

Advancing Systems Engineering Practice Using Model Based Systems Development

October 29, 2009

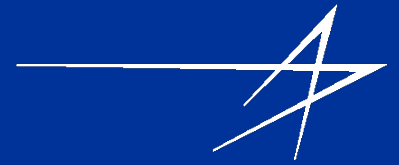


Sanford Friedenthal

Lockheed Martin

sanford.friedenthal@lmco.com

Topics



- **Model-based Systems Development Motivation, Scope, and Challenges**
- **MBSD Approach Using System Architecture Model as Integration Framework**
- **MBSD Observations**
- **INCOSE MBSE Initiative**
- **Summary**



MBSD Motivation, Scope, and Challenges



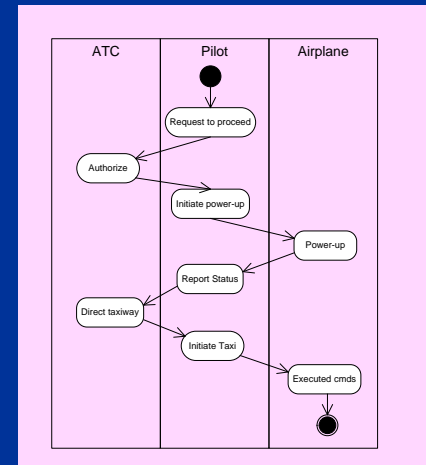
SE Practices for Describing Systems

Past



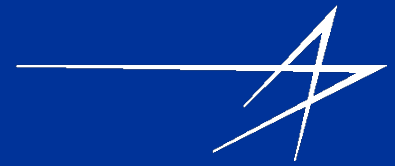
- Specifications
- Interface requirements
- System design
- Analysis & Trade-off
- Test plans

Future



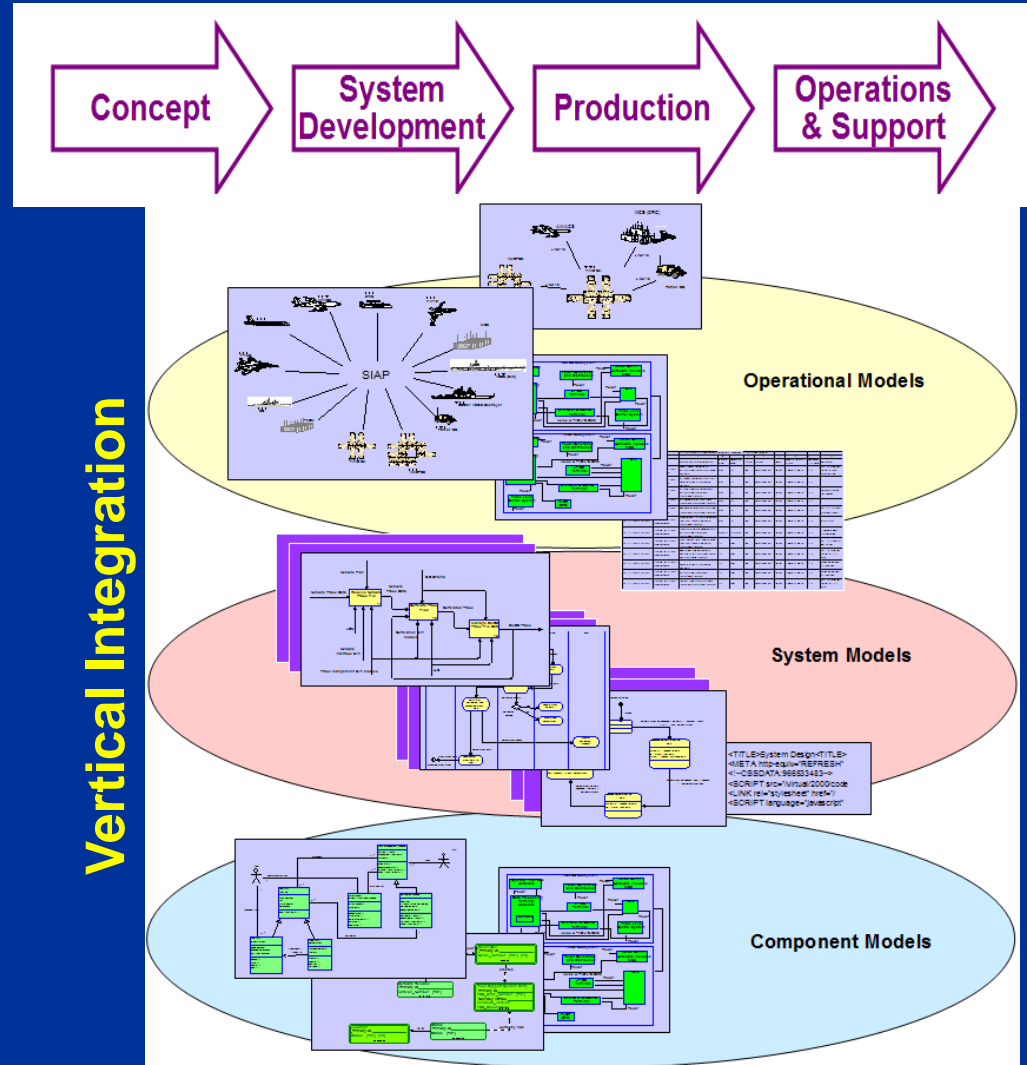
Moving from Document centric to Model centric

