Challenges For M&S in Army Test and Evaluation

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Modeling and Simulation in Support of Army Transformation

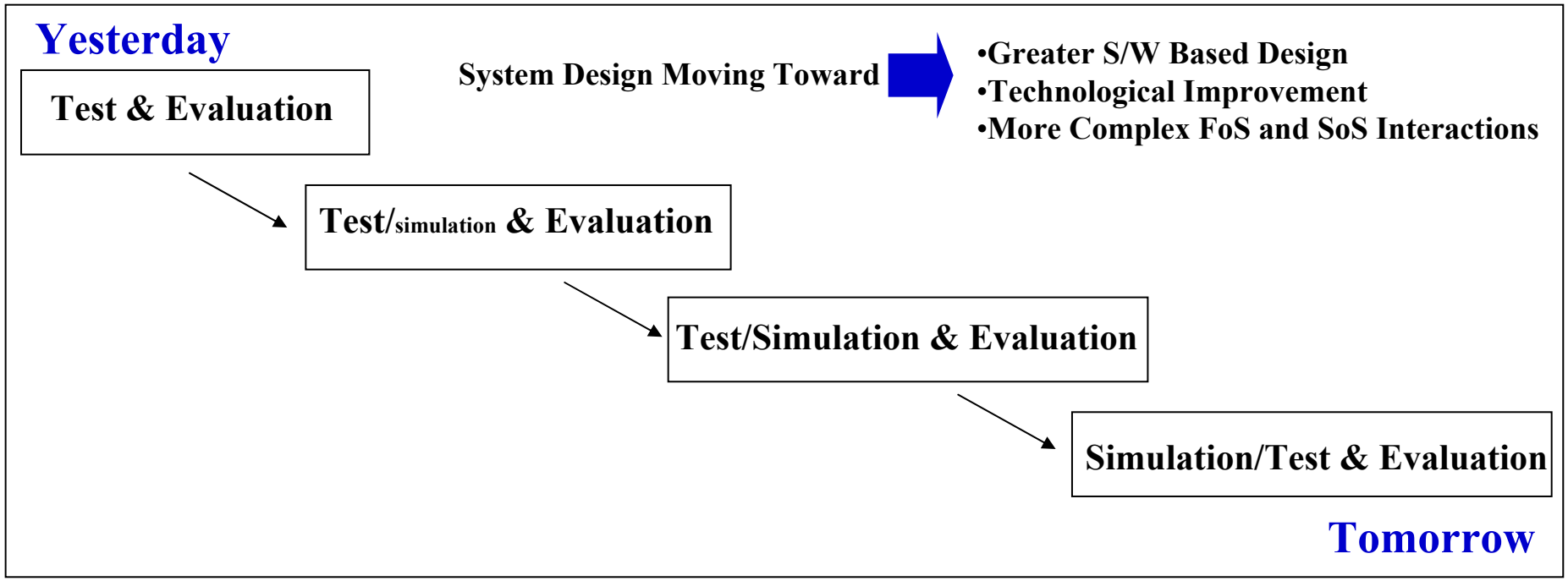
Quality Control for the US Army

Challenges For M&S in T&E : Outline

- Reality of T&E Transformation
- Getting Your Needs Identified: Plan & Execute
  - Requirements Identification and Decomposition
  - T&E
  - M&S
  - Architecture
  - V&V –and "A"
- Lack Of Success—From Some Experts!
- Challenge to T&E--Make it Better?

ATEC's T&E Mission is Changing

Transformation of Test and Evaluation



Bottom Line:

We'll always test hardware, but are seeing an increased reliance on M&S which will have a more prominent role in our evaluations and increase our need for technical expertise.

Challenge Facing ATEC

Providing fully integrated Test & Simulation Evaluations.

