

# **High-Level Architecture (HLA) Transition Report**

## **March 1998**

### **INTRODUCTION**

This report is a product of the High Level Architecture (HLA) Transition Issues Team, a caucus of representatives from the DoD Component (modeling and simulation) M&S Management Offices and the Defense Modeling and Simulation Office (DMSO). This team operates in support of the DoD Executive Council for Modeling and Simulation (EXCIMS). The team began meeting soon after the Department's HLA policy was announced in USD(A&T) Memorandum "DoD High Level Architecture (HLA) for Simulations," September 10, 1996 (see Attachment 1). The team's goal has been to foster a coordinated, common-sense implementation of HLA policy across the DoD. It will continue to function in this role throughout the HLA transition period (notionally until October 1, 2000).

This HLA Transition Report provides an overview of the rationale for HLA use, describes progress to date in the Department's HLA transition, and recommends the adoption of certain definitions for the implementation of DoD HLA policy. It also provides lists of DoD simulations committed to HLA compliance, those the team recommends the USD(A&T) waive from HLA compliance, and those that will be retired from use, and hence will not transition to the HLA.

### **RATIONALE FOR HLA USE**

To establish an informed perspective for dealing with HLA policy implementation issues, the team first reviewed the rationale for DoD's mandate of the HLA as "the standard technical architecture for all DoD simulations."

Advanced simulation can provide a powerful tool to help maintain readiness, plan operational missions, make optimal investment decisions, analyze force structure alternatives, and achieve dramatic acquisition improvements. Simulations (a general term including both pure-software, or "constructive," simulations and human-in-the-loop, or "virtual," simulators) are abstractions of the real world. Different user needs dictate different abstractions: different entities, attributes and interactions must be represented, at different levels of resolution and fidelity. These representations will, of necessity, be implemented in different computing environments and run on hardware platforms that range from personal computers to massively-parallel, high performance computers.

The DoD will thus need many different simulations. However, if the Department is to use simulations cost-effectively, it needs the flexibility to reuse simulations to the maximum possible extent, building new representations only when existing simulations cannot provide the needed capabilities. To get the greatest return on investment for the simulations it does build and

maintain, DoD must be able to team these representations together in different combinations (“federations”) to satisfy a diverse and ever-evolving set of user needs.

Simulations must also be able to interoperate with various real-world, or “live,” systems, such as command and control systems, weapon systems on instrumented ranges, and weapon system or sensor components on test benches. This live system interoperability is necessary to:

- facilitate test and evaluation of the live systems;
- deliver training, course of action analysis tools, and mission rehearsal capabilities to humans operating those live systems; and
- allow authoritative representation of the system and its operator(s) in a simulation exercise being conducted for other purposes.

Thus, for reasons of capability, timeliness and cost-effectiveness, DoD needs a flexible, composable approach to constructing synthetic environments, bringing together simulations and live players in various combinations, as user needs dictate. This means that interoperability must be “built-in” to the maximum possible extent. This need was reflected in the 1995 Chairman’s Program Assessment, which noted that the *“lack of M&S interoperability is our largest shortfall”* and in FY 1997 Defense Planning Guidance to *“restructure M&S activities for interoperability and reuse.”*

HLA compliance satisfies the most important condition for interoperability and reuse: a common, efficient technical means to join simulations together in federations, optionally including live players, and exchange information in a coherent manner. However, the HLA is not an interoperability “magic wand,” that is, it will not automatically make every simulation suitable for federating with every other simulation nor guarantee a valid, meaningful exchange of information across the federation. Prudent, common sense planning is still required, but the HLA does provide the critical technical foundation for the interoperability of simulations among themselves, and with live systems. For this reason, the HLA’s broad adoption across DoD is essential.

HLA compliance delivers new functional capabilities and allows different organizations to produce/maintain a diverse set of products (e.g., simulations, live system interfaces, utilities, runtime infrastructures) which can be wisely used together in different combinations as user needs dictate. This yields reuse of individual products and allows simulations to bring in new capabilities without having to build them. This in turn equates to reductions in time, expense, and risk that justify the modest near-term costs of transitioning legacy systems to the HLA.