Model-based Systems Development (MBSD)

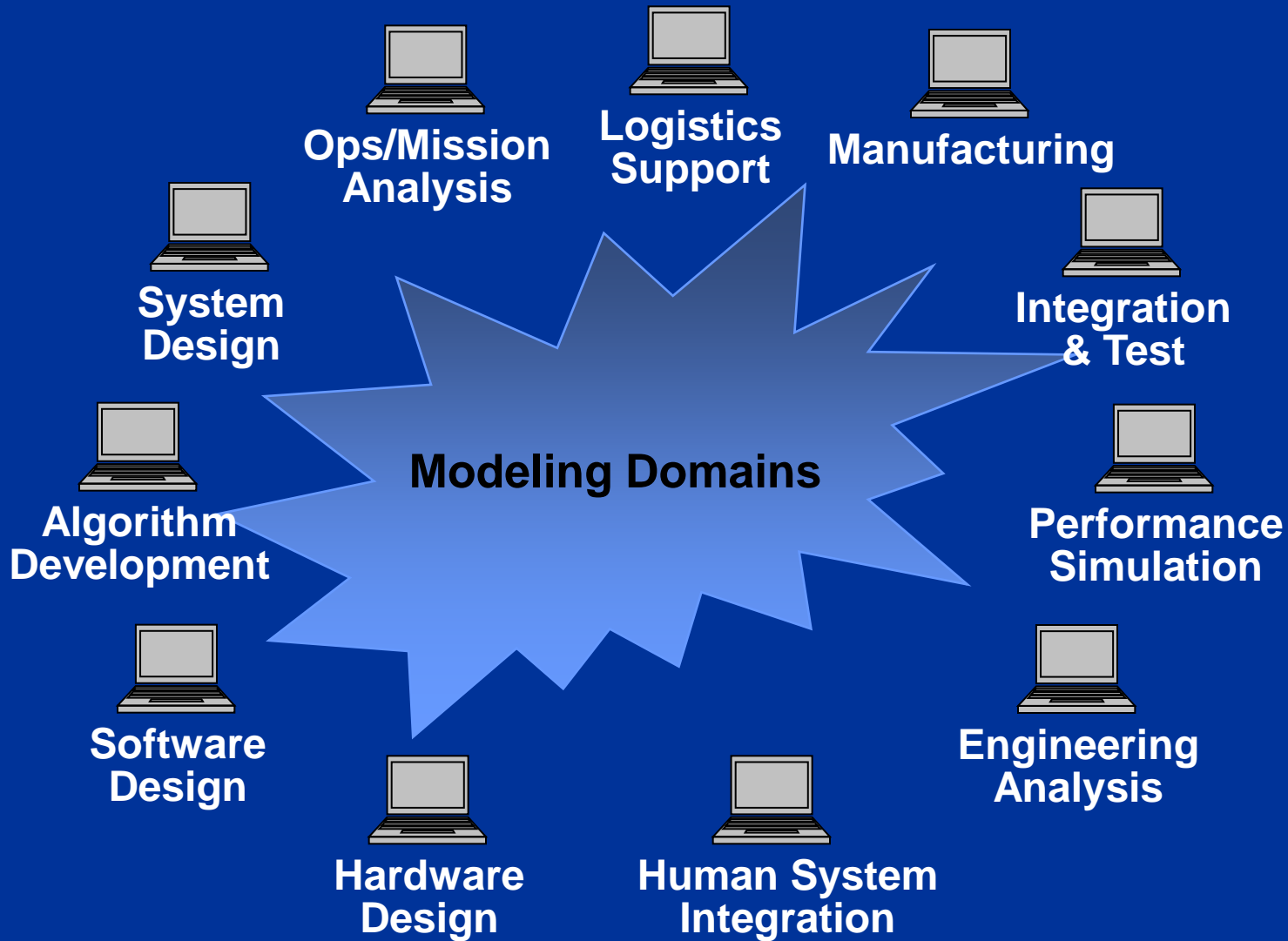
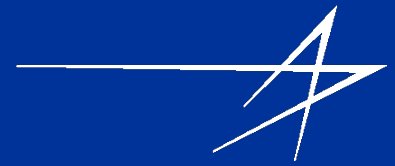


