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INSTITUTE FOR DEFENSE ANALYSES

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Volume I: Review of Training Capabilities

Prepared for the Modeling and Simulation Steering Committee

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PREFACE

The 2007 edition of the Training Community Modeling and Simulation Business Plan (TMSBP) was prepared in two volumes by the Institute for Defense Analyses (IDA), under a task titled "Business Plan for Modeling & Simulation," funded by the newly formed Modeling and Simulation Steering Committee for the training community led by the Office of the Under Secretary of Defense (Personnel and Readiness), OUSD(P&R). The task was executed by the Modeling and Simulation Coordination Office (MSCO), with oversight from the Director of Readiness and Training Policy and Programs and the training stakeholders as represented by the Training Transformation Senior Advisory Group and the Training Transformation Executive Steering Group.

Volume I of the TMSBP provides a detailed description of the initial review of the 130 models, simulations, and simulation tools that were identified as part of the Training Capabilities Analysis of Alternatives (AoA) base case of capabilities. Volume II provides additional data and analysis details from a data call to the training community in the summer of 2007. Both Volume I and Volume II of this revised edition of IDA Document D-3562 have been updated to accommodate the decision to approve the document for public release.

The TMSBP was strongly influenced by work begun in 2005 to produce a Training Modeling and Simulation Master Plan. The draft master plan served as the basis for some of the discussion and analysis included in this document. The underpinning analysis framework and a baseline of training needs and capabilities as published in the July 2004 Training Capabilities Analysis of Alternatives (TC AoA) have provided a logical start point for this and the preceding Training Modeling and Simulation Master Plan work.

IDA led the effort to prepare this document, with significant contributions from the broad training community stakeholders as represented in the Training Transformation management structure and with their supporting contractors. This document pulls training needs (gaps) as presented in the TC AoA and incorporates a survey conducted with training stakeholders to update their training tools/capabilities baseline.

Careful review of this and earlier draft documents by the training community and internal editors, as well as a number of key government officials, has greatly improved this effort. In particular, the authors acknowledge the significant support and guidance of Mr. Dan Gardner and Ms. Annie Patenaude of OUSD(P&R) in their role as training community modeling and simulation managers. In addition, we appreciate the excellent advice and material contributions of dozens of members of the defense training community, to include the Services, Major Commands, and Agency representatives. In addition to the authors indicated on the cover, who provided input to various sections of the two volumes, we are indebted to Ms. Laura Clark of Addx Corp. and Mr. Olaf Elton of MITRE Corp. While the authors benefited from all these interactions, they are solely responsible for the document's final content.

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1. EXECUTIVE SUMMARY

The purpose of the Training Community Modeling and Simulation Business Plan is to provide linkages from the training functional stakeholders as represented in the Training Transformation Senior Advisory Group and Executive Steering Committee to the Department's larger M&S strategic vision and goals.

1.1 BACKGROUND

The training community has the advantage of a relatively recent Analysis of Alternatives that focused on training gaps and modeling and simulation (M&S) capabilities to fill those training needs. The Training Community Modeling and Simulation Business Plan brings forward a detailed look at the training gaps as they were derived and validated during the Training Capabilities Analysis of Alternatives (TC AoA) published in July 2004. The initial list of 35 training gaps has been subsequently updated with the training stakeholders to indicate progress in satisfying those needs. The training gaps form a baseline of requirements for training that is larger than just the M&S capabilities tool set and may be filled by other training tools. A corresponding baseline of training M&S capabilities was provided in the TC AoA Final Report, Section V, Assessing Effectiveness. This baseline detailed those training models and federations identified by the Services, the Joint Forces Command, and the intelligence community as relevant to the AoA training requirements.

1.2 APPROACH

Since needs and technology are constantly changing, the Training Community Modeling and Simulation Business Plan will continue to evolve as a living document. The 2007 Edition of the Training Community Modeling and Simulation Business Plan informs the M&S Steering Committee project call for near-term (FY 09) M&S projects and provides justification for major investments in training capabilities enabled by M&S in future Program Objective Memorandum submissions. It also identifies capabilities that the training community can leverage to achieve interoperability, reuse, and efficiencies among the other M&S communities. The next edition of this document will update needs and requirements and M&S training capabilities necessary to respond to changing war-fighting training needs.

This Training Community Modeling and Simulation Business Plan describes the process that the joint training community used to analyze those improvements in M&S capabilities most needed to enhance joint training. It describes a logical, iterative process that began with the 2004 TC AoA, which analyzed the top training gaps, and how the training community developed the final recommended investment strategies to fill those gaps. This plan leverages the M&S efforts, key enablers, and joint federations currently underway.

1.3 KEY FINDINGS

- Executing this plan will play a key role in improving DoD training capability consistent with the service-oriented architectures, network-centric data integration, and a distributed environment that will allow live, virtual, and constructive training capabilities to interoperate seamlessly.
- The M&S investment strategies articulated in this plan will support a broad range of roles and responsibilities in joint, interagency, intergovernmental and multinational contexts.
- These investment strategies will provide an environment of more affordable and effective capabilities for training U.S. forces in the joint mission essential tasks to meet the needs of the component commanders, joint task force staffs, standing joint force headquarters, component commands, and the military Services. These strategies will also assist DoD in meeting the challenges posed by advances in technology and, in many cases, train in situations where it is not feasible to train in a live-only environment.
- Investment strategies focus on common data, common infrastructure, and common DoD interests.
- Investing in M&S training capabilities will be a key factor in the Training Transformation Program goal of global presence: provide training and education anytime, anywhere, to a wide spectrum of training needs and audiences.
- Investment strategies address many of the crosscutting M&S capability gaps identified by the *Draft Department of Defense Modeling and Simulation Common and Crosscutting Business Plan,* 2008. They will play a key role in developing an integrated set of M&S capabilities that allows the DoD communities and military Services to employ M&S in the most effective and efficient manner to provide the benefits of M&S to the DoD total force.

1.4 RECOMMENDATIONS

The following recommendations respond to *The Strategic Plan for Transforming DoD Training* (May 8, 2006) through significant enhancement of the Live, Virtual and

Constructive training environment that will serve as an enabler for transforming our forces and missions across the full range of integrated operations:

- The 16 investment strategies in Section 6 of this Training Community Modeling and Simulation Business Plan should serve as a start point for the update to be published in the FY 09 Edition.
- The training stakeholders should participate with the Joint Staff J7 to update the list of TC AoA training gaps as an updated requirements baseline for future training M&S efforts.
- After the needs update, conduct a workshop with training stakeholders to translate the needs and capabilities to specific proposals for either the training community or the M&S Steering Committee for enterprise-level funding in FY 09 and beyond.
- All future training M&S proposals should be consistent with the future net-centric enterprise services (service-oriented architectures) and net-centric data strategies.

2. BACKGROUND

2.1 PURPOSE

The objective of the Training Community M&S Business Plan is to identify ways to improve and update the contribution of modeling and simulation to the ongoing enhancements of joint training. M&S is a key part of improving the DoD training capability with service-oriented architectures, network-centric data integration, and distributed environment that will allow live, virtual, and constructive training capabilities to interoperate seamlessly. This document contributes to this objective by starting with the vision of joint training, assessing current M&S capabilities (Section 3), assessing the gaps between current M&S capabilities and M&S goals (Section 4), describing M&S efforts that are currently underway to fill the gaps (Section 5), and providing a roadmap of management, investment, and technical strategies for identifying new M&S investments designed to help fill remaining training gaps (Section 6).

2.2 JOINT TRAINING VISION

"Training" as used in this business plan is narrowly defined as training, education, and job-performance aiding. The National Defense Strategy directed that military training be transformed in parallel with the ongoing transformation of U.S. forces and missions. It established operational goals for accomplishing this transformation; to carry out these goals, it directed that joint training take these steps:

- Support a broad range of roles and responsibilities in joint, interagency, intergovernmental, and multinational contexts.
- Be flexible and operationally effective.
- Be capable of assessing and reporting training readiness for both traditional and emerging joint operations.
- Employ war games and simulations to multiply the effects of field exercises and experiments.

The Strategic Plan for Transforming DoD Training (May 8, 2006) responded to the National Defense Strategy by calling for the creation of a live, virtual and constructive training environment that will serve as an enabler for transforming U.S. forces and missions: "Provide dynamic, capabilities-based training for the Department of

Defense in support of national security requirements across the full range of integrated operations."

The live, virtual, and constructive training environment will include using M&S systems to create war-fighting conditions through a networked collection of interoperable training sites and nodes and interconnected simulations and training tools.

The new training environment must provide affordable and effective capabilities for training U.S. forces in the joint mission essential tasks to meet the needs of the component commanders, joint task force staffs, standing joint force headquarters, component commands, and the military Services. In training U.S. joint forces to meet operational performance objectives, the ultimate goal of this new training environment is to train forces as they are intended to fight.

There have been changes in organization as the United States transforms to support the war on terror: shifting from permanent organizations and large hierarchies to smaller, highly distributed joint and combined forces and standing joint force headquarters that integrate Service capabilities at the lowest levels. New missions have been added: viewing military performance as an input to crisis-action planning, as well as war-fighter readiness.

The United States must train forces to seize opportunities and meet challenges posed by advances in technology. Training must support integrated joint and Service operations. The new environment must use not only traditional test and training facilities, but it must integrate these facilities with other areas of defense planning such as acquisition, logistics, personnel, professional development, and command-and-control processes.

The Training Transformation Program must have global presence to provide training and education anytime, anywhere to a wide spectrum of training needs and audiences. Below are some of the key enablers within the Training Transformation Program that will help establish the persistent global training and education presence:

- **Global Knowledge Network.** This enabler is an overarching, open-architecture M&S environment to provide plug-and-play interoperability in a full range of live, virtual, and constructive training. It must offer critical elements such as online interactive instruction, comprehensive content repositories, and the emerging Global Information Grid.
- **Joint Knowledge Development and Distribution Capability.** This training transformation program, which focuses on joint training of individuals, is responsible for establishing the Global Knowledge Network. It is the premier

conduit for timely and globally accessible joint knowledge and information in support of combatant commanders, Services, and interagency community partners. It must focus on training individuals to think intuitively in terms of joint operations.

- **Live, Virtual, and Constructive Training.** The live, virtual, and constructive training environment is designed to create joint war-fighting conditions through a networked collection of interoperable training sites and nodes that synthesize personnel, doctrine, and technology to meet the training needs of the combatant commanders and the Services. The live, virtual, and constructive environment melds existing operational and strategic facets of exercises with live forces and those training in simulators to create a more robust and realistic experience. It is supported by a wide spectrum of training simulations and tools.
- **Joint National Training Capability.** This training transformation program is responsible for building the global live, virtual, and constructive training environment for collective training. It promotes the integration of COCOM, Service, and government agencies to "train like we fight." It uses adaptive opposing forces, common ground truth, and high-quality feedback to achieve training realism in a joint context.
- **Joint Assessment and Enabling Capability.** This training transformation program is responsible for developing and using a comprehensive set of metrics to assess how well training transformation meets the joint training needs of its customers—individuals, units, and staffs. Training needs are related to readiness requirements.
- **Performance Assessment.** The training transformation community conducts a biennial Block Assessment to monitor how well joint forces are being trained to meet operational demands. The Block Assessments are part of a spiral-feedback mechanism to ensure that lessons learned are provided to the training transformation community.

2.3 M&S VISION

This Training Community Modeling and Simulation Business Plan contributes to the M&S vision statement, which is:

- Empower DoD with the M&S capabilities that effectively and efficiently support the full spectrum of defense activities and operations.
- The goals of DoD M&S efforts are to provide:
  - **Standards**, architectures, networks, and environments.
  - **Policies** at the enterprise level.
  - **Management** processes for M&S and data.

- **Tools** in the form of M&S and authoritative data.
- **People** that are well trained.

2.4 GOVERNANCE

The Training Community's Executive Steering Group and Senior Advisory Group oversee the development and execution of training transformation. Their oversight purview includes the resolution of training issues, all training M&S activities and capabilities, and the allocation, transfer, and execution of all training resources.

The Training Transformation Joint Integrated Process Team is the primary forum for providing input to the Executive Steering Committee and Senior Advisory Group and provides other Services in response to their guidance. The Joint Integrated Process Team is chaired by the Director, Readiness and Training Policy and Programs. It consists of senior analysts, planners, and action officers from the COCOMs, Services, Combat Support Agencies, Joint Staff, and other DoD staffs and agencies that contribute to DoD training transformation.

In addition to the training community governance processes, the M&S community has established the M&S Steering Committee and an M&S Joint Integrating Process Team for management at the department level. The following goals for M&S management are extracted from the M&S Vision Statement. The management goal of DoD's M&S efforts should provide:

- Management processes for models, simulations, and data that:
  - Enable M&S users and developers to easily discover and share M&S capabilities and provide incentives for their use.
  - Facilitate the cost-effective and efficient development and use of M&S systems and capabilities.
  - Include practical validation, verification, and accreditation guidelines that vary by application area.

3. ASSESSMENT OF CURRENT M&S CAPABILITIES

This section describes training activities, the functions to perform these activities, the tools used by the functions, the services that various training organizations perform for the training community, resources used by the training community, the current M&S governance structure, mechanisms to keep the training M&S community informed, and cross-community information sharing.

3.1 TRAINING ACTIVITIES

The training community must ensure that deploying forces are trained for operations before arrival and that learning continues while the forces are employed in the area of responsibility. To conduct joint operations across all campaign phases and operations, combatant commanders must be provided with individuals, units, and staffs. M&S requirements to accomplish this are:

- Rapid scenario generation for geospatial, force structure, readiness, weather, intelligence, logistics, and other relevant scenario-specific data.
- Ability to interface with, and train on, real-world command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) systems.
- Standardized interfaces for systems to access live, virtual, and constructive environment.
- Ability to train in multilevel, secure environments for interagency and multinational events.

3.2 FUNCTIONS

In building the global live, virtual, and constructive training environment, the Joint National Training Capability employs M&S to create and integrate training environments that are live (real people in real locations using real equipment), virtual (real people in simulators), and constructive (real people and simulated entities in a simulated environment). This enabler creates joint war-fighting conditions through a networked collection of interoperable training sites and nodes that synthesize personnel, doctrine, and technology to meet the training requirements of combatant commanders and Services. The live, virtual, and constructive environment melds existing operational and strategic facets of exercises with live forces, creating a more robust and realistic

experience. It strives for realistic combat training by using adaptive and credible opposing forces, establishing common ground truth, and providing high-quality feedback. Events include Service-to-Service training to improve interoperability and joint operation (horizontal training), strategic-to-tactical joint training to improve vertical command integration (vertical training), enhancement of existing joint exercises to address joint interoperability training in a joint context (integrated training), and dedicated joint training environment to train to specific war-fighting capabilities and complex joint tasks (functional training). Training is enhanced through experimentation, testing, and extending joint training globally into local training venues of the Total Force.

3.3 M&S TOOLS

In this document, M&S Tools are defined as *the development, management, and use of software that enables the creation and execution of simulated environments and the analysis of the simulation results.*

A series of initiatives have been underway following the TC AoA by the combatant commands (COCOMs) and Services. The following list of capabilities is discussed in more detail in Volume II of this report.

- **Joint Multi-Resolution Model Federation.** The Joint Multi-Resolution Model is a composable federation that uses the Joint Theater Level Simulation and the Joint Conflict and Tactical Simulation as the "core" models in the federation. Joint Multi-Resolution Model's name and capability are derived from the need to provide both high-level aggregation simulations to support the joint task force-level training and simultaneously provide entity-level representations to simulate the tactical force components of the joint task force.
- **Joint Live, Virtual, and Constructive Federation.** The Joint Live, Virtual, and Constructive Federation is focused on seamlessly integrating constructive entity-level stimuli with virtual and live simulations and simulators in a near-real-time synthetic environment. This federation comprises entity-level models and simulations that represent Service combat, intelligence, and logistic systems, including Joint Conflict and Tactical Simulation, Joint Semi-Automated Forces (JSAF), Air Warfare Simulation (AWSIM), Air and Spade Collaborative Environment Information Operations Suite (ACE–IOS), Tactical Simulation (TACSIM), National Wargaming Simulation Next Generation (NWARS–NG), and Joint Deployment Logistics Model (JDLM). The federation enables the integration of virtual simulators and live range instrumentation to support training from

COCOM Staff and Service Components, down to tactical units and individual/crew trainers.

- **Joint Training and Experimentation Network.** The Joint Training and Experimentation Network is a global network providing the backbone and connectivity for the live, virtual, and constructive simulation components to support a wide spectrum of joint and Service training requirements.
- **Joint Training Information Management System.** The Joint Training Information Management System is a Web-based system designed to provide automated support to the Joint Training System. Joint Training Information Management System directly supports the task-based, closed-loop features of the Joint Training System by facilitating the development of an integrated task-based thread to guide all Joint Training System training activities.

