



Federation Development and Execution Process and Supporting Tools Tutorial

DOD Modeling and Simulation Industry Days

June 1999



Outline

- **Motivations for HLA development**
- **The High Level Architecture (HLA)**
- **HLA Transition Progress**
- **HLA in related standards efforts: JTA, NATO, SISO/IEEE, OMG**



Importance of Modeling and Simulation

Continuing squeeze on DoD resources

- shrinking, dispersed force structure
- competition for funds limits field exercises
- need to carefully examine every investment

More demanding operational requirements

- new, more complex missions
- vastly expanding mission space
- increased complexity of systems and plans
- increasing demand for joint training
- security challenges (e.g., information warfare)

Much more technical capability at less cost

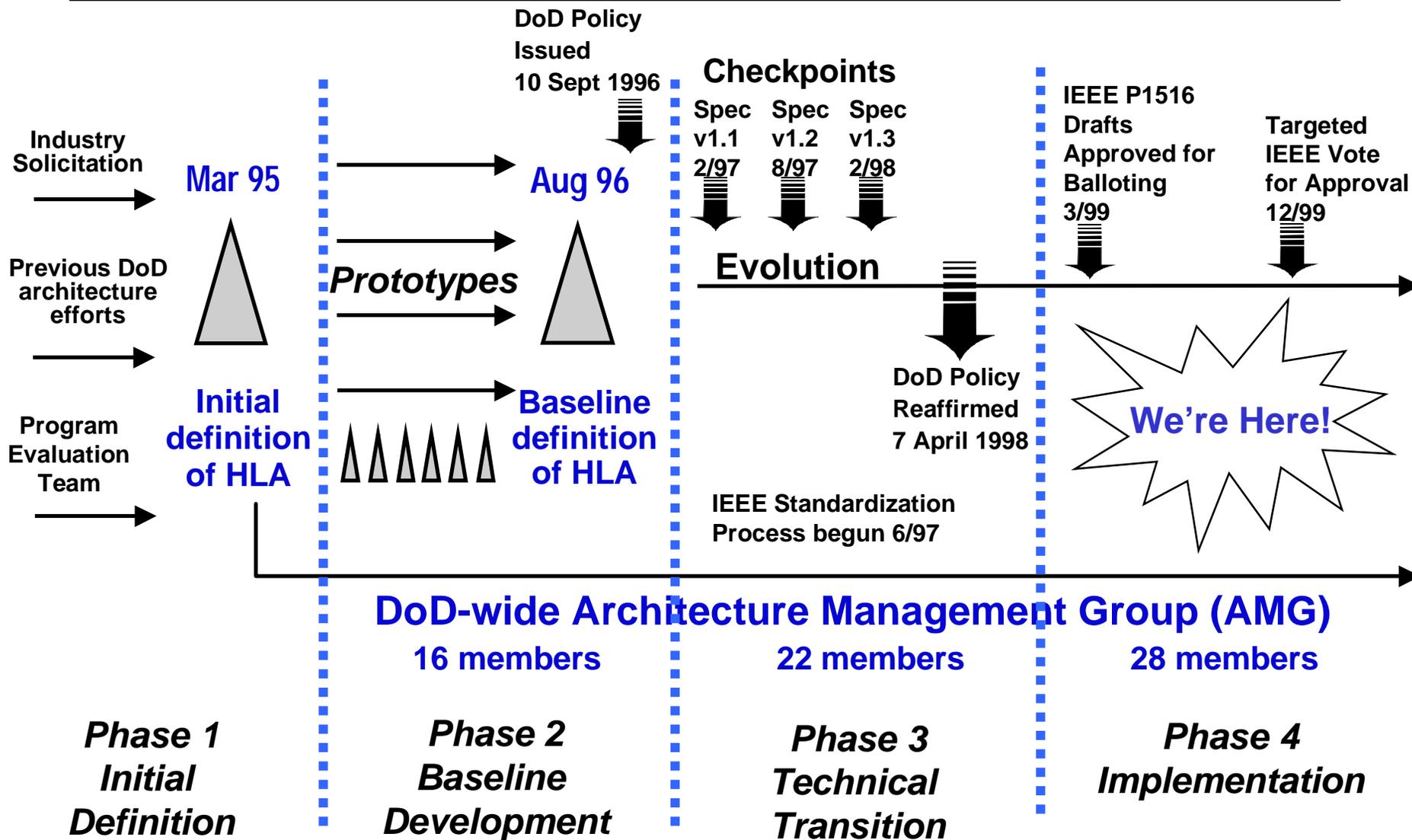
- communications
- computers
- software technology
- displays/human-machine interfaces
- data storage and management