## **HLA TRANSITION PROGRESS TO DATE**

The Department is only in the early stages of its multi-year transition to the High Level Architecture. However, comprehensive transition support capabilities have already been put in

place, the vast majority of the Department's simulations are committed to HLA compliance, and many HLA implementations are underway.

### **HLA Transition Support**

Responsive, professional evolution of the HLA is necessary to ensure any emergent issues (e.g., needed new capabilities) are addressed. As recommended by the HLA Transition Issues Team and approved by the DoD Executive Council for Modeling and Simulation (EXCIMS), the Architecture Management Group (AMG) has added additional members who are embarked on HLA transition. The AMG will continue as DoD's means to manage HLA evolution and support corporate decisions regarding M&S standards. An orderly issue identification and resolution process, technical support, and experimentation are in place to ensure an optimal, disciplined evolution. The AMG has scheduled HLA updates on a six-month cycle; HLA version 1.3 was approved in February 1998.

A comprehensive set of HLA supporting software is available to potential HLA users. The HLA is an architecture, not software. However, to facilitate cost-effective implementation of the HLA, DMSO has developed an initial suite of supporting software and is distributing it in the public domain. This software suite includes HLA runtime infrastructure software, object model development tools, an object model data dictionary system and an object model library. Full documentation, test applications and technical assistance are being provided. Over 1,000 copies of this software have been distributed through the end of February 1998. To foster the development of commercial software, all HLA specifications have been made public via the Internet, and HLA-based tools and development environments are already emerging in the commercial marketplace.

A comprehensive HLA education program is underway and evolving in response to user needs. Focused HLA introductory/issue courses are offered regionally, once or twice a month. A hands-on HLA implementation practicum is offered biweekly in the Washington area. Both of these courses are free of charge, with enrollment via the DMSO Home Page. Through the end of February 1998, 28 courses have been conducted, with 779 students in attendance. A full HLA Technical Library and briefings are available on the Internet, and an HLA Help Desk has been established to assist HLA implementors.

HLA outreach is being accomplished by bilateral exchanges with our allies and robust participation (briefings, tutorials, panel discussions, professional papers, and demonstrations) in major M&S forums outside DoD. These include the:

- Military Operations Research Society (MORS);
- Simulation Interoperability Standards Organization (SISO);
- Institute of Electrical and Electronic Engineers (IEEE);
- Society for Computer Simulation (SCS);
- International Test and Evaluation Association (ITEA);

- International Training and Education Conferences (ITEC);
- Object Management Group (OMG);
- National Defense Industrial Association (NDIA) conferences such as the Interservice/Industry Training, Simulation and Education Conference (I/ITSEC); and
- North Atlantic Treaty Organization (NATO) bodies involved with simulation.

After a thorough examination of the HLA, SISO and IEEE have begun the process of establishing the HLA as an IEEE standard and NATO's Steering Group on M&S has recommended the HLA as a NATO standard.

These encouraging developments mean that DoD will be able to enjoy the additional benefits of greater intellectual input to HLA evolution and software development, a broader industrial base, and more reuse candidates, including more commercial-off-the-shelf (COTS) products. International cooperation will also be facilitated in defense matters (e.g., training with allies, course of action assessment), civil matters (e.g., air traffic control) and other application areas such as manufacturing and hazardous operations.

An HLA compliance testing capability has been in place since October 1997. It provides a straightforward means to certify the conformance of simulations with the HLA, over the Internet (or Secret IP Router Network). Well-documented and supported by semi-automated test management, it provides a natural and simple process for simulations that have complied with the HLA specifications. Of the many simulations that use HLA, fewer than 10 have undergone formal compliance testing, but that number will increase significantly over the next six months.