3.4 DATA

For this document, M&S data are defined as: *A representation of real-world facts or concepts in a format usable by M&S.*

The use of data is extremely important for M&S-supported training. The ability to rapidly generate the scenario to perform realistic training is a very labor intensive, but important step in the training process. Several DoD initiatives are underway to enable net-centric data integration in a service oriented architecture that will be supported by the Net Centric Enterprise Services program of the Global Information Grid. The Joint Data Alternatives Study was completed in October 2007 but consequently was not incorporated in the Training Community Modeling and Simulation Business Plan data call or considered in the subsequent analysis. The work of that cross-community study team and the follow-on Joint Data Alternatives effort will be considered in the 2008 Training Community Modeling and Simulation Business Plan update for 2009 release. The Joint Data Alternatives study identified several alternative methods for handling data resources for the M&S community in a net-centric environment. The study identified anticipated actions needed to implement the net-centric data strategy to support a shared data environment leveraging the Global Information Grid and Defense Information Systems Agency programs. Among these efforts are the following:

- **Defense Readiness Reporting System.** Defense Readiness and Reporting System is an automated system developed to establish a mission-focused, capabilities-based, common framework that provides the combatant commanders, military Services, Joint Chiefs of Staff, and other key DoD users with the data-driven environment and tools to evaluate, in near real-time, the readiness and capability of U.S. Armed Forces to carry out assigned and potential tasks. The Defense Readiness and Reporting System will be the

authoritative data source for the joint mission essential tasks and potentially for unit and force structure data for use in the Joint Training System and building scenarios for training M&S applications.

- **Joint Rapid Distributed Database Development Capability.** The program, now named **Joint Training Data Services,** continues to provide solutions to important data issues for joint and Service training events. The Joint Training Data Services envisions the definition, design, development, and support of an integrated system for identifying, collecting, manipulating, capturing, storing, and retrieving geospatial/environmental (physical, natural, forces, order of battle, target, intelligence, geospatial, visual, etc.) data.
- **Joint Rapid Scenario Generation Pilot Program.** The Joint Rapid Scenario Generation is the DoD-wide instantiation of ongoing Joint Training Data Services work in the training community. The Joint Rapid Scenario Generation is one of four DoD-wide Concept Decision Pilot Programs sponsored by Under Secretary of Defense (Acquisition, Technology, and Logistics). The mission need for Joint Rapid Scenario Generation was validated in the Joint Capabilities Integration Development System (JCIDS) process and validated "with interest" by the Joint Requirements Oversight Council (JROC) in November 2005. The Joint Rapid Scenario Generation is intended to provide a capability enabling Joint, Service, COCOMs, and other DoD organizations to collaboratively produce mission-relevant, event-ready data sets supporting M&S, command and control, and information systems, particularly for the live, virtual, and constructive environments. The Joint Rapid Scenario Generation data sets and process will support operational decision-making, predictive analysis, adaptive planning, mission rehearsal, readiness, testing, and evaluation, in addition to training in a Joint mission environment with similar M&S and C4ISR applications.
- **Joint Data Alternatives Study.** The purpose of the Joint Data Alternatives effort, which was supported and funded by the M&S Steering Committee, was to (1) identify recommended methods for handling data resources for the DoD M&S community in a net-centric environment and (2) to identify anticipated actions needed to implement the Net-Centric Data Strategy to support a shared data environment. This effort complements the separate training-funded data efforts untaken in the Joint Training Data Services and Joint Rapid Scenario Generation programs. The Joint Data Alternatives study team drew together multiple M&S communities to discover evidence of prior and current M&S data efforts, defined the scope of the implied and explicit gaps in the area of simulation data interoperability, and documented a set of crosscutting use cases for data applicability to support M&S core capabilities across multiple functional applications. The Joint Data Alternatives study team produced a number of discrete and stand-alone deliverables. For a full list of deliverables, see paragraph 1.5.3, Project Deliverables, in the Joint

Data Alternatives Final Report. These deliverables are individual documents that when considered in the whole represent the study team's final report products. The Joint Data Alternatives library of documents will be considered as relevant research in the updated Training Community Modeling and Simulation Business Plan. The thrust of the Joint Data Alternatives effort was to inform the multiple M&S communities of the relevant issues as DoD moves to the future of net-centric data strategies supporting the Global Information Grid and related Defense Information Systems Agency programs.

3.5 M&S SERVICES

Additional training community activities enhance the work performed by the training components. The following list shows M&S services for the joint training community:

- Increased shared capabilities.
- Visibility on M&S requirements.
- Integrated M&S requirements.
- Shared community and component successes.
- Effective and efficient verification, validation, and accreditation.
- Awareness of M&S resources, best practices, and supporting tools.
- Education programs coordinated and integrated across DoD.

Training Community of Interest

The DoD Training Community of Interest has been established in accordance with the DoD net-centric data strategy[1] and with the Joint Staff's Draft of the Community of Interest and Service Oriented Architecture Implementation Recommendations for Warfighting Domain Systems (7 December 2004). It serves as the basis for future agreements on key aspects of Training Community of Interest activities. One purpose of the Training Community of Interest is to be the umbrella point of contact for service-oriented architecture efforts involving the training community and coordination with the Global Information Grid programs.

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1 *Data Sharing in Net-Centric DoD*, DoD Directive 8320.2, ASD(NII)/DoD CIO, 2 December 2004 (certified current as of 23 April 2007), http://www.dtic.mil/whs/directives/corres/pdf/832002p.pdf.

4. ASSESSMENT OF M&S GAPS

The first step to improving M&S is to first recognize the deficiencies of joint training—the gaps between current capability and ultimate goals. This section presents two analyses of these training gaps that require improvement in our M&S capabilities. Both analyses are based on the 35 gaps identified by the 2004 TC AoA. The AoA and the 35 gaps are described in Section 4.1. Section 4.2 describes the analysis carried out during the AoA of the top 10 gaps thought to critically need attention. Section 4.3 presents a recent analysis of the full 35 gaps that specifically focuses on M&S. It is based on a data call that solicited information on the ability of a sample of M&S federates to fill the gaps.

4.1 2004 TRAINING CAPABILITIES ANALYSIS OF ALTERNATIVES

The foundation of the training community's analysis of gaps and capabilities stemmed from the Analysis of Alternatives (AoA) for Joint and Service training, published in 2004. Further background on the TC AoA is in Appendix B.

The AoA analyzed the ability to meet joint training needs as defined by information in the following sources:

- Joint mission essential tasks identified by the COCOMs and Services.
- Higher level guidance and directives, such as the Quadrennial Defense Review.
- Training requirements and capabilities identified at the Joint Training Review Group.
- The Requirements/Alternatives Business Game and the Senior Steering Group meeting in January 2004.
- Data gathered by Joint Forces Command and the Services.

The AoA study team initially defined 13 gaps between training capabilities and requirements. These gaps were further reviewed by a "Tiger Team" composed of people from the Joint Staff (J7), the COCOMs, and the Services. This review led to an expansion of the gaps to 35, which are listed in Table 4-1 in order of decreasing priority as determined by the Tiger Team. (The Tiger Team divided the gaps into two tiers: Tier I comprises the first 30 gaps, which were identified as transformational and that should influence Program Objective Memorandum 06 and receive initial or increased funding; Tier II comprises the remaining 5 gaps, which were judged deserving of support at their

current levels and increases in funding as needed beginning in FY08.) Appendices B and C offer additional detail on the AoA and the 35 gaps.

Table 4-1. Training Gaps Identified by the 2004 TC AoA Gaps

TC AoA 2004	Gap
1	Train Combined Joint Task Force Staffs (includes need for Individual Joint Training)
2	Train Standing Joint Force Headquarters Staff (includes need for Individual Joint Training)
3	Train on Crisis Action planning and deployments
4	Provide faster/higher fidelity mission rehearsal
5	Train forces on joint urban operations
6	Train forces on information operations (including information warfare, computer network exploitation, computer network defense, and computer network attack)
7	Train forces in a joint interagency intergovernmental, multinational environment (including intelligence community participants)
8	Provide homeland defense training
9	Provide multi-command missile defense training
10	Train forces in enemy chemical, biological, radiological, nuclear, and electromagnetic exploitation and destruction
11	Train to operate in chemical, biological, radiological, nuclear, and electromagnetic environment
12	Train on effects based planning/operations
13	Train theater/strategic forces to conduct C4I operations using collaborative information environment
14	Train forces on realistic logistics requirements (including reception, staging, onward movement, and integration)
15	Practice Active Component/Reserve Component integration and mobilization training
16	Train forces on stability and support operations
17	Train forces on military assistance to civilian authorities operations
18	Train Special Operations Forces and conventional forces for integrated operations
19	Train forces (operational and tactical level) to use national intelligence systems
20	Train routinely with the Joint Operation Planning and Execution System
21	Train routinely with new adaptive planning and deployment system
22	Train Intelligence community as they fight (including all levels as a tactical participant)
23	Train the Joint Interagency Coordination Group
24	Train staff to coordinate personnel recovery operations
25	Train global ballistic missile defense
26	Conduct global strike training
27	Train critical infrastructure protection
28	Operations/intelligence center training, integration, and command education

TC AoA 2004	Gap
29	Strategic information assurance
30	Continuity of operations
31	Train on operational systems (dedicated bandwidth)
32	Train on consequence management operations
33	Provide special operations crisis action procedures training
34	Provide intelligence community Special Operations Forces specific training at the Operational level
35	Plan, coordinate and practice mission assurance

4.2 TEN AREAS OF TRAINING DEFICIENCY

As mentioned earlier, the AoA presented an analysis of 10 of the initial 13 gaps that were regarded as especially needful of remedial work. A more complete discussion of these gaps is presented in Appendix C. These gaps are listed below, followed by a brief summary focused on highlighting the problems that must be overcome in filling the gaps:

1. Mission rehearsal capability.
2. Adaptable constructive training systems.
3. Replication of ability to train nonkinetic processes and activities.
4. Multi-level security.
5. Multi-echelon training.
6. Strategic context.
7. Emerging concepts.
8. Emerging missions.
9. Embedded training capability.
10. Synthetic Natural Environment improvement.

4.2.1 Mission Rehearsal Capability

Preparing mission rehearsals is a time-consuming process: planning and executing major exercises and rehearsals normally takes a year or more. The goal is the ability to develop a large multi-corps (Unified Endeavor-type exercise) Synthetic Natural Environment and scenario database within 96 hours (assuming that source data are readily available) using eight qualified database builders. Achieving this goal requires

two actions: developing a capability to generate databases rapidly and taking steps to shorten the Joint Event Life Cycle process.

4.2.2 Rapid Database Development

Major exercises take a long time to plan, principally because the process is manpower-intensive—we lack coordinated data repositories. Each component model of the Joint Training Confederation has its own unique database that has been built according to its own format. A change in one model's database can generate changes in the other models.

Automating this process requires the following steps:

- Standardizing the format of all the databases so the data from any one can be recognized by all components of the simulation or federation.
- Developing a common set of tools with automatic features such as drag and drop and cut and paste to automate the archiving, cross checking, manipulating, retrieving, and transferring of data across the various databases.
- Developing the ability to generate distributed databases via an Internet-based repository accessible by multiple sites and a merge capability to "stitch together" multiple inputs.
- Ability to train to crisis action planning and deployment.

4.2.3 Shortening the Joint Exercise Life Cycle

Shortening the Joint Exercise Life Cycle requires efforts to shorten exercise planning, which typically takes three planning conferences, three database tests, and a host of other activities. Time can be shortened by these efforts:

- Streamlining and compressing preparatory events.
- Developing a common tool set to automate the five-phase Joint Exercise Life Cycle.
- Developing interoperability with the Joint Planning and Execution System (also known as JOPES), so exercise planners can directly access Courses of Action that combatant commanders have chosen to accomplish missions.

4.2.4 Develop Adaptable Constructive Training Systems

Design constructive simulations to support training, vice building a capability and then adapting the training program to the simulation. Future constructive simulations should possess the following characteristics:

- *Evolutionary vice Revolutionary*. Leverage off of existing systems and provide new capability through spiral development.
- *High Reliability, Availability, and Maintainability*. Apply reliability, availability, and maintainability requirements to all elements of all simulations and federations, for example, system hardware, software, High Level Architecture, etc.
- *Flexible and Composable*. Provide features to allow exercise designers to tailor federations to meet the needs of the training audience: object-oriented design to enhance modularity and ease modification; open architectures and operating systems; representation of the joint operational environment; ease of upgrade and enhancement; standardized tools effective across federates; interface interoperability with existing command, control, communications, computers, and intelligence (C4I) systems and networks; and links to live entities, ranges, and virtual simulators.
- *Scalable.* Build training systems able to support large numbers of complex objects and accompanying interactions while still maintaining timeliness and spatial consistency.
- *Aggregatable.* Simulations must be able to group entities while preserving their individual effects and interactions.
- *Distributable.* The simulation must be capable of distributing the exercise to better "move electrons vice people."
- *User Friendly*. Use graphical user interfaces, help menus, and overall construction to make simulations easy to use without extensive prior training.
- *Manage the growth of bandwidth and throughput* of the communications infrastructure.
- *Be able to simulate and interoperate* with interagency and C4I systems and Global Information Grid services.
- *Operationally capable*. Integrate with command-and-control services in-theater.
- *Multinational interoperability*. Be capable of interfacing with training systems of U.S. allies and Coalition partners.
- *Adaptability to doctrinal changes.* Allow rapid integration of training, doctrine, and lessons learned.
- *Interoperable* with the Defense Readiness and Reporting System and other training management and reporting systems.
- *Provide links* to the Joint Training System (via Joint Training Information Management System or its follow-on system).

4.2.5 Develop the Ability to Train Nonkinetic Processes and Activities

Legacy simulations have done well in representing traditional war-fighting, but are lacking in modeling nonkinetic processes. These capabilities are growing in importance, however, and the training community must remedy the following shortfalls:

- **Information Operations/Information Warfare.** The globalization of networked communications creates vulnerabilities in our information infrastructure, and new simulations must include information operations/information warfare threats to give training audiences experience in offensive and defensive operations. New capabilities should include the ability to:
  - For a computer network defense and attack, simulate actions (such as disabling computer networks or corrupting essential databases) that would be unacceptable to do in the real world.
  - Portray psychological operations and deception activities.
  - Represent the effects of conventional weapons on information grids and networks.
  - Portray electronic attacks to disrupt our information systems with jamming, broadcasting false signals, or generating bursts of electromagnetic pulse.
- **Space Operations.** An expansion of existing capabilities is required to train war-fighters to be fully prepared to use all space systems efficiently. Additional capabilities are needed in:
  - Depiction of orbiting platforms in the battlespace to allow portrayal of counter-space activities (kinetic kill vehicles or electromagnetic and laser-based systems).
  - Better representation of the effects of disruption or denial of space-based capabilities in surveillance and reconnaissance; communications; environmental sensing; navigation; and theater missile warning.
  - Better representation of ballistic missile launch processes and trajectories, including indications and warnings that would be available to a training audience in a real-world situation.
  - Better representation of ballistic missile warning—space-based and terrestrial systems that detect, track, and report on ballistic missile launches posing potential threats against North America, geographic theaters of operation, and space-based assets.

- **Battle Damage Assessment.** The battlespace and intelligence federates require enhancement to fully train the ability to identify and prioritize critical targets and conduct realistic battle damage assessment.
- **Intelligence, Surveillance, and Reconnaissance.** While there are good simulations of aspects of our intelligence capabilities, there is a need for more comprehensive representation in the following areas:
  - Representation of the entire intelligence cycle at the national, joint, theater, and tactical levels.
  - Higher fidelity simulation of tactical and national intelligence assets and behaviors.
  - Better integration of intelligence, surveillance, and reconnaissance products to produce fused and aggregated joint task force-level and higher formatted intelligence reports.
  - Better portrayal of human intelligence (HUMINT) and measurement and signal intelligence (MASINT) capabilities.
- **Military Assistance to Civilian Authority.** New emphasis on homeland security has generated a need for simulations to train staffs for man-made disasters and DoD assistance for civil disturbances, counterterrorism, etc.
- **Mobilization/Deployment/Redeployment.** A more comprehensive depiction of these activities is needed for joint training. Future simulations must incorporate the following features:
  - Automated Joint Logistics over the Shore operations.
  - Automated Maritime Pre-positioned Force operations.
  - Depiction of individual transportation vehicles moving equipment, personnel, and supplies between origins, ports of embarkation, ports of debarkation, and final destinations.
  - Airport and seaport throughput capabilities and operational activities, as affected by combat events.
  - Environmental factors that can impede the movement of equipment, personnel, and supplies.
  - All phases of redeployment, including reconstitution, movement to ports of embarkation, strategic lift, reception at ports of debarkation, and Joint Reception, Staging, Onward-movement, and Integration (defined below).
  - Rapid alteration of Time-Phased Force Deployment Data in response to ever-changing circumstances.

  - Depiction of Level 4 detail in Time-Phased Force Deployment Data data in the simulation battlespace.

- **Sustainment.** Simulations must provide more realistic treatment of in-theater sustainment, including health services; transportation and supply; maintenance, repair, and salvage; and engineering and communication systems.
- **Joint Reception, Staging, Onward Movement, and Integration.** Future simulations must more accurately portray moving forces all the way from reception at ports of debarkation to integration with parent organizations at combat sites. Reception, staging, onward movement, and integration operations should be modeled in ways that are transparent to the training audience, and require little or no human in the loop by exercise control people.

4.2.6 Multi-Level Security

The TC AoA validated the need and importance of addressing the Multi-Level Security issues as the security access significantly affects the ability to train with our interagency and multi-national partners in training exercises and events.

4.2.7 Multi-Echelon Training

The future constructive system must be capable of providing an environment that will allow end-to-end training—from the functional command element to tactical units in the field, involving command-and-control elements at every level in between.

4.2.8 Strategic Context

This issue involves national-level collaboration on joint training events to support the National Military Strategy and the Global War on Terrorism. Such training would also be used as a stepping-stone to focus the interagency training program on COCOM requirements.