Advanced
M&S can
offer a cost-effective
and affordable
solution



Review of the HLA Development Process





Prototyping During HLA Baseline Development

- **Over 25 different simulations**
- **One Runtime Infrastructure (RTI) prototype implementation**
- **Training, analysis, and acquisition support applications**
- **Unit, platform, and weapon system component level granularity**
- **Hardware-in-the-loop, human-in-the-loop, and closed-form simulations (live, virtual, and constructive)**
- **Both real-time and fast-as-possible discrete event simulations**
- **Both classified and unclassified federations**
- **Local and wide area networks (e.g., DSI, landlines) across the USA**
- **Run on Sun, Silicon Graphics, HP, and IBM workstations**
- **Addressed issues identified by the AMG and each protofederation**



Scope of HLA

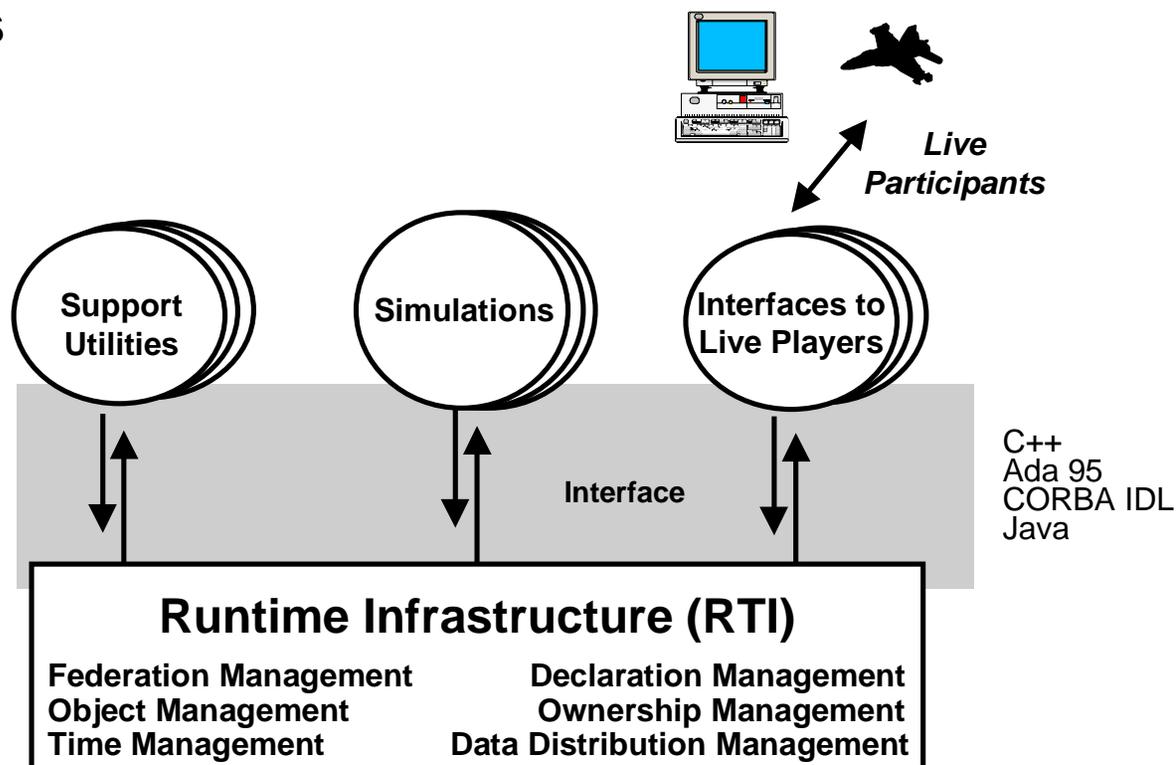
- **Applicable to broad range of functional areas (e.g., training, contingency planning, analysis, and acquisition)**
- **Applicable to simulations involving pure software representations, man-in-the-loop simulators, and interfaces to live components (e.g., instrumented-weapon systems and C3 systems)**



