

Common Technical Framework for Modeling and Simulations



Common Technical Framework (CTF) for M&S

DoD Modeling and Simulation Master Plan Objective 1:
“The *efficient and effective use of models and simulations* across the Department of Defense requires a *common technical framework* for M&S to *facilitate interoperability and reuse.*”

The Common Technical Framework for M&S:

- Enhances the re-use capability of simulations and components, resulting in lower development costs
- Supports interaction between simulations and real-world C4I systems.

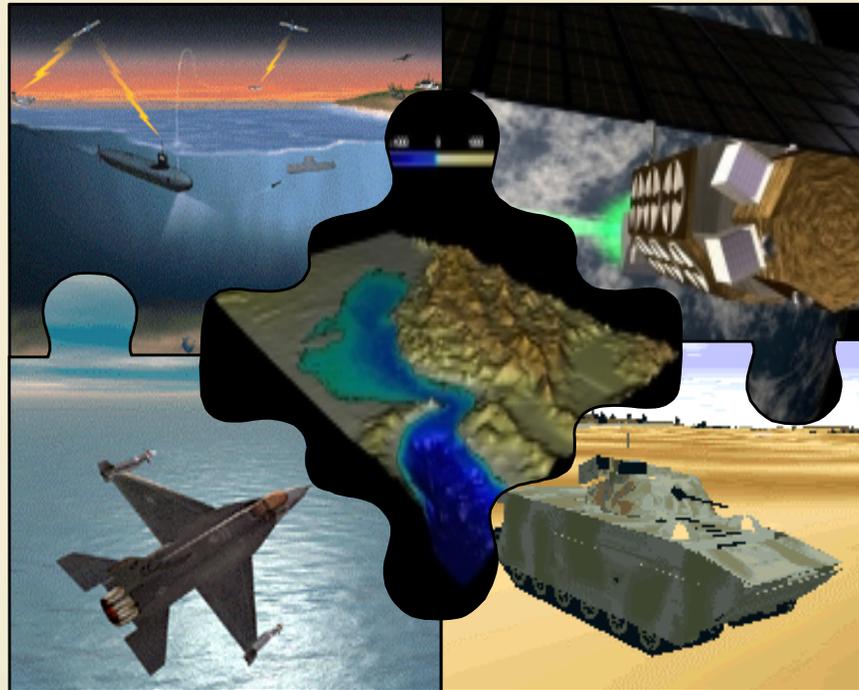
DoD M&S GLOSSARY Jan 98

www.dmsso.mil



Interoperability of M&S

The ability of a model or simulation to provide services to, and accept services from, other models and simulations, and to use the services so exchanged to enable them to operate effectively together.



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Crusader Planned Their Re-Use of M&S

Crew Modules developed early in the engineering design

Crew modules drive embedded training



Crew station trainers provide real-time training capability

Source: Crusader Simulation Support Plan

w3.pica.army.mil/crusader/

Crew stations in interactive simulations support refinement of Tactics, Techniques, & Procedures

Common Technical Framework for M&S

CTF

Conceptual Models
of the
Mission Space
(CMMS)

Data
Standards

High
Level
Architecture
(HLA)

CTF is the "Blueprint" for the technical components and infrastructure of M&S.

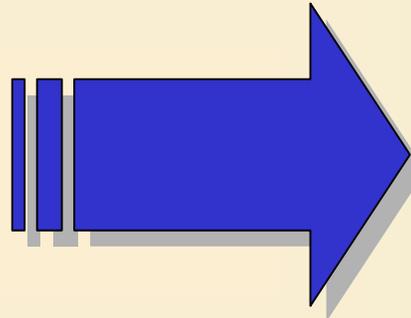
CMMS Program

A formalized system to document and store information



Warfighter Authoritative Source

**Analysis to
determine warfighter's
representation of the
operational mission**



Knowledge Engineer

Knowledge is captured in a Technical Framework:

Functional descriptions of key aspects of the real (or projected) world, including:

- *entities,*
- *processes,*
- *relationships and interactions, including environmental factors.*

CMMS Program

DMSO's Modeling and Simulation Resource Repository (MSRR) contains a library of conceptual models obtained from authoritative sources.

The PMO can:

- **review conceptual models of real systems and processes**
- **use CMMS documentation to support the development of M&S**
- **contribute project-specific input to CMMS**



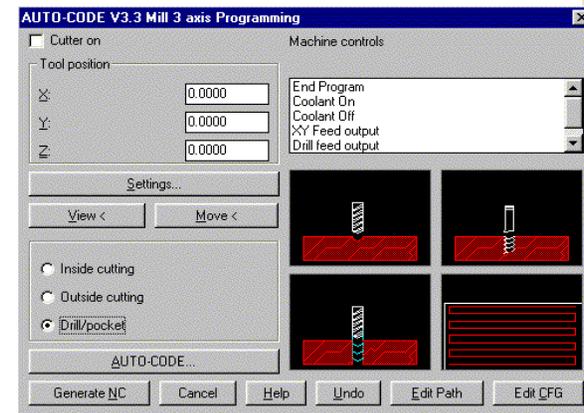
www.dmsso.mil/home/cmms/

CTF: Data Standards



Data: A representation of facts, concepts or instructions in a formalized manner suitable for communication, interpretation or processing by humans or by automated means

Data Standards: Data that has been coordinated through the standardization process and approved for use in information systems



Data Standards

Response to MSMP Objective 1-3:

“Establish Data Standards to support common representations of data in models and simulations.”

