Predominant Responsibility		Acquires	
Tools		Total Responsibility		Acquires	Acquires
Middleware Integration				Total Responsibility	
Federation Development				Participates	Predominant Responsibility

Focal points for each element of the transactional workflow are spread across multiple proponents. Standards development and evolution is owned by the HLA Standards Proponent, which is SISO (a subsidiary Standards Development Organization under the IEEE). Middleware and tool development/evolution is largely accomplished by Product Proponents. The act of bringing federates into compliance rests on the shoulders of the Federate Proponents. Federation Proponents are responsible for developing distributed simulation exercises.

The Keystone Organism is unclear in this case, as there is no clear leadership activity. In HLA's early days, DMSO was the clear Keystone Organism; however, their leadership has waned significantly over the last two years. Therefore, we have identified the Standards Proponent as the Keystone Organism because theirs is the venue for discussing standards development and interest.

We should note here that during our investigations, we discovered several off-standard variants of the HLA middleware. We refer to these as "black market" implementations and can draw several conclusions. First, they clearly represent a nuisance for those wishing to corral the proliferation of HLA middleware. Second, their existence demonstrates that some needs are not being met by the current set of middleware providers. Third, this indicates that the market space has room to grow and an Open Source solution may be an appropriate growth path.

3.3.2 Cost Structure

The HLA Business Model cost structure is one of nearly complete de-centralization. Up until 2004, DMSO provided a free version of the DoD-variant of the middleware to anyone who needed it; this offer was open to the international community. Now, proponents are required to either buy a middleware license from one of the many middleware providers, or obtain a copy of a black market middleware. Federate developers have always been responsible for funding their own efforts to bring their simulation assets into compliance. However, in many cases the requirement for federate interoperability is not readily derived from materiel requirements, making the allocation of resources to compliance activities difficult. The Modeling and Simulation Coordination Office (MSCO) currently provides free federate compliance testing, but the future of this offering is unclear.

Developers of HLA middleware bear their own costs and expect to recoup investment through the sale of licenses. Several companies develop and market HLA middleware. Three of them have recently been bought by larger firms. This indicates that there is value in the HLA middleware market (including tools and services).

All proponents pay to participate in the development and evolution of the HLA standard. SISO holds semi-annual meetings and charge a moderate fee for participation; they also collect fees (or more precisely IEEE collects fees) from those participating in the standards balloting process. Additionally, IEEE owns the copyright to the standard and charges a fee to obtain copies.

3.3.3 Revenue Stream

In the early days of the HLA, the DMSO had the clear lead. They defined tactical and strategic directions of the architecture, they brought about additions to policy (through policy memoranda) in attempt to force compliance, and they shepherded the various components of the architecture through both the Object Management Group (OMG) and the IEEE standards processes. The overall strategy was to commercialize HLA to minimize the burden to the DoD and to maximize innovation in the architecture products. Once the standard was moved to the private sector, DMSO began curtailing funding for HLA development. In FY08, M&S CO (formerly DMSO) initiated an action to terminate funding for HLA altogether. A tiger team was formed to evaluate transition opportunities for HLA; they have recommended to hold off debate until the LVC Architecture Roadmap is developed.

Today, HLA revenue streams are many and varied. Proponents are responsible for funding and executing their part of the transactional workflow. This has caused some discomfort for several stakeholders because the cost of compliance exceeds the value they derive from compliance.[7]
Figure 3.3 is a depiction of those elements as they were in the early days of HLA development.