- Formalizes the practice of systems development through use of models
- Broad in scope
 - Integrates with multiple modeling domains across life cycle from system of systems to component
- Results in quality/productivity improvements & lower risk
 - Rigor and precision
 - Communications among system/project stakeholders
 - Management of complexity

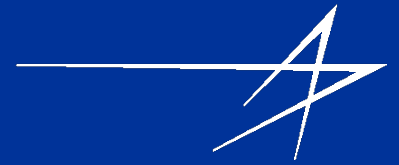
Life Cycle Support



MBSD Must Integrate across Modeling Domains



Modeling Challenges

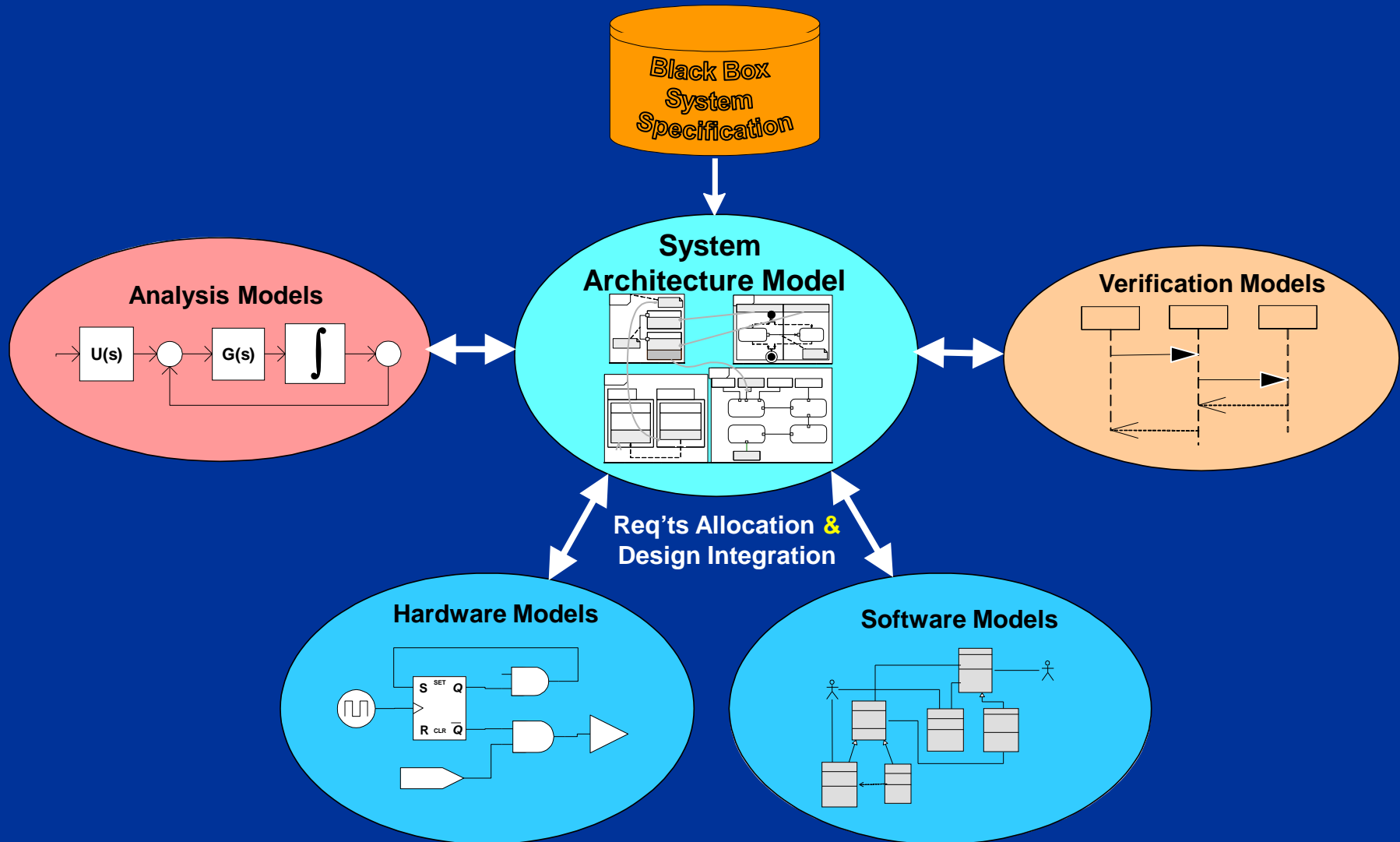
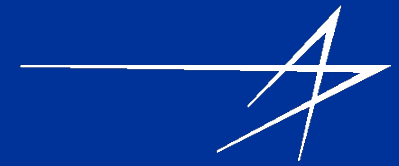


- **Lots of good modeling going on, but:**
 - Modeling practices in people's head, and not well codified and shared
 - Modeling still done in stovepipes, and not fully integrated into systems development workflow



MBSD Approach Using System Architecture Model as Integration Framework