Benefits to PMO:

- Affordable and timely data for M&S use
- Verified and validated data
- Data that promotes interoperability of M&S
- Improved credibility of M&S results



Data Standards

Knowledge
Collection



P
E
D
I
G
R
E
E



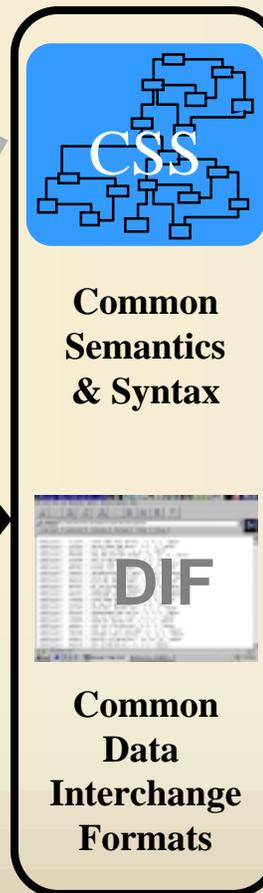
Component
Designated Sources



Subject Matter
Experts



Publications
Doctrine
Operations
Tactics



<http://dms0.mil/home/data>

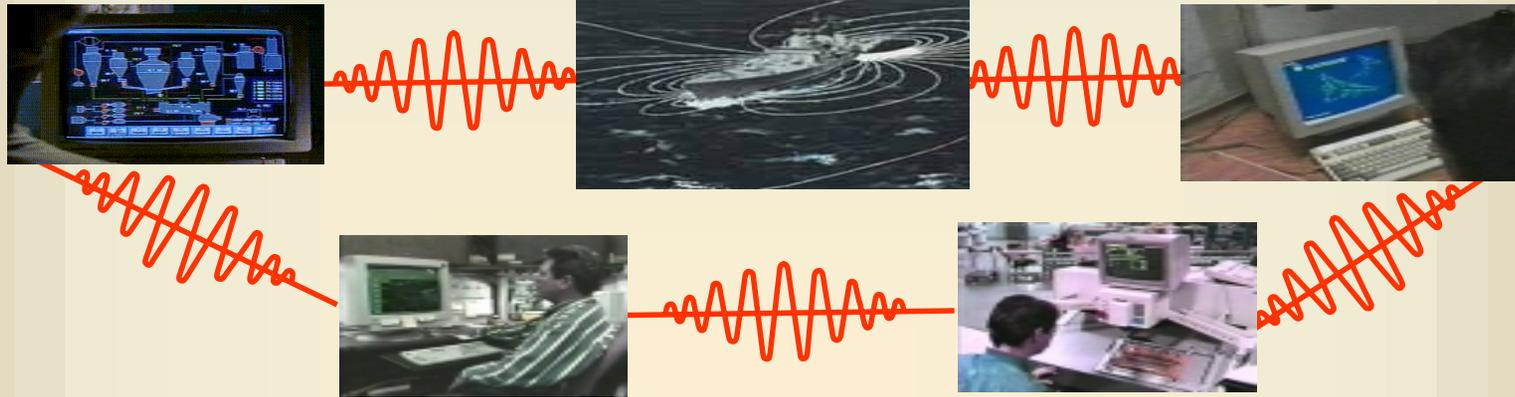


HLA Facilitates Simulation Interoperability

High Level Architecture (HLA) - 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.

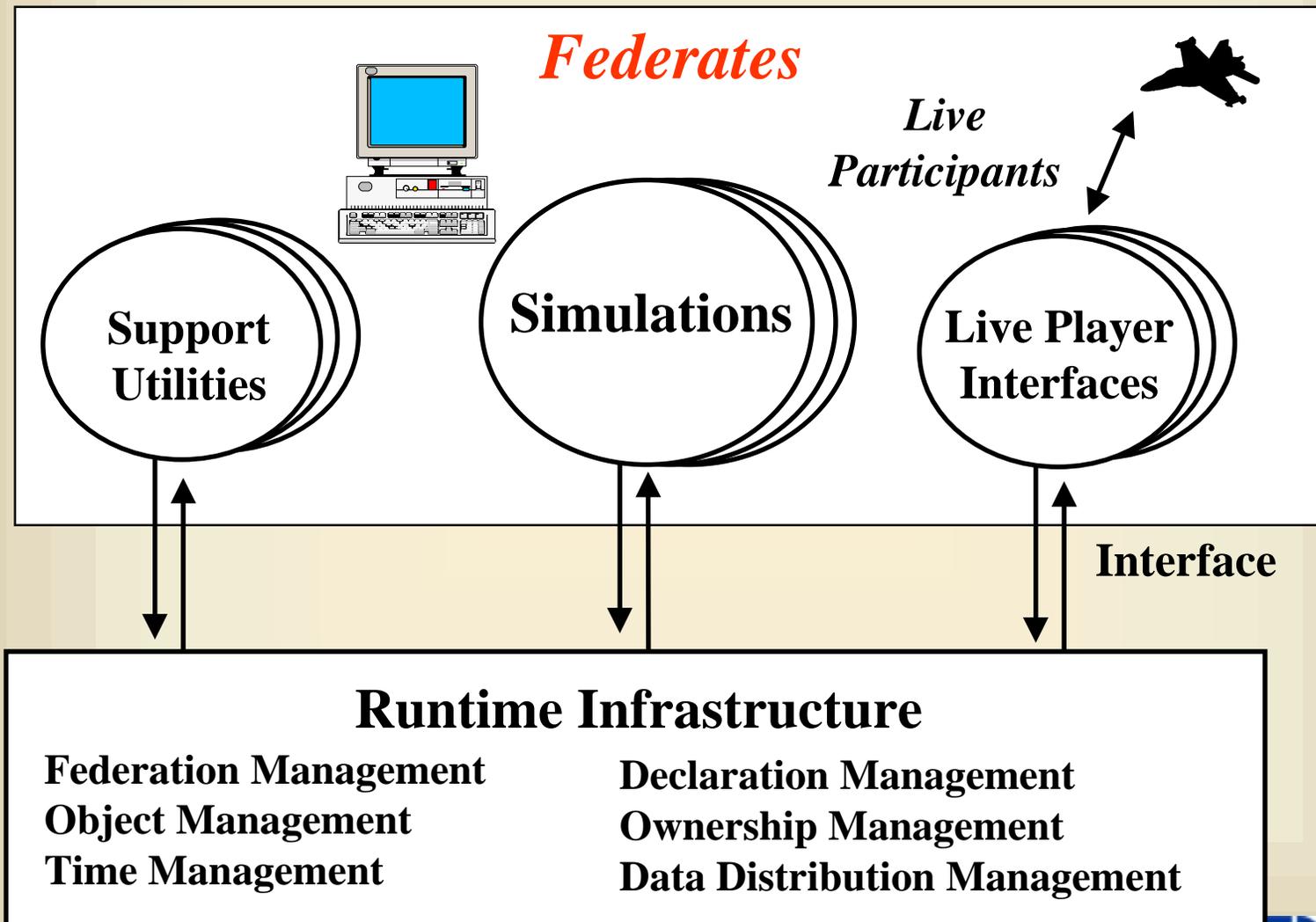
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Why HLA?