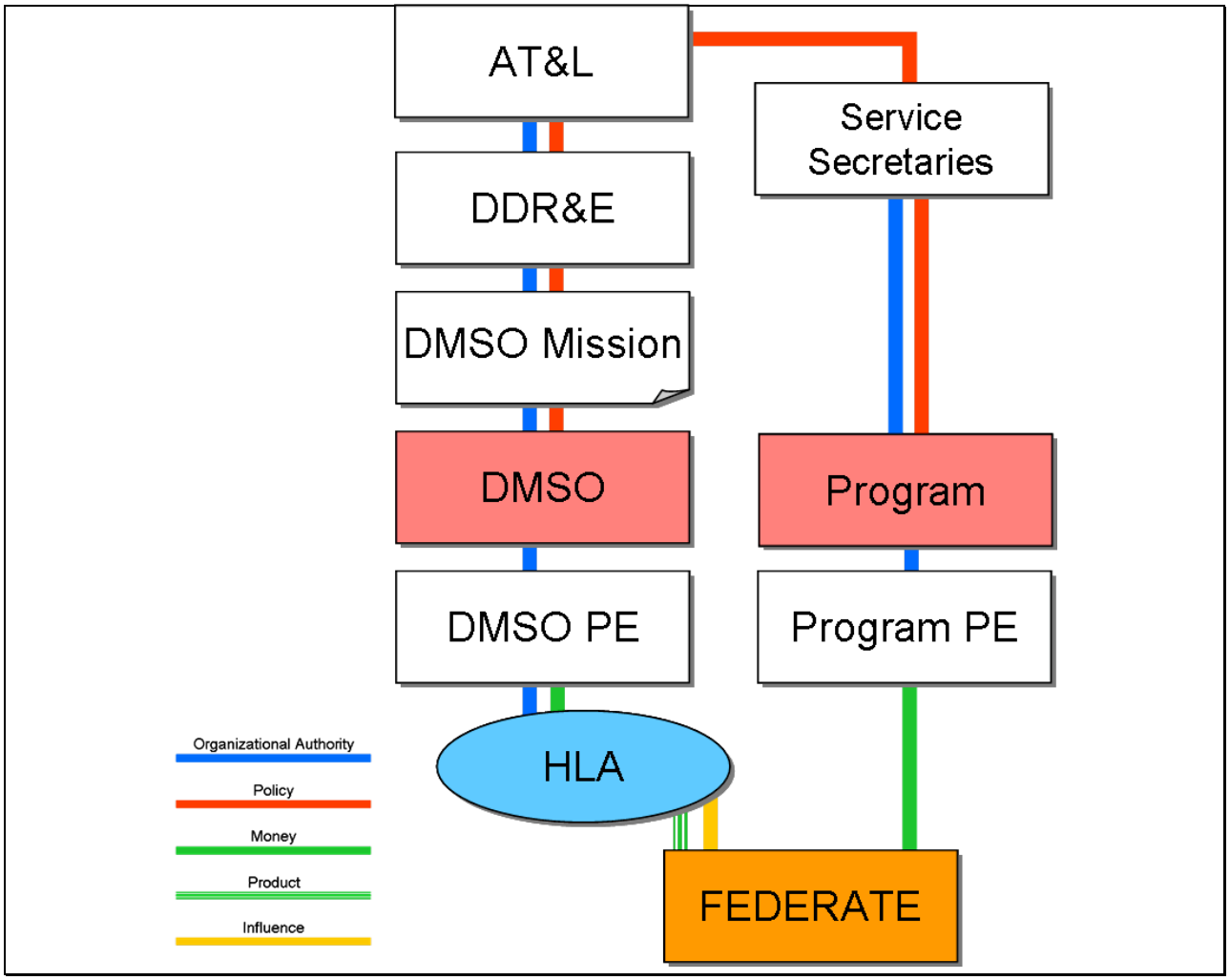

Figure 3.3 HLA Business Model Elements of Influence in Early Development

As mentioned earlier, DMSO played the policy card early on with limited success. In September 1996, Dr. Paul Kaminski [USD(A&T)] issued a policy memorandum designating "*the High Level Architecture as the standard technical architecture for all DoD simulations.*" This policy set the "No Can Pay" and "No Can Play" dates in an effort to force DoD components to bring their simulation assets into compliance. The policy had a significant impact on the DoD M&S community resulting in many compliant assets. However, the policy memo was never converted to long-term DoD policy and, to the best of our knowledge, the "No Can" dates were never enforced. In April 1998, Jacques Gansler [USD(A&T)] issued a policy memo reinforcing the department's move to HLA by stating:

> "*All new simulations will be built in accordance with the HLA. To reap the full benefits of simulation interoperability and reuse in the near-term, it is also important to quickly transition our legacy simulations to the HLA, … I encourage our industry partners to follow suit*"

7 This was a recurring theme during our discussions with the LVCAR expert team and workshop attendees.

This policy memo had a similar effect to the first, that is, many simulation assets transitioned but ultimately there was no enforcement of the policy.

Figure 3.4 illustrates the HLA Business Model's elements of influence as they stand today. There is no longer a policy enforcing HLA. Despite that, the international community has embraced it and DoD continues to transition its own simulation assets. We believe the primary element of influence in action today is that the HLA is owned by the community that uses it. Proponents have a voice in its development and evolution in fashioning their own applications in support of it.

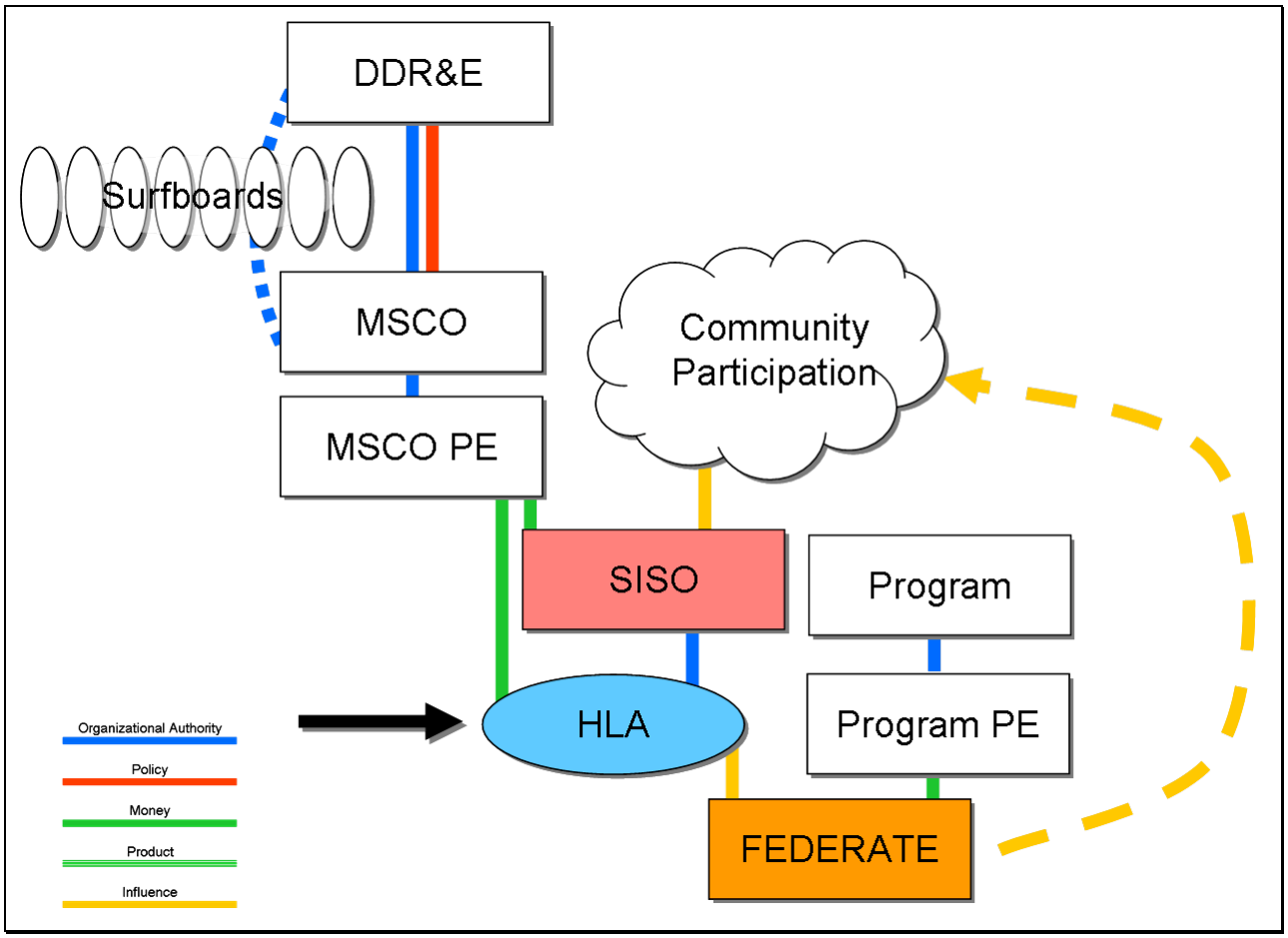

Figure 3.4 HLA Business Model Elements of Influence Today

3.3.4 Implications

Looking at the past and present HLA Business Models, we can gain significant insight into the efficacy of several key elements. These observations are:

