MBSE in Government Acquisition

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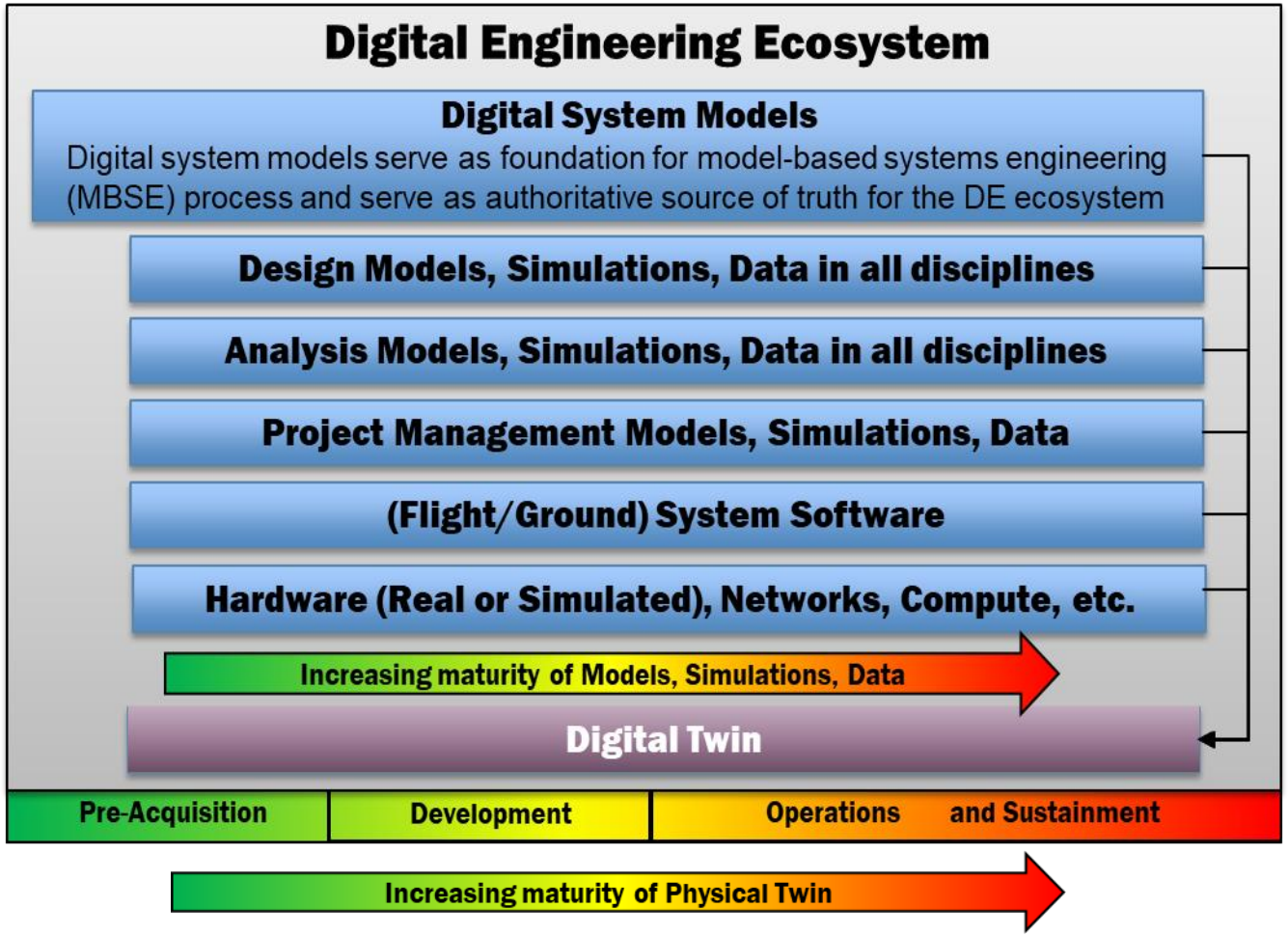
Outline

- Background—Digital Engineering (DE)
  - *Context for MBSE*
- Focus Areas for Advancing MBSE in Government Acquisition
- Enterprise Integration Levels of MBSE Implementation
  - *Moving Government acquiring agencies up this maturity scale*

Abstract

- Model-Based Systems Engineering (MBSE) is an emerging paradigm for improving the practice of systems engineering, in which integrated sets of digital system models serve as the focal point for knowledge management, technical communication, and data interchange. Adoption of MBSE by Government prime contractors has grown significantly, often motivated by the drive for improved efficiency from the commercial elements of their businesses. Interest in adopting MBSE on the Government side of that interface has also grown, motivated not only by desire for improved efficiency but also by the need for a better approach for managing the complexity of those Government mission enterprises.
- This presentation will describe how MBSE is being used in the context of a broader Digital Engineering paradigm in Government acquisition and mission enterprises.