- Simulation users have different needs.
- Simulations are implemented in different computing environments.
- Different systems and their interactions must be represented at different levels of resolution and fidelity.

Functional View of the Architecture



Three Elements of HLA

HLA Rules

Designed to achieve interaction. Include responsibilities of simulations and "Runtime Infrastructure" in HLA Federations

Interface Specification

Coordinates functions and data between the Runtime Infrastructure and simulations in HLA

Object Model Template

Helps characterize each object and interaction so all participating objects understand what it can do

HLA is independent of the simulations themselves

HLA is Viewed as Part of Broader Standards

DoD Joint Technical
Architecture
(JTA)

(Included)

Object Management
Group
(OMG)

(Adopted)

Simulation
Interoperability
Standards Organization
(SISO)
for IEEE Standards

(Nominated)

North Atlantic
Treaty
Organization
(NATO)

(Adopted)



Interoperability Today Means HLA

DoD Policy: “Under the authority of [DoD Directive 5000.59], and as prescribed by [the DoD Modeling and Simulation Master Plan], I designate the High Level Architecture as the standard technical architecture for all DoD simulations.”

“No Can” Dates

- “No Can Pay” - first day of FY99
 - ♦ *No funds for developing/modifying non-HLA-compliant simulations*
- “No Can Play” - first day of FY01
 - ♦ *Retirement of non-HLA-compliant simulations*
 - ♦ *Waivers must be decided on a corporate basis*

--Dr. Paul Kaminski, USD(A&T)
10 September 1996



Support for HLA Implementation

To facilitate cost-effective implementation of HLA by program offices, DMSO HLA project provides an initial set of software tools to include:

- Run-time infrastructure software (independent of simulations)*
- Object model development tools (e.g., object model template)
- Object model data dictionary
- Object model library

*COTS tools are available

hla.dmsso.mil



Sources of HLA Compliant Models and Simulations

A list of all simulations currently HLA-compliant is
available at

http://hlatest.msiac.dmsso.mil/compliant_feds.html

This listing is updated periodically.

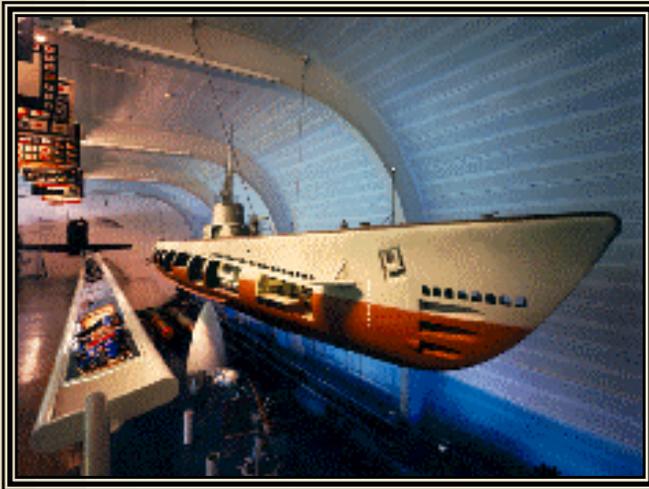


Representation & VV&A



Concept of Representation for Acquisition

Representation is not a new concept to the acquisition community!

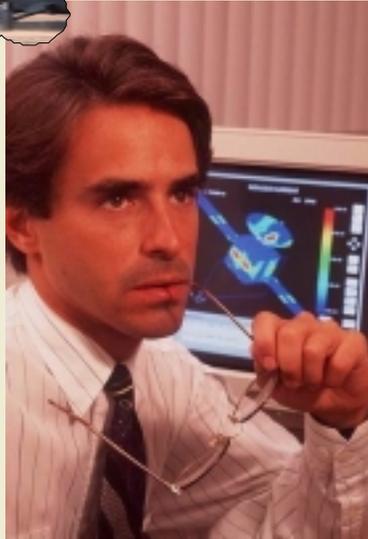


How we do representation is changing!