## **DEFINITIONS TO GUIDE HLA POLICY IMPLEMENTATION**

The DoD HLA policy, issued in September 1996, called for the DoD Components to list their HLA-compliance intentions for each simulation they own or sponsor. The HLA Transition Issues Team has worked together to craft a coherent, common sense implementation of the policy. The team developed working categories of various simulation types in order to facilitate a careful examination of each. An issue which arose early in the reporting process, and which resurfaced frequently, was the matter of definitions. The team recognized the need for common understanding among the DoD Components of the meaning of the terms and phrases used in the HLA policy memorandum. This problem encompassed such basic matters as what software applications are covered by the policy. After several iterations and practical application experience, the HLA Transition Issues Team arrived at a set of expanded working definitions, provided below. USD(A&T) approval is requested for these seven working definitions to guide the implementation of the DoD HLA policy.

## “DoD Simulations”

The USD (A&T) memorandum on HLA policy states: “...Under the authority of reference (a), and as prescribed by reference (b), I designate the High Level Architecture as the standard technical architecture for all **DoD simulations**.”

In order to promote a clearer understanding of the scope of this requirement, it is necessary to understand the difference between model and simulation. A model is “a physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process;” whereas, a simulation is “a method for implementing a model over time.” Models do not interoperate in parallel in a time-coordinated manner (except as internal components of simulations). HLA compliance is required of simulations, but not models. This means, for example, that spreadsheets and linear programs are not considered simulations and would not need to be HLA compliant. Such models may still benefit from HLA use, but, they are not required to comply as a matter of policy. It must be noted that many simulations use the term model in their names; the above functional definitions, not the name, govern whether they are required to be HLA-compliant.

In this light then, “DoD simulations” means the executing software that implements, over time, models representing the attributes of one or more entities. The simulation application represents or “simulates” real-world phenomena for the purpose of training, analysis, acquisition support, or other experimentation. Examples include manned vehicle (virtual) simulators, computer generated forces, integrated simulations (e.g. Air Combat Environment Test and Evaluation Facility (ACETEF), Theater Air Command and Control Simulation Facility (TACCSF)), environment simulators, closed-form simulations, and interfaces to ranges, command, control, communications, computers and intelligence (C4I) systems and other live players.

Furthermore, the following classes of applications should not be considered “simulations” in the context of the DoD policy. They are therefore exempt from the HLA-compliance mandate and need not be reported. Applications within these categories may still enjoy the benefits of HLA-compliance when deemed appropriate by their owners and/or sponsors, but the Department will not so insist.

1. The internal components of a simulation, even if that simulation is employed in a distributed manner (e.g., several instances of a single application interoperating over a wide-area network only with each other). Stated another way, any simulation need only be made externally, not internally, HLA-compliant. A simulation must use the HLA to interoperate with other simulations and live systems, but not with itself. Again, it is recognized that there may be opportunities to use the HLA internal to simulations, but this is not required as a matter of policy.
2. Part Task Trainers (PTT). A PTT is a training device having both of the following characteristics:

- a. Used to train humans in some portion of the tasks they are expected to perform in their occupational specialty of system operator or maintainer (e.g., pilot, gunner, mechanic, fire fighter, communicator), but does not provide a complete-enough representation of a system's functions, or the ability to interact with other persons normally present in the same crew compartment, as would be necessary to allow the trainees to simulate employment of the system in one or more of its primary missions; and
- b. Does not require input from, nor output to, other systems (e.g., other organizations/units; weapon systems; sensors; command and control systems) to accomplish the training.

Examples of simulations in this category may include certain emergency procedure trainers, air refueling trainers, fuel system management trainers, hydraulic system operation trainers, instrument flying trainers, and target/threat identification trainers. *(Note: Simulators which can be interconnected with other simulators or live systems to provide team/crew training, where interaction among the simulators/systems can enhance the skills of each team/crew member, are not considered Part Task Trainers.)* Some PTTs may benefit from HLA use, but they are not required to comply as a matter of policy.

- 3. Stimulators used only for production line quality control or diagnostic testing. These stimulators are used only to test subsystems or some portion of the internal interfaces of a system. They do not provide a complete-enough representation of functions as to allow them to simulate employment of the system in one or more of its primary uses. Examples of stimulators in this category include launcher interface stimulators, missile echo units, avionics diagnostic test suites, and weapon control system interface stimulators.