The High Level Architecture (HLA)

- Architecture calls for a federation of simulations
- Architecture specifies

- Ten **Rules** which define relationships among federation components
- An **Object Model Template** which specifies the form in which simulation elements are described
- An **Interface Specification** which describes the way simulations interact during operation



The HLA is not the RTI; the HLA says there will be an RTI that meets HLA requirements but it doesn't specify a particular software implementation



Some Terminology

- **Federation**: a set of simulations, a common federation object model, and supporting RTI, that are used together to form a larger model or simulation
- **Federate**: a member of a federation; one simulation
 - Could represent one platform, like a cockpit simulator
 - Could represent an aggregate, like an entire national simulation of air traffic flow
- **Federation Execution**: a session of a federation executing together



Some More Terminology

- **Object:** An entity in the domain being simulated by a federation that
 - Is of interest to more than one federate
 - Is handled by the Runtime Infrastructure
- **Interaction:** a non-persistent, time-tagged event generated by one federate and received by others (through RTI)
- **Attribute:** A named datum (defined in Federation Object Model) associated with each instance of a class of objects
- **Parameter:** A named datum (defined in Federation Object Model) associated with each instance of a class of interactions

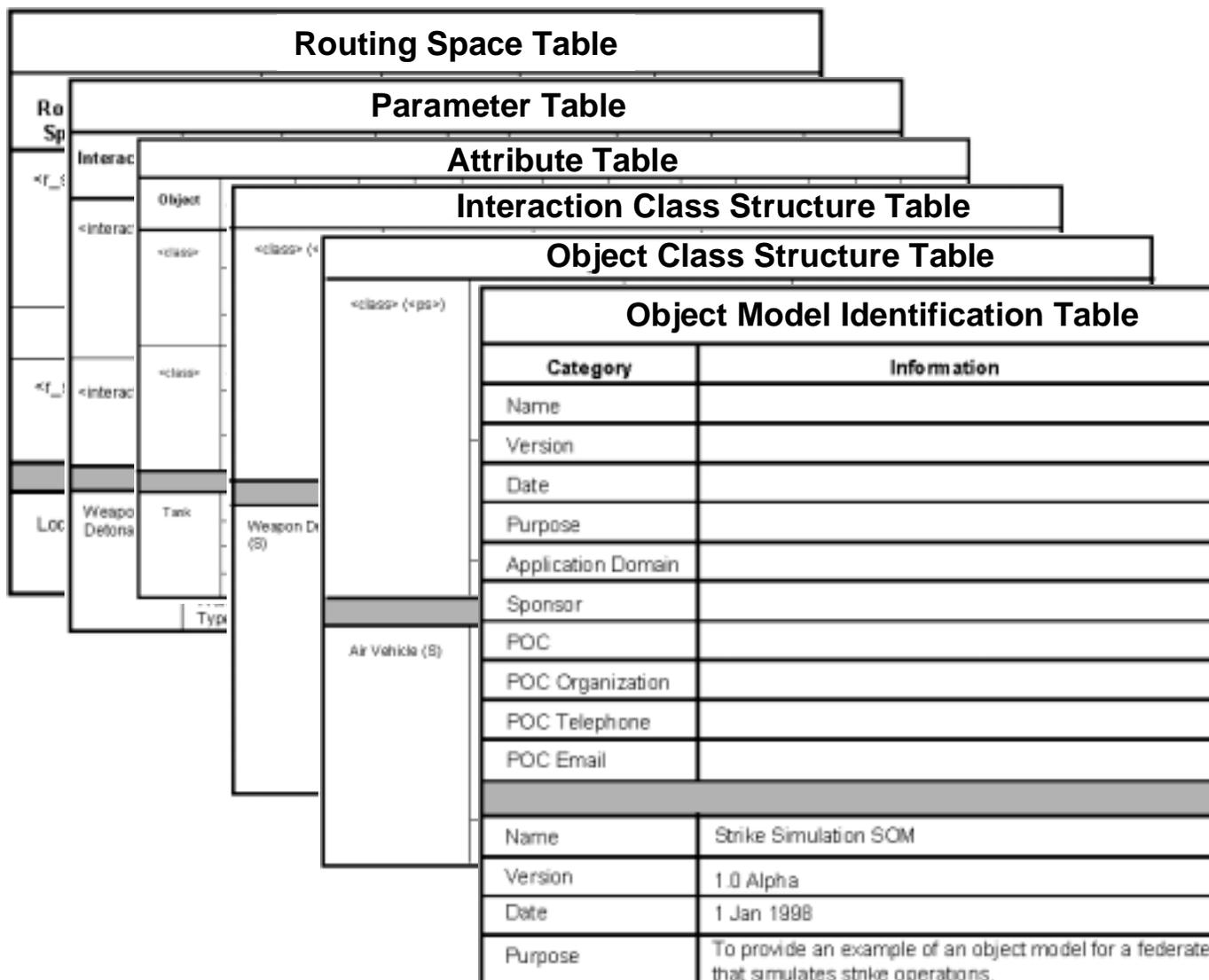


HLA Object Models and OMT

- **Federation Object Model (FOM)**
 - A description of all shared information (objects, attributes, and interactions) essential to a particular federation
- **Simulation Object Model (SOM)**
 - Describes objects, attributes and interactions in a particular simulation which *can* be used externally in a federation
- **Object Model Template (OMT)**
 - Provides a common framework for HLA object model documentation
 - Fosters interoperability and reuse of simulations via the specification of a common representational framework



Tables in the Object Model Template





Interface Specification

- **Provides a specification of the functional interfaces between federates and the RTI**
 - **Interfaces are divided into six service groups**
- **Each service specification includes:**
 - **Name and Descriptive Text**
 - **Supplied Arguments**
 - **Returned Arguments**
 - **Pre-conditions**
 - **Post-conditions**
 - **Exceptions**
 - **Related Services**