Using System Architecture Model as an Integration Framework



Using the System Architecture Model to Flowdown Requirements

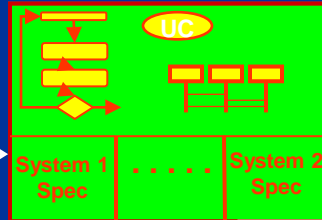


System-of-System Level

- 1st Level Of Decompositions
- How Our System Contributes to the Overall Mission



Mission Concept of Operations



Trade Studies, Simulation, Specification Reviews, etc.

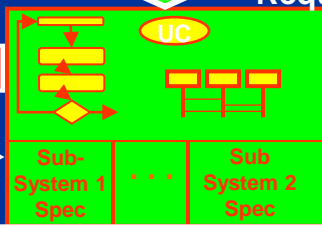
System Level

- Derives Subsystems
- Allocates Requirements



A-Spec

Subsystems



Behavior, Structure & Requirements

Trade Studies, Simulation, Specification Reviews, etc.

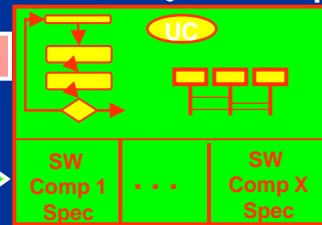
Element Level

- Derives Hardware and Software Components
- Allocates Requirements to Components



B-Spec

Behavior, Structure & Requirements

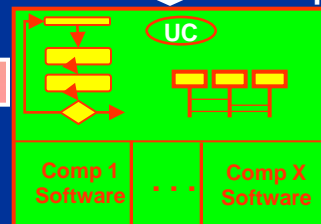


Trade Studies, Simulation, Specification Reviews, etc.