4.2.9 Emerging Concepts

Legacy constructive systems have not kept pace with new war-fighting capabilities and concepts:

- **Operational Net Assessment.** Operational net assessment is a tool to give joint task force commanders visibility of an adversary's full war-making characteristics—political, military, economic, social, infrastructure, and information. Future constructive simulations will require a comprehensive representation of operational net assessment capabilities.

- **Effects-Based Operations.** Future simulations must be capable of portraying a broad range of outcomes resulting from effects-based operations. Improvements include portrayal of these features:
  - Positioning of targets in the Synthetic Natural Environment and Civil Environment.
  - Enemy infrastructure (e.g., communication and electrical grids, gas and oil pipelines, rail and road lines, and command-and-control centers).
  - Psychological effects pursued by conventional military operations or psychological operations missions.
  - Weapons capabilities and their lethal and nonlethal effects on intended targets.
  - Cumulative effects resulting from the aggregation of direct and indirect effects at varying levels of war.
  - Cascading effects that can ripple through an adversary's target system and influence other related target systems as well.
  - Means of assessing of damage to targets to assist in Battle Damage Assessment.
- **Collaborative Information Environment.** Collaborative tools will help combatant commanders and Joint staffs plan and disseminate operations, link the staffs to subject matter experts, and integrate the joint force with allies and other partners.
- **Joint Urban Operations.** Since urban centers are becoming more common as sites of conflict throughout the world, constructive simulations must be able to portray Joint urban operations in enough resolution to depict forces in urban environments of varying character.
- **Joint Fires.** Destroying enemy forces before they can be used against friendly forces puts a premium on training the synchronization of intelligence, air operations, ground operations, maritime operations, and logistics in time and space.
- **Stability Operations.** We need simulations to train Joint Forces Command personnel to estimate the time and forces to control civilian populations through riot control and nonlethal munitions and techniques.
- **Joint Close Air Support.** The complexity of joint close air support mandates that the cross-federate interactions within the simulation battlespace be seamless and realistic.
- **Integration of Special Operations Forces with conventional Forces.** Current M&S tools do not depict Special Operations Forces. At minimum, simulations should consider Special Operations Forces mission areas such as

combating terrorism and psychological operations and collateral activities such as coalition support and foreign humanitarian assistance.

- **Special Operations Forces-specific platforms and communications.** Operations in Afghanistan and Iraq indicate a growing need to train the integration of Special Operations Forces with conventional forces.
- **Chemical, Biological, Radiological, Nuclear and Enhanced Conventional Weapons (CBRNE) operations, exploitation, and destruction.** The 9/11 attacks against the United States highlight interest by our adversaries in asymmetric attacks against undefended targets, as opposed to direct conventional military confrontations. Future training simulations must therefore incorporate realistic portrayal of CBRNE operations in military and domestic scenarios, including aspects of crisis management and consequence management.
- **Personnel Recovery Operations.** Simulations should be capable of portraying personnel recovery operations to recover captured, missing, or isolated personnel from harm's way.
- **Ability to train to force protection requirements.** We need to train improvements in the security of our forces against terrorist activities.
- **Test/training/experimentation environments.** Although the COCOMs and Services have expressed a desire that training simulations be capable of supporting the testing and experimentation communities, this capability is of secondary importance, and the resources spent on delivering it should be limited.

4.2.10 Emerging Missions

DoD must be capable of training new emerging missions such as U.S. STRATCOM (e.g., global strike and global ballistic missile defense), U.S. SOCOM (e.g., Global War on Terrorism), and U.S. NORTHCOM (e.g., homeland security to reduce U.S. vulnerability to terrorism and minimize the damage from any future attacks). Training to the homeland security mission requires:

- Training to CBRNE as discussed above.
- Providing a command-and-control capability ranging from interagency communications to communications with local law enforcement and other first responders.
- Providing the civil environment (e.g., transportation, utilities, electrical grids, community water systems, pipelines, etc.) with enough detail to support training for critical infrastructure protection.

- Providing intelligence and warning capabilities representative of real-world capabilities tailored for the homeland defense mission.
- Portraying the activities and behaviors of Coast Guard, law enforcement, first-responder units, NGOs, etc., within the simulated environment.
- Linking into the live, virtual, and constructive environment.
- Providing the means to train to consequence management and media relations.

4.2.11 Embedded Training Capability

Newly acquired real-world systems should possess embedded training capabilities that are interoperable with other systems in the live, virtual, and constructive training environment when appropriate.

4.2.12 Synthetic Natural Environment Improvement

The Synthetic Natural Environment provides simulations with the representation of natural features (e.g., terrain, atmosphere, ocean, space, and weather) and some man-made entities (e.g., nuclear, chemical, and biological contamination). These features are often included during runtime by controller modification.

4.3 SUBSEQUENT ANALYSIS OF 35 AOA GAPS

This section describes the second, more recent analysis of the AoA gaps mentioned in the introduction to Section 4. The purpose of this analysis was to review the extent to which current M&S federates can fill each of the 35 TC AoA. The analysis also determined how well the current and planned capabilities serve various training audiences.

Information for the analysis was obtained through a data call to major joint and service training organizations. These respondents were asked to provide information on several of the federates they manage. Section 4.3.1 describes the data call, and Section 4.3.2 presents the analysis.

(An assumption underlying this analysis is that joint training needs and capabilities continually change and that identifying joint training gaps is properly viewed as a process rather than a single product. This assumption suggests that the gaps analyses performed for the TC AoA and for this later analysis should be routinely repeated to sustain open and active communication between the joint training community and the joint operations community. The frequency, structure, and content of these analyses should also be topics for periodic review.)

4.3.1 Data Call

An initial review identified 130 existing simulations and simulation tools that might address one or more of the TC AoA gaps. Analyzing all these was beyond the scope of the analysis. Instead, we selected a sample of federations of simulations and simulation tools for analysis. In retrospect, however, it seems unlikely that examining all available simulations and simulation tools would have led to substantially different conclusions and investment recommendations.

Eight federations were selected for review. They are described in Appendix D and Volume II. The eight federations are listed below under the organizations that maintain them and that responded to the data call:

Joint Warfighting Center (Joint Training Directorate)

1. Joint Live Virtual Constructive
2. Joint Multi-Resolution Model

Army Program Executive Office for Simulation, Training, and Instrumentation

3. MRF (Joint Land Component Constructive Training Capability (JLCCTC) Multi-Resolution Federation)
4. ERF (Joint Land Component Constructive Training Capability (JLCCTC) Entity Resolution Federation)

Navy Fleet Forces Command (Training Operations Directorate)

5. BFTT (Battle Force Tactical Trainer)
6. NCTE (Navy Continuous Training Environment Federation)

Marine Corps Training and Education Command

7. DVTE (USMC Deployable Virtual Training Environment Federation)

Air Force Agency for Modeling and Simulation

8. ACE (Air and Space Constructive Environment)

The data call described the 35 TC AoA gaps and asked each respondent for information on the following five questions, designed to indicate how well each of the federates under their purview filled the needs of each of the 35 gaps. The focus was on M&S training capabilities that are either currently available or that are planned to be available by the end of FY08. Responses to these questions summed across all responding federations are shown in Volume II, Appendix D, for each TC AoA gap.

1. What major training M&S enhancements have occurred since 2004?

2. How well—High, Medium, Low, or Not Applicable—do the enhancements serve each of five levels of the training audience?
3. What are the major remaining shortfalls in filling each gap?
4. What solutions might be pursued to address these remaining shortfalls?
5. Any comments you wish to add?

The ratings and training audiences for the second question are as follows:

High—The federation fully (or nearly so) supports the training audience

Medium—The federation supports the training audience

Low—The federation supports the training audience to a minor degree

Not applicable—The federation does not support the training audience

Training Audience Level 1: Regional COCOM or Multi-COCOM

Training Audience Level 2: Joint Task Force (Operational)

Training Audience Level 3: Service Component (Operational)

Training Audience Level 4: Service (Tactical)

Training Audience Level 5: Crew/Individual (Tactical)

4.3.2 Analysis

4.3.2.1 How Well Do Federates Support the Training Audiences?

Table 4-2 shows the results of the query regarding the second question above. Responses to this part of the query were received for eight of the nine federations, so that the entries in the High, Medium, and Low ratings for each of the 5 training audiences sum to 280—the number of federations (8) multiplied by the number of gaps (35). For Training Audience 1, for example, 108 of the 280 responses were in the High category.

The figures indicate that according to the judgments of the sponsoring organizations, 83% of the federate-gap responses (ignoring Not Applicable) are satisfying Training Audience 1 in the High and Medium category. The results for Training Audiences 2–4 are similar, but Crew and Individual trainees are covered to a much lower extent—a little more than half as well.

Table 4-2. Reported Extent of Training Audience Support Summed over the Data Call Federations

Ratings	TA(1) Regional COCOM or Multi-COCOM	TA(2) joint task force (Operational)	TA(3) Service Components (Operational)	TA(4) Service (Tactical)	TA(5) Crew and Individual (Tactical)
High	108	117	104	69	26
Medium	53	54	54	100	37
Low	32	31	46	30	71
Not Applicable	87	78	76	81	146
Total	280	280	280	280	280
High + Medium	161	171	158	169	63
High + Medium + Low	193	202	204	199	134
Percentage	83%	85%	77%	85%	47%

4.3.2.2 What Are the Major Shortfalls in Filling the Gaps?

Table 4-3 indicates how well federates are addressing the various AoA gaps, the third question above. Table 4-3 lists the gaps in the upper and lower quartiles of support, along with their TC AoA priorities.

Table 4-3 indicates that the training community is performing better on the gaps with higher priority: the average priority of gaps was 12.0 in the upper quartile and 22.6 in the lower quartile.

Table 4-3. Ability of Federates to Address TC AoA Priorities

TC AoA Priority	Upper Quartile
1	Train Combined Joint Task Force staffs (although more attention to individual joint training appears may still be needed)
2	Train Standing Joint Force Headquarters staff (again, more attention to Individual joint training may be needed)
4	Provide faster/higher fidelity mission rehearsal
7	Train forces in a joint interagency intergovernmental, multinational environment (including intelligence community participants
8	Provide homeland defense training
22	Train Intelligence community as they fight (including all levels as a tactical participant)
24	Train staff to coordinate personnel recovery operations
28	Operations/intelligence center training, integration, and command education
TC AoA Priority	**Lower Quartile**
11	Train to operate in chemical, biological, radiological, nuclear, and electromagnetic environment
15	Practice Active Component/Reserve Component integration and mobilization training
17	Train forces on military assistance to civilian authorities operations
21	Train routinely with new adaptive planning and deployment system
23	Train the Joint Interagency Coordination Group
29	Strategic information assurance
30	Continuity of operations
35	Plan, coordinate and practice mission assurance

5. M&S EFFORTS CURRENTLY UNDERWAY

The 2004 TC AoA identified models and federations that the Services, Joint Forces Command, and the intelligence community regarded as relevant to joint training requirements. This list, identified as the "Base Case," includes the following:

- Logistics Federation (LOGFED)
- Warfighter's Simulation (WARSIM)
- One Semi-Automated Force (OneSAF)
- Army Constructive Training Federation (ACTF)
- Deployable Simulation for Collaborative Operations (DISCO)
- Adaptive Communications Reporting Simulation (ACRES)
- Information Warfare Effects Generator/Dynamic Communications Environment (IWEG/DCE)
- National Wargaming Simulation-Next Generation (NWARS-NG)
- Air Force Modeling & Simulation Training Toolkit (AFMSTT)
- Air Force Synthetic Environment for Reconnaissance and Surveillance/Multiple Unified Simulation Environment (AFSERS/MUSE)
- Suite of five computer simulation models for warfare command and control (JQUAD+)
- Joint Semi-Automated Forces (JSAF)
- Joint Theater-Level Simulation (JTLS)
- Joint Conflict and Tactical Simulation (JCATS)

Chapter V of the AoA, "Effectiveness Assessment," rated each of these simulations for its contribution to removing the training gaps listed in Chapter III of the report. It was observed that "taken together current simulations have significant capability for removing the TC AoA Training Gaps."

Since the summer of 2004 several efforts have been funded to enhance the above simulations for the purpose of further closing the gaps. In addition, after the publication of the AoA, an OSD Program Decision Memorandum identified $94 million in funding across FY06–11 for work in three of the alternatives the AoA recommended:

- **Alternative #3, Modeling and Simulations.** The AoA recommendation for achieving the objectives defined in the Alternative 3 course of action is to produce a Joint modeling and simulation (M&S) live, virtual, and constructive Toolkit. The Toolkit will consist of existing programs of record that can be tailored to meet the needs of the Joint user. Enhancements to these existing capabilities will be designed to close the functional gaps in Joint training requirements. A major advantage of this approach is that it gives DoD the ability to insert an emerging technology or existing system—examples are specialized models for Homeland Security training and for joint command-and-control COCOM training—into the architecture. The functional capability of the M&S tools in the Toolkit and the needs of the training audience, training objectives, will drive the composition of a simulation federation. This Alternative was funded at $43 million across FY06–11.
- **Alternative #4, Innovative Acquisition.** "The AoA Senior Steering Group directed a prototype activity to determine the viability of the business model described in Alternative 4.… The focus of the prototype is to explore the alternative business approach to acquiring training.… In simple terms, the prototype is about business efficiencies for providing training." Although the activities funded under this alternative are to examine the business aspects of purchasing training products and services, the functional training content provided to sponsoring COCOMs will also address one or more TC AoA training gaps. This alternative was funded at $14 million across FY06–11.
- **Alternative #5, Re-engineering Training.** "Re-engineering Joint training requires the Department of Defense to initiate two revolutionary changes to the Joint training construct. The first action is the near term objective to provide COCOMs with the personnel, funding, and the Joint training technology alternatives required to meet joint individual and staff training requirements." The Joint training technology alternatives identified in Alternative 5 provide the on-demand and composable capability required by COCOMS to conduct training for individuals and staff serving in Joint Force headquarters from Component Commands through Combatant Commands. These alternative technologies, which are defined in Chapter IV of the AoA and listed below, were funded at $37 million across FY06–11. Several of the alternative technologies are currently being funded in efforts led by Joint Forces Command:
  - Lightweight Simulations/Federations
  - Massively Multi-Player Gaming
  - Story Driven Training
  - Joint Community Unique Federates

- Instructor Support Tools
- Embedded Training

In addition to the list of these projects funded in response to the TC AoA, there have been changes to the federates as a result of new requirements articulated by stakeholders and sponsors, as well as continuing enhancements under existing Service and Joint Forces Command programs.

6. ROADMAP FOR THE FUTURE

6.1 INTRODUCTION

This section discusses recommended strategies for making future improvements in the contribution of M&S to joint training. Section 4 of this report addressed the broad areas in which current and programmed capabilities fail to meet the requirements of joint training. Section 5 discussed M&S efforts that are currently underway. We suggest that the training stakeholders hold one or more workshops in FY08 to plan future projects for funding by the training community and M&S Steering Committee.

6.2 INVESTMENT STRATEGIES

This section analyzes 16 investment strategies that represent the most significant gaps in joint training. The recommendations for these investment strategies are based on the various types of information obtained in the data call analyzed above—the training audience and gap analysis, enhancements to the federates, major shortfalls remaining, and proposals by the organizations who responded to the data call.

The investment strategies are listed below (lower number is higher priority). This is followed by detailed descriptions of the strategies in Sections 6.2.1–6.2.9. Each of these strategies represent capabilities that are not available today to the training community; therefore, the detailed descriptions in Section 6.3 analyzes them by specifying which of the 35 AoA gaps they are intended to fill.

Although the strategies are numbered in terms of priority, they are grouped here by functionality to better explain their common benefits:

1. Common object model
2. Rapid correlated terrain data
3. Rapid scenario-based individual and small team training

Architectures for common data—initialization of:

4. Operational environments
5. Logistics and infrastructure
7. Forces—unit and electronic order of battle
9. Mission environment—economic, diplomatic, political, and indigenous civilian

11. Mission environment—medical, public health, and related
6. Cross-domain security and multinational information sharing
8. Common general-purpose interface

Nonkinetic warfare including:

10. HUMINT
12. Information operations
13. Network warfare – net centric environments
15. Electronic and information warfare
14. Second-order effects for effects-based planning and operations
16. CBRNE, including human effects

6.2.1 Common Object Model

A common object model is software that provides a commonly understood mechanism for specifying the exchange of public data and general coordination among members of a federation of simulations. Its purpose is to improve interoperability and communication among other objects in distributed operating systems and protocols (heterogeneous networks) in the exercise. It also improves their reuse in other simulations. The model should operate independently of hardware type and facilitate the users' compatibility with all other devices.

Development of a common object model would facilitate realistic training in rapidly evolving environments requiring continual assessment of plans, policies, and procedures for lessons-learned reviews. It would also advance the development of simulation training for individuals and staffs across most, if not all, TC AoA gaps that can be addressed by joint training M&S. It would be especially important in training that requires communication and interoperability among federated simulations, such as staff operations; interagency, intergovernmental, and multinational operations; C4I; logistics; Active Component/Reserve Component integration; global strike; and other continuing operations.

