

Subject Matter Expert (SME)/Peer Use in M&S V&V

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Why Is SME Use Important?

SMEs play important roles in simulation planning & design – cannot use verification techniques or data comparison in this phase of simulation development

Few significant simulations are used in such data rich environments that comparison of simulations results and data **alone can provide adequate validation information – usually SME assessment is also required (to create appropriate context perspective if for no other reason)**

SME usage has much room for improvement.

Topics

Dale Pace

- ◆ **Introduction & Presentation Scope**
- ◆ **SME Definition**
- ◆ **SME Usage**
 - ◆ **Varieties of Simulation VV&A SMEs**
 - ◆ **SME Selection**
 - ◆ **SME Management**
 - ◆ **SME Reviews**
 - ◆ **Common SME Problems**
 - ◆ **Resource Considerations**

Jack Sheehan

- ◆ **Knowledge Production Using SMEs**
- ◆ **Key SME Issues**
- ◆ **Research Needs re SMEs Use in V&V**

Both Jack & Dale

- ◆ **Conclusion**

Presentation Scope

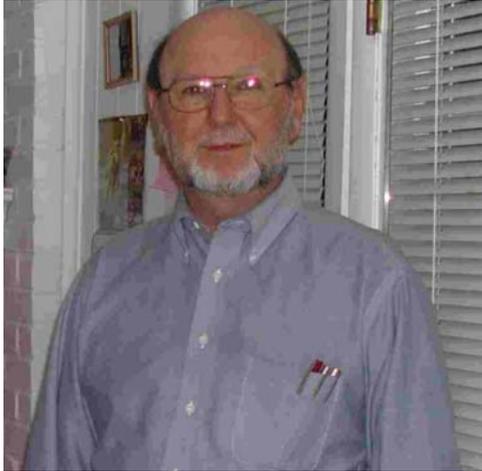
- ◆ **Important Information Sources**
- ◆ **Author Background – Who We Are**
- ◆ **What SMEs Are & How to Use Them Effectively in M&S V&V**
- ◆ **Knowledge Production Using SMEs**
- ◆ **Key SME Issues**
- ◆ **Research Needs re SMEs Use in V&V**
- ◆ **Conclusion**

Important Information Sources

- ◆ **DoD RPG for M&S VV&A**
- ◆ **Expert Qualifications & Testimony**
 - Rule 702 (Testimony by Experts),**
 - Rule 703 (Basis of Opinion Testimony of Experts),**
 - Rule 705 (Disclosure of Facts or Data Underlying Expert Opinion), and**
 - Rule 706 (Court Appointed Experts)**

in Federal Rules of Evidence
and discussions of them
- ◆ **Experiment using SMEs as data surrogate (oriented toward JWARS)**

Authors' Backgrounds



Dale K. Pace

- Led V&V reviews with SMEs
- Taught VV&A short courses
- VV&A leadership roles

Navy IPG, DIS, DMSO TST/TWG,
MORS SIMVAL99, Foundations '02

Jack Sheehan

- Knowledge Integration PM
- DMSO FDMS & DOTE



What Is a SME?



SME:

*An individual who, by virtue of position, education, training, or experience, is expected to have **greater than normal expertise** or insight relative to a particular technical or operational discipline, system, or process, and who has been **selected** or appointed to participate in development, VV&A, or use of a model or simulation.*

Contrasting “SME” Connotations



SME

Technical Qualifications

Vested Interests

Technical Expert

Can communicate to lay folks

Peer Review

Requires independence

Varieties of V&V SMEs

- **Requirement Validation SMEs**
- **Verification SMEs**
- **Validation SMEs**
 - **Conceptual Model Validation SMEs**
 - **Results Validation SMEs**

Non-V&V SMEs: **Domain Expertise SMEs**
Simulation Development SMEs
Simulation Application SMEs

Domain Expertise SMEs

After requirements are set for the simulation, authoritative information about the application domain supports development of a simulation conceptual model

Domain Experts provide that authoritative information about the application domain (Jack to say about this):

Challenge:

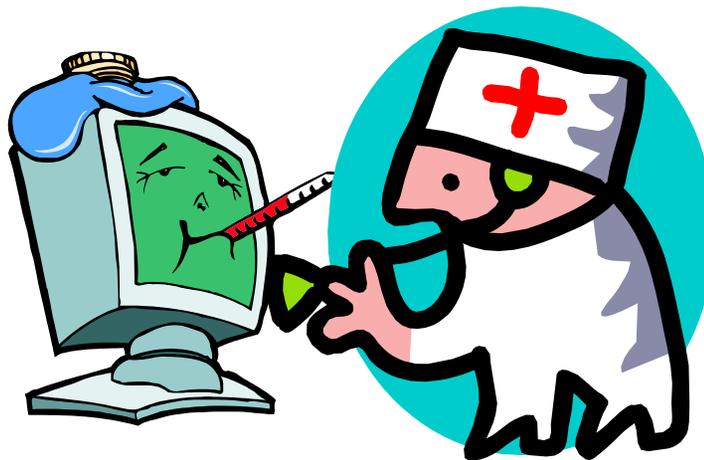
1. how to extract that knowledge & organize it appropriately – especially to support reuse of that knowledge
2. How to ensure that the knowledge is extracted correctly

Simulation Development SMEs

Helpful if SMEs have experience in similar applications

Provide advice about hardware, software,
architecture, algorithms

Review plans, designs, and implementation

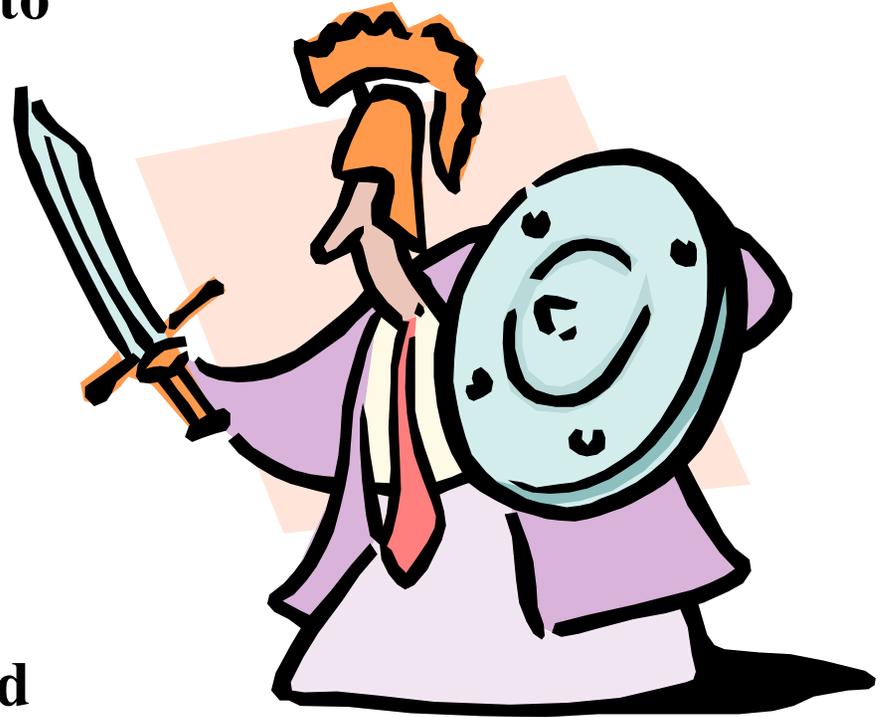


Simulation Application SMEs

In this arena, SMEs help focus on critical issues and help to identify ways to improve simulation credibility