- **Scalability.** By distributing the transactional workflow, maximizing participation in the architecture's evolution and involving the commercial and international sectors to the maximum extent possible, the HLA Business Model provides a high degree of scalability. As the HLA ecosystem grows, producers will organically respond with more producer choices and greater producer flexibility.
- **Market Size.** The early Architecture Proponents for the HLA were very liberal about limiting the scope of applicability of the architecture. The original Director, Defense Research & Engineering (DDR&E) policy memorandum, Dr. Kaminski designated "*the High Level Architecture as the standard technical architecture for all DoD simulations.*" The DoD M&S community challenged the broadness of the net cast and the DDR&E gave little guidance as to how to identify those

simulation assets that should be included in the mandate; however, it does demonstrate DoD leadership's clear sense that HLA was to appeal to as broad an audience as possible.

- **Distribution of Cost.** Today, the DoD is directly spending very little to maintain and evolve the architecture. The total DoD cost for maintenance and evolution is about $800K annually according to the *HLA Management Strategy Working Group.* Add to that, an annual support contribution of $100K to SISO (which contributes to development and maintenance of other products – DIS, CIGI, XMSF, etc. – in addition to the HLA). Given the magnitude of the market space inside and outside of DoD, less than $900K a year is a relative bargain for the taxpayer.
- **DoD has Forfeited Much of the Control.** A corollary to the low cost to DoD, is the attendant forfeiture of control. Depending on your perspective, this may be a good thing or it may be bad. To the international community, this is a good thing. Likewise, acceptance of the HLA by other federal agencies is probably enhanced because of DoD's restricted involvement. Alternatively, DoD might, in certain circumstances, feel the pain of less control when it requires rapid changes to the specification to meet an emerging demand. Arguably, this is one motivation behind the development of the so-called "black market" RTIs.
- **Potential for Innovation.** As product development is spread throughout the HLA ecosystem, innovation has a high probability of flourishing. As producers and would-be producers note gaps in capability, they have the opportunity to respond. Likewise, poor solutions, because they are not typically sustained by institutional (i.e., taxpayer) funding, are more likely to die. This makes for a healthy competitive environment.
- **Stability of the Specification.** Because the HLA standard, at least the IEEE 1516 variant, is under SISO stewardship. There is an articulated due process for reviewing, changing, and evolving the standard. Changes to the standards process itself are onerous and so the likelihood of major procedural swings is very low.
- **High Cost to the End User.** Whether this is actually true or only perceived to be true is irrelevant. A large percentage of the community believes that the value of HLA (or interoperability for that matter) is less than the cost. Such perception will greatly impact DoD's ability to achieve the network effect with the HLA.
- **No Flag Bearer.** There is no one at the vanguard for HLA development. There is no one looking at "what next". DMSO's last serious HLA development effort examined the ability to HLA to operate over the web. Many of those insights are being incorporated in this latest update of the HLA 1516 specification. To our knowledge, there is nothing else on the table. The likely place for that leadership is with SISO – the Standard Proponent for HLA – but SISO is a coalition of the willing. Without significant infusion of funds from some source, the probability that SISO could provide substantive technical leadership is low.

3.4 The Common Training Instrumentation Architecture (CTIA) Business Model

The CTIA model is very similar to the TENA model. Standards development belongs with the architecture organization for the development of a specific set of Army Live Ground Maneuver training products that is configuration managed as a product line by PEO STRI / PM Trade organization. PM Trade has identified this product line as the Live Training Transformation (LT2) Family of Training Systems (LT2-FTS) responsible for deploying common live training solutions to the Combat Training Centers, Homestation, and Deployed locations. A version of the middleware has been developed by the architecture organization and is being maintained. Development of middleware by other producers is allowed as is development of tools. All CTIA/LT2 components are available through the portal to all consumers belonging to the PM Trade LT2-FTS programs.

One major difference between CTIA and TENA is that CTIA provides source code with unlimited Government rights available to their LT2-FTS consumers in support for development of Live Ground Maneuver Training Systems with goal to maximize reuse of code across PM Trade training products and provide common interoperability solutions for our LT2-FTS (i.e. use of TENA) with external training

systems used on Army ranges or with other Joint ranges. The LT2-FTS requirements used to develop the architecture and middleware development were derived from multiple PM Trade program Operational Requirements Documents (e.g., CTC-OIS, HITS, Instrumented Ranges, MOUT, OneTESS, etc.).

Federation developers also serve as product developers. They may create CTIA components that find their way back into the repository and available for use by other consumers. CTIA product developers are associated with a product line scope identified as the LT2-FTS managed within PM Trade organization to achieve reduction in total ownership costs for the live training systems deployed and maintained throughout the life cycle of the training products

CTIA funding comes from PEO STRI and Department of the Army. ATSC is the user proponent for the architecture. Participating programs include CTC OIS, Instrumented Ranges, OneTESS, and HITS. Participating programs built CTIA-compliant LT2 components. The diagram below is pretty much ATSC (user proponent, combat developer) to PEO STRI (PM TRADE, material developer) to LT2 (CTIA program) with participating program (CTC-OIS, HITS, IR, OneTESS, FASIT, MOUT) linked to LT2 under PM TRADE management.

3.5 Summary of Analysis of Existing Business Models

The current set of business models teaches us that the following characteristics are valuable:

Equitable Distribution of Cost. The cost of development and maintenance of and compliance with an LVC architecture should be distributed across proponents and commensurate with the benefit realized. The Federate and Federation Proponents must perceive the cost of compliance to be less than or equal to its value. Since more value accrues at the corporate level, the Architecture Proponents, ostensibly operating at the corporate level, should assume greater responsibility for the cost of the LVC interoperability architecture.

