SAND2017-6561PE




MBSE Culture, Configuration, and Integration

At Sandia National Laboratories

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Sandia National Laboratories Panel

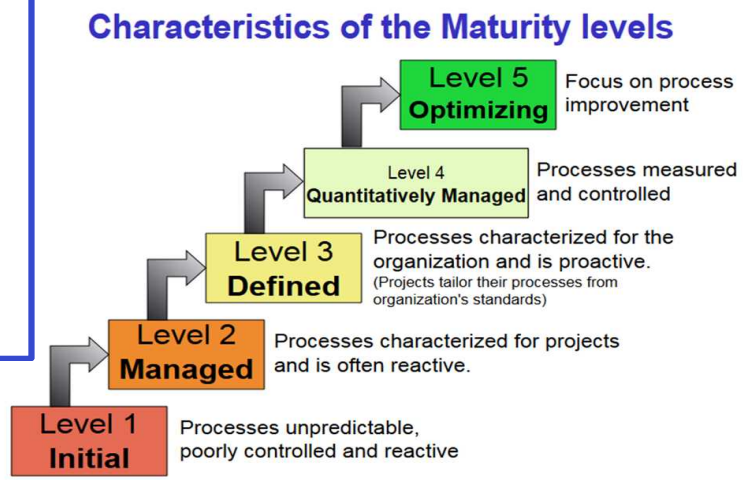
- As the systems engineering and integration lab for the nuclear weapons enterprise, Sandia has been addressing MBSE challenges for many years.
- Our panel of speakers will address topics that include the following:
  - An MBSE culture – Leadership , Process, and Infrastructure
  - Ontology/patterns/standards - the basis of an MBSE approach
  - Configuration Management vs. Configuration Control
  - Integration of MBSE/SysML to M&S and to executable models

We can share our journey so far, we are still working on the vision and the means to get there

We are trying to change our culture
– You can't just "put a Tool on it!"

Sandia National Laboratories

Consistent MBSE Processes
- Assist in resource development
- Updated steps, milestones, and criteria
- Reviews adapted to the MBSE process and its artifacts
- Time upfront, team-wide effort in learning how to communicate through process and the tools



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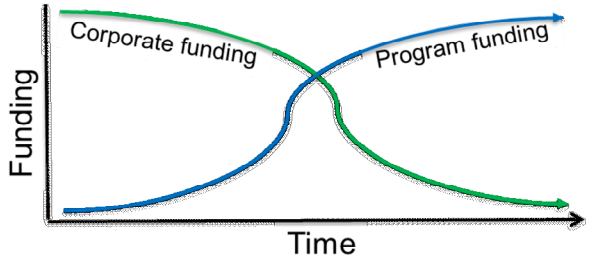
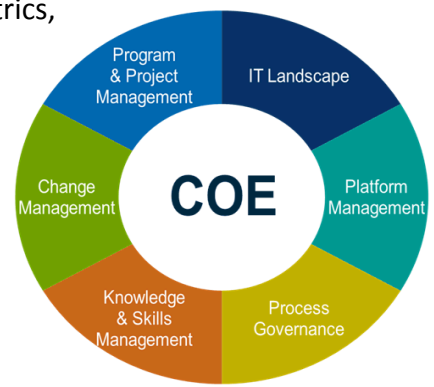
Corporate Support Creates a Strong MBSE Infrastructure
- Staff with deep understanding of both MBSE practices and the tools
- Methods to capture, store, access and share both artifacts *and* the central model

Smooth Tool Management is Essential
- Managing licenses and new users
- Multiple 'Projects' vs One single 'Project'
- Up-to-date access for viewing (not editing) and sharing with customers
- API needs/ communication between tools
- How/Whether to generate "documents"

Costs are mostly human labor:

Center of Excellence, development of software to check model patterns, establishing maturity metrics, developing schema for design options, architecture and tool integration