### **“Simulation Projects and Programs”**

The policy states: “DoD Components shall review **all of their simulation projects and programs** by the second quarter fiscal year (FY) 1997 in order to establish plans for near-term compliance with the HLA.”

The team agreed that “all of their simulation projects and programs” includes those:

- Programs developing simulations for specific purposes, e.g. training:
- Programs using simulations to support other objectives such as acquisition of weapons systems, and analysis of doctrine, tactics, and operational plans; and
- Centers (e.g., TACCSF, ACETEF) providing integrated simulation support to other programs.

### “Development or Modification”

The policy states: “The Department shall cease further **development or modification** of all simulations which have not achieved, or are not in the process of achieving, HLA-compliance by the first day of FY 1999.”

This means that there will be no changes, modifications, or enhancements to the capability of the executing simulation software that represents real world phenomena. Changes required for continued operations, such as changes to accommodate a new operating system, are permitted, as are those changes which would bring HLA compliance.

### “Retire”

The policy states, in part: “...and shall **retire** any non-compliant simulations by the first day of FY 2001...”

The Team agreed that this means that the non-compliant simulation will not be used by any of the DoD Components after September 30, 2000.

### “Own or Sponsor”

The policy states: “...the DoD Components shall submit an initial report to the Defense Modeling and Simulation Office by June 30, 1997, which summarizes their HLA-compliance intentions for **each simulation the Component owns or sponsors**, organized into three categories...”

The fact that many simulations are developed or used in cross-Service/agency fashion often makes it difficult to discern the true owner or sponsor. This makes a collaborative effort like the HLA Transition Issues Team essential for sorting out appropriate responsibilities. A simulation owner is the organization that has primary funding and configuration management responsibility for the simulation, even if configuration management is delegated to another agency for execution. A simulation sponsor is an organization that provides funding (perhaps by paying license fees) towards the development or maintenance of a simulation whose evolution is primarily controlled outside that DOD Component. The reporting process should include delineation of participating/using Services, agencies, and organizations.

### “Certification of Compliance”

The policy states: “The DoD Components shall submit periodic updates to these initial reports as required to ensure their accuracy and completeness. DMSO **shall establish a mechanism to provide for formal certification of compliance** and shall provide me with periodic reports on the Department's progress towards compliance with the HLA.”

In cooperation with the Services, a common compliance process has been developed and is being administered by Modeling and Simulation Operational Support Activity under the guidance

of DMSO. This process is based on the HLA compliance checklist and supporting test procedures available on the DMSO Internet homepage (<http://www.dmsomil/>). Certification of HLA-compliance will be granted by DMSO following successful completion of the compliance testing process.

### **“Waiver Submittal”**

The policy states: “If a Component believes it is impractical for a simulation to comply with the HLA, or that HLA-compliance cannot be achieved in a timely manner, **it may submit a waiver request to the Director of Defense Research and Engineering**, the chair of the EXCIMS. In consultation with the EXCIMS and its Training, Analysis, and Acquisition Councils, I will then decide if an exception to the HLA-compliance requirement is warranted, and if so, the form of that exception.”

This means that all HLA-compliance waiver requests must be submitted through the M&S management office of the DoD Component that owns or sponsors the simulation, to the DDR&E’s Defense Modeling and Simulation Office. DMSO will then coordinate consideration of the waiver request across the DoD Components and administratively process a recommended disposition to the EXCIMS and USD(A&T).

## **HLA TRANSITION PLANS**

In accordance with the DoD’s HLA policy, the Components submitted their initial reports of their HLA compliance intentions to DMSO on June 30, 1997. Applying the above working definitions, the DoD Components then refined their simulation inventories and examined those requesting waiver from HLA compliance. A workshop was held to gain insight into the issues that should be considered in judging waiver requests. The Components requested additional information wherever necessary to clarify the facts surrounding a request. The team then held extensive discussions on the simulations at issue. The outcome of this process reflected a strong commitment to the HLA. This is shown in the three lists that follow: (1) simulations committed to HLA compliance, (2) simulations proposed for waivers from HLA compliance, and (3) those that will be retired from use, and hence will not transition to the HLA.