Representation

Careful analysis of M&S requirements focuses attention on those representations necessary for M&S credibility.



DoD M&S Executive Agents for Environment



**National Imagery &
Mapping Agency**

Terrain Modeling
Project Office (TMPO)

www.tmpo.nima.mil



**Oceanographer
of the Navy**

Technical Director
Oceanographer of the Navy

OEA function transferred to SPAWAR-185, eff 1 Aug 99
<http://rsd-www.nrl.navy.mil/OceanEA/index.html>



**Air & Space Natural
Environment (ASNE)**

Air Force Director of Weather
(AF/XOW)

Director of Operations
Air Force Weather Agency
(AFWA/XO)

Chief, Air and Space
Natural Environment
(ASNE) MSEA Office

<http://msea.afcc.af.mil>



DoD M&S Executive Agent for Intelligence



Defense Intelligence Agency (DIA)

Director, Defense Intelligence Agency (DIA)
<http://www.dia.mil>

Vice Deputy Director
for Intelligence Production
Defense Intelligence
Agency (DIA/DI-D)

Chief, Threat Systems Office,
Missile and Space Intelligence
Center, DIA

*U.S. systems representations are the
responsibility of the individual services.*



Fidelity

Fidelity is the accuracy of the representation when compared to the real world.



Joint Strike Fighter
Simulator



Joint Strike Fighter Mockup

A model or simulation is said to have a fidelity **level** based on the degree to which it accurately represents the item or experience it was created to emulate.

Resolution

Resolution is the degree of detail and precision used in the representation of real world aspects in a model or simulation.

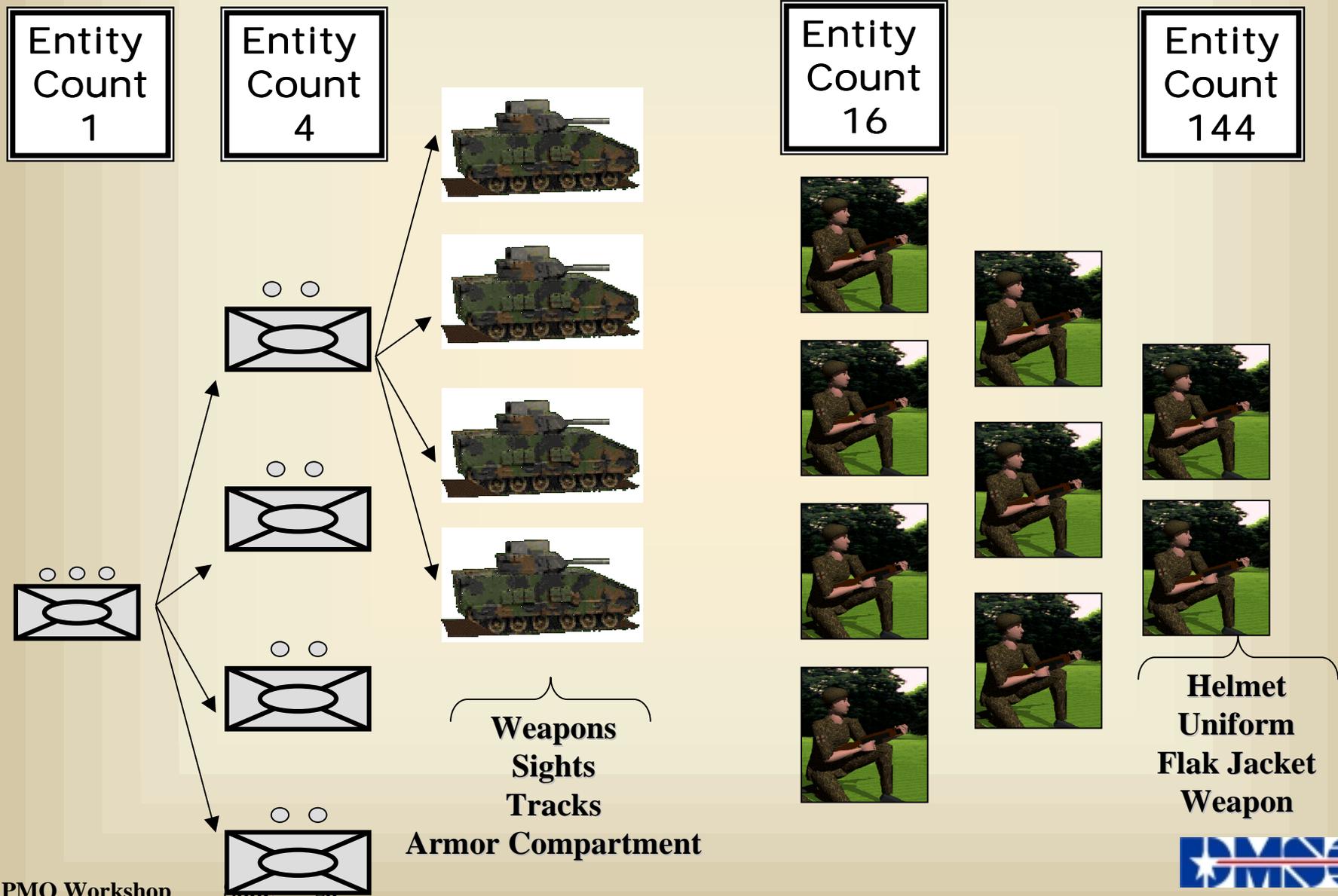


Vs



Resolution -- the fineness of detail that can be represented or distinguished in an image.