6.2.2 Rapid Correlated Terrain Data

Capabilities being developed in this area are designed to shorten the time to incorporate new terrain data into simulations, thus making it possible to shorten the Joint Event Life Cycle and more quickly train individuals and small teams in crisis action planning and local, joint urban operations. The preparation of visual terrain data is

typically a manual process with development teams spending several months and thousands of dollars to create small sections of a simulated environment. Techniques for rapidly producing correlated data, which may cover atmosphere, ocean, space, and terrain, are especially important in distributed simulations where each node is responsible for maintaining its own model of the environment. Inconsistent data among the separate nodes can produce insufficiently realistic simulation, training that is not credible to participants, unfair advantages for some participants, and a corresponding degradation of interoperability. Investment and development in this area will provide faster, more agile mission rehearsals; level the training field for all participants at all levels; and allow more ready use of national intelligence systems.

6.2.3 Rapid Scenario-Based Individual and Small Team Training

Capabilities being developed in this area would improve the ease with which local staffs in garrison or theater could author or edit both types of scenarios and, to some extent, simulations themselves to meet special, local, and short-fuse training needs. These capabilities will provide more realistic training in rapidly evolving environments, such as crisis action planning and local and joint urban operations.

6.2.4 Architectures for Common Data

6.2.4.1 Operational Environments

This investment strategy focuses on data and the specification of common procedures for initializing data for simulations. Proper data initialization supports the declaration of sharable objects and their management across federates. As the practice of federating simulations grows, the need for initialization processes common to all simulations grows. The challenge is that military simulations development is customized based on the experience of the designers and developers. Even if a data model is used as a common reference model for information exchange, composites and aggregates may not be explicit in it. Other data-related issues arise in simulations from omitting variables, lacking relevant data, using inappropriate data, and using data beyond its applicable range. Lack of documentation for assumptions about data and data sources is also a serious issue, as is inter-simulation data in federated simulations. Development of High-Level Architecture, with its standard Object Model Template, Simulation Object Model, and Federation Object Model, was an important step forward, but a more comprehensive architecture is needed—a commonly accepted architecture that suitably transforms data (numerical, textual, or graphical) to be used in distributed, federated applications in concert with other applications.

This capability would advance data initialization for individual or staff simulation training, and it would allow more realistic training in rapidly evolving environments that require rehearsals to perform collective command-and-control tasks by component command staffs. It would also enhance training in logistics for staging and onward movement, adaptive planning and deployment systems, global strike, and continuity of operations.

6.2.4.2 Logistics and Infrastructure

M&S training capabilities should cover the full range of military operations, from humanitarian relief and peacekeeping to conventional war, stability and support operations, logistics planning and operations, and training for intelligence personnel that goes beyond their injection of scripted events into ongoing exercises. Development is needed to improve training in information operations, including computer network warfare, information warfare, and effects-based planning and operations.

6.2.4.3 Forces – Unit and Electronic Order of Battle

The training community needs M&S training databases that provide information about what other units, personnel, and equipment participating units might encounter in operations. Such databases might include information on the composition, disposition, strength, training, tactics, logistics, effectiveness, history, and uniforms of other units, along with information on SIGINT and COMINT emitters, their geographic location or range of mobility, their signals, and their likely role in the broader order of battle. Electronic order-of-battle information might indicate enemy unit movement, changes in command relationships, and increases or decreases in capability. It would provide more realistic and intense mission rehearsals by using a collaborative environment to exchange information, using national intelligence systems to identify adversary and friendly force capabilities and probable courses of action, and integrating training for the Intelligence Community with other force components. Rapid production of these databases would facilitate mission rehearsal for local and short-fuse training needs.

6.2.4.4 Mission Environment (Economic, Diplomatic, Political, and Indigenous Civilian)

In the current environment, civilian factors seem inseparable from military operations and need to be included in joint training M&S. Doing so raises many new challenges for the training M&S community and requires new approaches, such as behavioral moderators, and realistic models of culture, religion, and civilian activities, reactions, and beliefs. The issues involved in creating these capabilities are quite different

from those involving terrain and weather, and they are more diffuse and less constrained than military domains involving unit capabilities, tactics, and operational plans.

Development of these capabilities will enhance joint training M&S for interagency operations, homeland defense, the full range of effects-based operations involving civilian populations, stability and support operations, military assistance to civil authorities, and critical infrastructure protection.

6.2.4.5 Mission Environment (Medical, Public Health, and Related)

Improved production of M&S databases covering medical and public health affects several training areas and, consequently, a variety of TC AoA gaps. They need to be developed and routinely integrated with other M&S capabilities to improve training for task force staffs, joint urban operations, homeland defense, effects-based operations, stability and support operations, military assistance to civil authorities, coordinated personnel-recovery operations, consequence-management operations, and critical-infrastructure protection.

6.2.5 Cross-Domain Security and Multinational Information Sharing

A key goal of training transformation is the ability to successfully perform joint, interagency, intergovernmental, and multinational operations. The ability to acquire and share sensitive, timely information across domains, agencies, and nations is vital in meeting this goal, but it remains a serious problem for distributed M&S. Some technical methods exist for sharing classified information across domains, but they tend to be inefficient, expensive, or difficult to use in federations. Investment in these capabilities will improve training in information operations, realistic interagency or multinational environments, homeland security, and use of national intelligence systems.

6.2.6 Common General-Purpose Interface

Simulation-based training should not bog down in simulation operating procedures. One way to allow concentration on the training that M&S is providing, rather than the M&S technology itself, is to develop and enforce, as far as reasonable, common operating processes and procedures to be used by simulations providing joint training—in short, a common, interoperable look and feel. The capability provided by this investment will apply to any TC AoA gap that can be met with M&S. It may prove particularly important in training individuals and small teams where access to technical aides may not be available.

6.2.7 Nonkinetic Warfare

6.2.7.1 Human Intelligence

Defense efforts in the area of intelligence have been criticized for emphasizing technological sources too much and human sources too little. The variety of HUMINT sources range across a full spectrum of activity, including military patrols, traveler debriefings, diplomatic reports, newspaper and magazine articles, and espionage. Because HUMINT has unique capabilities that can make contributions to the success of military operations, it should be included in joint training M&S.

M&S training capabilities that include HUMINT can enhance decision-making for information operations, improve task force staff training, improve training at the operational and tactical level to use national intelligence systems, help train intelligence community members and strengthen their participation in staff exercises, and better integrate training for operations and intelligence staffs.

6.2.7.2 Information Operations

Information operations are defined as integrated employment of electronic warfare, computer network operations, psychological operations, military deception, and operations security. Information operations are used, along with supporting and related capabilities, to influence, disrupt, corrupt, or usurp adversarial human and automated decision-making of adversaries, while protecting those of our allies and ourselves. In the TC AoA they involve information warfare, computer network exploitation, computer network defense, and computer network attack. They were specifically addressed in TC AoA as the sixth highest rated gap. Investment will improve training for effects-based operations, homeland defense, stability and support operations, consequence management operations, and intelligence and special operations personnel who work with command staffs.

6.2.7.3 Network Warfare – Net Centric Environment

The vulnerability and importance of networks makes investment in network warfare an important one. Network warfare includes network attack, defense, and exploitation. The focus is increasingly on computer networks, but it may cover others such as telephone networks, which have their own computer networking capabilities. Training to deal with all three areas is increasingly reliant on simulation, which provides the most realistic and credible representation of the network warfare environment. The network software itself can be used in various training environments, and the outer shell

with which participants interact commonly simulates environments in which decisions must be made about attacking, defending, exploiting, or otherwise dealing with the network.

Investment in these M&S capabilities in this area will improve training for information warfare, assist with training for homeland defense operations, crisis-management planning, effects-based operations, stability and support operations, consequence-management operations; and help train intelligence and special operations forces working with command staffs.

6.2.7.4 Electronic and Information Warfare

Information operations use offensive and defensive techniques to shape, disrupt, and exploit adversarial use of the electromagnetic spectrum, while protecting friendly use of it. Electronic and information warfare includes electronic attack, electronic protection, and electronic warfare support. Electronic attack uses electromagnetic energy to degrade, neutralize, or destroy enemy capability. Electronic protection involves actions taken to protect against allied or enemy use of electromagnetic energy that may degrade, neutralize, or destroy friendly capability. Electronic security allows an operational commander to locate, intercept, and identify sources of intentional and unintentional electromagnetic energy for immediate threat recognition, targeting, planning, and conducting operations.

Developing these capabilities will improve training for information operations and related areas, such as staff activities, crisis actions, homeland defense, C4I using collaborative information, stability and support operations, intelligence operations, critical infrastructure protection, and consequence-management operations.

6.2.8 Second-Order Effects for Effects-Based Planning and Operations

Development of capabilities in this area will help train the full range of military operations from humanitarian relief, peacekeeping, and peacemaking, to law enforcement, insurgencies, and conventional war. These capabilities focus on the effects produced by military operations rather than the operations themselves, which helps establish a perspective for tracing and anticipating direct and indirect effects as they propagate through political, military, economic, sociological, and information infrastructures. Capabilities will also enhance training for joint staffs and task forces; crisis management; joint urban operations; information warfare; interagency,

intergovernmental, and multinational operations; homeland defense operations; intelligence center battle staff integration; and consequence-management operations.

6.2.9 Chemical, Biological, Radiological/Nuclear, Explosive Detection and Effects

CBRNE events concern the deliberate or inadvertent release of chemical, biological, radiological, nuclear, or high-yield explosive devices that can cause massive damage and extensive human casualties. The number of nations, non-nation organizations, and even small groups of individuals capable of developing, possessing, and staging CBRNE events with little or no warning is steadily increasing; therefore, the need for training to manage and deal with CBRNE events is increasing. The impact of such attacks may reach much further than the scene of the disaster. Injured and possibly contaminated victims may depart the scene, returning to their neighborhoods and residences, and may privately seek medical assistance. Investment in M&S capabilities for CBRNE detection and effects will improve training to detect, interdict, isolate, or mitigate the use of CBRNE weapons, along with improving training to operate in CBRNE environments. This investment will also help integrate CBRNE effects into other training, such as crisis-action planning, urban operations, intergovernmental and multi-national operations, homeland defense, military assistance to civil authorities, use of national intelligence systems, and consequence management.

6.3 ANALYSIS OF INVESTMENT STRATEGIES

Table 6-1 lists the 16 investment strategies and the TC AoA gaps they are intended to address. The rankings listed in the second column of the table are estimates of the importance of each strategy to improving training M&S.

Each investment strategy satisfies more than one gap (third column). Some of the strategies are concerned with kinetic warfare and some with nonkinetic warfare. Strategies 1 and 8 are applicable across all the TC AoA gaps.

Table 6-2 is the reverse of Table 6-1. It lists each AoA gap and identifies which strategies address it. Eleven of the gaps are not addressed by any of the strategies. This analysis does not indicate the extent to which these gaps (1) are filled by existing capabilities; (2) are more properly regarded as exercise design issues than as needed M&S training capabilities; (3) are training, but not M&S issues; or (4) are M&S gaps that have not received adequate attention.

Table 6-1. Investment Strategies, Ranks, and TC AoA Gaps Addressed

	Strategy	Rank	TC AoA Gaps Addressed
1.	Develop a standard common object model that defines unit objects played by entity and aggregate level simulations.	1.5	ALL
2.	Develop M&S capabilities for rapidly producing initialization-ready, mission-environment databases that cover correlated terrain data.	1.5	4, 19, 22
3.	Develop scenario-based individual training and small team M&S development capabilities that allow locally usable, rapid simulation and scenario generation and/or editing.	3	1, 2, 3, 4, 5
4.	Develop M&S architecture specifications for common M&S data initialization of operational environments.	4	1, 2, 14, 21, 26, 30
5.	Develop M&S capabilities for rapidly producing initialization-ready, mission-environment databases that cover logistics, engineering infrastructure, networks, power lines, information grids.	6	6, 8, 12, 16, 17, 22, 27, 34
6.	Develop capabilities for Cross Domain Security and Multinational Information Sharing in training M&S.	6	6, 7, 8, 13, 19
7.	Develop M&S capabilities for rapidly producing initialization-ready, mission-environment databases that cover unit and electronic order of battle.	6	4, 13, 19, 22
8.	Develop specifications for a common, general-purpose interface that provides a common and interoperable ‘look and feel’ across different simulations.	8	ALL
9.	Develop M&S capabilities for rapidly producing initialization-ready, mission-environment databases that cover economic, diplomatic, political, and other civilian population factors.	9.5	7, 8, 12, 16, 17, 27
10.	Develop M&S capabilities for representing non-kinetic warfare domains including HUMINT.	9.5	6, 18, 19, 22, 28
11.	Develop M&S capabilities for rapidly producing initialization-ready, mission-environment databases that cover medical, public health facilities.	12	1, 2, 6, 7, 8, 12, 16, 17, 27, 32
12.	Develop M&S capabilities for representing non-kinetic warfare domains including information operations.	12	6, 8, 12, 16, 22, 34
13.	Develop M&S capabilities for representing non-kinetic warfare domains including network warfare.	12	3, 6, 8, 12, 16, 22, 34
14	. Develop M&S capabilities to portray second order effects in Effects Based Planning and Operations at all levels (tactical, operational, and strategic).	14.5	1, 2, 3, 5, 6, 7, 8, 12, 28, 32
15.	Develop M&S capabilities for representing non-kinetic warfare domains including electronic warfare.	14.5	3, 6, 8, 12, 13, 16, 19, 22, 27, 32
16.	Develop CBRNE detection and effects capabilities for training M&S that include effects on civilian populations and infrastructure.	16	9, 10, 11, 25, 32

Table 6-2. TC AoA Gaps Addressed by Candidate Investments

	2004 TC AoA Gaps Listed in Order of TC AoA Priority	Investment Strategies
1.	Train Combined Joint Task Force Staffs (including Individual Joint Training)	1, 3, 4, 8, 11, 14
2.	Train Standing Joint Force Headquarters Staff (including Individual Joint Training)	1, 3, 4, 8, 11, 14
3.	Train on Crisis Action planning and deployments	None
4.	Provide faster/higher fidelity mission rehearsal	2, 3, 7
5.	Train forces on joint urban operations	3, 11
6.	Train forces on information operations (Information Warfare, Computer Network Exploitation, Computer Network Defense, and Computer Network Attack)	5, 6, 10, 11, 12, 13, 14, 15
7.	Train forces in a Joint Interagency Intergovernmental, Multinational environment (including intelligence community participants)	6, 9, 11, 14
8.	Provide Homeland Defense Training	8, 9, 11, 14
9.	Provide multi-command missile defense training	8, 16
10.	Train forces in enemy Chemical, Biological, Radiological, Nuclear, and Electromagnetic exploitation and destruction	16
11.	Train to operate in Chemical, Biological, Radiological, Nuclear, and Electromagnetic environment	16
12.	Train on Effects Based Planning/Operations	5, 9, 11, 12, 13, 14, 15
13.	Train Theater/Strategic forces to conduct C4I operations using Collaborative Information Environment	None
14.	Train forces on realistic logistics requirements (including Reception Staging and Onward Movement Integration)	1, 4, 8
15.	Practice AC/RC Integration and Mobilization training	None
16.	Train forces on Stability and Support Operations	5, 9, 12, 13, 15
17.	Train forces on Military Assistance to Civilian Authorities Operations	9
18.	Train Special Operations Forces and conventional forces for integrated operations	10
19.	Train forces (operational and tactical level) to use National Intelligence Systems	2, 7, 10, 15
20.	Train routinely with the Joint Operation Planning and Execution System	None
21.	Train routinely with new adaptive planning and deployment system	1, 4, 8
22.	Train Intelligence community as they fight	2, 5, 7, 10, 12, 13
23.	Train the Joint Interagency Coordination Group	None
24.	Train staff to coordinate Personnel Recovery operations	None
25.	Train Global Ballistic Missile Defense	16
26.	Conduct Global Strike Training	1, 4, 8
27.	Train Critical Infrastructure Protection	None

	2004 TC AoA Gaps Listed in Order of TC AoA Priority	Investment Strategies
28.	Operations/Intelligence Center Training, Integration, & Command Education	10, 11, 14
29.	Strategic Information Assurance	None
30.	Continuity of Operations	1, 4, 8
31.	Train on operational systems (dedicated bandwidth)	None
32.	Train on Consequence Management Operations	14, 16
33.	Provide Special Operations Crisis Action Procedures Training	None
34.	Provide intelligence community Special Operations Forces specific training at the Operational level	5, 12, 13
35.	Plan, coordinate and practice Mission Assurance	None

7. FINDINGS AND RECOMMENDATIONS

7.1 SUMMARY OF FINDINGS

Executing this plan will play a key role in improving the Department training capability with Service-oriented architectures; network-centric data integration; and a distributed environment that will allow live, virtual, and constructive training capabilities to interoperate seamlessly. This plan leverages the M&S efforts, key enablers, and joint federations currently underway.

The M&S investment strategies recommended in this plan will support a broad range of roles and responsibilities in joint, interagency, intergovernmental, and multinational contexts. They respond to "The Strategic Plan for Transforming DoD Training" (8 May 2006) through significant enhancement of the live, virtual and constructive training environment that will serve as an enabler for transforming U.S. forces and missions across the full range of integrated operations. This live, virtual, and constructive training environment will include M&S systems to create war-fighting conditions through a networked collection of interoperable training sites and nodes and interconnected simulations and training tools.

The investment strategies will provide an environment of more affordable and effective capabilities for training U.S. forces in the joint mission essential tasks to meet the needs of the component commanders, joint task force staffs, standing joint force headquarters, component commands, and the military Services. As operational performance objectives change—and with them the proliferation of a wide variety of military missions—M&S capabilities can help train U.S. forces as they are intended to fight. M&S capabilities can help DoD train forces to meet the challenges posed by advances in technology and in many cases, train in situations where it is not feasible to train in a live-only environment. M&S training capabilities contribute greatly to integrated joint and Service operations, not only traditional test and training facilities, but in integrating these facilities with other areas of defense planning such as acquisition, logistics, personnel, professional development, and command-and-control processes.