- **Application Programmer Interfaces (APIs) in CORBA IDL, C++, Ada '95 and Java**



HLA RTI Services Categories

Category	Functionality
Federation Management	Create and delete federation executions Join and resign federation executions Control checkpoint, pause, resume, restart
Declaration Management	Establish intent to publish and subscribe to object attributes and interactions
Object Management	Create and delete object instances Control attribute and interaction publication Create and delete object reflections
Ownership Management	Transfer ownership of object attributes
Time Management	Coordinate the advance of logical time and its relationship to real time
Data Distribution Mgmt	Supports efficient routing of data



Federation Rules

- 1 Federations shall have an HLA Federation Object Model (FOM), documented in accordance with the HLA Object Model Template (OMT).**
- 2 In a federation, all representation of objects in the FOM shall be in the federates, not in the runtime infrastructure (RTI).**
- 3 During a federation execution, all exchange of FOM data among federates shall occur via the RTI.**
- 4 During a federation execution, federates shall interact with the runtime infrastructure (RTI) in accordance with the HLA interface specification.**
- 5 During a federation execution, an attribute of an instance of an object shall be owned by only one federate at any given time.**



Federate Rules

- 6 Federates shall have an HLA **Simulation Object Model (SOM)**, documented in accordance with the HLA Object Model Template (OMT).**
- 7 Federates shall be able to update and/or reflect any attributes of objects in their SOM and send and/or receive SOM object interactions externally, as specified in their SOM.**
- 8 Federates shall be able to transfer and/or accept ownership of attributes dynamically during a federation execution, as specified in their SOM.**
- 9 Federates shall be able to vary the conditions (e.g., thresholds) under which they provide updates of attributes of objects, as specified in their SOM.**
- 10 Federates shall be able to manage local time in a way which will allow them to coordinate data exchange with other members of a federation.**



HLA Transition Support

- **HLA Standardization Efforts**
- **User Services**
- **Compliance Testing**
- **Use Processes**
- **Supporting Software**



HLA Standardization Initiatives

- **Government**

- HLA established as technical architecture for DoD Simulations -- **Sept 96**
- HLA is a part of the DoD Joint Technical Architecture -- **May 98**