SMEs need:

- **experience in the kind of application, and**
- **connections with expected users/consumers of simulation results**



Requirement Validation SMEs

Requirements need to be **correct, complete, consistent, and stated properly** in ways that facilitate their automated checking and tracing to simulation design & implementation.

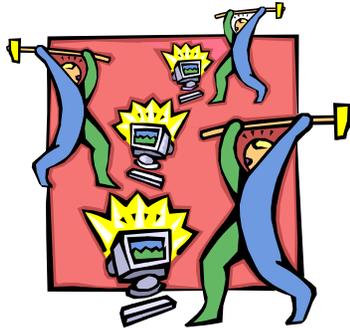
SMEs usually are not brought in early enough to prevent unnecessary problems caused by inappropriate requirements.



Bad Requirements

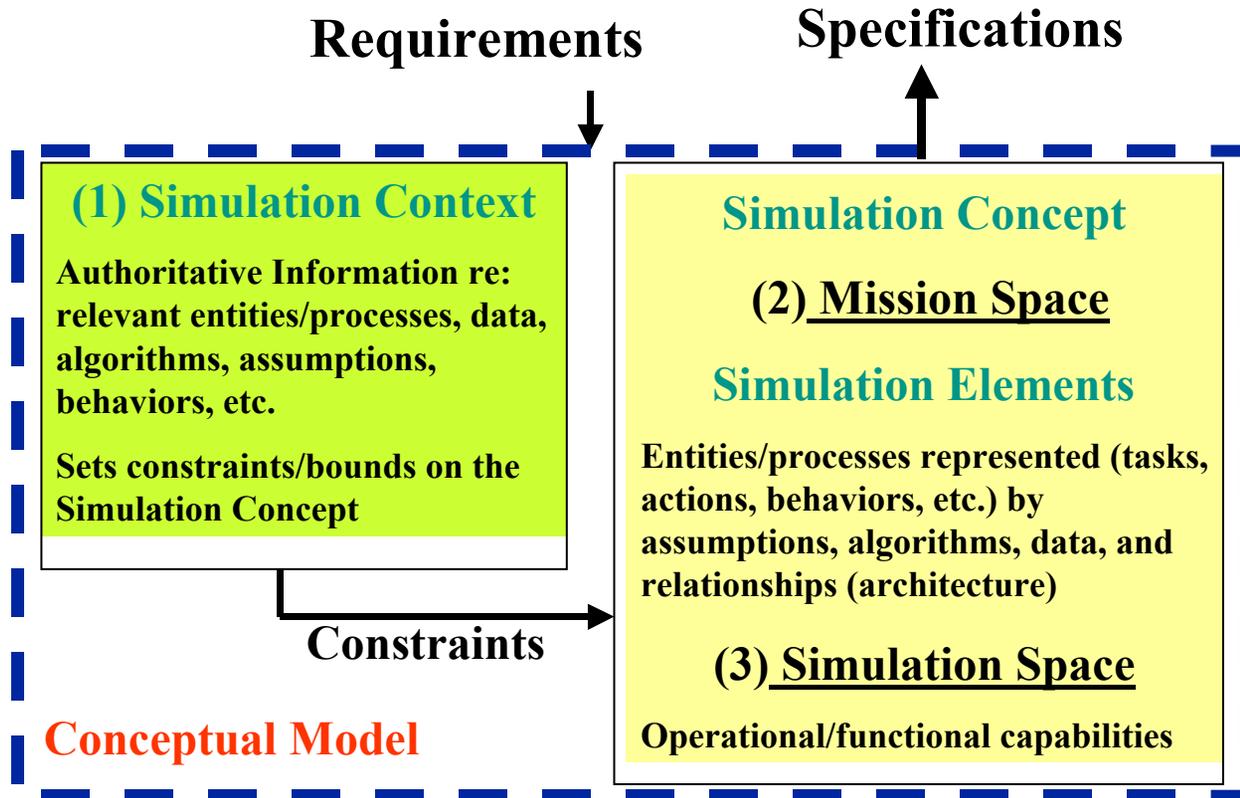
Verification SMEs

Unfortunately many M&S V&V personnel are not expert (and some are not competent) in many areas of verification technology – SMEs can help with selection of CASE tools and employment of specialized techniques important with formal methods, adaptive processing, statistical evaluations, etc.