Clear Leadership. Leadership has a tremendous impact on healthy, focused product evolution. Leadership that can exercise influence on multiple levels (i.e., policy, financial, or technical) greatly improves the likelihood of success. Finally, leadership conveys a sense of stability and longevity to the marketplace.

Scalability. As market size grows, it is essential that the architecture proponents can continue to satisfy customer needs.

Sufficient Market Size. If the market artificially narrowed, the network effect, as canonically understood, will likely never materialize. Market size drives overall value to all proponents.

Innovation. Healthy product evolution is dependent upon an organization's ability to innovate. An environment that encourages and, indeed, rewards innovation will ensure product health over the long haul.

Stability in the Specification. Changes to the specification are costly for all involved. Some adopters may be tolerant, and in fact invite, a rapid rate of change; most users will not. The organization must balance the needs of long-term health (through innovation) and customer satisfaction. Clear leadership plays a significant role in maintaining an appropriate balance between stability and innovation. Lack of leadership often results in a detrimental imbalance.

4 The LVCAR Business Model Vision

The ecosystem concept fits. Business ecosystem creation is being driven by the realities of the information economy. The literature is replete with high-flying examples: Wal-Mart, IBM, Intel, Microsoft, FedEx, Cisco Systems, Autoweb and automobile manufacturers[8].

The very nature of government business, with its loosely connected organizations, industry partners, multiple influence vectors and its capacity to create value through fiscal appropriations, defines the concept of ecosystem. Furthermore, government organizations are perfectly placed to be keystone organism.

Given all of this, we have adopted the Business Model Tiger Team's candidate vision statement:

"Establish the most efficient ecosystem for LVC environment instantiation, use, and reuse."

4.1 Desirable Characteristics of the LVCAR Business Model

4.1.1 Economically Attractive

By definition, this means that from a proponent's perspective, the perceived value of the product must be higher than the cost of adoption. The LVC architecture and its attendant business model must align cost and benefit across the proponents. As market size grows and the network effect takes hold, the value of interoperability should increase markedly. Arguably, the network effect is greatly inhibited by a market space that's been arbitrarily divided among a large number of architecture choices.

4.1.2 Practical

The LVC architecture and it business model must be practical in cost, schedule, risk and process – it can't be *too hard*.

4.1.3 Productive

The business environment should foster creation of new products and technologies and seek to deploy existing products and technologies with greater efficiency. Investment should be targeted toward stimulating the market space by creating substantive value to the proponents.

4.1.4 Robust

Proponents, overall, must be able to withstand changes in technology, business practice, and policy changes. This is particularly important in the DoD where new administrations, personnel changes, and congressional oversight are the norm. Sustainability is a direct result of a robust business environment.

4.1.5 Niche Creation

The ecosystem should foster admission of new organisms. Occasional departure from the main course should be tolerated, but controlled. Competition should also be encouraged because healthy competition gives birth to substantive innovation – both evolutionary and revolutionary.

4.1.6 Legal

There is little doubt that the LVCAR will lead to scrutiny from both inside and outside of the ecosystem. The business model must fall within legal boundaries. Of particular interest are FAR Parts 10 and 12; the National Technology Transfer Advancement Act; and OMB Circular A-119.

8 James Moore, in particular, draws much of his insight into business ecosystems from the automotive industry.

5 Candidate Business Model Strategies

We looked at five distinct business model strategies aimed at addressing the desirable characteristics developed in the previous section to substantively attain to the LVCAR Business Model vision. They are:

5.1 Business Strategy 1: Distributed Customer Focus

Distributed Customer Focus is a broad campaign to improve awareness of the value of LVC interoperability and, by extension, the value of the interoperability architecture. The assumption is that education will raise the perceived value of compliance above the perceived cost and therefore entice Federate Proponents to invest in compliance. Inherent in this strategy is the assumption that Federate Proponents who have not brought their capability into compliance simply lack appropriate understanding of the value LVC interoperability to them and to the DoD enterprise.

The program will focus on the entire base of existing and emerging Federate Proponents. The bulk of the activity will be on education and outreach. This can be likened to an evangelization activity that includes education; familiarization with the architecture(s) and its application; and tearing down myths currently being circulated and those that might arise through the lifecycle. This also includes addressing shortfalls in the architecture but these shortfalls should be from the customer's perspective.

5.1.1 Pros

- Maintains direct provider/user relationship
- This activity can be stood up very quickly
- The actual development work will remain distributed across the DoD enterprise.
- Not as expensive to the central authority as centralized development
- "Hands off" approach; lets market forces work to provide solutions
- Can be combined with other strategies
- Argues mission goal - not solution

5.1.2 Cons

- Subject to the vagaries of management and is dependent upon corporate commitment
- Indirect approach to solving the problem
- May not be able to make a sufficiently compelling argument for LVC interoperability in which case this strategy will fail

5.2 Business Strategy 2: Market Leader Focus

Market Leader Focus concentrates is a campaign to lure high value Federate and Federate Proponents into the LVC interoperability ecosystem. Tipping points are triggered by a few key players (i.e., connectors, salesmen and mavens) [8]. By focusing resources on key players and leveraging them with existing resources, greater effect can be achieved.

The campaign will focus on three or four – maximum – programs and interoperability efforts to surmount their particular challenges. It will concentrate on those efforts that have the most to gain by achieving LVC interoperability. Additionally, those market leaders that have broad reach and influence to suppliers and Federate Proponents are most desirable. Examples include JNTC, JMETC, and/or high value acquisition programs or Program Executive Offices. This strategy is likely insensitive to DoD's lack of strategic patience as key players often drive corporate resilience.