Concept of Aggregation and Disaggregation



Dependency in Representation

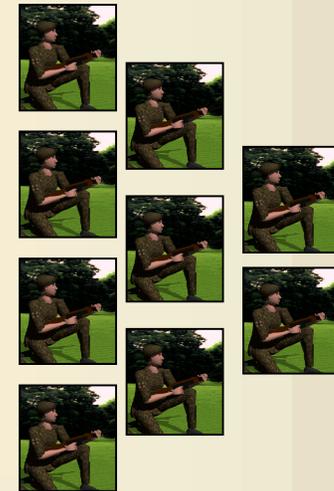
High Fidelity +



High Resolution +



Low Aggregation =



High Processing Requirements



Natural Environment for Acquisition



Real World Test Results

Testing &
Evaluation
Implications



Place Test Results in Various
Other Simulated Environmental
Conditions



Determine Performance
Capabilities Based on
Simulation Output



Determine Additional
Live Testing

Systems Representation for Acquisition

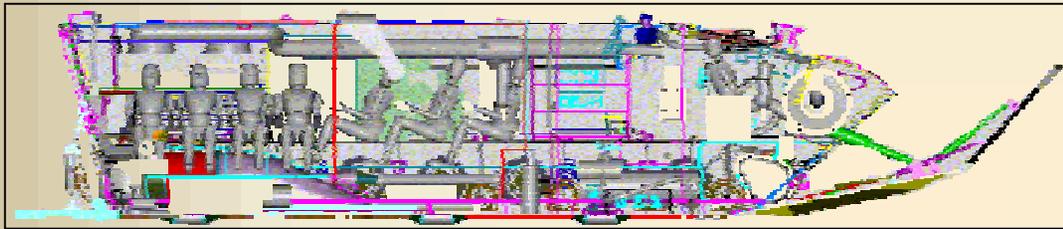
Production & Logistic Implications



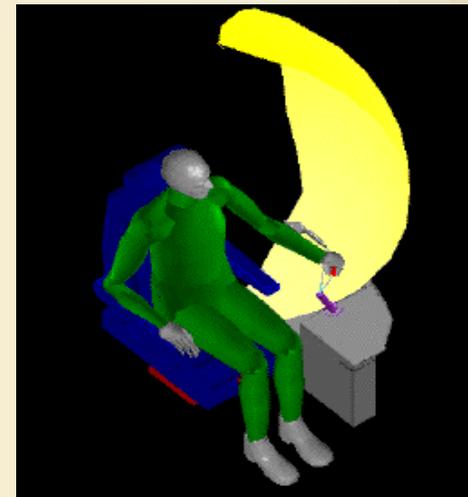
Transportation Movement Mix

Human Behavior Representation for Acquisition

Research & Development Implications



Accelerates design integration of hardware, software and human systems



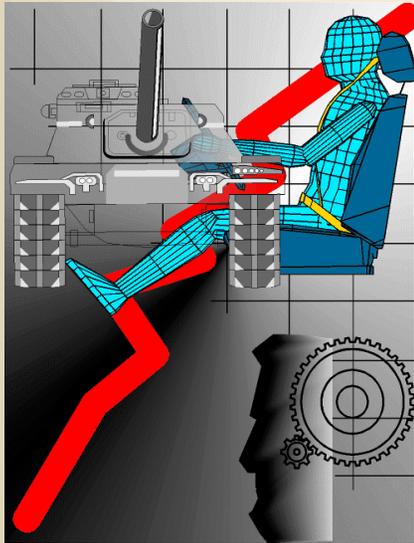
Validates human interface design

Provides visual models for understanding design

<http://www.bdi.com/index.html>

Human Behavior Representation for Acquisition

Production and Logistics Implications



Analyzes human-machine system to derive training tasks



Investigates maintainability trade-offs in early design phase

Human model interacts with solid CAD model

http://129.11.240.90/News/jack_the.html

Verification, Validation & Accreditation

Verification

The process of determining that a model or simulation implementation accurately represents the developer's conceptual description and specification. Verification also evaluates the extent to which the model or simulation has been developed using sound and established software engineering techniques.

Validation

The process of determining the degree to which a model or simulation is an accurate representation of the real-world from the perspective of the intended uses of the model or simulation.

Accreditation

The official certification that a model or simulation is acceptable for use for a specific purpose.

Verification, Validation, and Accreditation

Verification &
Validation Work



Accreditation of an
M&S **application**
(not M&S itself)

Intended Use
of M&S



Representation
Accuracy Needed

Selection
and Scope
of V&V
Tasks

VV&A effort depends on requirements
for representation accuracy and
intended use of M&S.

Verification, Validation & Accreditation

The Generic VV&A Process

- Determine VV&A requirements
- Initiate VV&A planning
- V&V the conceptual model
- V&V the design
- V&V the implementation (code)
- V&V the M&S application
- Perform acceptability assessment
- Make an Accreditation decision

VV&A Recommended Practices Guide
<http://www.dmsomil>



Verification, Validation & Accreditation

Well-planned and responsively executed V&V reduces the risk of reliance on M&S to support major program decisions

The issue is not the cost of V&V, but rather the cost of NOT doing V&V.

www.dmsso.mil/home/vva/



Verification, Validation, and Accreditation

M&S is invaluable when it catches a situation that would have undermined system behavior.



A virtual simulation discovered a program in the F-16 that would cause the aircraft to flip over whenever it crossed the equator.

Verification, Validation & Accreditation

M&S is a potential source of disaster when it fails to catch situations that will undermine system behavior; especially if its apparent success promotes false credibility.