To accomplish that mission ATEC must develop and maintain adequate technical expertise to support the command in the following areas:

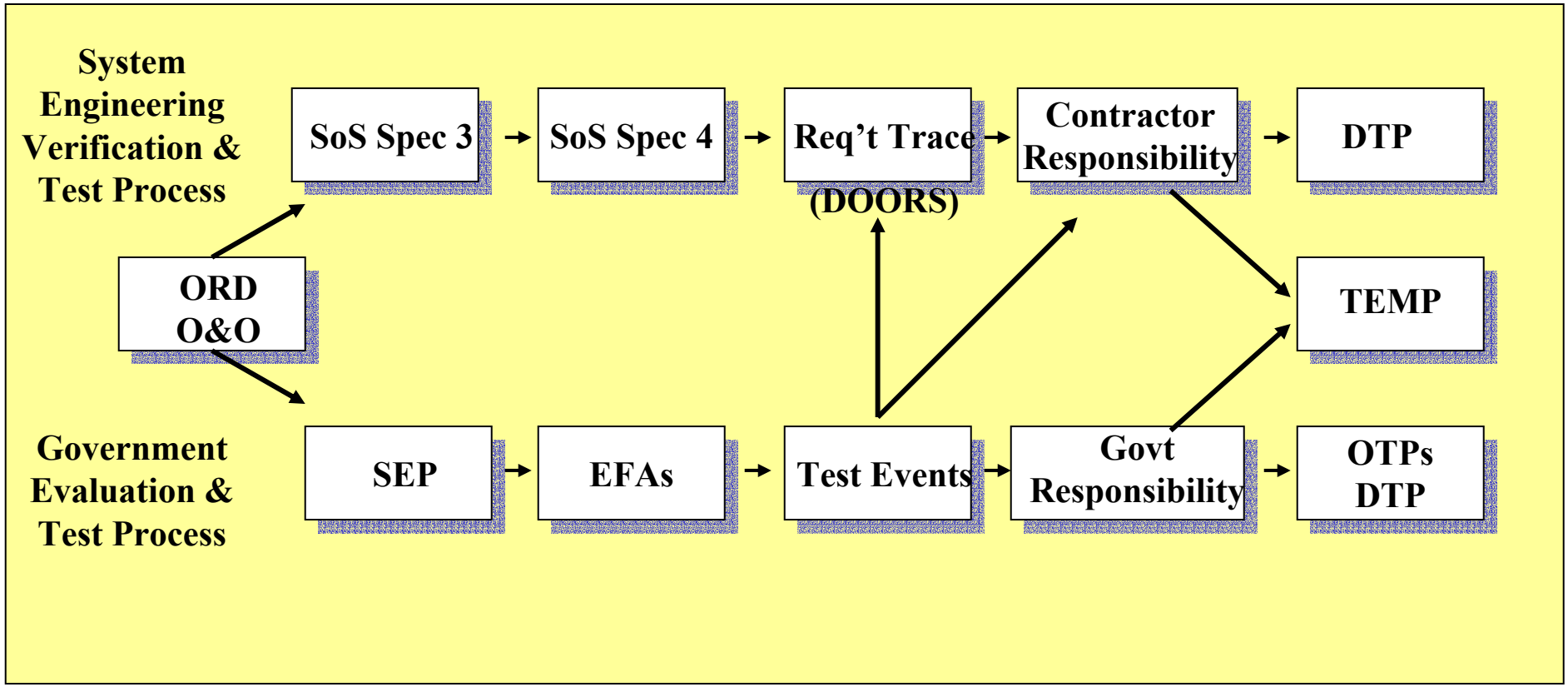
What we evaluate

- **Technology Development – Integrating FoS and SoS technologies and architectures to develop comprehensive evaluation approaches.**