Market leaders, if enticed to join the LVC interoperability ecosystem, will provide testimony to the local and corporate value of LVC interoperability. This will cause the rest of the market to follow suit – either through a direct consequence of the target leader or by example – when success is achieved. Architecture Proponent funding will leverage ongoing research and development (R&D) funding already in place with the chosen market leaders. The market leaders help set development priorities. Acquisition of specific capability can be structured to apply across DoD or the Federal Government through broad agency or multiple agency site licenses and government enterprise agreements.[9] This further creates a real and tangible marketplace for commercial goods and services.

5.2.1 Pros

- Exploits tipping point
- Focuses on those players where interoperability is important
- Focuses funding; reduces dilution of funding
- Easy to get useful metrics because of single conduit for metrics
- Provides for a real "marketplace"

5.2.2 Cons

- Difficult to come to a meaningful strategic agreement and goals between all parties
- Requires sophisticated business management and negotiating acument
- Possible to come up with *N* separate solutions

5.3 Business Strategy 3: Hybrid Focus

Hybrid Focus is an amalgam of Business Strategies 1 and 2. It "fights the war along two distinct fronts". It combines the target market-leader customer focus of Strategy 2 with the intent of getting to early success will maintaining the broader market focus of Strategy 1 to keep the larger community engaged in the activity.

5.3.1 Pros

- Reduces the risks associated with a single approach by "covering more bets" than either of the other two
- Is more inclusive to the entire community while leveraging the market leader approach

5.3.2 Cons

- Funding is diluted against two "fronts"
- Requires two different management skills
- Risk of losing focus
- Competing interest among Federate and Federation proponents

5.4 Business Strategy 4: Minimalism

Minimalism indicates a financial hold position on the current architecture set. This strategy advocates cessation of substantive DoD-level funding and maintenance of existing architectures, infrastructure, and tools. The money currently spent on these activities is "banked"[10] for later LVC environment use. This

9 This capability is provided for under the Clinger-Cohen Act.

10 What this means in the government context is, as yet, unclear. Perhaps it simply means that DoD corporate funding is spent elsewhere including R&D on the next interoperability technology step.

strategy waits for market forces to produce leaner solutions and baits the larger community with the prospect that money will return when things have settled out. The various Proponents would continue to influence standards activities with an eye toward future value.

This is an attempt to balance the ecosystem by reducing funding for competing architectures. The ecosystem is freed up to focus on interaction with standards bodies, other governments, commercial, and international entities. LVCAR product requirements and sourcing responsibilities shift to users (i.e., Federate and Federation Proponents primarily).

This strategy shifts acquisition of goods and services from a central source out to the user. More corporate money is available to concentrate on other pressing M&S challenges. Money is only spent where and when there are explicit requirements. This will have the tendency to accelerate the depreciation of solutions without substantive supporters.

5.4.1.1 Pros

- DoD funding has typically been the source of architectural divergence - stop the funding, stop the divergence
- Lowest enterprise level funding amongst proposed strategies
- Small organizational footprint
- User is in direct contact with vendors thereby providing them maximum opportunity to influence vendor direction
- DoD enterprise level can focus on enterprise policy, external standards, and common licensing
- Money can be refocused on high priority initiatives
- Allows commercial sector to assume more responsibility

5.4.1.2 Cons

- It will take time for organization to adjust and ecosystem to come into balance
- Greatly reduces DoD buying power
- Some organizational duplication amongst users
- DoD loses control over the solution

5.5 Business Strategy 5: Open Source

Open Source embraces a significant trend in commercial software. The following quote from Eric Raymond's *The Magic Cauldron* is representative:

> *The experience of the open-source culture has certainly confounded many of the assumptions of people who learned about software development outside it. ``The Cathedral and the Bazaar'' [CatB] described the ways in which decentralized cooperative software development effectively overturns Brooks's Law, leading to unprecedented levels of reliability and quality on individual projects. ``Homesteading the Noosphere'' [HtN] examined the social dynamics within which this `bazaar' style of development is situated, arguing that it is most effectively understood not in conventional exchange-economy terms but as what anthropologists call a `gift culture' in which members compete for status by giving things away.*

DoD should be about the business of the Warfighter. LVCAR is a means to an end not the end. By moving the source into the public domain for cooperative development by those so inclined, DoD focuses on establishing the requirements and needs rather than solutions.

Over time, the cost and control of the architecture is moved into a shared innovation and development space. This opens up the core capability to innovation by other organizations, governments, commercial entities, and academia. Investment in development is pushed out to the community. This might

appropriately follow any of the other strategies, but it is particularly apropos to Strategy 4. An Open Source mechanism (i.e., administrative structure) would need to be established.

This would be a highly disruptive, in the business sense, activity if strictly dictated by the US government. It may be viewed as public socialism at its worst. The commercial market must be given time to react and adjust their business model lest the industry be crushed.

This strategy greatly improves the potential for innovation by spreading access and risk to a greater constituency. Barriers to entry are all but eliminated thereby encouraging investment from a broader range of interested parties.

5.5.1 Pros

- Balances the marketplace. By zeroing the cost of procuring HLA middleware, HLA is on even business ground with TENA.
- Provides a common target for architecture convergence and evolution.
- Open Source Model has been demonstrated to establish or enable a common computing and communications infrastructure
- Broadens the available participants in the ecosystem beyond DoD thereby significantly reducing costs and improving innovation over an internal development effort
- Eventually provides self-sustaining, evolutionary process
- Peer review expands the validity space
- Spreads financial risk over more organizations
- Consistent with emerging Government and Industry Business models
- Would potentially make room for new and emerging business models

5.5.2 Cons

- Could be detrimental to current commercial providers
- Innovation could overwhelm DoD's ability to control it
- Reduces control
- Requires funding for transition and maintenance - IT IS NOT FREE!
- Broad participation may be difficult to scale unless you allow peer review
- Once pursued it would be difficult to recall
- Requires sophisticated configuration management

6 Recommended LVCAR Business Model Strategy

Upon examination, it became clear that no single strategies, as stated above, would form a fully-orbed business model solution. More appropriately, we have carefully combined the strategies into a single well-formed recommendation. Therefore, we have combined the desirable aspects from each of the strategies above to accentuate the pros while mitigating the cons of each. What follows is a detailed discussion of the recommended strategy.