- **International**

- HLA is named as NATO standard architecture in the NATO M&S Master Plan prepared in June 98 and approved -- **Nov 98**

- **Industry**

- Object Management Group (OMG) Standardization
 - HLA Interface Specification and RTI Services are approved by OMG Board of Director as OMG standards -- **Nov 98**
- HLA is a draft IEEE standard, IEEE1516
 - 18 month review process underway with anticipated IEEE approval -- **Dec 99**



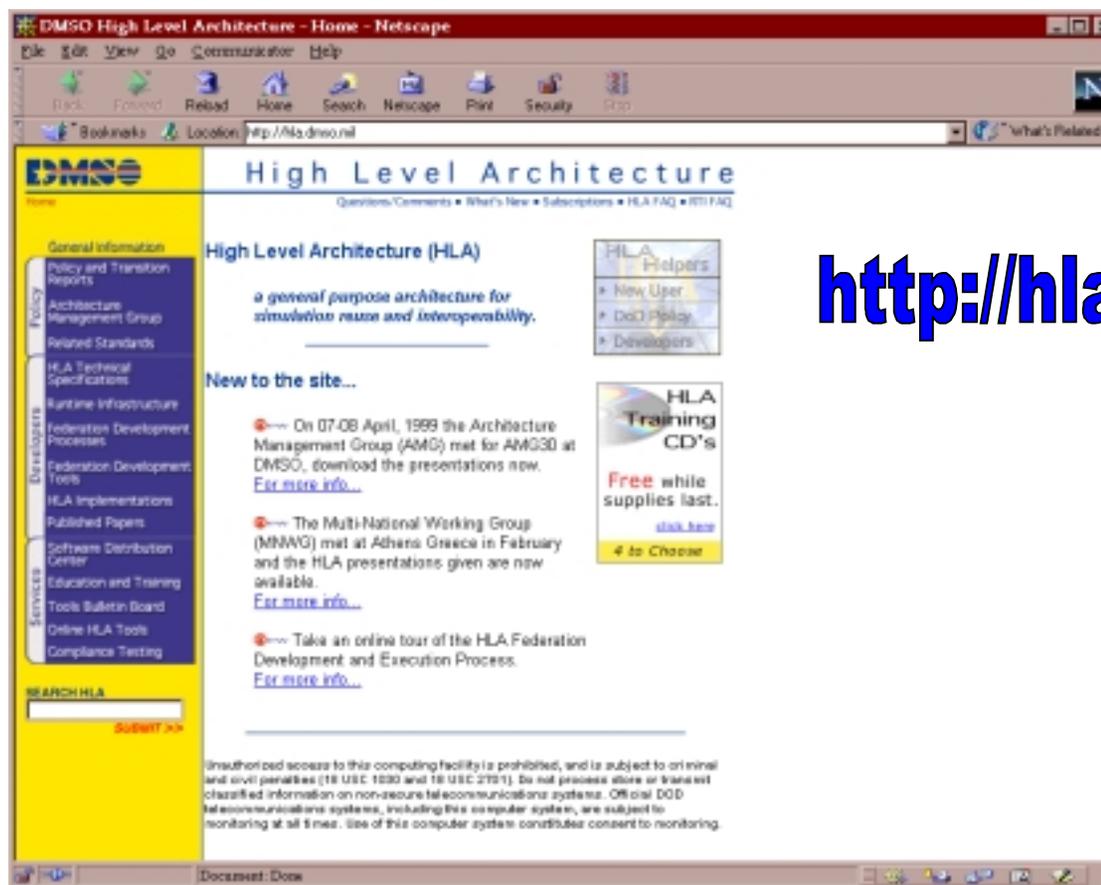
HLA User Services

- **DMSO is fostering a broad user support services to facilitate the HLA transition**
 - **DMSO HLA Home Page**
 - **HLA Help Desk**
 - **HLA Education/Outreach**



HLA User Services: DMSO HLA Home Page

- Provides full service access to the broad HLA user community
 - materials, software distribution, training registration