How we evaluate

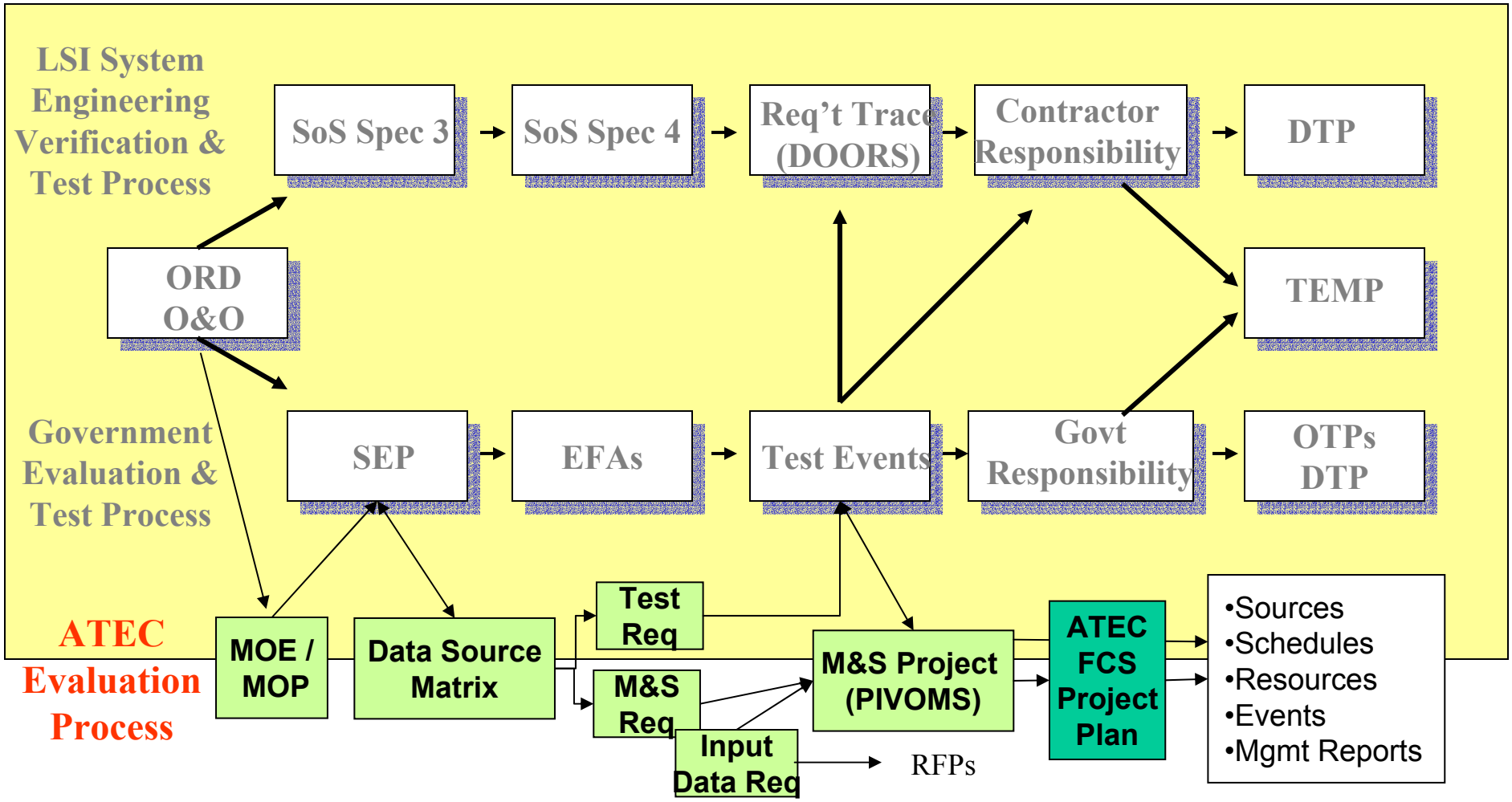
- **Modeling and Simulation – Tracking the development, VV&A of models.**
- **Employing Model-Test-Model to evaluation phases (pretest---test---post test)**
- **Experimental Design – Designing tests that make the most out of expensive hardware testing while taking into consideration how M&S will be used.**

Requirements Planning Process



The KEY to being successful is approved requirements ---- driving the evaluation focus areas. If requirements are changing---a ripple effect occurs at every level of the process.

Test & Evaluation Planning Process



View of M&S Development Process For FCS

SOS M&S Reqs

SVF Reqs Panel

Mgmt | Exec

SME | Auth

Approved / Prioritized Reqs.

SVF Build 1…n

SOS M&S Development

M&S IPT Panel

Mgmt | Exec

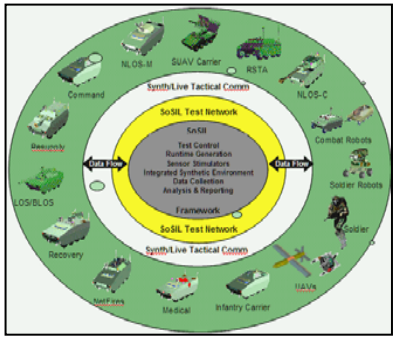
SME | Auth

SOS M&S VV&A

SVF V&V

A

S2F/FSE Application



Applications:

- Spec Demo
- ORD
- ESS

Participants:

- PM / LSI
- ATEC
- UAMBL
- RDECOM
- DEVELOPERS

SOS Level

System Level

LSI System Engineering Verification & Test Process

SoS Spec 3 → SoS Spec 4

ORD O&O

Plan Together, Test Once, Distribute Data

Government Evaluation & Test Process

SEP → EFAs

Integrated Verification Method(s)