Investing in M&S training capabilities will be a key factor in the Training Transformation Program goal of global presence: provide training and education anytime, anywhere, to a wide spectrum of training needs and audiences.

These investment strategies satisfy several of the crosscutting M&S capability gaps identified by the 2008 "Department of Defense Modeling and Simulation Common and Crosscutting Business Plan." These strategies will play a key role in developing an integrated set of M&S capabilities that allows the DoD communities and military Services to employ M&S in the most effective and efficient manner, one that benefits the DoD total force.

The investment strategies set forth in this plan concentrate on these key areas for improvement:

- Common data.
- Common infrastructure.
- Common interests within DoD such as underlying standards, architectures, and verification, validation, and accreditation processes.

Finally, executing this plan will help the DoD M&S Steering Committee focus future efforts on addressing the following capability gaps, as stated in the business plan noted above:

- Simulation interoperability.
- Verification, validation, and accreditation.
- Systems, family of systems, and system of systems.
- Command and control.
- Human and organizational behavior.
- Environmental representation.
- Workforce development.

7.2 RECOMMENDATIONS

- The 16 investment strategies in Section 6 of this Training Community Modeling and Simulation Business Plan should serve as a start point for the update to be published in the FY 09 edition.
- The training stakeholders should participate with the Joint Staff J7 to update the list of TC AoA training gaps as an updated requirements baseline for future training M&S efforts.
- After the needs update, conduct a workshop with training stakeholders to translate the needs and capabilities to specific proposals for either the training community or the M&S Steering Committee for enterprise-level funding in FY 09 and beyond.

- All future training M&S proposals should be consistent with the future net-centric enterprise services (service-oriented architectures) and net-centric data strategies.

APPENDIX A—M&S TOOLS

M&S tools are particular software devices used to create and execute simulated environments and analyze simulation results.

In an effort to make training tools more efficient, the number of separate training federations for joint training is being reduced. The ability to more rapidly and effectively share data and simulation resources in composable federations is emerging as enhanced capabilities are developed on the Joint Training and Experimentation Network infrastructure. The Joint Forces Command has progressed over the last several years to reduce to two major training federations as described below.

Joint Multi-Resolution Model Federation. The Joint Multi-Resolution Model is a composable federation utilizing the Joint Theater Level Simulation and the Joint Conflict and Tactical Simulation as its core models. Still under development, the federation has already been used by U.S. Joint Forces Command's Joint Warfighting Center (http://www.jfcom.mil/about/abt_j7.htm) for training event support, validating the concept of federate selection based on functional requirements. Joint Multi-Resolution Model's name and capability derive from the need to simultaneously provide high-level aggregate simulation to support joint task force-level training events and entity-based representation to stimulate tactical forces. Table A-1 lists Joint Multi-Resolution Model elements.

Table A-1. Joint Multi-Resolution Model Elements

Joint Combat Simulations	Joint Theater Level Simulation, Joint Conflict and Tactical Simulation
Linkages to Live Systems/ Forces	RTM, GEM, TBMCS
AAR and Federation Tools	SITH, AAR High-Level Architecture Results, ARCHER
Virtual Simulators	MUSE/AFSERS
Logistics	JDLM
Intelligence	NWARS, JQUAD, TACSIM, MDST

Joint Live Virtual Constructive Federation. Consists of the following models and interfaces in a typical training exercise: Joint Conflict and Tactical Simulation,

SELS, JSAF, SIMPLE, JDLM, Vision XXI, ASTi, TACSIM, MUSE, and D-ISE. This federation operates primarily using a high-level-architecture protocol. Table A-2 lists joint live, virtual, and constructive elements.

Table A-2. Joint Live, Virtual, and Constructive Elements

Service Combat Simulations	AWSIM, SELS, Joint Conflict and Tactical Simulation, JSAF, POLARUS/FMS-D
Linkages to Live Systems/Forces	ASTI Radios, SIMPLE, BFTT, Range Integration
AAR and Federation Tools	High-Level Architecture Results, ARCHER, SNN, Analysim
Virtual Simulators	DVTE, V MH-53, V AC-130U, EP3 MAST, TENCAP MUSE, SSE, V JSTARS
Logistics	JDLM
Intelligence	NWARS, JQUAD, TACSIM, MDST

Joint Training & Experimentation Network. This is a global network of live, virtual and constructive components that provides a seamless training environment that supports a broad spectrum of joint and Service training requirements. It is a persistent U.S. secret wide-area network, tying together DoD live training sites and ranges, constructive M&S sites, virtual simulators, and battle labs and schoolhouses. The Joint Training and Experimentation Network uses SIPRnet IPs and the SIPR domain, as well as DATMS-U and DREN, as "transport only."

Joint Training Information Management System. This is a Web-based system designed to provide automated support to the Joint Training System. Joint Training Information Management System directly supports the task-based, closed-loop features of the Joint Training System by facilitating the development of an integrated task-based thread to guide all Joint Training System phases. Joint Training Information Management System incorporates the Universal Joint Task List and all associated Service task lists, making it an ideal tool for mission/task decomposition in support of joint and Service training. The system features easy-to-understand user interfaces such as the schedule de-confliction screen that automatically highlights conflicts in red in the Gantt chart associated with exercises. Joint Training Information Management System functionality associated with the schedule de-confliction screen enables users to explore "what-if" options to avoid event scheduling and resource conflicts.

APPENDIX B—TRAINING CAPABILITIES ANALYSIS OF ALTERNATIVES

The Training Capabilities Analysis of Alternatives (TC AoA) was directed by OSD Program Decision Memorandum 1, Joint Simulation System (JSIMS), 12 December 2002. The study plan was published in October 2003. This appendix discusses the analysis the TC AoA carried out that was mentioned in Volume 1 of this M&S Business Plan: the ability of current simulations to meet deficiencies, or gaps, in joint training. The analysis used information from these sources:

- Joint mission essential tasks identified by the COCOMs and Services.
- Higher level guidance and directives, such as the Quadrennial Defense Review.
- Training requirements and capabilities identified at the Joint Training Review Group.
- The Requirements/Alternatives Business Game and the Senior Steering Group meeting in January 2004.
- Data gathered from Joint Forces Command, the COCOMs, and the Services.

The gaps selected for analysis changed during the study. The TC AoA study team initially defined 13 gaps between training capabilities and requirements. These gaps were further reviewed by a Tiger Team composed of people from the Joint Staff (J7), the COCOMs, and the Services. This review led to an expansion of the gaps to 35, which are listed in Table B-1 in order of decreasing priority as determined by the Tiger Team. The gaps are discussed in detail in Appendix E, Volume 2, of the TC AoA. The Joint Staff (J7) reanalyzed the 35 gaps in 2006, which led to changes in the priority of some of them and the addition of 5 new gaps. This effort was not formally staffed, however, so Table B-1 remains the current baseline.

Table B-1. Training Gaps Requirements Identified by the TC AoA

1	Train Combined Joint Task Force Staffs (includes need for individual joint training)
2	Train Standing Joint Force Headquarters Staff (includes need for individual joint training)
3	Train on crisis action planning and deployments
4	Provide faster/higher fidelity mission rehearsal
5	Train forces on joint urban operations
6	Train forces on information operations (including information warfare, computer network exploitation, computer network defense, and computer network attack)
7	Train forces in a joint interagency intergovernmental, multinational environment (including intelligence community participants)
8	Provide homeland defense training
9	Provide multi command missile defense training
10	Train forces in enemy chemical, biological, radiological, nuclear, and electromagnetic exploitation and destruction
11	Train to operate in chemical, biological, radiological, nuclear, and electromagnetic environment
12	Train on effects-based planning/operations
13	Train theater/strategic forces to conduct C4I operations using collaborative information environment
14	Train forces on realistic logistics requirements (including reception, staging, onward movement, and integration)
15	Practice Active Component/Reserve Component integration and mobilization training
16	Train forces on stability and support operations
17	Train forces on military assistance to civilian authorities operations
18	Train Special Operations Forces and conventional forces for integrated operations
19	Train war-fighters (operational and tactical level) to use national intelligence systems
20	Train routinely with the Joint Operation Planning and Execution System
21	Train routinely with new adaptive planning and deployment system
22	Train intelligence community as they fight (including all levels as a tactical participant)
23	Train the Joint Interagency Coordination Group
24	Train staff to coordinate personnel recovery operations
25	Train global ballistic missile defense
26	Conduct global strike training
27	Train critical infrastructure protection
28	Operations/intelligence center training, integration, and command education
29	Strategic information assurance
30	Continuity of operations
31	Train on operational systems (dedicated bandwidth)
32	Train on consequence management operations
33	Provide special operations crisis action procedures training
34	Provide intelligence community Special Operations Forces specific training at the operational level
35	Plan, coordinate, and practice mission assurance

The simulations chosen for analysis also evolved during the study. The TC AoA began by considering 12 models (referred to as "Use Cases"). It became apparent, however, that these cases did not adequately represent the totality of used in joint and Service training. A list of 70 simulations, federations of simulations, and tools was first compiled for consideration. (Some of the tools are listed in Table B-2 for information.) The subset of 14 simulations listed in Table B-3 was eventually selected for analysis. (For convenience, we will use the term "simulations" for training models, tools, simulations, and federations of simulations.)

Table B-2. M&S Tools Analyzed Used in the TC AoA Base Case

ACRONYM	NAME	USER	DESCRIPTION
ABCS C4I Adapter	Army Battlefield Command System C4I Adapter	JFCOM	Interface for C4I
ADSI	Air Defense Simulation Integrator	JFCOM	Display of tracks from C4I
ARCHER	Archiving and Enhanced Retrieval System	USA	ARCHER captures data from the simulation and the C4Isystems to answer the question relating to what happened during command post exercises.
ASCOT	Airspace Control and Operations Trainer	JFCOM	ASCOT is a DIS compliant new radar systems trainer. It interfaces with AWACS, MCE V1, MCE V2, BFTT, ECS, ACSIS, AWSIM, and DMT to provide the theater air picture.
ASTi	Army Secure Tactical Initiative	USA	Radio Communications
AWSIM	Air Warfare Simulation	JFCOM, USAF	AWSIM simulates air warfare. It models all aspects of the forces that the Air Force employs (air and ground) and the targets and threats that it opposes. Administrative and logistics functions are modeled in addition to warfare.
BFTT	Battle Force Tactical Trainer	USN	An integrated system to tie in short trainers and certain classes of ships, to allow realistic tactical training while the ships are in port.
BICM	BCTP Intelligence Collection Model	USA	Battle Command Training Program (BCTP) Intelligence Collection Model (BICM). The BICM provides CBS users the means to exercise all-source intelligence functions. It integrates meaningful intelligence functions into a free-play, force-on-force exercise.

Table B-3. Simulations Analyzed in the TC AoA

Acronym	Name	User
LOGFED	Logistics Federate	Army
WARSIM	Warfighter's Simulation	Army
OneSAF	One Semi-Automated Forces	Army
ACTF	Army Constructive Training Federation	Army
DISCO	Deployable Intelligence Simulation for Collaborative Operations	DIA
ACRES	Adaptive Communications Reporting Simulation	NSA
IWEG/DCE	Information Warfare Effects Generator/Dynamic Communications Environment	NSA
NWARS-NG	National Wargaming Simulation–Next Generation	NRO
AFMSTT	Air Force Modeling and Simulation Training Toolkit	Navy and Joint Forces Command
AFSERS/MUSE	Air Force Synthetic Environment for Reconnaissance and Surveillance /Multiple Unified Simulation Environment	Air Force
JSAF	Joint Semi-Automated Forces	Air Force
Joint Theater Level Simulation	Joint Theater-Level Simulation	Joint Forces Command
Joint Conflict and Tactical Simulation	Joint Conflict and Tactical Simulation	Joint Forces Command
JQUAD+	Consists of four related sub-models: JECEWSI, JCAS, JOISIM, and JNETS	Air Force

Table B-4 is a major result of the TC AoA gap analysis, in which the following "stoplight" scale is used to describe how well the 14 simulations address the 35 training gaps.

Table B-4. How Well the Simulations Cover the Training Gaps

Priority	Joint Training Requirement	LOGFED	WARSIM	OneSAF	ACTF	DISCO	ACRES	IWEG/DCE	NWARS_NG	AFMSTT	AFSERS/MUSE	JSAF	JTLS	JCATS	JQUAD+
1	Train CJTFs	Y	Y	Y	Y	W	Y	W	Y	Y	W	Y	G	G	W
2	Train SJFHQ	Y	Y	Y	Y	W	Y	W	Y	Y	W	Y	G	G	W
3	Train on Crisis Action	Y	W	W	G	W	Y	W	W	W	W	Y	Y	G	W
4	Faster/hi-fi Msn Rehearsal	Y	Y	Y	G	W	Y	Y	Y	Y	Y	G	G	G	Y
5	Train forces on JUO	Y	Y	G	G	W	Y	Y	Y	W	W	G	Y	G	W
6	Train forces on IO	W	Y	Y	Y	W	Y	Y	W	W	Y	Y	W	W	Y
7	Train forces in JIIM envmt	Y	Y	W	Y	Y	Y	Y	Y	W	W	Y	Y	Y	W
8	Provide Hmlnd Dfns Trng	Y	W	Y	W	W	Y	Y	Y	Y	Y	Y	Y	G	W
9	Provide multi-cmd MD trng	W	Y	W	Y	W	W	W	W	W	W	Y	G	Y	W
10	Train CBRNE expn/dstrctn	W	Y	Y	G	W	Y	Y	Y	W	W	Y	G	G	W
11	Train ops in CBRNE envmt	W	Y	Y	G	W	Y	Y	Y	W	W	Y	G	G	W
12	Train on EBP/EBO	Y	Y	Y	Y	W	Y	Y	Y	W	W	Y	Y	Y	W
13	Train C4I ops using CIE	Y	Y	Y	Y	W	W	W	Y	W	W	G	G	G	W
14	Train forces on log rqrmnts	G	Y	Y	G	W	W	W	W	W	W	Y	G	Y	W
15	Practice AC/RC Int & Mob	W	Y	Y	W	W	Y	W	W	W	W	Y	G	Y	W
16	Train forces on SASO	Y	Y	W	Y	W	Y	Y	Y	W	W	W	W	G	W
17	Train forces on MACA Ops	Y	W	G	Y	W	Y	Y	W	W	W	W	W	G	W
18	Train SOF/conv intgrtd ops	W	Y	W	Y	W	Y	Y	Y	W	W	Y	Y	G	W
19	Train on Ntnl Intel Systs	W	Y	W	Y	W	Y	Y	G	W	W	Y	Y	W	W
20	Train routinely with JOPES	Y	Y	W	Y	W	W	W	W	W	W	Y	G	W	W
21	Trn adpt plng & dplmt syst	G	Y	Y	Y	W	W	W	W	W	W	Y	G	W	W
22	Train IC as they fight	W	Y	W	Y	Y	Y	Y	Y	W	W	Y	Y	Y	W
23	Train the JIACG	W	W	Y	W	W	Y	Y	W	W	W	Y	W	Y	W
24	Train to coord PR ops	W	Y	W	G	W	Y	Y	Y	W	W	Y	Y	G	W
25	Train GBMD	W	W	W	W	W	W	W	W	W	Y	Y	Y	Y	W
26	Conduct Glbl Strk Trng	W	W	W	W	W	W	W	Y	W	W	Y	G	Y	W
27	Train CIP)	W	W	W	W	W	Y	Y	W	W	W	Y	Y	Y	W
28	Ops/Intel Cntr Trng & Ed	W	W	W	Y	Y	Y	Y	Y	Y	Y	Y	Y	G	Y
29	Strategic Info Assurance	Y	W	Y	W	W	Y	W	W	W	W	W	W	W	W
30	Continuity of Operations	W	W	W	W	W	W	W	W	W	W	W	W	W	W
31	Train on opnl systems	W	Y	Y	G	Y	Y	Y	Y	Y	Y	Y	G	G	Y
32	Train on CM Operations	Y	W	Y	W	W	Y	Y	W	W	W	Y	Y	Y	W
33	Trn SO CA Procedures	Y	W	Y	Y	W	Y	Y	W	W	W	W	Y	G	W
34	Provide IC SOF trng	W	W	W	Y	W	Y	Y	W	W	W	Y	Y	G	W
35	Plan, crdnt, practice MA	W	W	W	W	W	Y	Y	W	W	W	W	Y	G	W

Notes:

Green – the simulation fully supports the training requirement.

Yellow – the simulation partially supports the training requirement.

White – the simulation does not support the training requirement.

APPENDIX C—TEN AREAS OF TRAINING DEFICIENCY ANALYZED BY THE TC AOA

As mentioned in a previous appendix, the TC AoA initially identified 13 gaps in which then-current and programmed training capabilities failed to meet COCOM and Services training needs. The TC AoA analyzed 10 of these gaps in detail, and that analysis is summarized in this appendix.