Digital Engineering: An Ecosystem of Models, Simulations, and Data

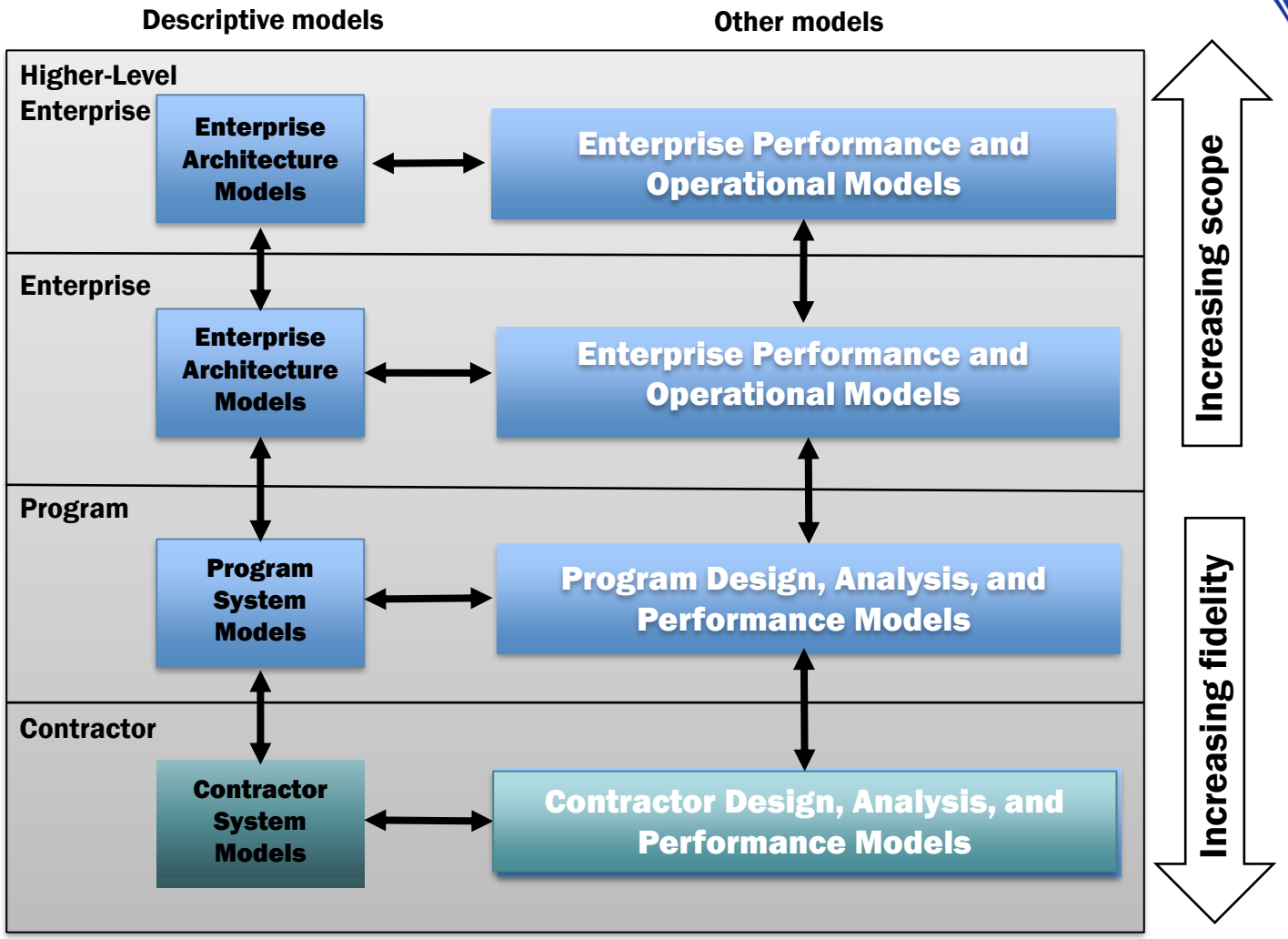


- Digital Engineering (DE) ecosystem includes models, simulations, and data across many disciplines
- Digital system models (DSM) are central to MBSE implementation
- Digital Twin integrates models, simulations, and data across many disciplines
- Digital Twin serves as an evolving virtual representation of an evolving entity (the Physical Twin)