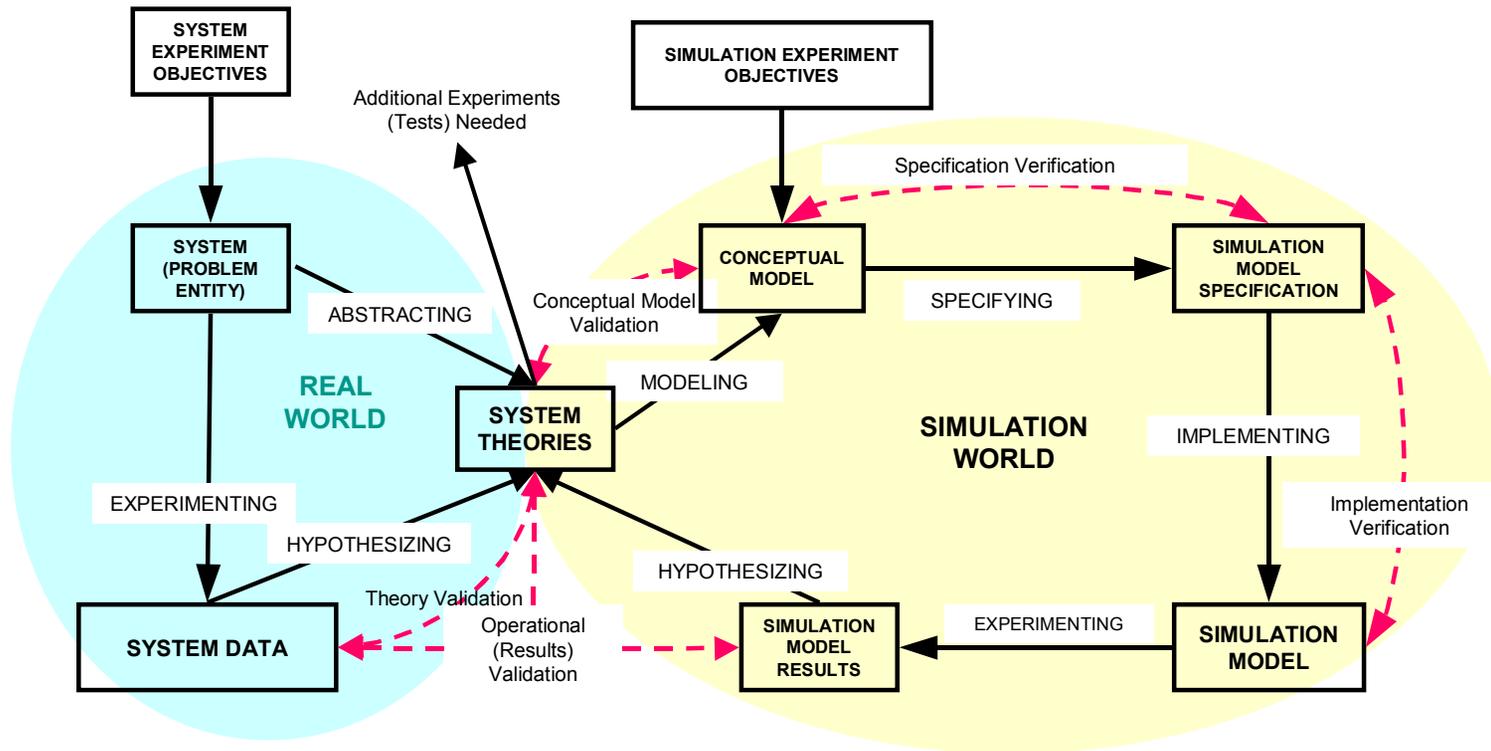


Conceptual Model Validation SMEs

Simulation Conceptual Model Components



Real World & Simulation World Relationships in Developing System Theories and Simulation Models with Verification and Validation (V&V) -- additional explanation in annotation



Notes:

Experiment objectives should derive from validated requirements

Dotted red implies comparison, assessment, or evaluation

Validation is always relative to objectives/requirements/intended use

Diagram developed & copyrighted by Robert G. Sargent (Syracuse U) Jan 01

Results Validation SMEs

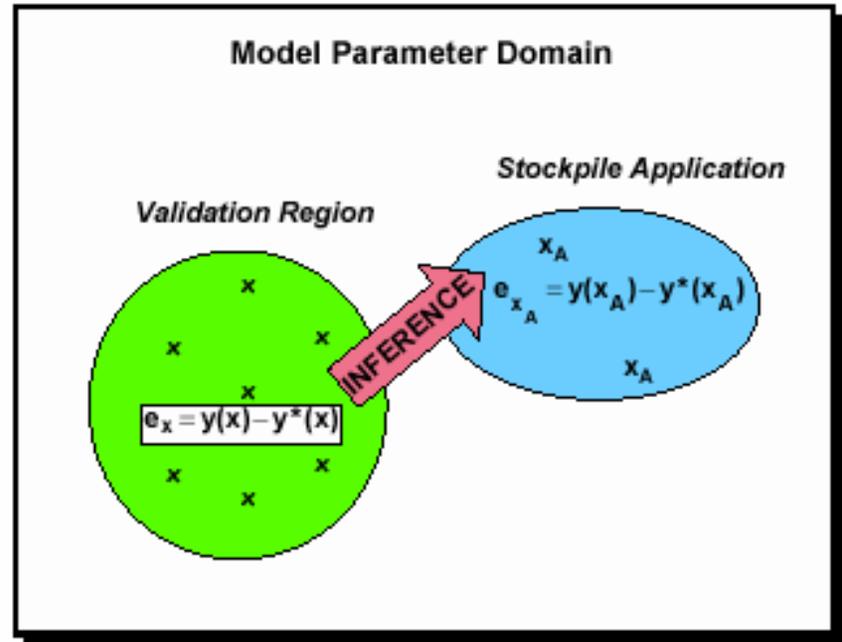
Multiple Roles

Input data assessments

Qualitative assessments

Qualitative assessment as surrogate for quantitative

Quantitative assessments



Context development for perspective

SME Selection

Answer *Why* first, then *Who*

Desired SME Attributes

Adequate independence for honest & candid evaluation

Competence & recognition of competence

Trusted by the simulation developer

Good judgment

Proper objective

SME Management

SME Nomination Forms

SME Orientation:

General Information

Review Perspective

Review Process

Special Topics

SME Tracking Databases

Combining Reviews from SMEs

SME Nomination Forms

Function:

- Determine/document SME qualifications
- Indicate SME personal attributes

Typical Contents:

- *SME Contact Information*: name, organization, position, address, phone/FAX, email, etc.;
- *SME Qualifications* (re potential areas of use): education, experience, positions, etc.;
- *SME Simulation Knowledge* (of the simulation in question and of simulation in general);
- *SME Availability*; and
- *Other Information* of possible pertinence.

SME Reviews

Establish Process & Guidelines

Information to be used

How information is to collected/assessed/processed

Who has opportunity to participate/interact

Review Reports

“Informal” response by simulation developer prior to report finalization is very useful in many ways

Review Scheduling

Combining Reviews from SMEs

Give priority to most expert SME in the particular topic where differences occur

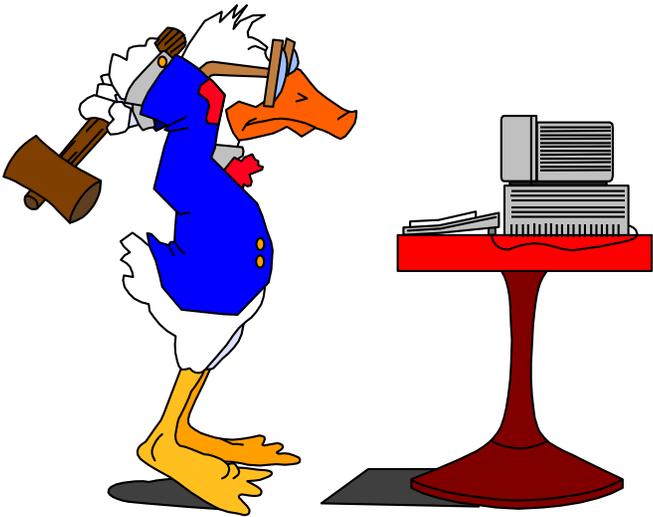
Emphasize reviews with more substantial factual & logical evidence