Test

Analysis

Demo

Inspect

Stimulators, Emulators, Instrumentation

M&S Reqs

Simulators, Analysis M&S

Integrated Requirements

M&S Components/Functions for Service-based Architecture

M&S Selection

Panel Process

V&V By Provider

A

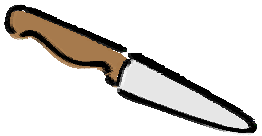
System Evaluation

Candidates M&S from Providers

Test, Demo, Inspection

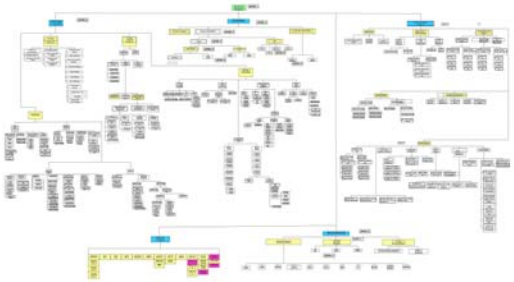
Getting M&S Requirements Allocated

TEMP, SIP
LFDs, IPs



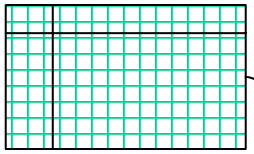
Slice through

Functional Decomposition
Capabilities Analysis



Yields

Phases Steps per
Engineering Iteration

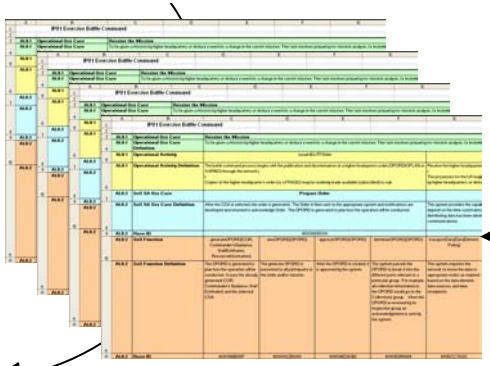


Used to Annotate

SoS Arch

Generates

Iteration Specific SV-5 views



Vetted/Edited though IPTs

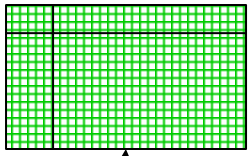
SoS Arch

is linked

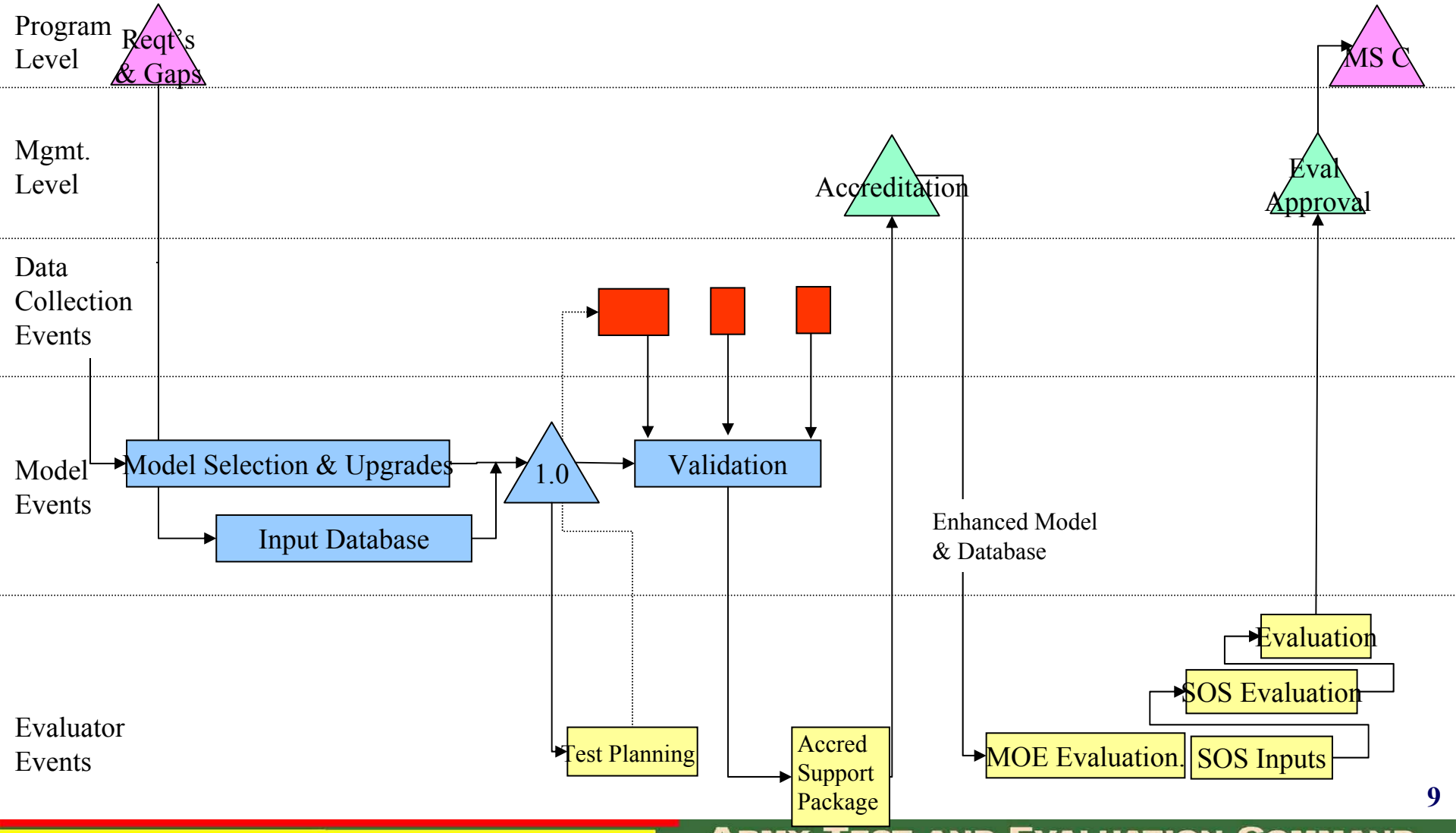
DOORS

Generates

Requirements per phase



The VV&A Process: Lots to Do Over Time



High Level M&S Challenges (1 of 2)

- **Incorporating requirements into tracking and allocation database**.
  - If a requirement is uniquely government, who is responsible for that integration?
  - Is the allocation decomposition completed?

- **Overlap between test execution and development/execution of the next phase**.
  - Is there sufficient time to implement required fixes or apply lessons learned in schedule?

- **Bow wave effect of pushing off M&S requirements to future phases**.
  - How early are M&S (and T&E) requirements needed to be identified?
  - 2 years before execution?
  - Ability to verify and validate (and increase risk) as schedules slip?

High Level M&S Challenges (2 of 2)

- **Changes in plans regarding M&S in test augmentation.**