1. Mission Rehearsal Capability

Some contingencies develop rapidly in time, so that deploying forces require mission rehearsal training exercises that must be constructed in far less time than the year or more of the historical Joint Event Life Cycle. Developing this capability requires improvements in two shortfall areas:

- Rapid database development.
- A Shortened Joint Event Life Cycle. The current Joint Event Life Cycle process used for the planning and execution of a joint training event usually involves three planning conferences, three database tests, and a host of other activities that normally span upwards of a year or more. Joint and Service trainers therefore need the capability to rapidly construct rehearsal exercises. The following steps would be instrumental:
  - Changes in the Joint Event Life Cycle process to streamline and compress preparatory events leading up to an exercise or rehearsal.
  - Having a common tool set that automates the Joint Event Life Cycle process.
  - Achieving interoperability with Joint Planning and Execution System (also known as JOPES). The Joint Planning and Execution System is the integrated, joint, command-and-control system that the Joint Planning and Execution Community uses to conduct joint planning, execution, deployment and monitoring activities. It includes people, procedures, policies, communications, and supporting information system software. The Joint Planning and Execution System supports senior-level decision-makers and their staffs at the National Command Authority and throughout the Joint Planning and Execution Community. Combatant commanders use the Joint Planning and Execution System to determine the best course of action to accomplish the mission. Interoperability with the Joint Planning and Execution System (or its follow-on system) will

therefore allow exercise planners to directly access courses of action and other planning information with which to design the rehearsal exercise.

2. Adaptable Constructive Training Systems

We should "think training first" in designing training simulations, which means building a simulation to support training requirements, vice building a capability and then trying to adapt the training program to the simulation. To meet this objective, as well as the general goals of effectiveness and efficiency, future constructive simulations should possess these characteristics:

- *Evolutionary instead of revolutionary*—Development of new capabilities should leverage off of existing systems to the extent possible, and provide new training capabilities through an incremental, spiral development process.
- *High reliability, availability, and maintainability*—These requirements should be applied across the board, to all networks of the joint training architecture—system hardware, software, C4I adapters, high-level architecture, and run-time infrastructure. The architecture includes all components of the federation, although reliability, availability, and maintainability requirements for a given simulation will depend on the architecture and configuration.
- *Flexible and composable*—The simulation system should allow the exercise designer to tailor the federation to best meet the objectives of the training audience. This involves a wide variety of attributes:
  - Object-oriented design to enhance modularity and ease of upgrade and enhancement.
  - Open architectures and operating systems.
  - Complete representation of the joint operational environment.
  - Standardized tools effective across federates, where applicable.
  - Transparent interface and interoperability with existing C4I systems and networks.
  - Links to live entities, ranges, and virtual simulators.
- *Scalable*—A simulation should be able to support large numbers of complex objects and accompanying interactions while still maintaining time and spatial consistency. At minimum, the simulation should be able to scale sufficiently to support an Ulchi Focus Lens multi-corps exercise without suffering performance degradation. In addition, it should be able to accommodate growth of bandwidth and throughput.

- *Aggregable*—The simulation must be able to group entities while preserving the effects of entity behavior and interaction while grouped. The ability to aggregate is essential to reducing the total number of controllers required for a joint exercise.
- *Distributable*—The simulation must be capable of being distributed to the exercise audience; moving electrons is easier than moving people.
- *User friendly*—Graphical user interfaces, help menus, and the overall construction design should be used to promote ease of use. The training audience should be able to use the simulation without extensive prior expertise or training.
- *Multi-Agency*—Ability to simulate, stimulate and interoperate with interagency and DoD C4I systems and the Global Information Grid.
- *Operationally capable*. The simulation must be able to integrate with the command-and-control system and services used in the theater of operations.
- *Multinational interoperable*—The simulation should be capable of interfacing (e.g., exchanging data) with Allied and Coalition systems.
- *Adaptable to doctrinal changes*—The simulation must be able to rapidly accept integration of training, doctrine, and lessons learned.
- *Interoperability*—Interoperability requires that the simulation be easily linked with other training management and reporting systems such as the Defense Readiness and Reporting System, the Joint Training System via the Joint Training Information Management System or its follow-on system.

3. Replication of Ability to Train Nonkinetic Processes and Activities

Legacy simulation systems have had generally good capability in representing the war-fighting capabilities of the Services. What has been lacking is the ability to represent capabilities that are nonkinetic in nature. Current events suggest that these capabilities are growing in importance, and M&S designers must incorporate them in the future system of simulations. The following is a discussion of these nonkinetic shortfalls:

- **Information Operations/Information Warfare.** U.S. global communication networks have become vulnerable to unwanted worldwide access to its information infrastructure. Information operations/information warfare involves a wide range of (1) hostility levels (from peacetime to wartime), (2) adversary types (from hacker to foreign intelligence service or military), and (3) adversary options (unauthorized access through use of conventional weapons). The new simulation system must represent these threats with enough realism to provide training audiences with experience in defending

against attacks or utilizing information operations/information warfare to their benefit. Representation should include the following:

  - Computer Network Defense and Attack—Simulations offer the ability to train for threats that would be difficult to mount in the real world (i.e., disabling computer networks or destroying essential databases). Any solution must be tailorable to the training objectives, cost effective to produce, and have no impact on C4ISR systems outside of the training environment. Actions must be equally applicable against Blue force and OPFOR systems.
  - Portrayal of psychological operations and deception activities and their outcomes.
  - Better representation of the effects of conventional weapons attacks on information grids and networks.
  - Better portrayal of electronic threats to information systems, such as jamming, broadcasting false signals, or generating bursts of electromagnetic pulse.

- **Space Operations.** Training war-fighters in the use of space systems requires incorporating the following objects and systems in our system of simulations:
  - Orbiting platforms as objects in the battlespace to allow portrayal of counter-space activities through kinetic kill vehicles or electromagnetic and laser-based systems.
  - Disruption or denial of space-based capabilities in surveillance and reconnaissance, communications, environmental sensing, navigation, and theater missile warning.
  - Ballistic missile launch processes and trajectories, including indications and warnings that would be available to a training audience in a real-world situation.
  - Space-based systems and terrestrial sensors that detect, track, and report on ballistic missile launches posing potential threats against North America, geographic theaters of operation, and space-based assets. Ballistic missile warning provides critical information essential for training at the National Command Authority, COCOM, and joint task force/Joint Force Air Component Commander levels when conducting counter-air operations during global or theater ballistic missile defense.
- **Battle Damage Assessment.** As an adjunct to effects-based targeting and operations, the battlespace and intelligence federates need to be enhanced to represent real-world capabilities necessary to identify and prioritize critical targets so that the Joint Forces Command can achieve his operational goals in

a timely fashion. The simulation system must enable the training audience to conduct realistic battle damage assessment linked to combat events taking place in the synthetic battlespace.

- **Intelligence, Surveillance, and Reconnaissance.** While there are good simulations of aspects of our intelligence capabilities, there is a need for more comprehensive representation in the following areas:
  - The entire intelligence cycle at the national, joint, theater, and tactical levels.
  - Higher fidelity simulation of tactical and national intelligence assets and behaviors. This becomes more important as the intelligence community is integrated into the training audience and receives intelligence, surveillance, and reconnaissance feeds from the synthetic battlespace.
  - Better integration of intelligence, surveillance, and reconnaissance products to produce fused and aggregated joint task force-level and higher formatted intelligence reports.
  - Better portrayal of HUMINT and MASINT capabilities.
- **Military Assistance to Civilian Authority.** New emphasis on homeland security has generated a need for simulations to train staffs in Military Assistance to Civilian Authority. These simulations must be capable of representing natural and man-made disasters and DoD assistance for civil disturbances, counter-drug operations, sensitive support, counterterrorism, and law enforcement. This will involve simulating civilian systems that are needed to operate the economy and government (e.g., telecommunications, energy, banking and finance, transportation, water systems, and emergency services, both governmental and private).
- **Mobilization, Deployment, and Redeployment.** These activities require better representation than our current training system of simulations provide. Current events are driving a shift in focus toward adaptive regional planning to provide more options for decision-makers. The role of the combatant commanders in the planning process continues to expand. More than ever, the strategy is based on developing forces that are ready to move either from the CONUS or forward-deployed locations to the scene of a crisis. Successful execution gives the combatant commander the ability to mass overwhelming force to terminate crises swiftly and decisively. To portray these movements, the future system of simulations must incorporate the following systems and activities:
  - Automated Joint Logistics over the Shore.
  - Automated Maritime Pre-positioned Forces.

- Individual transportation vehicles moving forces (equipment, personnel, supplies) from origins to ports of embarkation, from ports of embarkation to ports of debarkation, and from ports of debarkation to final destinations.
- Airport and seaport throughputs and activities, as affected by combat events.
- Environmental factors that impede the movement of forces, equipment, and supplies.
- All phases of redeployment, including:
  - Reconstitution for strategic movement.
  - Movement to redeployment assembly areas.
  - Movement to ports of embarkation.
  - Strategic lift.
  - Reception at ports of debarkation.
  - Joint Reception, Staging, Onward-movement, and Integration (as defined below)
- Dynamic Time-Phased Force Deployment Data. Time-Phased Force Deployment Data are ever-changing to reflect decision-maker desires and events within the simulation battlespace. Environmental factors and enemy action can damage, delay and divert air and sea transports and their cargo and passengers. Airports and seaports may be blockaded, damaged, or destroyed. These factors cause planners to adjust port throughput databases; delete damaged, destroyed, or delayed lift assets; and reschedule missions. Rescheduling missions will lead planners to update the Global Transportation Network Exercise System database and issue new movement orders to the forces. The training simulation should also allow joint force commanders to explore "what if" scenarios so they can make better decisions regarding joint deployment and missions. Implementing a dynamic Time-Phased Force Deployment Data capability might best be done through federating simulations that accommodate these features with the USTRANSCOM Analysis of Mobility suite of models or through a new, organic capability built into a legacy system. However it is done, the simulation battlespace should incorporate Level 4 data in the Time-Phased Force Deployment Data.

- **Sustainment.** Sustainment means providing provisions and other support to maintain personnel and equipment during prolonged combat or other operations. U.S. sustainment models must provide more realistic simulations of sustainment activities, including the following:

  - Health services and patient evacuation.
  - Procurement, transportation, and supply in foreign theaters.
  - Maintenance, repair, and salvage operations.
  - Engineering activities.
  - Communications system support, security assistance, host-nation support, and related logistic activities.
- **Joint Reception, Staging, Onward Movement, and Integration.** Future M&S models dealing with deployment must simulate reception, staging, onward movement, and integration operations: the process of receiving personnel that have deployed into a contingency theater, marrying them up with their unit equipment and materiel, and forming them into forces capable of carrying out operational missions. These actions involve:
  - Receiving personnel, equipment and materiel at airports and seaports of debarkation.
  - Convoying them to dismount points or railheads.
  - Moving them from dismount points and railheads to staging areas.
  - Joining personnel with their unit equipment and materiel.
  - Providing personnel with the supplies, services, and life support necessary to achieve readiness for onward movement.
  - Integrating the unit with its parent organization.

RSO&I requires robust logistics forces to perform the support tasks. The reception, staging, onward movement, and integration must be portrayed realistically and be transparent to the training audience, requiring little or no human-in-the-loop interaction by exercise control group personnel to achieve training objectives.

4. Multi-Level Security

Multi-level security means personnel at a variety of sensitivity levels handling information without disclosing it to unauthorized people. This usually involves mechanisms that only allow data to flow upward in terms of sensitivity. Modern notions of “information dominance” and “sensor to shooter,” however, involve downward flow: intelligence assets identify targets, pass the information to mission planners, who assemble a mission and pass the mission details to tactical assets, who may in turn share details with support and maintenance assets. The problem is becoming more complex as multinational involvement brings more foreign nationals into U.S. training events. The system must therefore differentiate between NOFORN and NATO releasability markings,

as well as between these categories and the normal U.S. classifications. Workstation accessibility is also an issue when classified databases are used, requiring protections to prevent unauthorized access by foreign nationals who may be acting in role-player positions. The challenge, therefore, is to develop an Multi-Level Security system that prevents the disclosure of sensitive information to unauthorized individuals without impeding the legitimate flow of information that personnel need to carry out their missions.

5. Multi-Echelon Training

Since combat operations are typically multi-echelon—between functional command elements and tactical units in the field and every command and control element in between—training must be multi-echelon as well. Training end-to-end communication and coordination is needed to achieve the benefits of information superiority operations and network-centric warfare. Multi-echelon training is also a necessary requirement if the full benefit of an integrated live-virtual-constructive environment is to be realized. The simulation must be able to feed realistic battlespace scenario information at the proper level of resolution through these real-world systems in a way that is completely transparent to the training audience.

6. Strategic Context

This issue involves national-level collaboration on joint training events to support the national military strategy and the global war on terrorism. Strategic national-level training, involving cross-COCOM and national command structure participation in training events, is at the heart of the issue. Such training would also be used as a stepping-stone to helping the interagency training program meet COCOM requirements.

7. Emerging Concepts

Unless legacy constructive simulations are upgraded to train new concepts, manpower-intensive work-arounds will have to be used to meet training objectives. The future system of simulations must have the ability to represent the following emerging war-fighting concepts and capabilities:

- **Operational Net Assessment.** Operational net assessment means identifying key links and nodes in an adversary's capability for war—political, military, economic, social, infrastructure, and information. Operational net assessment thus helps commanders identify operations to deter or defeat the adversary. The future system of constructive simulations must therefore represent the full gamut of adversary political, military, economic, social, infrastructure,

and information capabilities within the synthetic battlespace. The simulation must relay that information either directly to the training audience through normal intelligence gathering and C4ISR processes or indirectly through the appropriate role player or response cell. Operational net assessment is therefore a critical enabler for achieving rapid decisive operations.

- **Effects-Based Operations.** Portraying effects-based operations processes will challenge the state of the M&S art. Simulation will have to include a great variety of factors in many different domains, for example the Synthetic Natural Environment, the Civil Environment, the electromagnetic environment, and theater communications. Data are critical here, so the training community should take steps to standardize and improve the quality of the data used in the various databases. The range of factors includes the following:
  - Representation and positioning of targets within the Synthetic Natural Environment and Civil Environment.
  - Enemy infrastructure, such as communications and electrical grids; gas and oil pipelines; rail-lines, roads, and other transportation features; higher headquarters; and other command and control centers.
  - Psychological effects, the kinds that would be obtained either through conventional military operations or psychological operations missions.
  - Weapons effects (both lethal and nonlethal) on intended targets (first-order effects).
  - Cumulative effects from the aggregation of direct and indirect effects at varying levels of war.
  - Cascading effects that can ripple through an adversary target system and influence other target systems as well.
  - Replication of the means for assessing damage to targets for purposes of battle damage assessment.
- **Joint Interactive Planning.** Joint Interactive Planning, which was formerly called Collaborative Information Environment, addresses command-and-control infrastructure and battlespace awareness issues that are critical to enabling the Common Relevant Operational Picture/Rapid Decisive Operations concepts. The hypothesis underlying Joint Interactive Planning is that if the ability to plan the various elements of joint operations in parallel rather than in sequence can be increased, then commanders will be able to decide and act faster than the adversary. The exact manner in which a constructive simulation system would interact with such an environment (e.g., response-cell/role-player interaction with the training audience via the

collaborative environment) has yet to be determined. The Joint Interactive Planning vision is therefore as follows:

- Commanders and joint force staffs plan operations using advanced, automated planning and decision-support tools.
- The joint force commander's intent is disseminated to all levels and at all times.
- The staffs are globally linked to virtual collaborations of subject matter experts, expert organizations, and support establishments.
- Virtual organizations are also formed to support any joint-force-unique requirements for the mission.
- The joint force is fully integrated with allies and other partners across the full range of military operations.
- Planning and execution are continuous, simultaneous, and mutually supportive to shorten the observe, orient, decide, and act loop.

- **Joint Urban Operations.** Joint urban operations are joint operations conducted in civilian surroundings, where the density of noncombatants is usually high. Achieving military objectives with minimum own casualties and collateral damage is a goal. Weapons used in joint urban operations include nonlethal weapons and precise weapons. Achieving situational awareness via surveillance and communication is critical. The operational advantage that heavy, long-range, and high-technology weapons give U.S. forces is significantly reduced in urban environments, so the weapon of choice for Joint Urban Operations is the individual combatant working within a small unit in Army and Marine light forces at echelons of battalion and below. Since urban centers are increasingly becoming sites of conflict throughout the world, constructive simulations that can portray joint urban operations must be constructed. They must have enough resolution to depict forces at the entity level operating in urban environments of varying size, building and street patterns, industrialization, lines of communication, and mobility corridors. The environment must be three-dimensional, including subterranean, ground-level, building-level, and above-ground features. Joint urban operations functionality requires civil environment development of population demographics, political and socioeconomic factors, and urban infrastructure features such as telecommunications and power grids. Intelligence models should also be capable of providing appropriate reports and analyses to allow the training audience to develop courses of action and conduct suitable intelligence preparation of the battlefield tailored for the urban environment.
- **Joint Fires.** Lethal or nonlethal, joint fires are used to support attack by two or more components on enemy air, sea, and land forces before they can

attack U.S. forces. Synchronization is critically import in achieving success without friendly losses. This requires simultaneous integration of intelligence, air operations, ground operations, maritime operations, and logistics. Fires can be used against a wide variety of targets:

- Leadership.
- Infrastructure and key production components (transportation, energy, C4I).
- Nuclear biological and chemical (also known as weapons of mass destruction).
- Theater ballistic missiles.
- War-making industries.
- Nonlethal methods targeted at the population.