Ensure SME assessments actually address the same situation

Include all SME perspectives in the report, even those that are contrary to the report's conclusions

It is helpful to include info re SME qualifications

Common SME Problems



Perspective Problems

Performance Problems

Perception Problems

Perspective Problems



**SME assessments must
relate to simulation
intended use & purpose**

**“Hidden agendas” must
be avoided**

Performance Problems



SME capability & willingness to comply with specified review processes

Adequate time to perform expected review

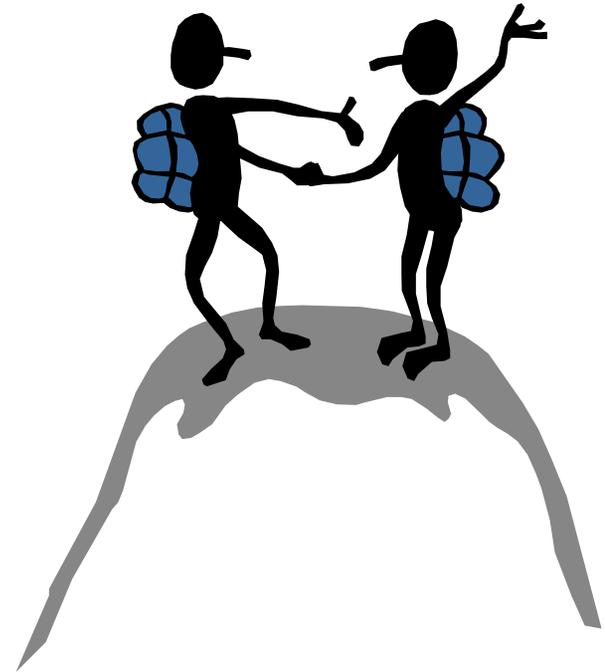
Availability of required information in appropriate format

Perception Problems

Suspicious about SME competence or agenda

SME relationship with sponsor and other influential parties

SME nomination forms and assessments which are factually and logically sound help to overcome perception problems



Resource Considerations

Who pays for V&V SMEs?

Simulation developer or user?

Those with vested interests?

How much is needed for SMEs?

Inadequate accounting of M&S development or use costs to allow factual basis for “normal” V&V costs (or SME costs)

SME amount depends upon importance of the M&S application and available of data for comparison in results validation

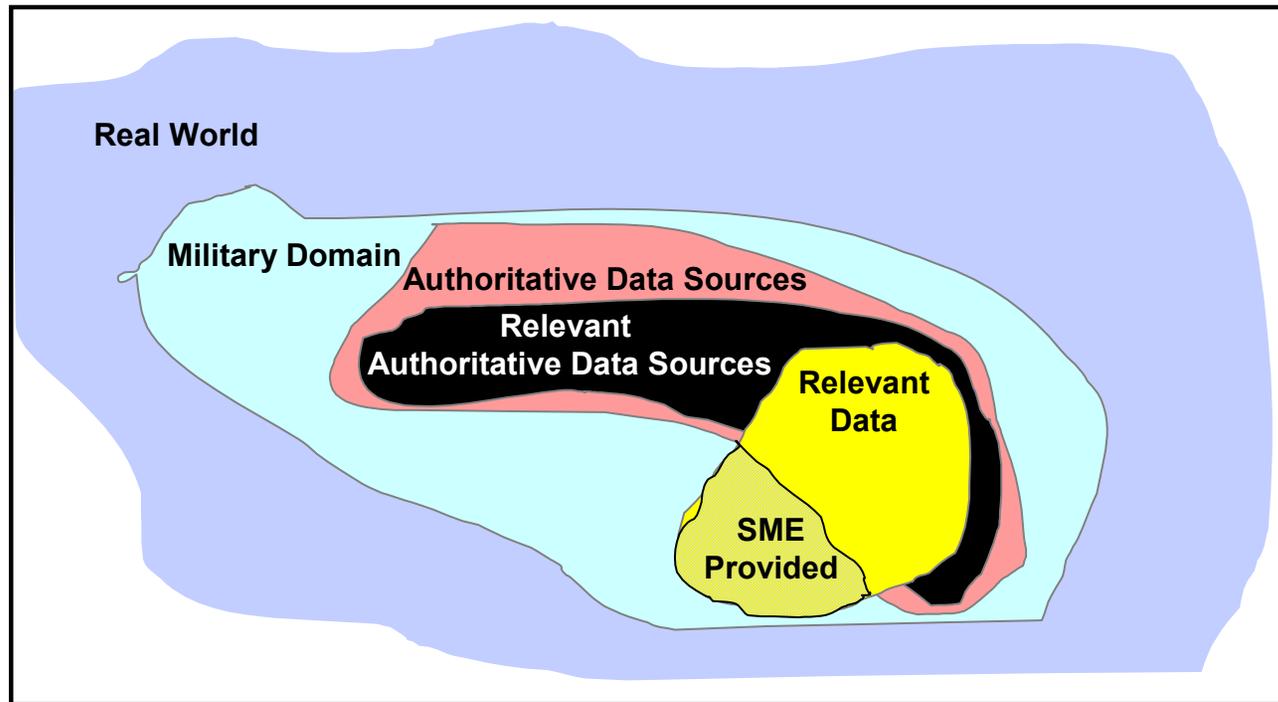


Switch Presenters

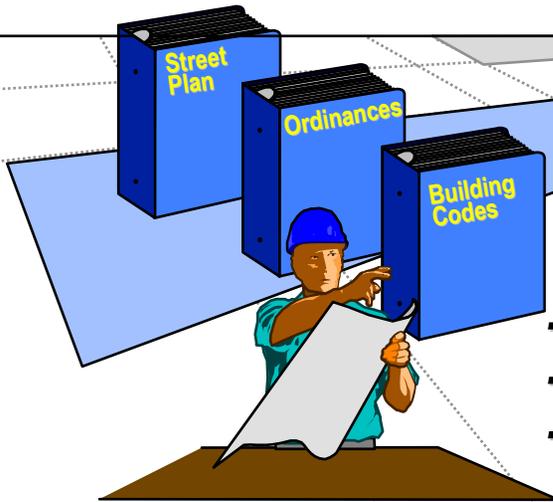
**Change focus
from SME selection & management
to knowledge extraction from SMEs**