6.1 Establish DoD LVC Interoperability Keystone

DoD Modeling and Simulation business is conducted in an ecosystem. The organisms of that system include coordination offices at the OSD and Service levels, government labs and private firms that develop modeling and simulation assets; and, analysis, acquisition and training organizations that use modeling and simulation carry out their mission. M&S development and use is spread across a large number of program elements and authority for executing those funds is spread across and equally large number of organizations. Arguably by design, there is no single organization which controls both policy and funding under a single mission umbrella.

Leaders interested in modeling and simulation would like to spend millions to leverage the billions currently being expended within the Department. The central player in a healthy ecosystem is the

keystone organism, which serves as the leader of the ecosystem. Leadership was/is a key component of the success of the existing business models. In order to successfully execute the LVC Architecture Roadmap, an OSD-level organization should be given the responsibility to function as the LVC Interoperability Keystone Organism. The Keystone is the ecosystem's value dominator and seeks to create and share value across the DoD enterprise as a means to foster broad participation in the Keystone's cogent LVC agenda. The Keystone should be a credible organization with appropriate technical and management personnel and sufficient authority to execute the requisite means of influence (e.g., policy, communication, direct sponsorship, and technical leadership) and structure actions to achieve the vision of the LVCAR. The LVC Keystone will be required to work with key partners in the LVC Ecosystem to establish and maintain buy-in to the overall LVC strategy. The Keystone should be in a position to maintain situational awareness over the entire Department in all LVC matters so as to align ongoing activities and identify, understand and influence clearly redundant activities.[11] Furthermore, the Keystone will need to maintain cognizance of LVC-related activities outside the Department. Specific classes of organizations with which to develop strategic relationships include Standards Development Organizations, other Federal agencies, and coalition partners. The Keystone should have the capacity to obtain and maintain the necessary funding required to carry out Keystone responsibilities. This includes resources to maintain a technical staff that understands the challenges of LVC interoperability and have a vested interest in customer needs and requirements. Finally, the Keystone must have the long term view. They must be able to exhibit the strategic patience required to see the LVCAR to fruition.

This activity establishes leadership requirements associated with Distributed Customer Focus and Market Leadership Focus discussed in Section 5 above. It also captures an initial leadership role for the development of an Open Source solution.

6.2 Balance the Market Place (Open Technology Development)

The current LVC marketplace is incoherent. Differences in institutional investment and cost of entry for the users have resulted in marketplace where the array of possible key products – the various architectures and interoperability middleware – can not compete on technical merit alone. The situation is made worse by the lack of clear direction from the top. As a result, organizations participating in LVC exercises are compelled to maintain multiple interfaces in order to participate in the broadest possible array of revenue-producing exercises. This tends to suppress the perceived value of interoperability among practitioners. Separate architectures means that growth is compartmentalized making it more difficult to achieve the network effect at the Department level.

Balance to the market must be restored and maintained.

There are two business-related challenges that must be surmounted in order to restore market coherence. The first challenge is to level the cost of entry for users. This can only be accomplished by equalizing the cost of competing middleware products. TENA requirements dictate that middleware costs be minimized; therefore, it is unreasonable to expect the TRMC to charge for middleware. The other option is to eliminate the cost of HLA middleware. This can be accomplished one of two ways: 1) the government obtains one or more commercial site licenses for the middleware and provides them to government users at no cost to them and 2) the government develops a version of the middleware and distributes it. The second challenge is to level investment in middleware evolution; this is especially important in light of the technical recommendations of the LVCAR.

Purchasing site commercial site licenses is a reasonable quick fix but has serious negative effects for the long term. Commercial site licenses will require constant renewal representing a long term government funding commitment. If corporate interest in LVC wanes, the budgetary commitment will wane; this will

11 During the 2008 SBIR cycle, the Navy issued a topic seeking small business proposals "to provide an open architecture solution to interprocess communications between real-time simulation applications and services." [SBIR Topic N08-116 (Navy)]. Given SBIR topics are vetted through OSD, it's hard to understand how this made it through the selection wickets.

have a deleterious affect on the LVC community. Furthermore, any government investments made in achieving the LVCAR vision will be placed in the private sector and government will risk forfeiting intellectual property rights. Finally, success in this case is dependent on the viability and/or commitment of the private firms to maintain competing – and incidentally non-interoperable – middleware solutions.

If the government develops a competing RTI middleware implementation, government will find itself competing with the private sector; this is a dubious activity. The long term effect negative on the private sector could be irreparable.

At the intersection of these two alternatives lies a workable hybrid – development of an Open Source middleware solution for both TENA and HLA. An Open Source solution provides a medium for government investment in architecture evolution while allowing private firms to align their businesses – in whatever way they see fit – to the Open Source solution. In April 2006, the Deputy Undersecretary of Defense for Advanced Systems and Concepts published a roadmap for Open Technology Development (Herz, 2006) which embraces government's calculated use of Open Source alternatives. This provides the necessary impetus for a middleware Open Source, or more appropriately Open Technology development. Additionally, the government has already undertaken or completed Open Technology initiatives under similar circumstances[12] providing the ample precedent and experience. In the case of HLA middleware, the government has the compelling case to develop evolutionary LVC middleware concepts in one place. Finally, a recent MITRE report on the use of Open Source within the government context highlighted the vital role that Open Source plays within DoD's operational and security environments:

> *The main conclusion of the analysis was that [Free and Open Source Software (FOSS)] software plays a more critical role in the DoD than has generally been recognized. FOSS applications are most important in four broad areas: Infrastructure Support, Software Development, Security, and Research. One unexpected result was the degree to which Security depends on FOSS. Banning FOSS would remove certain types of infrastructure components (e.g., OpenBSD) that currently help support network security. It would also limit DoD access to—and overall expertise in—the use of powerful FOSS analysis and detection applications that hostile groups could use to help stage cyberattacks. Finally, it would remove the demonstrated ability of FOSS applications to be updated rapidly in response to new types of cyberattack. Taken together, these factors imply that banning FOSS would have immediate, broad, and strongly negative impacts on the ability of many sensitive and security-focused DoD groups to defend against cyberattacks.* (Bollinger, 2002)

There are strong technical motivations that drive the selection of an OTD solution. According to Eric Raymond in his seminal work in Open Source development the following characteristics warrant consideration of an Open Source project:

(a) reliability/stability/scalability are critical
(b) correctness of design and implementation cannot readily be verified by means other than independent peer review
(c) the software is critical to the user's control of his/her business
(d) the software establishes or enables a common computing and communications infrastructure
(e) key methods (or functional equivalents of them) are part of common engineering knowledge. (Raymond, 2001)

All of these are applicable to the LVC middleware solution.