Use of joint fires is closely tied with effects-based operations, and many of the data requirements needed for depicting effects-based operations in the synthetic battlespace also apply to joint fires: representation and positioning of targets within the Synthetic Natural Environment and Civil Environment, portrayal of enemy infrastructure and capabilities within the Civil Environment, and the socioeconomic and demographic characteristics of the population. Accurate across-domain or cross-simulation interactions among federates is a must. Time management within the simulation to maintain the cause-and-effect relationship is also required, although this may be very difficult to achieve should the simulation solution involve loose federations or use in a combined live, virtual, and constructive environment.

- **Stability Operations.** Stability operations are those that security forces (military, paramilitary, and police) carry out to restore and maintain order. The realities of the post-Cold War environment indicate that joint force commanders will be conducting extended “peace operations” that have complex and changing relationships within the military, political, and cultural contexts. It is increasingly important to provide joint force commanders with the training required to anticipate the force sizes, capabilities, and application times required to restore and maintain order in a failed state. The future system of simulations must be capable of portraying these political and cultural factors in a realistic and scenario-dependent manner. Also required is the ability to portray multiple sides and factions, their relationships to each other, and the rules of engagements. Knowledge of population control via riot-control measures and use of nonlethal munitions is also required.
- **Joint Close Air Support.** Joint close air support refers to close air support operations across components. Army pilots flying Army aircraft to support

Army ground forces, for example, is not considered joint close air support. Close air support requires an integrated, cross-component command and control structure to process close air support requirements, assign assets, communicate taskings, deconflict fires and routing, coordinate support, establish airspace control measures, and update or warn of threats to close air support assets. The Joint Forces Command normally exercises operational control through Service component commanders. The Joint Forces Command, through the Joint Force Air Component Commander, tasks air assets made available for joint tasking through these Service component command-and-control systems. Close air support in joint operations is planned via the Joint Air Operations Center, using host-component organic command and control architecture. The air support operations center is the primary control agency component of the theater air control system for the execution of close air support. Close air support requests may be either preplanned or immediate. Preplanned requests normally do not include detailed target information and may not include detailed timing information because of the lead time involved. Immediate requests, on the other hand, arise from situations that develop once the battle is joined. Immediate requests cannot be identified early enough to allow detailed coordination and planning. The complexity of joint close air support mandates that the cross-federate interactions within the simulation battlespace be seamless and realistic. Interactions among all players in the joint close air support process, whether they are part of the training audience or a role player/response cell, must also be realistically portrayed over organic command-and-control devices. Joint close air support missions can be conducted using a variety of aircraft (attack helicopters, attack fixed-wing aircraft, AC-130 gunships, etc.) and a variety of weapons (guns, gravity weapons, and powered weapons, either “smart” or “dumb”).

- **Integration of Special Operations Forces with Conventional Forces.** Special Operations Forces operations in Afghanistan and Iraq have led to a growing trend of increasing the integration of Special Operations Forces with conventional forces to leverage the former’s specialized capabilities. Special Operations Forces operations are not represented in the current inventory of M&S tools, however. The future training simulation systems must be capable of portraying integrated operations in a realistic way that is consistent with joint doctrine. Special Operations Forces operations could be incorporated into the future system of simulations either by directly including them into an existing simulation within the system of systems or by developing a new federate containing specific Special Operations Forces models. At minimum, the simulation should include high-resolution portrayal of the following features:

- **Nine Special Operations principal mission areas**—the missions that Special Operations Forces are organized, trained, and equipped specifically to accomplish:
  - Direct action.
  - Combating terrorism.
  - Foreign internal defense.
  - Unconventional warfare.
  - Special reconnaissance.
  - Psychological operations.
  - Civil affairs.
  - Counter-proliferation of weapons of mass destruction.
  - Information operations.
- **Seven Special Operations collateral activities**—missions that will shift more readily because of the changing international environment. (Special Operations Forces are not manned, trained, or equipped for collateral activities, but rather conduct these activities using the capabilities that have been developed for the primary missions.)
  - Coalition support.
  - Combat search and rescue.
  - Counter-drug activities.
  - Countermine activities.
  - Foreign humanitarian assistance.
  - Security assistance.
  - Special activities.
- **Chemical, biological, radiological, nuclear and enhanced conventional weapons (CBRNE) operations, exploitation, and destruction.** The 9/11 attacks on the World Trade Center Towers and the Pentagon are examples of adversaries' attempts to counter the preeminence of U.S. power (cultural, diplomatic, economic, and military) through asymmetric attacks against undefended targets, rather than through conventional military confrontations. CBRNE terrorism by states and nonstate actors presents unprecedented challenges to government and military leadership that have not been adequately addressed in training simulations. The future systems of training simulations must incorporate realistic portrayal of CBRNE operations in military and domestic scenarios, focusing primarily on the crisis-

management and consequence-management aspects of such an attack. Desired portrayal should include the following:

- Intelligence capabilities, processes, and products that may provide indications and warnings of CBRNE attack.
- Portrayal of terrorist activities at entity level.
- Weapons effects, both immediate (blast, electromagnetic pulse, radiation, etc.) and delayed (site contamination/denial, incubation rates, rates of disease, cross-contamination, etc.).
- Monitoring and detection capabilities that would alert a joint forces commander of an attack.
- Environmental impacts on weapon effects (winds, rain, etc.).
- Impact of CBRNE attack on civil infrastructure, economy, and populace (e.g., loss of utilities, stock market disruption, mass casualties, panic, etc.).
- Ability of military, federal, or local fire-fighter/HAZMAT teams to decontaminate sites, equipment, and personnel.

– **Personnel recovery operations.** Personnel recovery is the umbrella term for the collection of military, civil, and political efforts to recover captured, missing, or isolated personnel from hostile environments. Recoveries might be conducted by U.S., allied, coalition, or friendly military or paramilitary forces or through diplomatic initiatives as designated by the National Command Authority. Personnel recovery includes, but is not limited to, the following missions: combat search and rescue; survival, evasion, resistance, and escape; and the coordination of negotiated as well as forcible recovery options. The future simulation system should be capable of portraying these operations in a transparent, realistic manner to the training audience.

– **Ability to train force protection.** Force protection means protecting military personnel, civilians, family members, facilities, and equipment in all locations and situations. It is accomplished through antiterrorism activities, physical security, operations security, and personal protective services supported by intelligence, counterintelligence, and other security programs. The simulation system should be capable of representing an improved resistance to attack resulting from actions taken by a Joint Forces Command to improve the security of the force. The exact means to achieve this has yet to be fully determined, but could include explicit portrayal of terrorist activities; checkpoints along roads, patrols, etc.; or by implicit representation of an adjustable degree of

resistance to attack based on actions taken by the Joint Forces Command and the level of threat.

- **Test/training/experimentation environments.** The COCOMs and Services have expressed a desire that the simulation system be capable of supporting the testing and experimentation communities, as well as training. This capability is of secondary importance, however, and should not result in excessive development costs or delays in the delivery of the required training capabilities.

8. Emerging Missions

The simulation system must be capable of training new, emerging missions resulting from Unified Command Plan reorganizations or current events, such as the following:

- Global strike and global ballistic missile defense, the new STRATCOM mission.
- Global war on terrorism, the new SOCOM mission.
- The new NORTHCOM homeland security missions:
  - Prevent terrorist attacks within the United States.
  - Reduce America's vulnerability to terrorism.
  - Minimize the damage of terrorism; promote the recovery from attacks that do occur.

To train to this mission the simulation system must:

- Train to CBRNE as discussed above.
- Provide a command and control capability ranging from high-level interagency communications to low-level communications with local law enforcement and other first-responder units.
- Portray the civil environment (transportation systems, utilities, electrical grids, community water systems, pipelines, etc.) in enough detail to train personnel in protecting critical infrastructure.
- Provide intelligence and warning capabilities representative of real-world capabilities tailored for the homeland defense mission.
- Portray the activities of Coast Guard, law enforcement, first-responder units, NGOs, etc., within the simulated environment.
- Link into the live, virtual, and constructive environment.
- Provide the means to train consequence management and media relations.

9. Imbedded Training Capability

Newly acquired real-world systems should possess embedded training capabilities that are interoperable with other systems.

10. Synthetic Natural Environment Improvement

Synthetic Natural Environment models provide simulations with data on natural and some man-made entities. The data include over 50 features regarding terrain (e.g., elevations, roads, forests), atmosphere (e.g., temperature, fog, nuclear, chemical, biological contamination), ocean (sea state, acoustic propagation), space (communication and navigation satellites, vehicles), and weather (rainfall, icing). As the list suggests, the Synthetic Natural Environment models react to events that occur in the battlespace, such as nuclear, chemical, and biological contamination. The Synthetic Natural Environment models allow exercise controllers to retrieve, modify, update, and delete various types of information during runtime.

APPENDIX D—FEDERATIONS

Eight federations were selected for review:

- Joint Live Virtual Constructive.
- Joint Multi-Resolution Model.
- Joint Land Component Constructive Training Capability (JLCCTC) Multi-Resolution Federation (MRF).
- Joint Land Component Constructive Training Capability (JLCCTC) Entity Resolution Federation (ERF).
- Battle Force Tactical Trainer (BFTT).
- Navy Continuous Training Environment (NCTE) Federation.
- USMC Deployable Virtual Training Environment (DVTE) Federation.
- Air and Space Constructive Environment (ACE).

They are discussed in turn.

1. Joint Live Virtual Constructive

The Joint Live, Virtual, and Constructive core provides an integrated backbone for training COCOM staff and Service components down to tactical units and individual/crew trainers. It provides COCOM/joint task force training in Tiers 1 and 2, and Tiers 3–5 in several specific gap areas. It is composed of three major capabilities: planning, exercise control, and AAR (After Action Review).

Joint Live, Virtual, and Constructive integrates constructive simulations with virtual simulators and live range instrumentation in a near-real-time synthetic environment. It consists of entity-level models and simulations that represent Service combat, intelligence, and logistic systems. It also provides training for a range of joint interagency, intergovernmental, and multi-national audiences, allowing Active Components, Reserve Components, State Police, Red Cross, and other national and state agencies to train together with joint and Service battle staffs.

Joint Live, Virtual, and Constructive employs the following simulations, sublevel federates, and tools:

- Session Initiation Protocol for Instant Messaging and Presence Leveraging Extensions (SIMPLE).

- Air and Space Collaborative Environment Information Operations Suite (ACE-IOS).
- Air Warfare Simulation (AWSIM).
- Joint Conflict and Tactical Simulation (JCATS).
- Joint Deployment Logistics Model (JDLM).
- Joint Semi-Automated Forces (JSAF).
- Missile Defense Space Warning Tool (MDST).
- National Wargame Simulator – Next Generation (NWARS-NG).
- Joint Conflict and Tactical Simulation Low Overhead Driver (JLOD).
- Tactical Simulation (TACSIM).
- Joint Theatre Distribution System.
- Multiple Unified Simulation Environment/Air Force Synthetic Environment for Reconnaissance and Surveillance (MUSE/AFSERS).
- Joint Distributed After-Action Review System (JDARS).

2. Joint Multi-Resolution Model

The Joint Multi-Resolution Model uses the Joint Theater Level Simulation and the Joint Conflict and Tactical Simulation as its core models. Joint Multi-Resolution Model has been used to validate the concept of federate selection based on user functional requirements. Its name and capabilities derive from the need to simultaneously provide high-level aggregate simulations to support joint task force training events and entity-based representations to simulate tactical forces. Joint Forces Command is integrating other federates into the Joint Multi-Resolution Model federation. An entity-level server aggregates units to provide a common template for intelligence federates while off-loading some of the entity-level representation requirements from Joint Conflict and Tactical Simulation.

Joint Multi-Resolution Model employs the following sub-federates and tools:

- Joint Theater-Level Simulation.
- Joint Conflict and Tactical Simulation (JCATS).
- Joint Deployment Logistics Model (JDLM).

3. Joint Land Component Constructive Training Capability (JLCCTC) Multi-Resolution Federation (MRF)

JLCCTC–MRF is one of two federations in the Army Constructive Training Federation. A medium-resolution federation, it is designed for training audiences at the division and corps levels, including commanders and battle staffs of Joint Task Forces. If used in a smaller composition, MRF can also be used for training brigade combat teams and functional and multifunctional support brigades that include intelligence, fires, aviation, air defense, and sustainment. The collection of simulations, interface devices, security systems, and communication nodes in JLCCTC–MRF allow for battle command training over a distributed network or at individual nodes. It enables stimulation of Army Battle Command Systems and provides a digital common operational picture. It allows small units to realistically replicate high-resolution combat activities and features a non-kinetic event model. It supports detailed logistical and intelligence play.

JLCCTC–MRF employs the following federates and tools:

- Corps Battle Simulator (CBS).
- Joint Deployment Logistics Model/Logistics Federation (JDLM/LOGFED).
- Joint Non-Kinetic Effects Model (JNEM).
- Independent Stimulation Module (ISM).
- WARSIM Intelligence Module (WIM).
- Joint Conflict and Tactical Simulation (JCATS).
- Tactical Simulation (TACSIM).
- National Wargame Simulator (NWARS).
- Multiple Unified Simulation Environment (MUSE).
- After Action Review System (AARS).

4. Joint Land Component Constructive Training Capability (JLCCTC) Entity Resolution Federation (ERF)

JLCCTC–ERF is a high-resolution federation designed for training brigade combat team commanders and battle staffs serving in a Joint Task Force. It is also suitable for training functional and multifunctional support brigades that include intelligence, fires, aviation, air defense, and sustainment. JLCCTC–ERF can support limited training for brigade internal operations, with representation of supported units only as necessary to create Service “demands.” JLCCTC–ERF is a collection of constructive simulations, interface devices, security systems, and communication nodes

designed to allow for battle command training over a distributed network or at individual nodes. It enables stimulation of Army battle-command systems and provides a digital common operational picture and allows for battle-command training, including stimulation of Army battle-command systems. It also includes a reduced overhead training system for delivering routine digital training of battle staffs at all levels.

JLCCTC–ERF provides interfaces and models that enable company, battalion, and brigade training audiences to meet their command and control training objectives in a joint, combined environment. It allows realistic replication of military operations in urban terrain and includes detailed intelligence play and fairly robust logistics representation.

JLCCTC–ERF employs the same federates and tools as JLCCTC–MRF.

5. Battle Force Tactical Trainer (BFTT)

BFTT supports training and mission rehearsal across all warfare areas and all naval force elements ranging from "deck plate" operators and decision-makers to commanding officers, to Afloat Training Organization and Battle Group/Battle Force commanders. BFTT employs a distributed, simulation-based architecture that networks on-board and embedded training systems. It supports training of integrated forces or independent ships worldwide across the full command and decision line, including multiple warfare areas for vessels in port and staffs ashore or embarked. Shipboard subsystem training capabilities are organic and designed around existing onboard/embedded trainer configurations. Simulation of the combat system is transparent to the operators. All controls and displays are in a tactical mode. Combat system monitoring devices are nonintrusive and have no negative impact on system operation. BFTT collects selected data to provide real-time and post-event feedback of operator and team performance and transmission in real or near real time to a shore site for further processing after a training event. Performance assessment reports cover all command levels from the battle group commander through individual operators aboard ship.

BFTT employs the Joint Semi-Automated Force (JSAF) federate.

6. Navy Continuous Training Environment (NCTE) Federation

NCTE and Joint Forces Command's Joint Training and Experimentation Network enable real-time battle simulation for top-level staff training aboard ships with optional links to Air Force and Army training simulators.

NCTE employs the following federates and tools:

- Battle Force Tactical Trainer (BFTT).
- Joint Semi-Automated Force (JSAF).
- SIMTT.
- High-Level Architecture analyzer.
- Analysim.

7. USMC Deployable Virtual Training Environment (DVTE) Federation

DVTE is a first-person skills sustainment trainer for the Marines. It provides a custom-built combined-arms network covering most U.S. Marine Corps ground and air weapon systems, and it is a U.S. Marine Corps critical capability for Joint National Training Capability participation. DVTE also serves as a platform for delivering individual and team training simulations, including a family of tactical decision games called the Infantry Tool Kit. DVTE uses a simulation network with reconfigurable workstations. Individuals select a weapon, vehicle, or leadership billet and then join a virtual battlespace where other individuals and synthetic forces are engaged in virtual operations. Individual Marine Air-Ground Task Force (MAGTF) skills can be trained in this virtual environment using JSAF. DVTE provides a flexible, deployable training system for combined arms, MAGTF, and naval integration training. It specifically relies on the MAGTF Tactical Warfare Simulation (MTWS) and the Combined Arms Command and Control Trainer System Upgrade (CACCTUS), which is an upgrade of the Combined Arms Staff Trainer (CAST).

CAST provides fire-support training for the MAGTF elements up to and including the Marine Expeditionary Brigade level. It provides staff training for battalion and regimental size organizations as well as MAGTF headquarters staffs. The CACCTUS upgrades CAST, providing more realistic training for MAGTF staff elements in fire-support employment, coordination, and integration, and providing interoperability between Marine Corps ground training systems and the Joint National Training Capability Complex. In addition, CACCTUS provides a robust after-action playback capability, a realistic C4I tactical data system, and interoperation with operational communications equipment. Finally, MTWS is the Marine Corps advanced tactical combat simulation designed as a decision-support system in real and constructive environments to augment Marine Corps command-and-control systems. MTWS provides interactive, multisided, force-on-force, real-time modeling and simulation for stand-alone tactical combat scenarios for air, ground, surface, and amphibious operations. The system

is also capable of integrating with other service models of the Joint Training Confederation through the Aggregate Level Simulation Protocol.