<http://hla.dmso.mil>



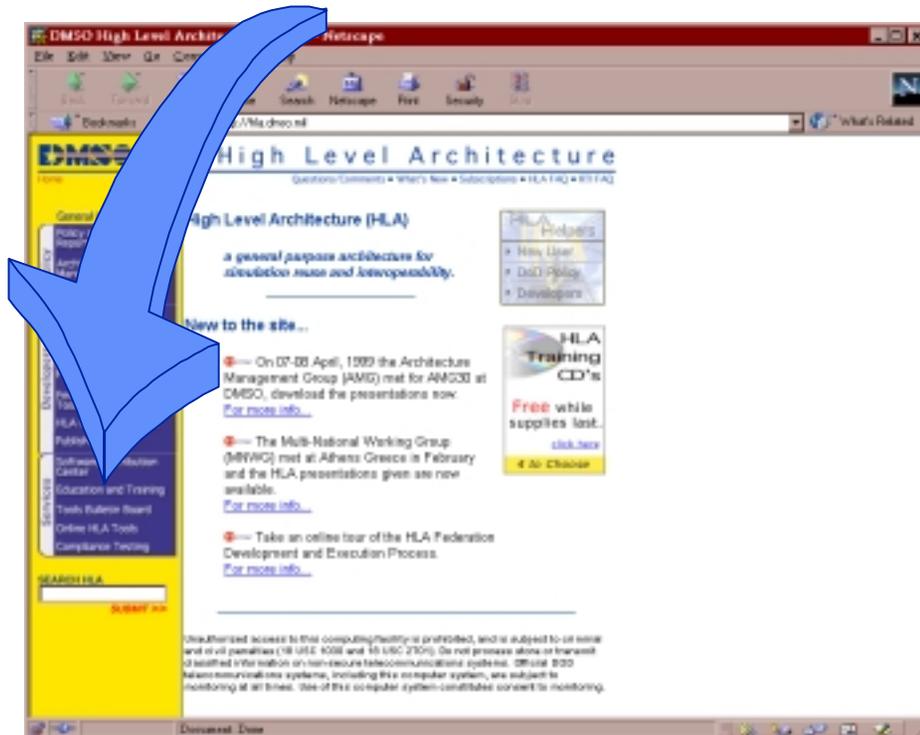
HLA User Services: HLA Help Desk

- An on-line **Help Desk** was established in May 97
 - Operated as a specialized support desk at the Modeling and Simulation Operational Support Activity (MSOSA)
- Focal point for inquiries on HLA
- hla@msis.dmsc.mil e-mail goes to the HLA Help Desk
 - directly responds to general inquiries
 - refers
 - training requests
 - policy questions
 - RTI-specific technical questions
 - logs and tracks