Colorado dam model that miscalculated how much water should be stored and the resulting flood process. Resulted in six deaths and a large amount of property damage.

For additional info see JASA website:
<http://www.nawcwpns.navy.mil/~jasa/>

Planning and Contracting for M&S Support



Successful M&S Planning Principles

Successful M&S support planning requires an *integrated team* effort.

Where possible, M&S support planning activities should *be inherent acquisition planning activities*.

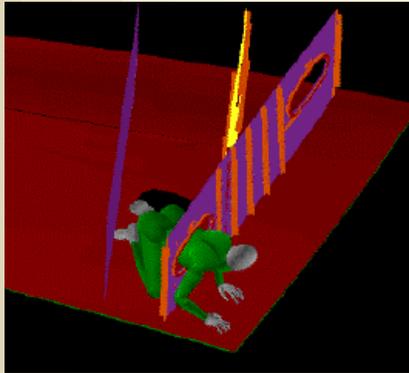
This integration provides the capability to *link acquisition activities with* related *M&S activities*.

Selection of an *M&S Planning Methodology* should allow the planner to start from a *"big picture" perspective* and work successively into the details of the actual data produced from the M&S that support acquisition program decision-making.



Funding Considerations

Weigh benefits of M&S against the investment cost in M&S.



“Dual - Use” of Technology (military and private sector) will decrease cost

“Off-the shelf” software

The cost of M&S can be shared. Articulate who is expected to accomplish which tasks and provide which resources.



New Attack Submarine

M&S Re-Use will promote cost-sharing among functional areas of acquisition program

Planning Considerations

Is strategic M&S support planning being conducted, and documented in an M&S support plan?

How is the M&S management function organized?



Is M&S support infrastructure linked to acquisition products?

Are M&S needs highlighted in the solicitation as a separately evaluated element?



Is M&S planned throughout the acquisition process?

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Planning Considerations

An effective M&S Support Plan should address the following issues:



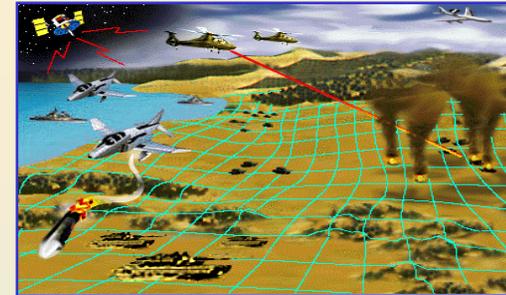
Conducting VV&A of the models used for program decision-making



Integrating M&S applications throughout program planning activities and functional disciplines