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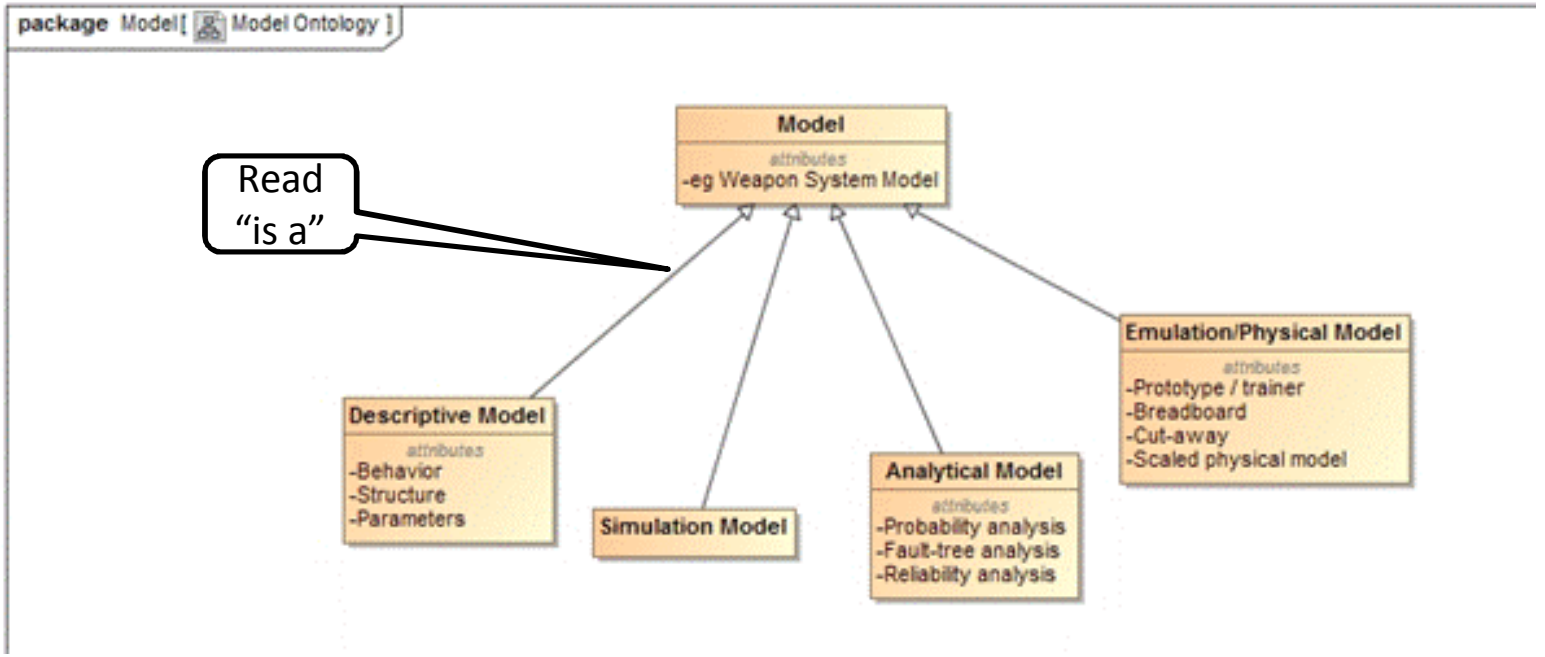
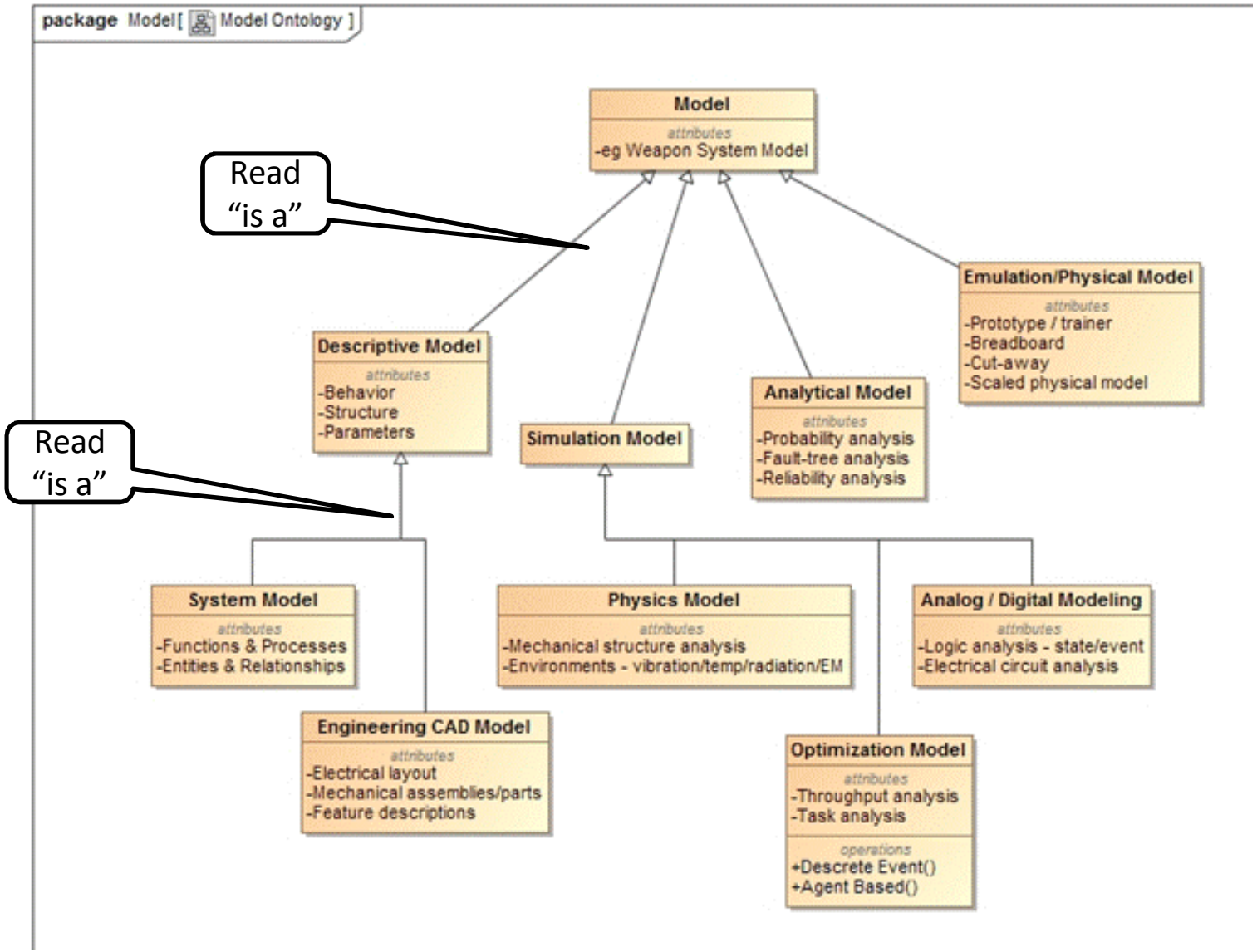
Leadership Sets Direction, Supports Staff Development, Organizes for Project and Infrastructure Development, Support and Sustainment
- Ask for artifacts
- Implement MBSE-based reviews
- Establish and Reward Milestones
- Measure Progress