Knowledge Production Using SMEs

Finding the Right Stuff:
One Small Part of
the Universe of Knowledge

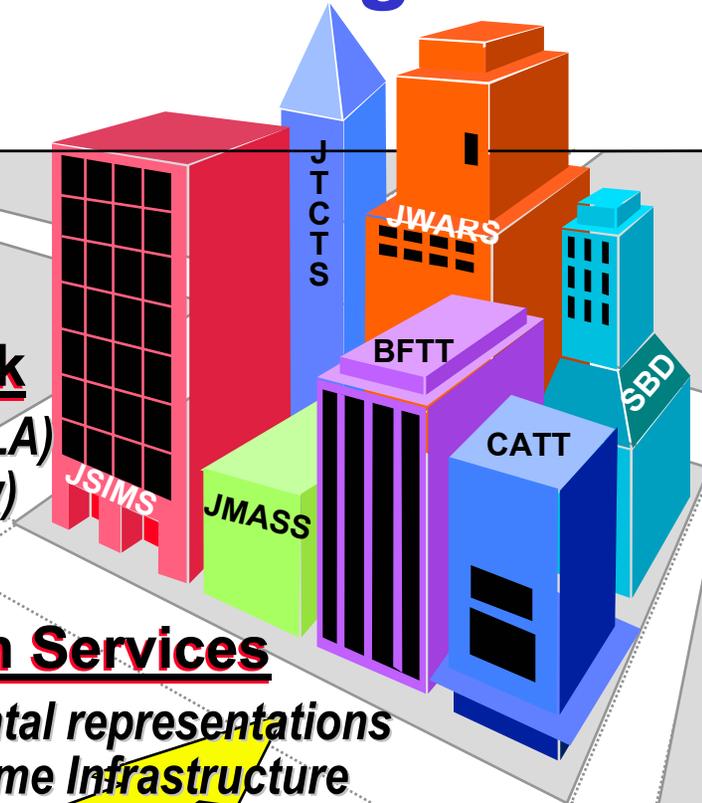


DMSO M&S Strategy: An Analogy to City Planning



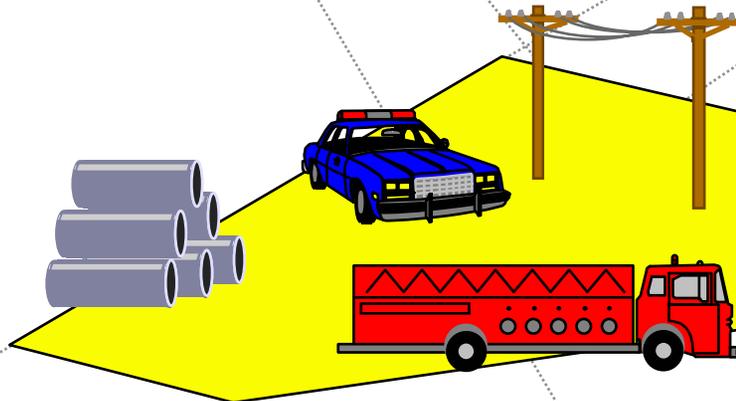
Technical Framework

- High Level Architecture (HLA)
- MDRF (common world view)
- Data standards

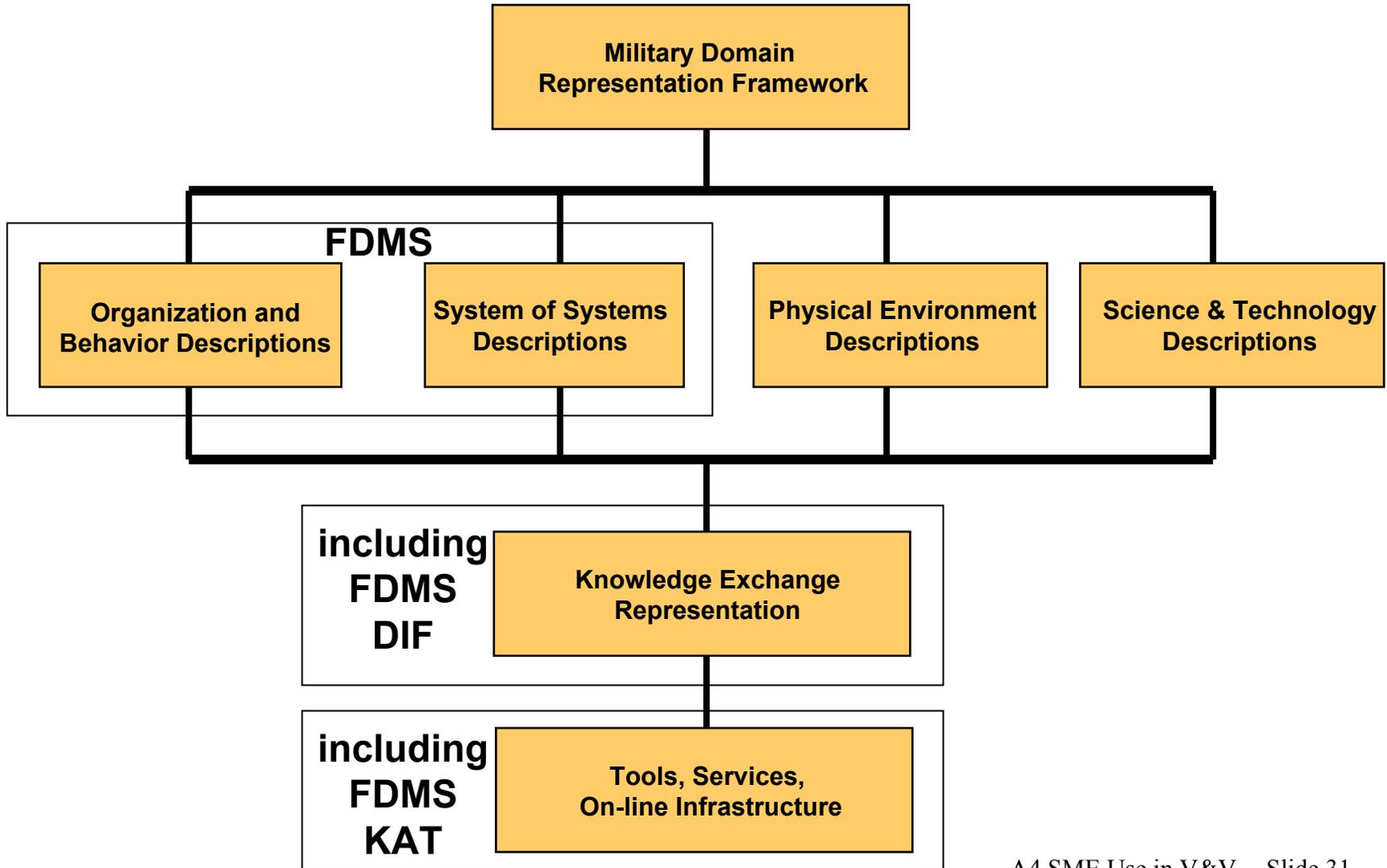