Re-using M&S throughout the life-cycle

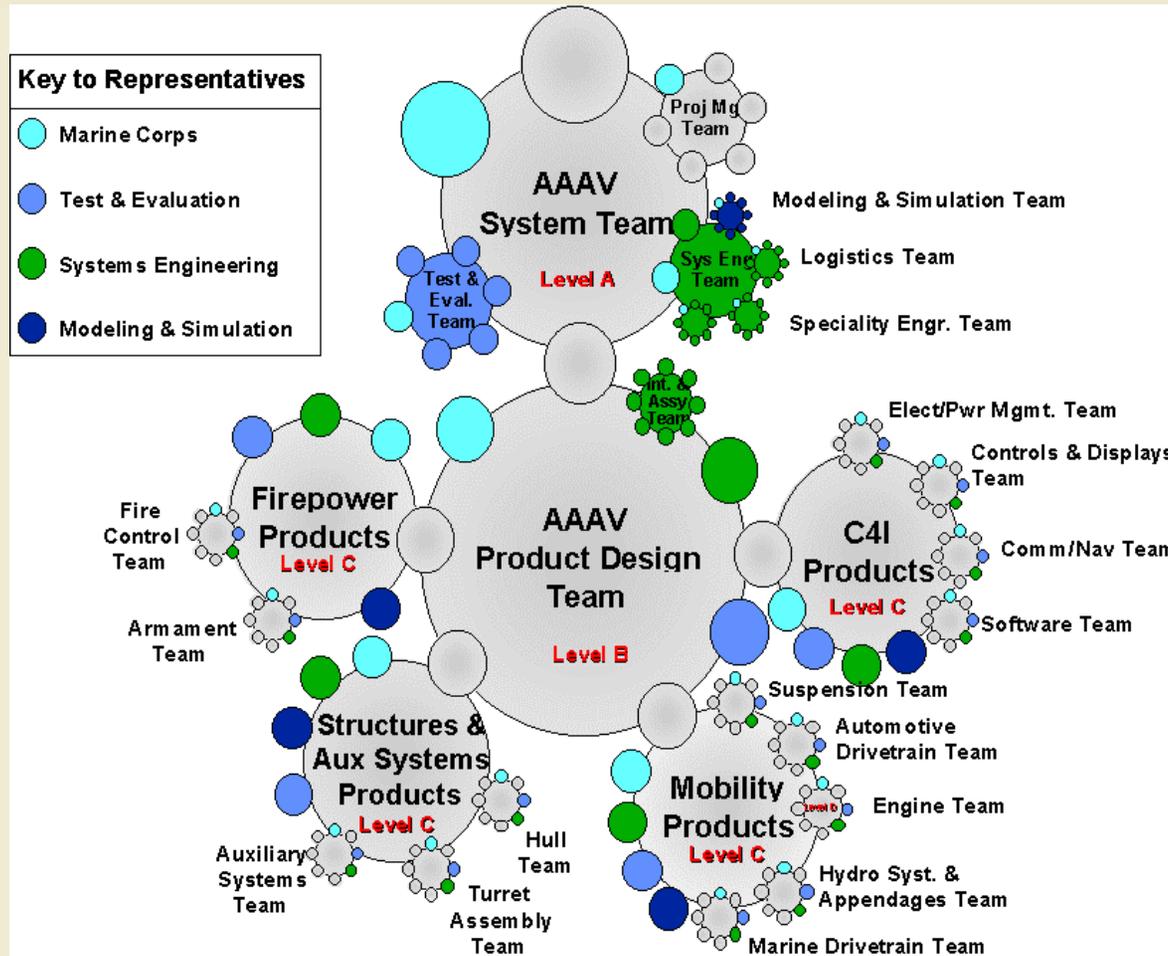


Re-using and supporting M&S resources in other programs

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Organizing the M&S Team



The Advanced Amphibious Assault Vehicle (AAV) Example

www.acq-ref.navy.mil/ipt/html/iptgif13.htm



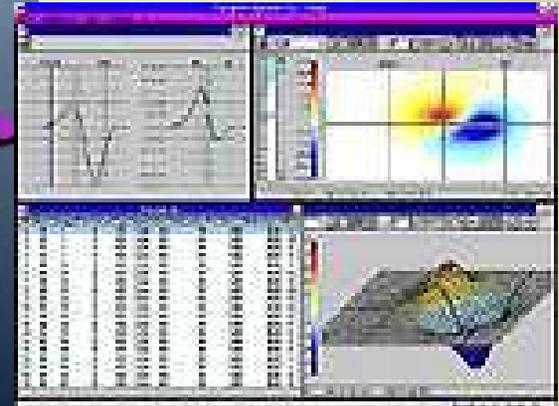
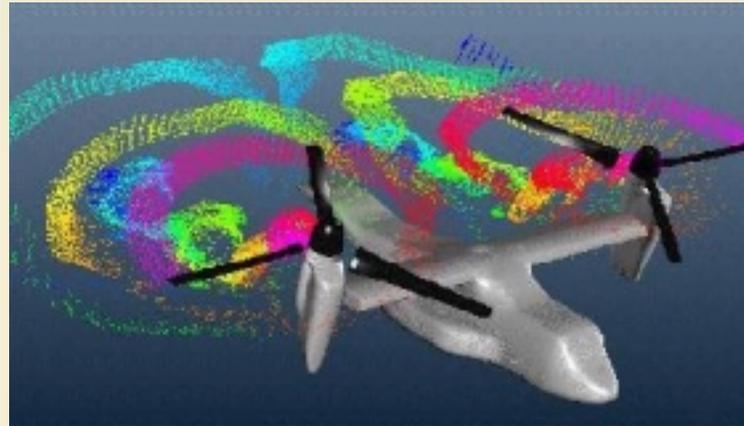
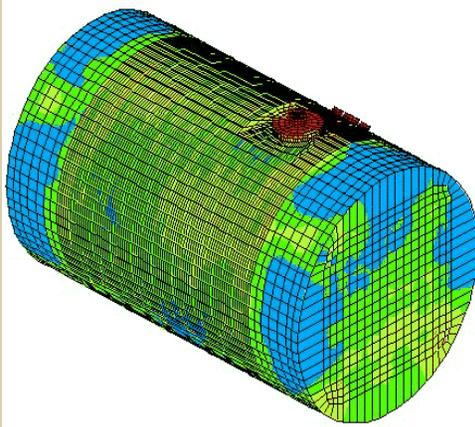
Example of the Army's Simulation Support Plan (SSP) Format

1. Purpose
2. Executive Summary
3. System Description
4. Acquisition Strategy - M&S Synopsis
5. M&S Strategy - M&S Used to-date, Future Simulation
6. Related Simulation Activities
7. Management
8. Facilities & Equipment Requirements.
9. Funding
10. Supplemental Information
11. Appendices
 - Program Schedules
 - M&S Schedules
 - Acronyms & Abbreviations
 - Related Standards
 - Related Government Documents

DA-Pam 70-3



Contracting for M&S



Answer these questions before you decide to contract for M&S:

- What are my M&S needs?
- Where can I get help?
- How do I word the RFP?
- How do I evaluate the contractor?
- Do I have the necessary expertise to develop this M&S in house?

If you decide to use a contractor for M&S, be aware that you may have to:

- Accept M&S that has limited re-use and is not fully interoperable
- Rely heavily on a contractor
- Pay a high price for software/data rights
- Include HLA compliance

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Contracting for M&S

Contracting for M&S is a continuous process which should consider the following:



Technology refreshment

<http://www.dtic.mil/techtransit/>



Impact Assessment

<http://www.msiac.dmsomil/ia/default.asp>



"Lessons Learned"