DVTE employs the following federates:

- Joint Conflict and Tactical Simulation (JCATS).
- Combined Arms Command and Control Trainer System Upgrade (CACCTUS).
- MAGTF Tactical Warfare Simulation (MTWS).

8. Air and Space Constructive Environment (ACE)

ACE is the constructive element and integrator for the Air Force's Distributed Mission Operations capability. It combines live, virtual, and constructive simulations to support training, mission rehearsal, and operations. ACE provides air and space simulation of a full theater of war environment. It is a collection of M&S capabilities that provide the foundation for Air Force live, virtual, and constructive components in a Distributed Mission Operations environment. (Distributed Mission Operations is the Air Force initiative supporting the DoD Strategic Plan for Training Transformation.) ACE provides the air and space power representation within Joint National Training Capability. ACE enables Joint air component headquarters and other elements of the command and control constellation to create an air and space synthetic environment for training and operations.

ACE employs the following federates and tools:

- Air Warfare Simulation (AWSIM).
- Information Operation Suite (IOS).
- Logistics Simulation (LOGSIM).
- Air Force Synthetic Environment for Reconnaissance and Surveillance (AFSERS).
- Graphical Input Aggregate Control System (GIAC).
- Command and Control Simulation Interface (CSI).
- Architecture Assessment Tool (AAT).

APPENDIX E—GLOSSARY

Aggregation. The ability to group entities while preserving the collective effects of entity behavior and interaction.

Architecture. The structure of components in a program/system, their interrelationships, and principles and guidelines governing their design and evolution over time.

Base Case. For the Training Capabilities Analysis of Alternatives, the base case is a list of those joint and Service exercises that best describe current training capabilities.

Business Strategy. The approach designed to achieve the most effective use of resources and the best return on investment. It includes an emphasis on modern business practices, to make the most of available defense dollars. Included in this is competitive sourcing.

Constructive Model or Simulation. Models and simulations that involve simulated people operating simulated systems. Real people stimulate (make inputs) to such simulations, but are not involved in determining the outcomes.

Database. A collection of interrelated data, often with controlled redundancy, organized according to a schema to serve one or more applications; the data are stored so that they can be used by different programs without concern for the data structure or organization. A common approach is used to add new data and to modify and retrieve existing data.

Definitive Priority List. The Definitive Priority List is a product of work accomplished by the Training Capabilities Analysis of Alternatives (TC AoA) Tiger Team. The purpose of the Definitive Priority List is to identify and prioritize joint training requirements, joint training capability requirements, and baseline current funding levels supporting joint training. A memorandum from the Director, Joint Staff to the combatant commands (COCOMs) initiated the Tiger Team effort by requesting individual COCOM input on a set of joint training areas. The COCOM inputs were assembled, documented, and consolidated into identified areas of prioritization by the Joint Staff J-7 Directorate and subsequently presented to the members of the Tiger Team as a departure point for further definition and analysis.

Embedded Training. Embedded training is training capability that is an inherent part of an operational system, such as a simulation embedded in a command-and-control system for battle staff training or a simulation embedded in a weapon system for gunnery training. Embedded training capabilities can be linked with each other or with external simulations/training capabilities to support joint training. Recently updated DoD acquisition regulations encourage the use of embedded training to avoid the added expense of separate training systems. However, very few current

systems have embedded training capability, and it is not a viable solution for the AoA.

Entity. A distinguishable person, place, unit, thing, event, or concept about which information is kept.

Federate. A member of a high-level-architecture federation. All applications participating in a federation are called federates. This may include federation managers, data collectors, real-world ("live") systems (e.g., C4I systems, instrumented ranges, sensors), simulations, passive viewers, and other utilities.

Federation. A named set of interacting federates, a common federation object model, and supporting runtime infrastructure that are used as a whole to achieve some specific objective.

Federation Object Model (FOM). An identification of the essential classes of objects, object attributes, and object interactions that are supported by a high-level-architecture federation. In addition, optional classes of additional information may also be specified to achieve a more complete description of the federation structure and behavior.

Functional Requirements. A description of the end product from the user's perspective, including how the system will be used. (Ivar Jacobson, *Object-Oriented Software Engineering,* Addison-Wesley, 1992, p. 119.

Gaps. The difference between current requirements and existing capabilities.

High Level Architecture. Major functional elements, interfaces, and design rules, pertaining as feasible to all DoD simulation applications, and providing a common framework within which specific system architectures can be defined.

Intelligence Community. The Intelligence Community Coordinating Group serves as the intelligence community's forum for M&S exchange, fostering improved communication among community and other government agencies and industry. The Intelligence Community Coordinating Group promotes sharing of programs, methodologies, tools, techniques, data, and other information.

Joint Community Unique Simulations. Joint Community Unique Simulations are simulations that specifically target only those functions required to train a Joint Force Commander and staff, as opposed to creating a Joint Force Commander training capability by federating several Service simulations. Depending on the overall training objectives of the exercise, Joint Community Unique Simulations can be used stand-alone or federated with Service simulations. The idea of Joint Community Unique Simulations is to create separate simulations for the joint community where possible, reducing the dependence on large Service simulations at the tactical level, which necessitate larger exercises and complicate configuration management and acquisition. Joint Community Unique Simulations such as the Joint

Theater Level Simulation are a subset of large constructive simulations/federations and light simulations/federations.

Large Constructive Simulations/Federations. Large constructive simulations/federations are those constructive simulations and federations typically used to support large training exercises such as Ulchi Focus Lens. These simulations/federations provide a great deal of functionality and fidelity, but normally require a large amount of time and resources to develop, configure, operate, and maintain. Large constructive simulations are the focus of Alternative 3.

Light Federation. A light federation is a group of light simulations federated together to provide the necessary fidelity and functionality to support a given purpose. Light federations are flexible and responsive in that federates can be added and deleted and new technologies can be injected with relative ease, allowing diverse users to customize the federation for their unique needs. Like the light simulations, light federations should be used to provide a targeted functionality or less fidelity than a large constructive simulation federation.

Light Simulation. A light simulation is a simulation that provides targeted functionality or less fidelity than a large, complex, general-purpose simulation system. Light simulations require significantly less time and resources to develop, configure, operate, and maintain as compared to a "heavy" simulation.

Live Simulation. A simulation involving real people operating real systems.

Live, Virtual, and Constructive Simulation. A broadly used taxonomy for classifying simulation types. The categorization of simulation into live, virtual, and constructive is problematic, because there is no clear division between these categories. The degree of human participation in the simulation is infinitely variable, as is the degree of equipment realism. This categorization of simulations also suffers by excluding a category for simulated people working real equipment (e.g., smart vehicles)

Massively Multiplayer Games. Massively multiplayer games are online simulated environments that allow large numbers of players/trainees to interact while striving to achieve individual or group objectives. Massively multiplayer games can range from an environment for users to interact in an unstructured manner to games with strictly defined player roles, rules for interaction, and game objectives. The chief advantage of massively multiplayer games is the ability to provide a continuous, distributed, online training environment for a potentially large number of trainees. Trainees learn through interactions with each other and the simulated environment. Massively multiplayer games often use light simulations as the "gaming engine."

Measure of Effectiveness. A qualitative or quantitative measure of the performance of a model or simulation or a characteristic that indicates the degree to which it performs the task or meets an operational objective or requirement under specified conditions.

Model. A physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process.

Requirements. Operational capabilities needed to perform a future military operation or to better perform a current military operation. Requirements speak to capabilities, which are attained through changes to or development of new doctrine, organization, training, materiel, leadership and education, personnel, and facilities, or a combination thereof. (CJCSM 3170.01A)

Resolution. The degree of detail and precision used in the representation of real-world aspects in a model or simulation; granularity.

Runtime Infrastructure. The general-purpose distributed operating system software that provides the common interface services during the runtime of a high level architecture federation.

Scalability. The ability of a distributed simulation to maintain time and spatial consistency as the number of entities and accompanying interactions increase.

Spirals. Spirals are those discrete development periods (or increments) when requirements for a system are refined through demonstration and risk management, with continuous user feedback, all designed to provide the user with the best possible capability. (DoDI 5000.2)

Standard. A rule, principle, or measurement established by authority, custom, or general consent as a representation or example.

Story-Driven Training. Story-driven training is computer-based training that immerses the trainee in a situation or series of situations (i.e., a "story") designed to achieve specific training objectives. Story-driven training is either video-based or computer-generated imagery-based, and is primarily used for training individuals or small teams. It is particularly well-suited for training aspects of military operations that require cognitive skills, decision-making, and human interaction, such as those that are currently trained with seminar games, political/military games, etc.

Taxonomy. A classification system that provides the basis for classifying objects for identification, retrieval, and research purposes.

Training. As used within the TC AoA to define the scope of the effort, based upon direction from the SSG, training is focused on those modeling and simulation systems and tools that support collective and staff functional capabilities. The level of staff training addressed is at the operational/joint task force level. The scope of the staff training ranges from one level up (COCOM staff) and two levels down from the operational/joint task force to the extent that it is necessary to provide the appropriate context and stimulation supporting the operational/joint task force level of training. Training as used in the context of the Training Capabilities Analysis of Alternative (AoA) does not include entry-level Service/agency training, individual or operator training, or professional military education. These efforts are focused on individual skill proficiency and education that each Service/agency must source to provide trained individuals, crews, and leaders. More specific training definitions follow:

- *Military Training.* 1. The instruction of personnel to enhance their capacity to perform specific military functions and tasks. 2. The exercise of one or more military units conducted to enhance combat readiness. (JP 1-02)
- *Joint Training.* Military training based on joint doctrine or joint tactics, techniques, and procedures to prepare joint forces or joint staffs to respond to strategic and operational requirements deemed necessary by combatant commanders to execute their assigned missions. Joint training involves forces of two or more military departments interacting with a combatant commander or subordinate joint force commander; involves joint forces or joint staffs; and is conducted using joint doctrine or joint tactics, techniques, and procedures.
- *Service Training.* Military training based on Service policy and doctrine to prepare individuals and interoperable units. Service training includes basic, technical, operational, and interoperability training in response to operational requirements deemed necessary by the COCOMs to execute assigned missions.)

Use Case. A use case defines a goal-oriented set of interactions between external users and the system under consideration or development. Use cases have become a widespread practice for capturing functional requirements in software design, especially in the object-oriented community where they originated, but their applicability is much wider. (Ivar Jacobson, et al, *Applying Use Cases: A Practical Guide*, Pearson Education, 2001, p. 272.) For the Training Capabilities Analysis of Alternatives, a use case is a joint or Service training requirement, represented by the exercise, which is designed to meet that requirement.

Virtual Simulation. A simulation involving real people operating simulated systems. Virtual simulations inject human-in-the-loop in a central role by exercising motor control skills (e.g., flying an airplane), decision skills (e.g., committing fire-control resources to action), or communication skills (e.g., as members of a C4I team).

APPENDIX F—ACRONYMS

AAR	After Action Review
AARS	After Action Review System
ABCS	Army Battlefield Command System
ACE	Air and Space Constructive Environment
ACRES	Adaptive Communications Reporting Simulation
ACS	Agile Combat Support
ACTF	Army Constructive Training Federation
ADL	Advanced Distributed Learning
ADSI	Air Defense Simulation Integrator
AFMSTT	Air Force Modeling & Simulation Training Toolkit
AFSERS	Air Force Synthetic Environment for Reconnaissance and Surveillance
AoA	Analysis of Alternatives
ARCHER	Archiving and Enhanced Retrieval System
ASCOT	Airspace Control and Operations Trainer
ASTi	Army Secure Tactical Initiative
AWSIM	Air Warfare Simulation
BCTF	Battle Command Training Program
BFTT	Battle Force Tactical Trainer
BICM	BCTF Intelligence Collection Model
C4I	Command, Control, Communications, Computers, and Intelligence
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
CBRNE	Chemical, Biological, Radiological, Nuclear and Explosive
CBS	Corps Battle Simulator
CJTF	Commander, Joint Task Force
COCOM	Combatant Command
COMINT	Communications Intelligence
CONOPS	Concept of Operations
COP	Common Operational Picture

DCE	Dynamic Communications Environment
DIME	Diplomatic, Information, Military, Economic
DISA	Defense Information Systems Agency
DISCO	Deployable Simulation for Collaborative Operations
DoD	Department of Defense
DPS	Defense Planning Scenarios
DTIC	Defense Technical Information Center
DVTE	Deployable Virtual Training Environment
EBO	Effects Based Operations
ERF	Entity Resolution Federation
ESG	Executive Steering Group
EW	Electronic Warfare
FMS-D	Full Mission System- Distributed
FOM	Federation Object Model
GEM	Generic External Module
GIG	Global Information Grid
GWOT	Global War on Terror
HAZMAT	Hazardous Material
HLA	High Level Architecture
HUMINT	Human Intelligence
ICD	Initial Capability Document
IDA	Institute for Defense Analyses
IO	Information Operations
IOS	Information Operations Suite
IPT	Integrated Product Team
ISM	Independent Stimulation Module
ISO	Information Operations Suite
ISR	Intelligence, Surveillance, and Reconnaissance
IWEG	Information Warfare Effects Generator
JAEC	Joint Assessment and Enabling Capability
JCAS	Joint Close Air Support
JCATS	Joint Conflict and Tactical Simulation

JCB	Joint Capabilities Board
JCIDS	Joint Capabilities Integration Development System
JDLM	Joint Deployment Logistics Model
JECEWSI	Joint Electronic Combat Electronic Warfare Simulation
JFCOM	Joint Forces Command
JKDDC	Joint Knowledge Development and Distribution Capability
JLCCTC	Joint Land Component Constructive Training Capability
JLOD	JCATS Low Overhead Driver
JLVC	Joint Live Virtual Constructive
JMET	Joint Mission Essential Task
JMRM	Joint Multi-Resolution Model
JNEM	Joint Non-Kinetic Effects Model
JNETS	Joint Network Simulation
JNTC	Joint National Training Capability
JOISIM	Joint Operations Information Simulation
JOPES	Joint Planning and Execution System
JQUAD+	Suite of five computer simulation models for warfare command and control
JROC	Joint Requirements Oversight Council
JSAF	Joint Semi-Automated Force
JSIMS	Joint Simulation System
JTA	Joint Technical Architecture
JTC	Joint Training Confederation
JTF	Joint Task Force
JTIMS	Joint Training Information Management System
JTLS	Joint Theater-Level Simulation
JTRG	Joint Training Requirements Group
JTS	Joint Training System
JUO	Joint Urban Operations
JWFC	Joint Warfighting Center
LOGFED	Logistics Federation
LVC	Live, Virtual, and Constructive
M&S	Modeling and Simulation

MASINT	Measurement and Signal Intelligence
MDST	Missile Defense Space Tool
MLS	Multi-Level Security
MRF	Multi-Resolution Federation
MRX	Mission Rehearsal Exercise
MSCO	Modeling and Simulation Coordination Office
MSSC	Modeling and Simulation Steering Committee
MSEL	Master Scenario Events List
MUSE	Multiple Unified Simulation Environment
NCTE	Navy Continuous Training Environment
NTISR	Non-Traditional ISR
NGO	Non-governmental Organization
NORTHCOM	Northern Command
NWARS	National Warfare Simulator
NWARS-NG	National Warfare Simulator Next Generation
OneSAF	One Semi-Automated Force
OUSD(P&R)	Office of the Under Secretary of Defense (Personnel and Readiness)
PMESII	Political, Military, Economic, Social, Information, Intelligence
RTI	Run Time Infrastructure
RTM	Run Time Manager
SAF	Semi-Automated Force
SASO	Stability and Support Operations
SDB	Small Diameter Bomb
SELS	Scalable Entity Level Simulation
SIGINT	Signals Intelligence
SIMPLE	Session Initiation Protocol for Instant Messaging and Presence Leveraging Extensions
SIPRNET	Secret Internal Protocol Router Network
SITH	Simulation Interface Test Harness
SOCOM	Special Operations Command
SSE	Squad Synthetic Environment
STRATCOM	Strategic Command
T2	Training Transformation

TACSIM	Tactical Simulation
TBMCS	Theater Battle Management Core System
TC	Training Capabilities
TENA	Test and Training Enabling Architecture
TENCAP	Tactical Exploitation of National Capabilities
TMSBP	Training Community Modeling and Simulation Business Plan
UAV	Unmanned Aerial Vehicle
UJTL	Universal Joint Task List
VV&A	Validation, Verification, and Accreditation
USAF	United States Air Force
WARSIM	Warfighter's Simulation
WIM	WARSIM Intelligence Module

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14. ABSTRACT

The Training Community Modeling and Simulation (M&S) Business Plan (TMSBP) provides linkages between the training functional stakeholders as represented in the Training Transformation (T2) Senior Advisory Group (SAG) and Executive Steering Committee (ESG) to the Department's larger M&S strategic vision and goals. Since needs and technology are constantly evolving, the TMSBP will continue to evolve as a living document. The 2007 Edition of the TMSBP is provided to inform the M&S Steering Committee (MS SC) project call for near-term (FY 09) M&S projects, and to provide justification for major investments in training capabilities enabled by M&S in future Program Objective Memoranda (POM) submissions. It also identifies capabilities that the training community can contribute to greater interoperability, reuse, and efficiencies among the cross-cutting community. Volume I of the 2007 TMSBP provides an initial review of the models, simulations, and tools identified as part of the Training Capabilities Analysis of Alternatives (AoA) base case of capabilities. Volume II provides additional data and analysis details from a data call to the training community in the summer of 2007.

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