What is a “model”



Need an ontology for the word “Model”

What is a “model”



Ontology, Patterns, and Standards

An ontology is critical to model success

Organizes and describes content
Metadata, structure, relationships

- Inputs
  DG Implementation Team, Data Stewards/Owners, SMEs
- Outcomes
  Navigation, taxonomy, search, audience

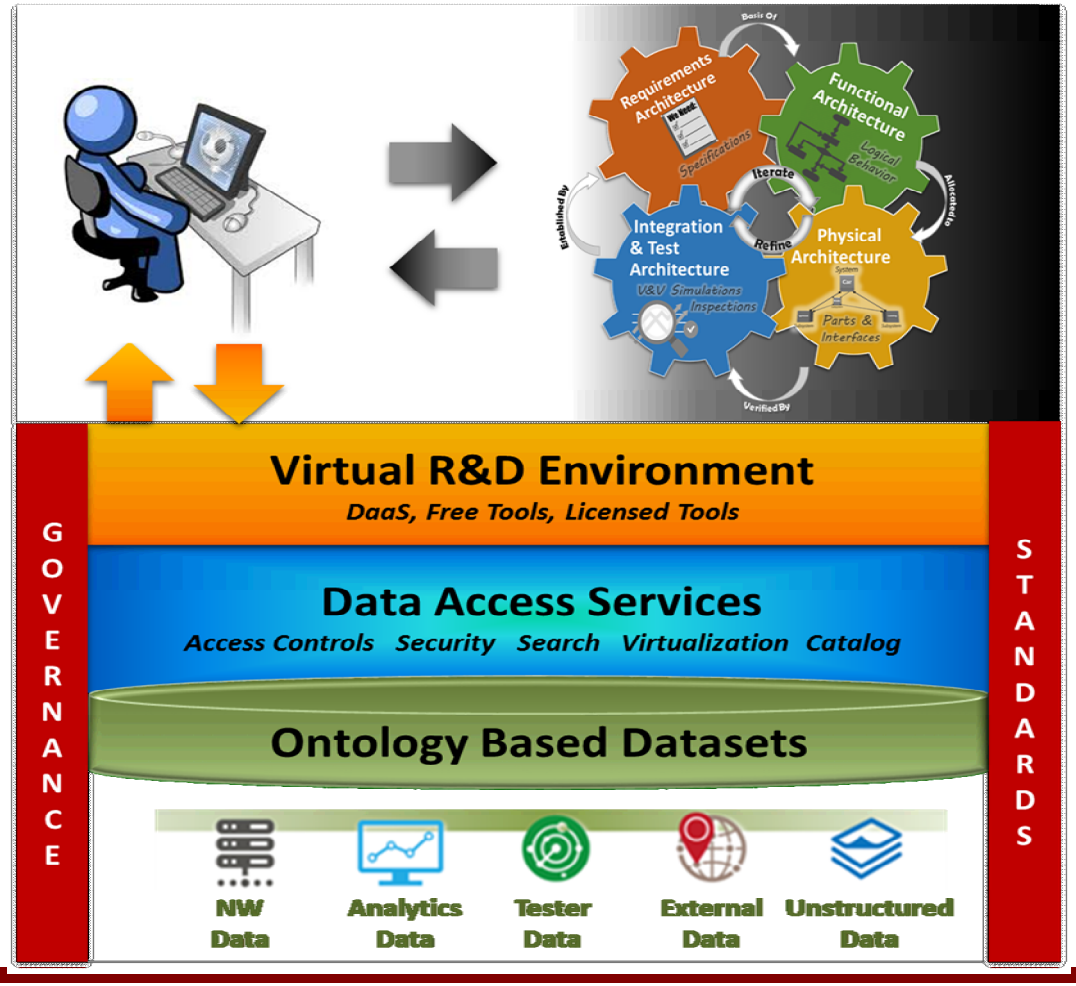
Data is Accessible: Our workforce will experience a first day on an assigned project in which they will have seamless access to the data and tools they need.

Data is Trusted: Protected, but access to data within a person's authorization level is seamless; the method by which data is authorized is also seamless.