<http://www.acq.osd.mil/dsac/>

*The planning and management of M&S
does not end upon contract award.*

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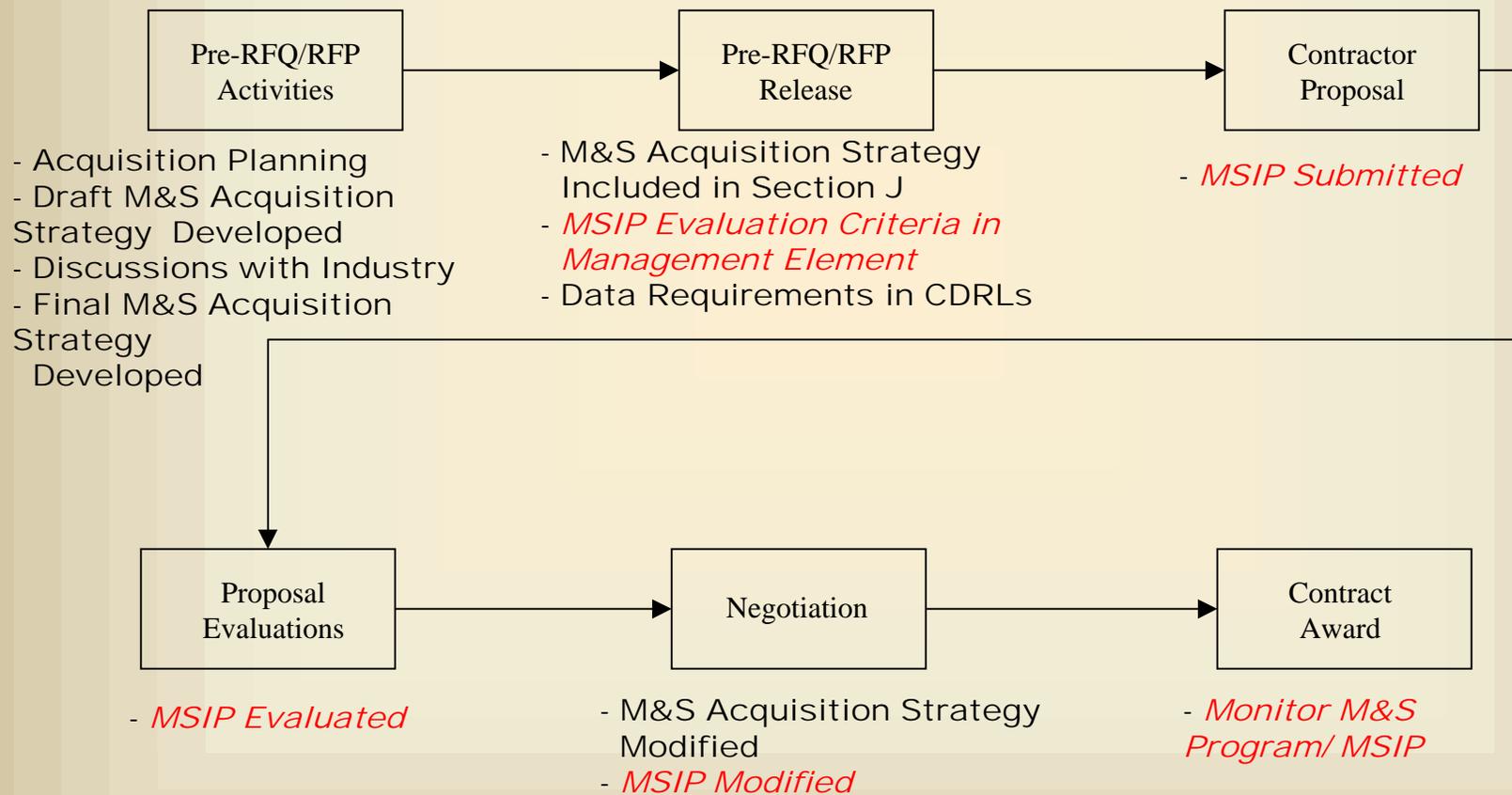
Contracting for M&S

Modeling & Simulation Implementation Plan (MSIP)

- “MSIP” is a *Contractual Document*
- *Prepared by the contractor* as part of the proposal process
- *Responds to M&S requirements* specified in the solicitation
- Describes ways to apply M&S throughout the life of the contract in support of various acquisition activities
- *May propose an environment* that emphasizes reuse and interoperability
- *Living document.* Permits flexibility to evolve models and simulations as systems design matures and new technology becomes available
- MSIP evaluation criteria included in Management Element of RFP/RFQ



Contracting for M&S in the Acquisition Process



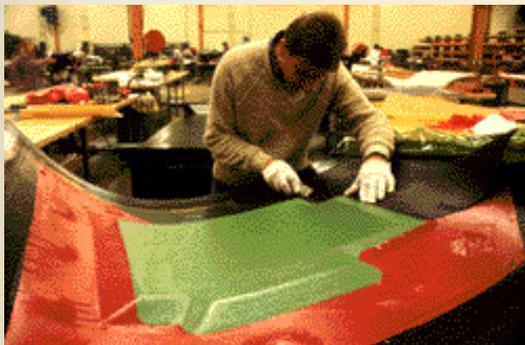
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Contracting for M&S in the Acquisition Process

Source Solicitation

Ensure that the technical approach facilitates M&S use.



Make M&S an explicit element of the source selection plan.



Encourage innovative use of M&S by contractors in the "Instructions to Offerors" section of the solicitation.

Provide positive incentives in the "Evaluation Criteria" section of the solicitation.

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Contracting for M&S in the Acquisition Process

Potential Source Selection Criteria



A business case is established for using M&S across phases and across programs.



The proposed M&S infrastructure fully supports M&S and Acquisition policy.



M&S are applied early in the design and development process.



Re-use and interoperability opportunities are identified.

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Summary

- M&S can support acquisition tasks in all phases of the acquisition cycle
- Challenges accompany the use of M&S in achieving cost and schedule cuts and to support SBA
- Recognize how your program can use and contribute to the Common Technical Framework for M&S
- Understand the V&V process and how VV&A establishes credibility for M&S usage in support of your program
- How an effective M&S plan establishes a basic approach for M&S use throughout all phases of the acquisition program