  - Example: ability to test tactical SW in emulators and collect V&V artifacts

- **Battle Command Simulation Needed? Yes or NO?**
  - Representation of the fully integrated Battle Command capability. Available when? Final delivery of the actual code (Phase 4/Post MS C)?
  - Can incremental deliveries of tactical software integrated into the simulation environment be used? Available?
  - Ability to TEST all of the systems together within a full SoS context. Test articles with C4ISR and full functionality available when?
  - Ability of M&S to represent full FCS BCT. Available when?

- **A V&V Plan—(versus a strategy)-- for M&S tools is required.**
  - Accreditation criteria needed (ATEC Action)
  - V&V Plan needed (PM-Action)

Example of M&S Challenge Affecting Evaluation

- **Demonstrate low risk of KPP completion at Milestone C**
  - FCS BCT consists of three battalions, cannot realize this complexity in actual hardware
  - Virtual and constructive simulation capability critical
- **KPP's Not Possible without the network**
  - Must objectively load the network for results to be credible
  - Data, voice, video, messaging, etc..
- **M&S's critical function is to provide the "wrapper" or stimulus for the objective simulation/software**
  - Must provide an environment from where system and SoS capabilities may be demonstrated
  - Terrain, weather, lethality brokerage, etc…
- **Non-intrusive network simulation and credible aggregate force representations are of the highest priority**
  - Critical to provide "wrap" for the equipment on the range
  - "A Must" to fill out the missing hardware (FCS BCTs/UEx/UEy) in the Experiments and TFTs
- **Non-Intrusive test network for testing at system, FCS BCT, Complementary and Joint systems**