Digital Engineering integrates information across all disciplines and life cycle phases

Digital Engineering: A Network of Interconnected Models

- Decisions at all levels are informed by a comprehensive knowledge of impacts and dependencies
- Models at each layer of the organization are loosely coupled with models in adjacent layers
- Sharing of models reduces duplicative work and reduces the risk of inconsistencies
- Synchronization of models enforces concept of authoritative source of truth (ASOT)
- System models provide authoritative sources of data to feed other disciplines and domains



Model integration enables integration of knowledge from isolated islands to holistic knowledge at all levels

Focus Areas for Advancing MBSE for Government Acquisition

- **Enabling Enterprise Systems Engineering**
  - Enhance decision-making, improve enterprise capabilities and resilience, and architect enterprise-wide solutions, by better integrating knowledge across the enterprise and its constituent programs
- **Improving System Acquisition and Execution Outcomes**
  - Reduce risk of delays, cost overruns, and underperformance in acquisition programs by improving the quality of systems engineering
- **Institutionalizing Evolved Systems Engineering**
  - Accelerate adoption of MBSE by addressing key cultural, organizational, and infrastructure challenges

Enabling Enterprise Systems Engineering with MBSE

- Using MBSE methods to improve execution of enterprise systems engineering processes
  - *Enhance enterprise decision-making*
  - *Improve program decision-making through better understanding of impacts and dependencies*
  - *Enable better enterprise-wide solutions*

- Key challenges with enterprise application of MBSE include the greater complexity of integration/federation of models and data from many different stakeholders

- Developing digital engineering strategies and implementation plans for enterprises
- Developing governance and management processes for authoritative models and data
- Architecting enterprise-scale digital engineering ecosystems

Improving System Acquisition and Execution Outcomes

- MBSE is being increasingly used by system developers to improve quality and efficiency of the development process

- Government agencies responsible for acquiring systems are starting to use MBSE to improve quality and efficiency of their own acquirer processes
  - *Requirement development*
  - *Architectural trades*
  - *Communication (two-way) with contractors*
  - *Assurance and oversight activities (e.g., verification and validation, milestone reviews, hardware acceptance)*
  - *Integration, esp. where the Government is the System Integrator*

- MBSE can also provide enduring value to system users/operators and maintainers long after the system has transitioned to the Operations and Sustainment phase
  - *Digital Twins – answer questions throughout the system life cycle with increasingly high-fidelity data*
  - *Enable "what if?" exercises, aid in impact analyses, and inform tactics, techniques, and procedures (TT&P)*

Institutionalizing Evolved Systems Engineering

- Transitioning from traditional SE implementation to more modern practices is far from trivial

- While some of the challenges are technical…
- Government organizations often have greater cultural, political, and financial impediments to rapid, substantive change

- Need to overcome these obstacles through communication, education, leadership, and publicized demonstrated success

- Developing and executing multiple tiers of workforce training in MBSE principles, practices, and techniques
  - *Enabling execution of MBSE within the acquisition agency*
  - *Enabling Government acquirers to be "better buyers" of models from their system developers*

Enterprise Integration Levels of MBSE Implementation

- MBSE is applied at different levels of integration maturity in the Enterprise
  - ***Level 0:*** *Deploy MBSE in an ad hoc manner on individual programs*
  - ***Level 1:*** *Efficiently and consistently deploy MBSE on many programs managed by an enterprise*
  - ***Level 2:*** *Federate program-level system models to enable MBSE to be performed on the enterprise's collection of technical systems—Mission Engineering*
  - ***Level 3****: Perform systems engineering using models on the combination of the enterprise's technical and business architectures in an integrated manner*