Common Services

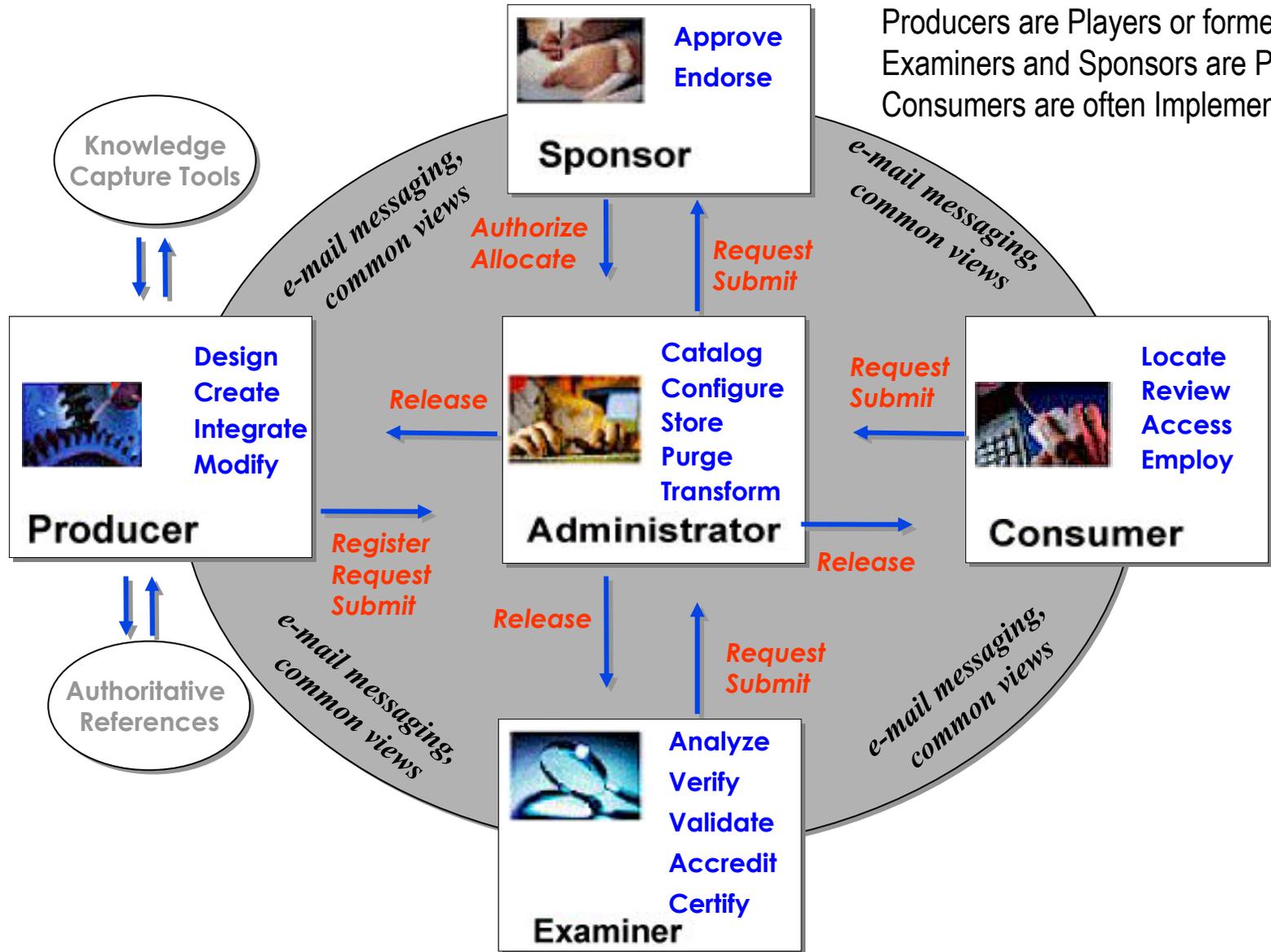
- Environmental representations
- HLA Run-Time Infrastructure
- Communication networks
- VV&A methods
- Classified resource repositories
- Unclassified resource repositories
- Help Desk
- Education



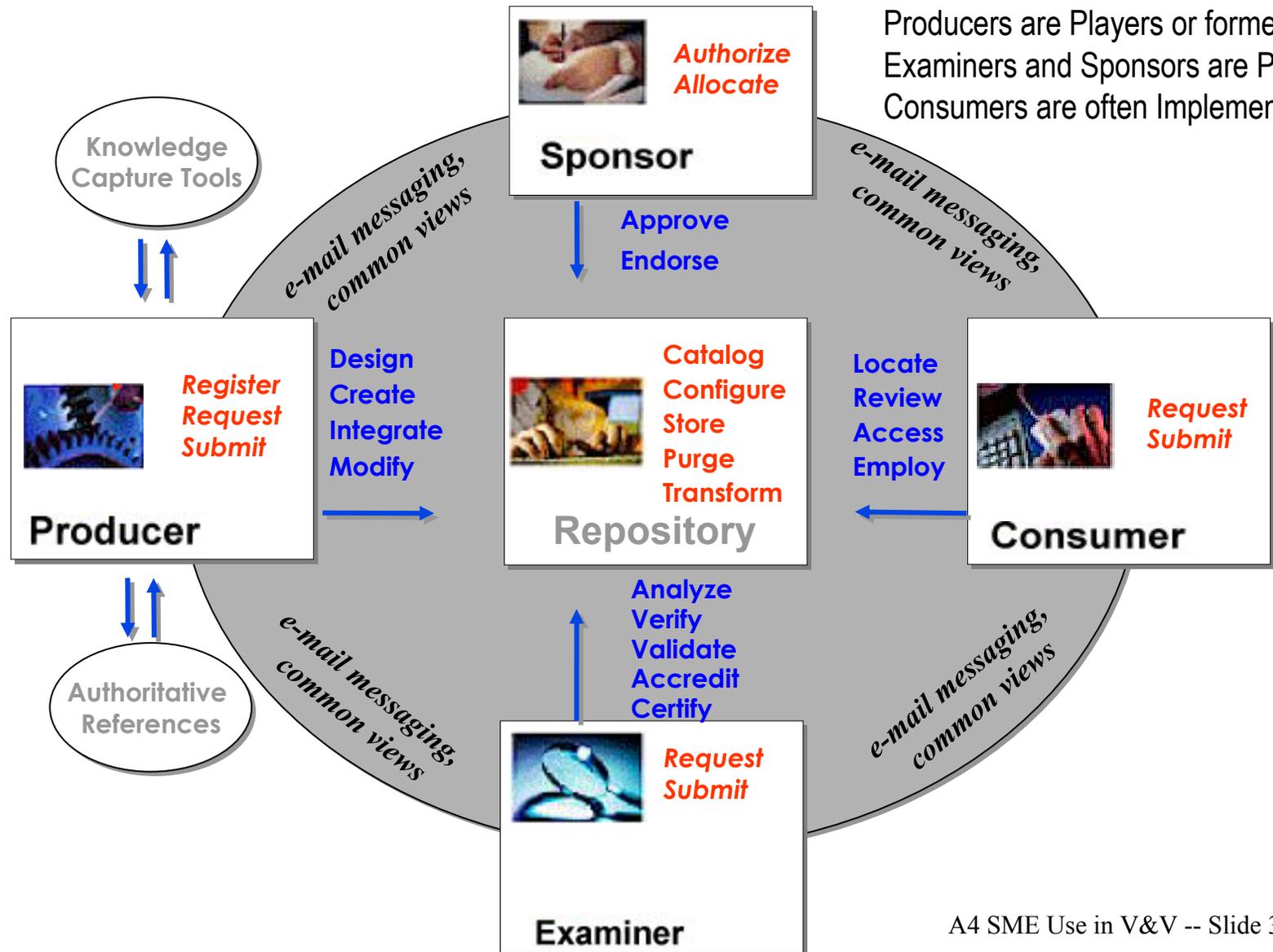
Military Domain Representation Framework