HLA User Services: HLA Education/Outreach

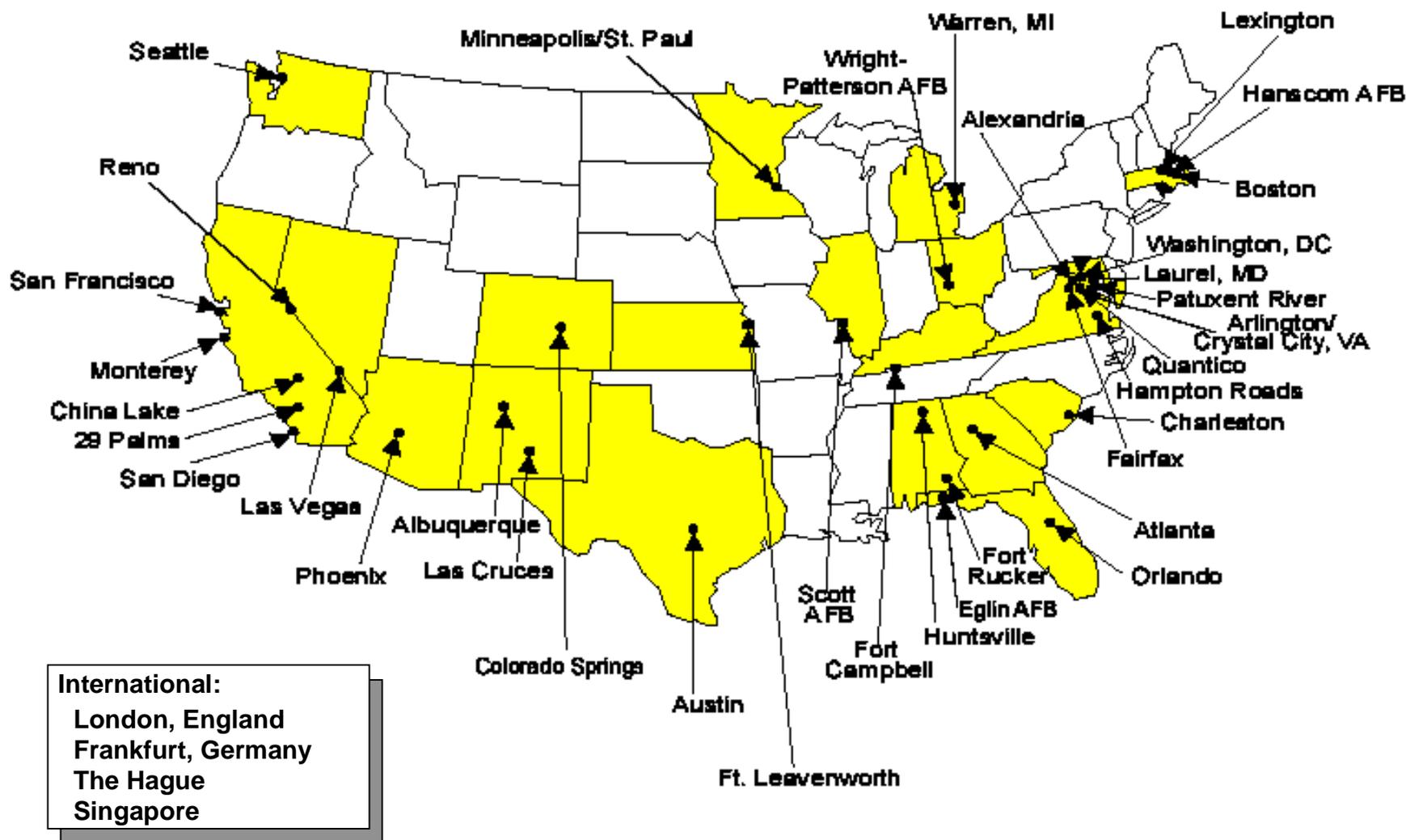
- **Integrated DMSO HLA training/outreach program is underway**
 - no cost to recipients other than TDY costs
 - register at HLA Home Page



- **Regional -- Comprehensive introduction to HLA offered monthly**
- **Focused Training -- Half day focused sessions as adjuncts to Regionals or standalone offerings**
 - HLA Compliance Testing
 - Adapting Your Simulation to HLA
 - Using Automated Tools to Develop HLA Object Models
- **Hands-on Practicum -- twice a month offerings for implementer-level training in use of HLA**
- **CD education materials to supplement HLA live training**
- **HLA Video**