### **Simulations Committed to HLA Compliance**

Since all DoD simulations must become HLA compliant unless waived by USD(A&T), the first list, (see Attachment 2), while containing over 450 simulations, is provided for information only. Given the extensive use of simulation across DoD, the team concludes some simulations have probably been missed. If so, this does not change the requirement for such simulations to comply with the HLA; they must do so unless granted a waiver.

## **Simulations Recommended for Waiver from HLA Compliance**

The second list, of simulations, at Attachment 3, is recommended for long-term waiver from the HLA compliance mandate. This list requires a USD(A&T) decision. The extensions to the investment (“no can pay”) and use (“no can play”) deadlines of these simulations are indefinite. This is because for various reasons it is not reasonable to require HLA compliance for these simulations (although they may still enjoy the benefits of HLA-compliance should their owners/sponsors so decide). Continued investment beyond October 1, 1998, is permitted for these waived simulations. The list of approved waivers will be reviewed by the team (or other body tasked by the EXCIMS) on an annual basis to determine if changed circumstances may make a waiver no longer advisable. In that case, a waiver withdrawal recommendation will be forwarded to USD(A&T). It should also be noted that the waivers are for these specific simulations only, not their successors or others of similar design, function or purpose.

Any decision to waive a simulation from HLA compliance requires careful consideration. Each simulation on this list has been examined on its individual circumstances. In many cases a careful investigation is required to ascertain additional information required for an informed decision. The distinguishing characteristics of simulations on this list include, but are not limited to, one or more of the following:

- Simulations with a planned and programmed replacement which will not be available prior to the “no can play” date of October 1, 2000.
- Simulations of systems that are scheduled to be retired from the operational inventory by October 1, 2002.
- Parametric assessments in design simulations.
- Simulations whose decidedly infrequent projected use of only once or twice annually does not justify the cost of HLA-compliance.
- Simulations that are commercial off the shelf (COTS), licensed or proprietary, were built primarily for other than DoD-customers, and over which DoD has no effective leverage to achieve compliance.
- Simulations whose national security circumstances/risks preclude federation.
- Simulations whose only computational platforms are obsolete and for which source code is no longer available.
- Simulations of systems where the systems themselves are used exclusively for training and not intended to perform any other operational mission (e.g., training aircraft such as the T-45).

Each waiver decision requires appropriate investigation and discernment. The above characteristics are just a starting point for an examination of each simulation on its particular capabilities, potential utility, security constraints, relationship to other activities, progress in the development of a replacement, etc. These characteristics have evolved, and will continue to evolve, as we gain experience with more simulations and accomplish more HLA transitions. They

are provided here to offer insight into the factors used by the team in arriving at these waiver recommendations. They are not precise criteria and no assumptions should be made that a simulation having one of these characteristics should pursue a waiver or would automatically be granted a waiver if it is requested. Nor should it be expected that a replacement for one of these simulations would be waived.

Again, it is recognized that the owners, sponsors and developers of these simulations granted a waiver may subsequently see benefits in using the HLA, but with the granting of a waiver by USD(A&T), HLA-compliance for these simulations will not be required as a matter of policy.

### **Simulations to be Retired**

The third list of simulations are those that will be retired from use by October 1, 2000, and hence will not transition to the HLA. (See Attachment 4.)

### **FOLLOW-ON ACTIONS**

Upon receiving the USD(A&T) response to this report, the M&S management offices of the DoD Components shall be responsible for conveying waiver decisions to the appropriate organizations and personnel.

Upon receiving the USD(A&T) response, DMSO will post this report and the USD(A&T) response on the DMSO HLA Internet site (<http://hla.dmsomil>) to promote broad awareness across the Department of Defense.

In the fall of 1998 the HLA Transition Issues Team will forward another recommendation regarding those simulations which are committed to HLA compliance but whose circumstances warrant a time extension to achieve this.

#### **4 Attachments:**

1. USD(A&T) Memorandum "DoD High Level Architecture (HLA) for Simulations," September 10, 1996
2. Simulations Committed to HLA Compliance
3. Simulations to be Waived from HLA Compliance
4. Simulations to be Retired by October 1, 2000