Charles Riechers, Principal Deputy, Secretary of the Air Force (Acquisition), succinctly states that "OTD is about fostering *collaboration* across DoD on technology acquisition and development." (Reichers, 2007) A

12 Examples include NSA's SELinux (Ballard, 2008; Web Site 24) effort which could be construed as competing with Sun's Solaris Operating System and DOE's VisIT (Web Site 25) which could be seen as competing with any number of commercially-developed data visualization packages.

middleware OTD initiative is about cooperation among competing architecture solutions and ultimately about fostering convergence among those solutions. Cost is certainly a motivation for selecting an Open Source (vice proprietary) solution; but the MITRE study on Free and Open Source Software found that cost was seldom the only reason for selecting Open Source solutions: "the strongest deciding factors for choosing [Free and Open Source Software] products were capability and reliability." (Bolinger, 2002) Finally, Maj. Seiferth (USAF) argues that OTD represents an incentive for quality software developers to remain in government and government contractor employment:

> *I will argue that the use of open licensing should decrease the turnover and increase the job satisfaction of government employees and contractors. … Many developers and administrators place greater value [than on financial remuneration] on the opportunity to do interesting work. Open source development projects are regarded as challenging work offering the extra benefit of being able to obtain reco gnition by sharing the full extent of your talents with others. Many open source projects are able to use this effect to achieve excellent retention rates.* (Seiferth, 1999)

This last point was driven home during the 4th LVCAR Workshop when a representative of one of the Navy labs stated that he was looking for challenging opportunities for his software development team and volunteered some of his engineers to the Open Source middleware effort.

There are three principle objections to OTD that need to be addressed. The first is the apparent risk of a rapid emergence of multiple versions (i.e., forkability) of the LVC middleware. Fogel observes that "[t]he paradoxical thing is that the *possibility* of forks is usually a much greater force in free software projects than actual forks, which are very rare." (Fogel, 2007) The possibility of forking, in practice, is a strong incentive for the development team to work through their differences rather than risk the negative effects of a fork (e.g. bifurcation of developers and users between the original and forked versions). The leader of the Open Technology initiative plays a vital role in sifting through the difficult decisions in light of project goals and should, as required, play the role of the "benevolent dictator" and settle the matter.

The second objection comes from the fear that Open Source Software is less secure than COTS or GOTS software. The fact is, as the MITRE study cited above demonstrates, the security community is dependent upon access to Open Source Software for counter measures against on network security and detection of emerging cyber threats. The Future Combat Systems Program relies very heavily on both COTS and Open Source software. A 2007 Defense Science Board study found:

> *"The IT hardware and software within FCS includes COTS, GOTS, Open Source, Proprietary and Military unique components. For software, in particular, about 27 million lines of code are COTS or open source. This constitutes over 42% of the total delivered executable lines of source lines of code.*
>
> *"The System of Systems Common Operating Environment (SOSCOE) and the Integrated Computer System / Operating System (ICS/OS) rely predominantly [sic] COTS and Open Source software. The ICS/OS is almost 99% COTS/OS. The SOSCOE, essentially the 'middleware' for FCS, is almost 80% COTS/OS.*
>
> *"… Furthermore, COTS/GOTS/OS can be highly secure. The FCS operating system, part of the ICS, employs LynxOS-SE, a security enhanced real time operating system from LynuxWorks.*
>
> *"The FCS Program Office has assessed that there is a low to moderate risk that malicious code could be inserted into the FCS Master Software Baseline and exploited. The program has identified the following counter measures to reduce that risk to an acceptable level:*
>
> - *Establish "software pedigree."*

- *Incorporate malicious code detection tools into the software development process.*
- *Execute defined software configuration management processes.*
- *Detect and remove "dead" code.*
- *Use secure code development processes.* (DSB, 2007)

The third objection will likely come from the current set of commercial vendors of LVC middleware. An OTD initiative for LVC middleware would be a highly disruptive, in the business sense, activity if strictly dictated by the US government. It may be viewed as public socialism at its worst. The commercial market must be given time to react and adjust their business model lest the industry be crushed. Consultation with other government agencies that have applicable experience (e.g. NSA for their SELinux project and the Department of Energy for the VisIT application) should be consulted in how best to handle this particular challenge.

There are several Open Source RTI initiatives underway including France's CERTI and HP CERTI (Web Site 26) and Australia's Portico Project (Web Site 27). Anyone of these could be the solution or at a least a basis for a U.S.-specific Open Technology Development (OTD) solution. The role of the Keystone in framing the OTD solution can not be overemphasized. The Keystone should, in consultation with key members of the LVC ecosystem, determine the appropriate starting point for the OTD initiative. They will need to assess the risk of adopting an existing Open Source product against the cost of unique development. They will need to assess impact to the commercial sector and help them identify business alternatives so as to remain viable in the presence of an ODT product set. The Keystone will need to oversee and provide corporate leadership in the development and adoption of the LVC Open Technology Development. The Keystone should work with target standards development organizations to ensure an appropriate level of synchronization among ongoing standards efforts and the ODT initiative. Once initiated, the ODT middleware solution should be the platform for all middleware solutions. Finally, the TENA middleware should migrate into the ODT paradigm thereby fostering ultimate convergence among the competing architectures.

DoD should be about the business of the Warfighter. LVC interoperability is a means to an end not <u>the end</u>. By moving the source into the public domain for cooperative development by those so inclined, DoD focuses on establishing the requirements and needs rather than solutions. Over time, the cost and control of the architecture is moved into a shared innovation and development space. This opens up the core capability to innovation by other organizations, governments, commercial entities, and academia. Investment in development is pushed out to the community. OTD greatly improves the potential for innovation by spreading access and risk to a greater constituency. Barriers to entry are all but eliminated thereby encouraging investment from a broader range of interested parties.