- The ideal implementation of system modeling may differ in each of these cases
  - *Local application of modeling practices can have significant implications for integration of those models to achieve enterprise objectives*
  - *Need to balance the needs of individual programs with the needs of the enterprise*

Think Globally (to enable enterprise objectives) when Acting Locally (to achieve local program objectives)

Level 0 – Individually Optimized MBSE Implementations

- At Level 0, programs within an enterprise adopt their own MBSE approaches at their own pace
  - *Unique modeling methodologies*
  - *Unique modeling processes*
  - *Unique modeling toolsets and repositories*
  - *Unique modeling templates*
  - *Unique modeling profiles--usually SysML-based (and possibly other languages)*
  - *Little reuse of models and datasets*
- These programs may have one or more prime contractors, who may or may not be doing MBSE
  - *Unique modeling methodologies*
  - *Unique modeling processes*
  - *…*
- Each program may optimize their approach to meet their own needs, at best

- Enterprise doesn’t have an effective model ecosystem to support ESE activities

Level 1 – Standardized MBSE Implementations

- At Level 1, programs within an enterprise achieve efficiencies by minimizing unnecessary divergence in their MBSE implementation
  - *Common modeling methodologies*
  - *Common modeling processes*
  - *Common modeling toolsets and repositories*
  - *Standardized modeling templates*
  - *Standardized modeling profiles—often SysML*
  - *Standardized modeling style/patterns—with automated model checking*
  - *Some reuse of models between programs*

- Organization assesses its overall MBSE state and attempts to improve its quality and efficiency by adopting best practices and standards

- Each program may still optimize their approach, tailoring the standard approach to address their unique needs

- However, these standards may not be sufficient to enable seamless interoperability
  - *Focus is primarily on achieving efficiency and improved quality*

Level 2 – Standardized Enterprise-Ready MBSE Implementations

- At Level 2, enterprise-level systems MBSE is used to manage the integrated set of technical systems comprising the enterprise

- Programs within an enterprise achieve even greater opportunities for enterprise integration by minimizing divergence in their MBSE implementation and by adopting key Enterprise-Ready modeling practices
  - *Clear Partitioning of Authoritative Sources of Truth (ASOT)*
  - *Modeling for Federation*
  - *Modeling for Reuse*
  - *Exploiting Abstraction Layers*

- Organization improves its decision making process by improving its holistic understanding of the enterprise's technical architecture and cross-system dependencies and impacts

- Enterprise is primed to achieve an effective modeling ecosystem to support ESE activities

- Use enterprise level modeling approaches, such as the Unified Architecture Framework (UAF) Profile from OMG, to facilitate modeling with enterprise scope

Level 3 – Apply MBSE on the Enterprise Itself

- At Level 3, MBSE is applied to engineer the enterprise itself
  - *The enterprise is treated as a complex system of interest for the application of systems engineering*
  - *This system includes not only technical system components, but also humans and organizations*
  - *Technical architecture and business architecture are modeled in an integrated fashion*
  - *Enables greater understanding and more effective architecting of materiel and non-materiel solutions*
  - *Organization improves its decision making process by improving its holistic understanding of the enterprise's technical and business architectures and the more complex dependencies and impacts*
    - Regularly reviews and updates its awareness and harmonization processes

- Enterprise level issues and solutions are given prominence
  - *Modeling strategic drivers and challenges (and the mission and business capabilities that address them)*
  - *More focus on capability-driven system development (rather than just function and requirements driven)*
  - *Modeling aggregations of projects (and their dependencies) rather than just individual projects*

- Level 2 needs for MBSE are also needed at Level 3
  - *Other modeling languages or approaches may be well suited for modeling enterprise-level concerns and challenges*
    - e.g., UAF Profile, Business Process Modeling Notation (BPMN)

Summary

- In Government acquisition, MBSE is a key element of a broader Digital Engineering paradigm
  - *MBSE has a different flavor for the acquirer than it does for the system developer*

- Digital Engineering and MBSE are a critical enabler for Enterprise Systems Engineering
  - *Improves the management and exchange of exponentially growing sources of data, information, and knowledge spanning an enterprise*

- Programs within an enterprise achieve even greater opportunities for enterprise integration by
  - *Minimizing divergence in their MBSE implementation*
  - *Adopting key Enterprise-Ready modeling practices*

Think Globally (to enable enterprise objectives)
when Acting Locally (to achieve local program objectives)