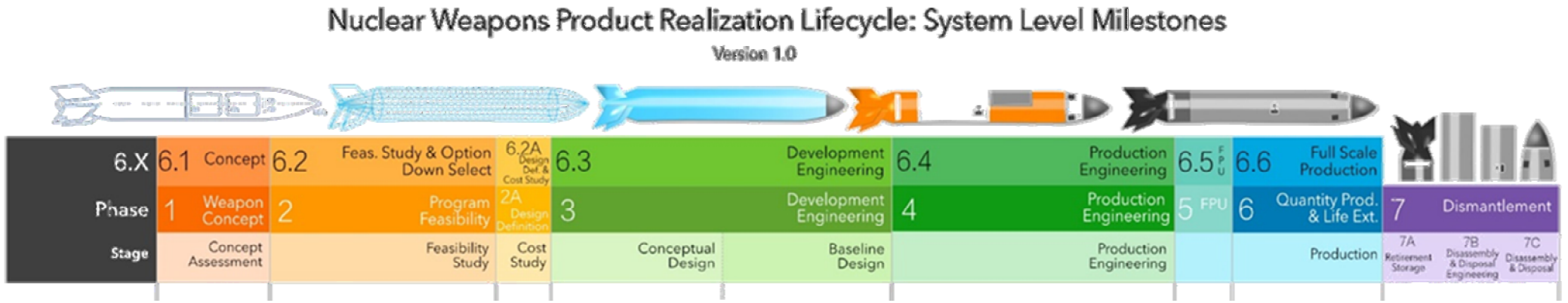
Data is Useful: Data is readily shared and available to a broad set of users allowing different "lenses" to view and use the data.

Data is Traceable: Our workforce knows where to find data and whether or not it is the right data to use.

Data is Understandable: lifecycle is considered at beginning of any program/project.



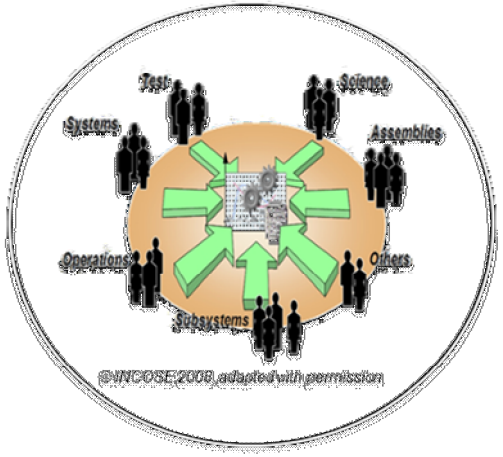
Managing vs Controlling Model Configuration



- Comparable DoD & DOE Lifecycles:
  - Multi-year with PM oversight
  - Typically includes:
    - Technology maturation
    - Feasibility studies
    - Concurrent engineering
    - Trade-off analyses
    - Unique products
    - Critical Interfaces
    - Extensive integration

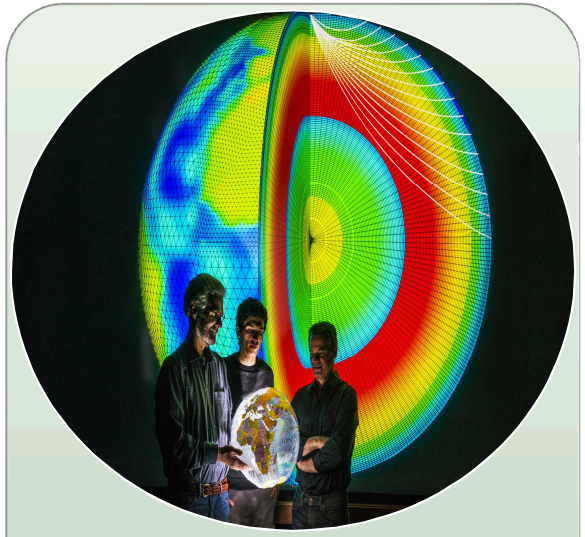
- Imposing Rigorous Change Control too early can kill the MBSE approach & add program risks
  - Version control early – yes
  - Configuration *control* – only after stabilization
    - Model changes involve not only words --- *but also relationships, objects, diagrams – AND review time*
- Where possible, use separate projects and use relationships to relate subsystem/component models to the level above