This action is a direct lift, with amplified concepts, for the Open Source strategy discussed in Section 5.

6.3 Create Market Opportunities

The Keystone must work to tip the marketplace in favor of the ODT middleware. Tipping points are triggered by a few key players (i.e., connectors, salesmen and mavens) (Gladwell, 2001). By focusing resources on key players and leveraging them with existing resources, greater effect can be achieved. In an effort to foster expedient migration of federates and federations into the LVCAR, the LVC Keystone should large scale, issue-driven exercises as a market force for testing evolutions of the interoperability architectures. The LVC Keystone should identify important Federation Proponents (JFCOM, NCTE, large PEOs) and work with them (i.e., provide incremental funding, services, etc) to integrate emerging development by using the LVC OTD as a basis for their chosen middleware solution.

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Market leaders, if enticed to join the LVC interoperability ecosystem, will provide testimony to the local and corporate value of LVC interoperability. This will cause the rest of the market to follow suit – either through a direct consequence of the target leader or by example – when success is achieved. Architecture Proponent funding will leverage ongoing research and development (R&D) funding already in place with the chosen market leaders. The market leaders help set development priorities. Acquisition of

specific capability can be structured to apply across DoD or the Federal Government thus creating and expanding a real and tangible marketplace for commercial goods and services.

This is a direct lift from Market Leader Focus described in Section 5 thereby creating a viable marketplace for LVC interoperability.

6.4 Establish Targets for Improved Interest and Participation in Developing and Shepherding Open Standards and Undertake Specific Actions to Meet Those Targets

The LVC Keystone must maintain vigilance across a broad user marketplace. They should stimulate interest in the broader community and establish a substantive government role in developing and vetting the interoperability standards. The primary target for standards development and vetting is the Simulation Interoperability Standards Organization (SISO) and is the right place to establish a presence. In so doing, members of the larger LVC marketplace will be able to maintain situational awareness of ongoing developments and will, as required, play a role in their evolution.

As marketplaces are created amongst the large Federation Proponents, it will be necessary to keep the rest of the community interested in LVC interoperability. The government needs to ensure that its needs/requirements are being adequately addressed in the standards arena. Thus a general campaign to improve awareness of the value of LVC interoperability and, by extension, the value of the interoperability architecture is required. Education will raise the perceived value of compliance above the perceived cost and therefore entice Federate Proponents to participate in standards development and ultimately invest in compliance. The focus of this activity will be the entire base of existing and emerging Federate Proponents. The bulk of the activity will be on education and outreach. This can be likened to an evangelization activity that includes education; familiarization with the architecture(s) and its application; and tearing down myths currently being circulated and those that might arise through the lifecycle. This also includes addressing shortfalls in the architecture but these shortfalls should be from the customer's perspective.

This is nearly direct lift from Distributed Customer Focus described in Section 5. This action provides a specific target for reaching out to the broadest possible customer space in substantively productive way. By using the standards forums as a means for attracting Federate and Federation Proponent involvement, development of robust standards is greatly enhanced. Furthermore, the standards forums provide a ready means for distributing information to an interested community.

6.5 Define and Collect Business Measures

> *By benchmarking, setting goals, measuring progress, providing incentives, and capturing lessons learned to go forward, you have begun an upward spiral of continuous improvement. By constantly improving and changing your business processes and involving your entire organization, you stay flexible to market changes and ahead of the competion.* (Gamonal, 2003)

A business metric is any type of measurement used to gauge some quantifiable component of a company's performance. (Web Site, 20) Collecting, understanding and measuring progress against a cogent set of business metrics are essential to a successful and adaptive business strategy. The business model for the LVCAR is no exception. The keystone should undertake a cogent strategy of identifying measures, assessing progress and using performance measured against those metrics to adapt components of the business model.

In **The Keystone Advantage**, the authors recommend several measures for continuously assessing ecosystem health. They include:

- Change in productivity over time

- Delivery of innovations
- Survival rates of ecosystem members
- Persistence of ecosystem structure
- Rate of obsolescence
- Growth in ecosystem partner variety
- Growth in product and technical variety (Iansiti, 2004, 10)

Careful consideration should be given to the selection of appropriate metrics in light of the government and LVC contexts.

This activity runs throughout all of the strategies laid out in Section 5. It seeks to identify and collect all of the metrics required for understanding, encouraging and maintaining a strong M&S interoperability ecosystem.

7 Conclusion

We have reviewed the existing business models and vetted conclusions about their efficacies. We have reviewed current business-world thinking and mapped their applicability to and efficacy in the government LVCAR context. We have synthesized the results of this analysis and developed five distinct business strategies for consideration. This document lays out two key ideas about the go-ahead business model for LVCAR interoperability. They are:

- The Network Effect
- The Business Ecosystem

The network effect has to be the objective of the business model. The value of the network, both perceived and actual, will only reach the tipping point when a critical mass of LVC assets is compliant and available to the broadest possible user base. This is best accomplished by recognizing that an LVC business ecosystem exists and a cogent set of keystone strategies are adopted.

Specific actions that should be taken are summarized thus:

- Establish a DoD LVC Interoperability Keystone
- Balance the Marketplace Using an Open Technology Development paradigm
- Create Market Opportunities
- Establish Targets for Improved Interest and Participation in Developing and Shepherding Open Standards and Undertake Specific Actions to Meet Those Targets
- Define and Collect Business Measures

Finally, it is our sincere hope that this evaluation will bring “business thinking” into the LVC interoperability debate. We use the terms innovation/invention/creative interchangeably. However, there is an important distinction. As Jan Fagerberg wrote:

> *An important distinction is normally made between invention and innovation. Invention is the first occurrence of an idea for a new product or process while innovation is the first attempt to carry it out into practice.*

The attempt to “carry it out into practice” has “business model” written all over it. The invention of technology is a wonderful thing; however, only when the explicit concern on how the invention will be practically deployed will the concomitant return on investment be realized.

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