Knowledge/Data Engineering Process



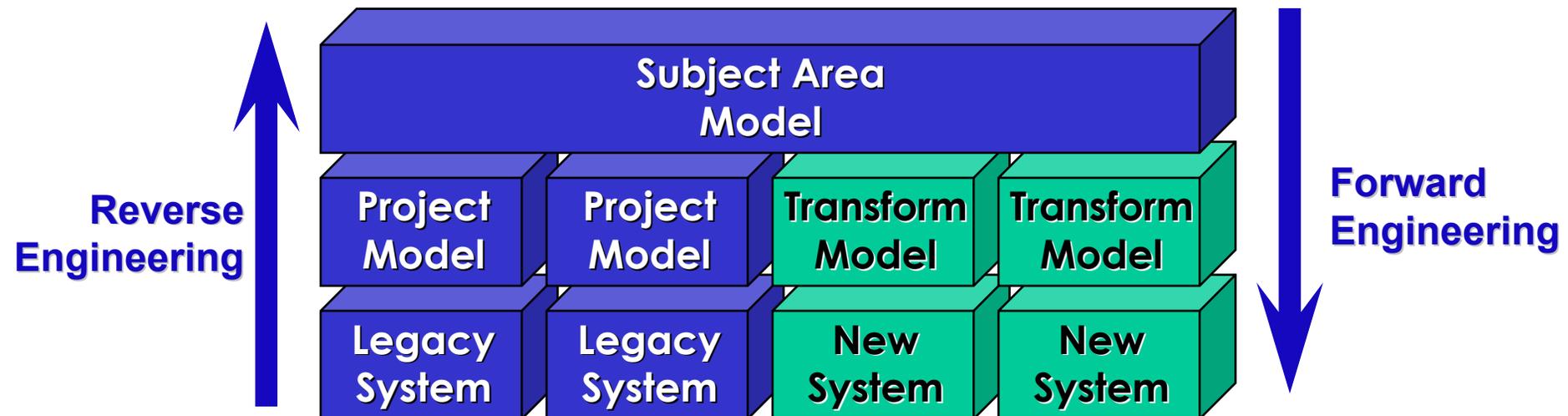
Knowledge Data Engineering Process View 2



Producers are Players or former Players;
 Examiners and Sponsors are Planners;
 Consumers are often Implementers

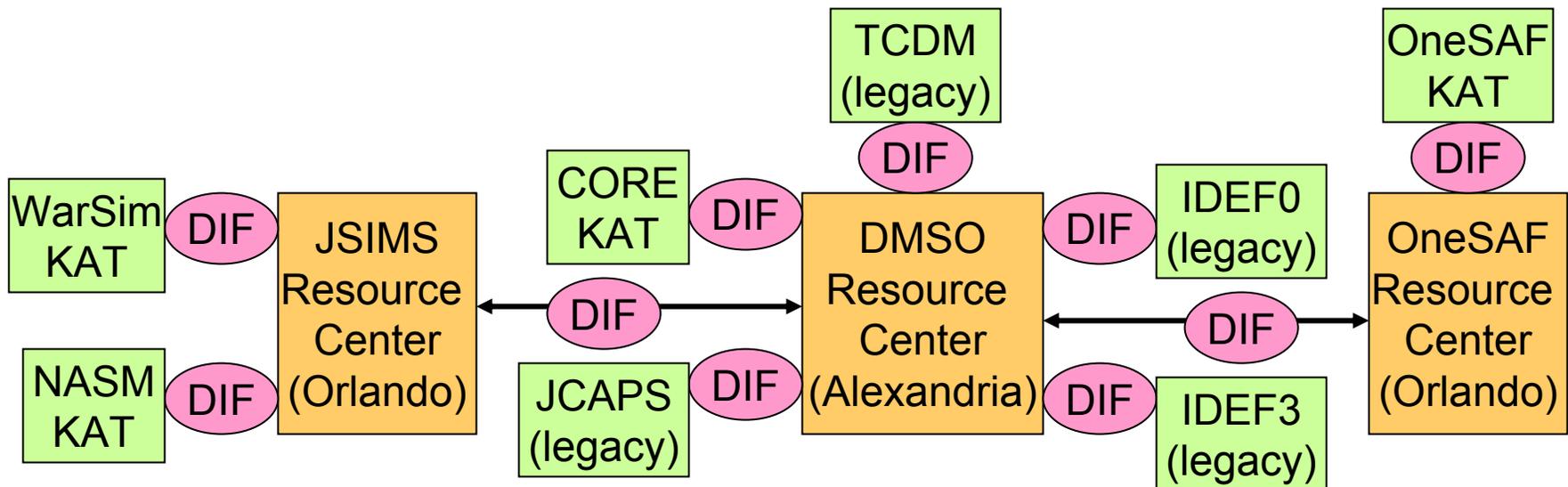
Knowledge/Data Reengineering Lifecycle

- ◆ Project models are developed from legacy systems
- ◆ Similar Project Models are combined into Subject Area Models (integrated logical schemas)
- ◆ New systems are built using common data structures and rules as exemplified by Transform Models