Desired State is Integrated Model Centric Engineering



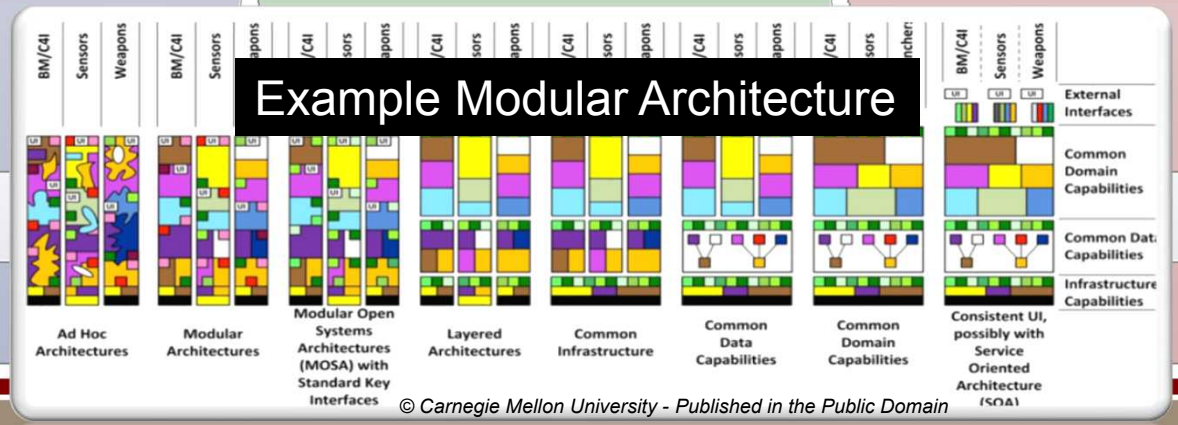
- Make the model the center from concept to operations
- Thread a digital path with model-centric engineering
- Share capabilities across systems and enable a digital approach (an NW engineering initiative):
  - MBSE is fundamental for successful delivery of a modular weapon system architecture, model-centric engineering, and lab-wide design and qualification.
  - It will be critical to the success of specific projects such as high-tempo flight tests, that require coordination across a diverse set of organizations internal to SNL

MBSE



Modeling & Simulation

Design Engineering



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BACK-UP

MBSE Vision Initiatives

Journey of systems engineering utilizing models in nuclear weapons engineering projects

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MBSE by other names ~mid 80's	Significant M&S Investment ~mid 90's	MBSE more formally introduced ~mid-2000's	Recent NW Capability attempts ~2010	Establishing Grassroots Capability 2015	Current Customer Requests ~2017	Enterprise Capability?
MBSE application to systems •NW Telemetry Systems •High-integrity SW Simulation/ Emulation external capability •Daisy for digital logic •SPICE, etc. Healthy M&S investments	End of Cold War, NNSA S&T Program Stood-up for Stockpile Stewardship •Invested in making tools available through corporate resources •Visualization tools were world-class •Projects to integrate capability maturity and delivery 1st full system model (RDD-100)	MBSE application to systems •Integrated Surety domain modeling •Initial models of B61 MBSE application to enterprise •Technical business processes •New NNSA Product Realization processes •Production plant special tooling •Qualification for radiation environments Simulation/ Emulation Internal Capability	W88 Modernization B-61 Modernization Infrastructure challenges Cultural change too drastic for	High Confidence System Environments Department established corporate commitment Supported MBSE Tools mentioned on CEE Training established Community of Practice established Resources Committed to Projects LCMD, ESH, CMS, High Risk Transportation A&E continued efforts •W88 •JTD	W88 Modernization GBSD W80 Modernization High Op Tempo ELNG ESH	Need an organization committed to: •the maturity of systems engineering practices •implementation of procedures, •application of tools, •and support of project level needs.

***Note this list is not all inclusive, as many efforts have occurred but meant to be an overview*