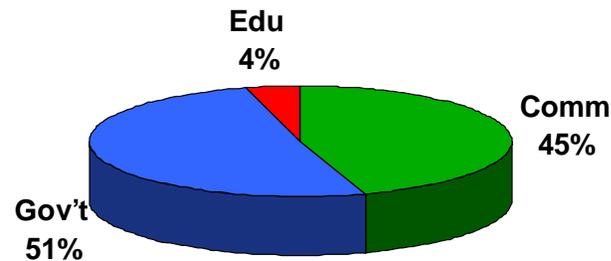
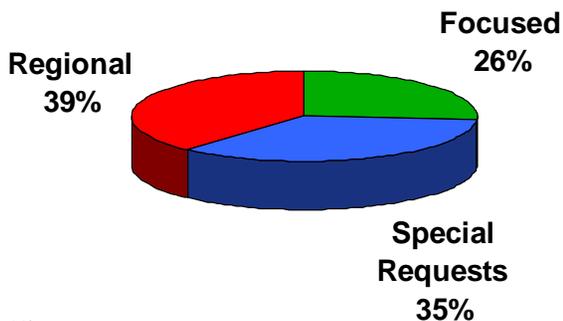
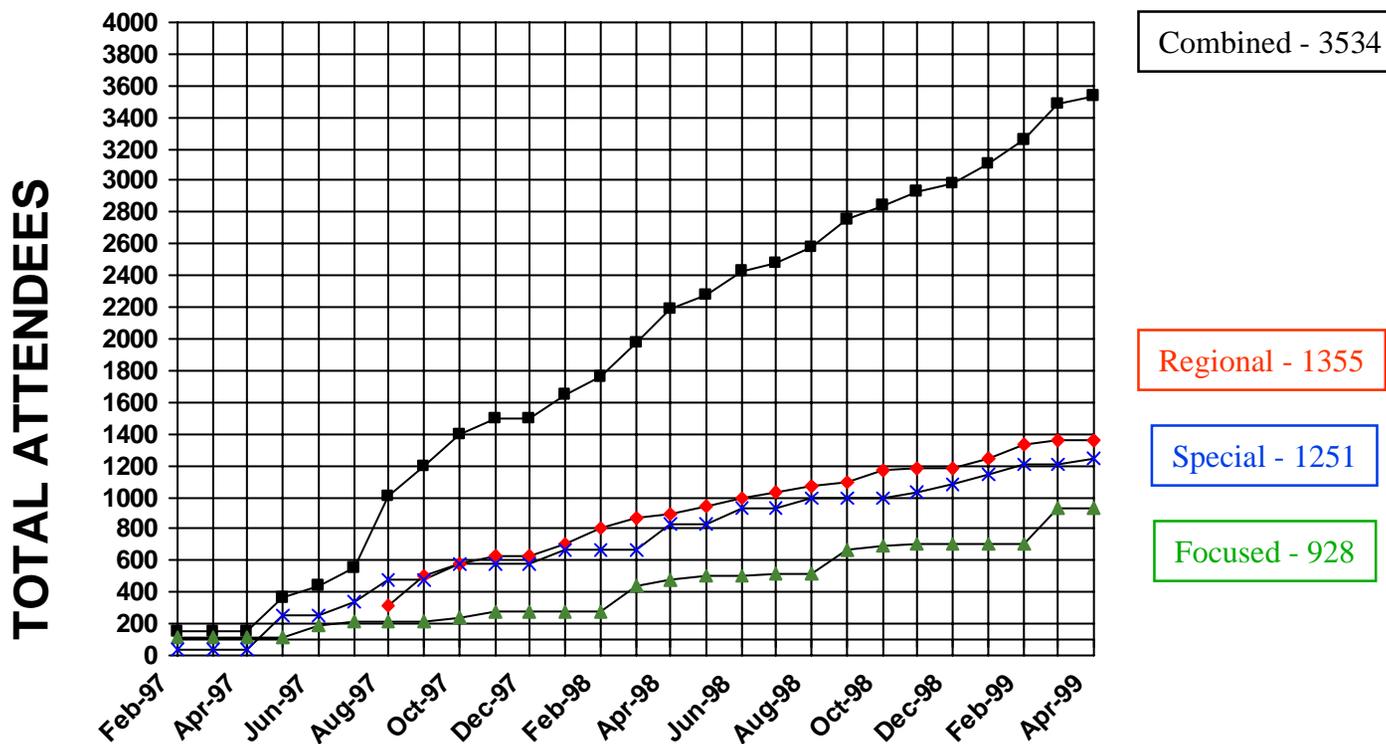


HLA Integrated Training Program Nationwide Outreach





HLA Integrated Training Program Statistics through April 1999





HLA Federate Compliance Testing

- **Compliance to HLA defined in 'HLA Compliance Checklist' and test procedures were developed with baseline definition**
- **Federate compliance testing**
 - **Straightforward, over the network**
 - **Minimal effort required by federate**
 - **A semi-automated Test Management System**
 - **Documented test process in easy-to-use guide: procedures, sizes, submission formats, examples, etc.**
 - **Web-based, on-line test preparation (for federates) and test management (for certification authority), integrated with test tools**
 - **Testing capability placed in operation 31 Oct 97**
- **RTI compliance testing**
 - **Testing system in development**
 - **First use planned for CY99**