M&S—Not Worked as Often as Liked

- 2003 Academy Industry Symposium on Mathematical Modeling discussed reasons for the lack of success in use of models:
  - Inappropriate method of formulating or representing the problem
  - Ill-conceived multi-disciplinary integration
  - Inability to communicate among multi-disciplinary team members
  - Few existing value/reward systems actually reward collaboration
  - Funding sources not deal well with multi-disciplinary work
  - Isolation of modeling community
  - Difficulty in integrating models of different resolution
  - The practical sociology between modelers and decision makers:
    - Modeling should help/be an aid to critical thinking

EXCERPT FROM: PHALANX Article, Sep 2003: "Issues in Model Integration to Support Decision Makers"; by Dr. Ernest Seglie

M&S
Not Worked as Often as Liked

2003 Academy Industry Symposium on Mathematical Modeling discussed reasons for the lack of success in use of models:

- Inappropriate method of formulating or representing the problem
  - Requirements Identification process cumbersome (Subcontractors, Prime, Engineering, Test, Evaluation)
  - T&E issue is--can we live with less testing? So, we become a user of these products
  - Example: JTRS: supporting development of FCS NW for Current Force and Future Force
    - Modeling while development ongoing. Objectives are?
    - Is transport layer for FCS; yet architecture definition evolving.
    - Planned integrated approach through PM M&S team, but harder to say what we can bank on

- Ill-conceived multi-disciplinary integration
  - So many systems + Network; Modeling and development ongoing simultaneously
  - Have SOS to address; Who has done this before—at a level of required fidelity?
  - Inability to communicate among multi-disciplinary team members
    - Players: Subs + LSI + ATEC + Evaluation (SEP) + PM + CTO + PM M&S (MSMO) + Training
    - T&E challenge to program is: Communicating requirements for this SOS M&S to this hugh crowd – to include JOINT---with varying crowd experience-NOT EASY!
  - What does program integrator know about how ARMY does SOS testing? Evaluation?

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M&S
Not Worked as Often as Liked (continued)

2003 Academy Industry Symposium on Mathematical Modeling discussed reasons for the lack of success in use of models:

- **Few existing value/reward systems actually reward collaboration**
  - **Stove pipe development; scramble for dollars to develop products; parochial views**
- **Funding sources not deal well with multi-disciplinary work**
  - **Program dollar cuts; is sudden at times.**
  - **Other priorities evolve and take over**
  - **SW development—costly and difficult**
- **Isolation of modeling community**
  - **What IS out there that can provide best insights into effectiveness, suitability, survivability?**
- **Difficulty in integrating models of different resolution**
  - **Major integration effort on this program; multiple BOS systems**
- **The practical sociology between modelers and decision makers:**
  - **Modeling should help/be an aid to critical thinking…**

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Challenge to T&E--Can We Make it Better? Summary

- **Encourage programs to integrate modeling into their development and decision process.**

- **Integrate into T&E evaluation ONLY IF modeling has demonstrated it is an integral part of the program processes and demonstrates it is an aid to critical thinking.**
  - Multi-disciplinary team established, in place, and functioning to add information to contractors, PM, and evaluators. Needed 7-10 years before IOT.
  - Feedback loop working through cycle on early component testing and early operational assessments.
  - M&S developed in sufficient resolution so that test planning parameters can be, and are, calculated using the model.

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Conclusion:
Simply the place where someone got tired of thinking.
Great Quotes From Great Skeptics

- Well informed people know it is impossible to transmit the voice over wires and that were it possible to do so, the thing would be of no practical value. *Editorial in the Boston Post (1865)*

- That the automobile has practically reached the limit of its development is suggested by the fact that during the past year no improvements of a radical nature have been introduced. *Scientific American, Jan. 2, 1909*

- Heavier-than-air flying machines are impossible. *Lord Kelvin, ca. 1895, British mathematician and physicist*

- While theoretically and technically television may be feasible, commercially and financially I consider it an impossibility, a development of which we need waste little time dreaming. *- Lee DeForest, 1926 (American radio pioneer)*

- There is not the slightest indication that [nuclear energy] will ever be obtainable. It would mean that the atom would have to be shattered at will. *Albert Einstein, 1932.*

- Where a calculator on the ENIAC is equipped with 19,000 vacuum tubes and weighs 30 tons, computers in the future may have only 1,000 vacuum tubes and perhaps only weigh 1.5 tons. *Popular Mechanics, March 1949.* (Try the laptop version!)