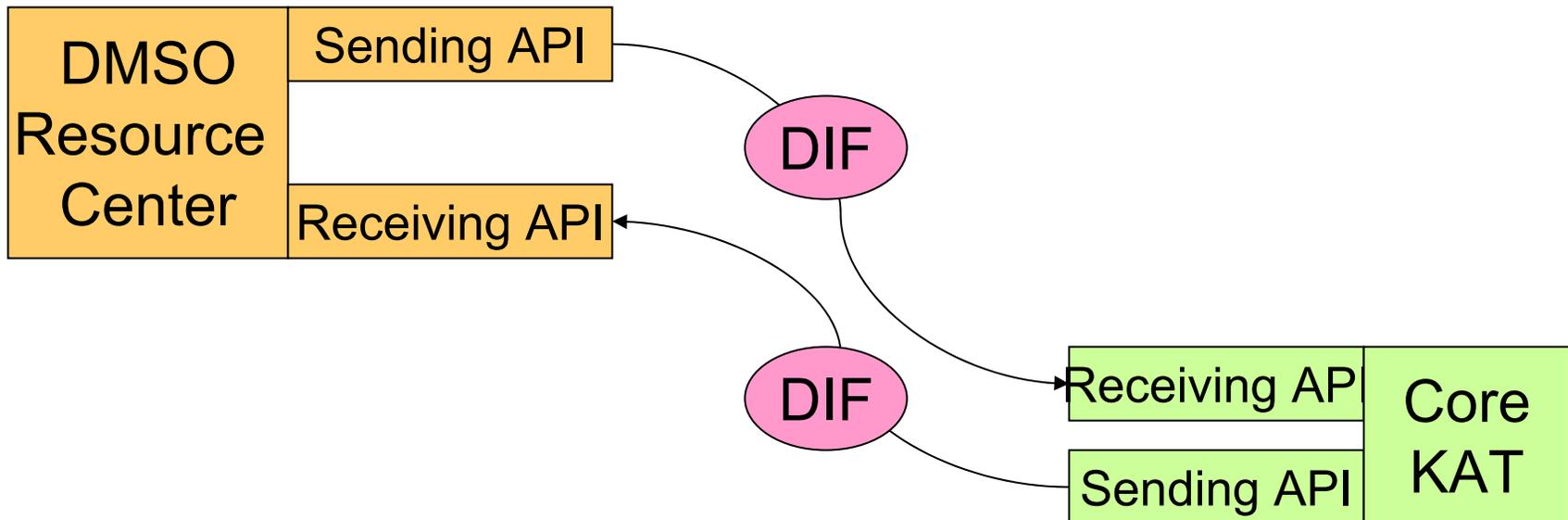
Networking Knowledge/Data Management

- The Resource Centers consolidate knowledge, store consolidated knowledge, and supply consolidated knowledge to Consumers.
- Knowledge Acquisition Tools (KATs) are used by individual knowledge producers which have programmatic customizations and may only use a subset of the knowledge capability
- A legacy system such as JCAPS represents knowledge in formats existing prior to FDMS development
- The Data Interchange Format (DIF) is the single unifying medium of knowledge transfer and consolidation.



Interface Detail

- ◆ Part of the Application Program Interface (API) is the converter from/to the native format of the knowledge to/from the Data Interchange Format (DIF).
- ◆ The DIF is based on the FDMS Data Model, as are the Resource Centers and Converters.
 - ◆ The KATs and legacy systems are not required to comply with the FDMS Data Model: The converters provide interoperability between local formats and the FDMS DIF



Executable Mission Content (EMC)

- ◆ **Utilizing a tiered approach to construction**
- ◆ **Allows sequential development of useful capabilities**

Libraries for Generation of Executable Mission Content
E.g., Generation of Simulation Federation Specification

Libraries for Animation of Mission Content Execution
E.g., Integration with Composable Reusable Environment for Acquisition, Training, and Experimentation (Create)

Libraries for Animation of Mission Content Execution
E.g., Single Thread Animation with dynamic business rules

Libraries for Sequential Execution with Human Interaction
E.g., Advanced Distributed Learning (ADL) content deliver

Libraries of Examination, Translation, Transfer, and Retrieval Routines
E.g., FDMS KAT, FDMS DIF, FDMS Translators

Repositories for Specifications of Actors and Activities
E.g., FDMS Resource Center for Specifications of Entities and Processes

Key SME Issues

- 1) knowledge development
(elicitation, acquisition, etc.),
- 2) SME selection and qualification,
and
- 3) quality of review processes.

SME V&V Use Research Needs - 1

Ideas from Sargent, Glasow, Kleijen, Law, McGregor, & Youngblood [SCSC 2000] and Balci, Nance, & Arthur [WSC 2002]

- **Research about how V&V should change with M&S size, type, and application.**
- **Research re cost estimation processes for M&S V&V/SME review costs.**
- **Research about how to use visualization capabilities to enhance SME reviews.**
- **Research connecting statistical processes & SME validation reviews.**
- **Research for disseminating insights from experiences to M&S/V&V communities.**
- **Research for better ways to provide computer support for VV&A, especially for validation and accreditation reviews.**

SME V&V Use Research Needs - 2

Ideas from Feinberg, Goalwin, Mayne, & Abold [SCSC 2001]

- *Develop more automated support tools for VV&A.*
- *Adopt or adapt tools from the software industry.*
- *Make better use of visualization tools.*

***Knowledge Engineering* discipline will work techniques to improve knowledge elicitation, representation, & integration.**

SME V&V Use Research Needs - 3

Ideas from Pace & Sheehan – we endorse the above, and suggest the following to supplement the above:

- *Research about processes to improve consistency in SME assessments.*
- *Research about processes to ensure correct capture of expert knowledge.*
- *Research about what truly characterizes an **expert**.*

Better sharing of all aspects of SME VV&A use experience via workshops, papers, and other publications is essential for significant improvement in this arena.

Conclusion



SMEs are important for simulation VV&A.

They are indispensable for meaningful V&V of many M&S applications.

They should be used wisely.

There is great room for improvement in SME use in M&S VV&A.

Comments by Sheehan

Comments by Pace

I have focused on SME management & Jack has focused on knowledge development from SMEs – both perspectives are important

Much opportunity for improving SME usage by doing what we know should be done

Much opportunity for improving SME usage by research to discover some of the fundamentals in using SMEs that we at best understand poorly

Simulation sponsors, developers, & users need to appreciate these points as well as V&V practitioners