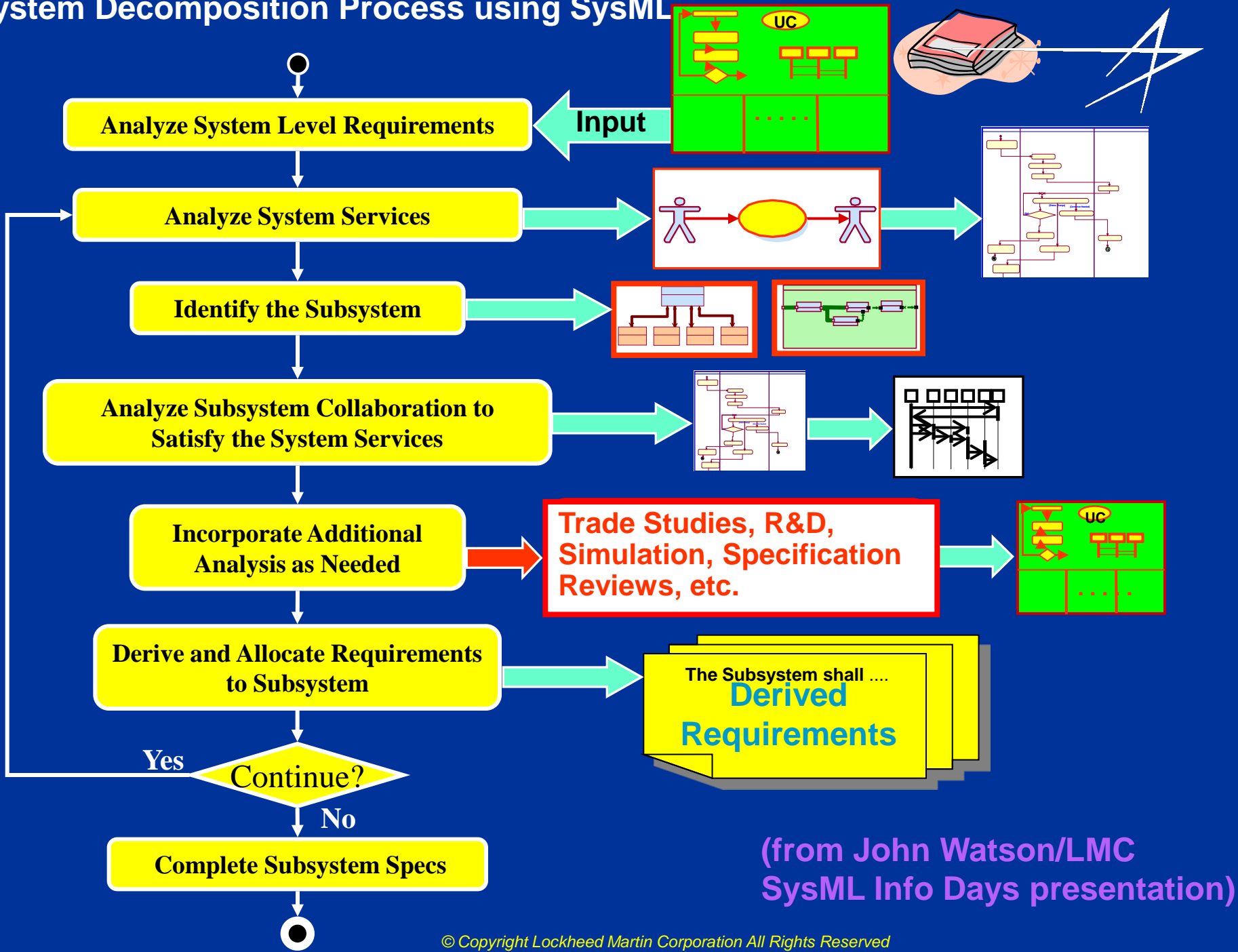
Component Design & Implementation Level

(from John Watson/LMC SysML Info Days presentation)

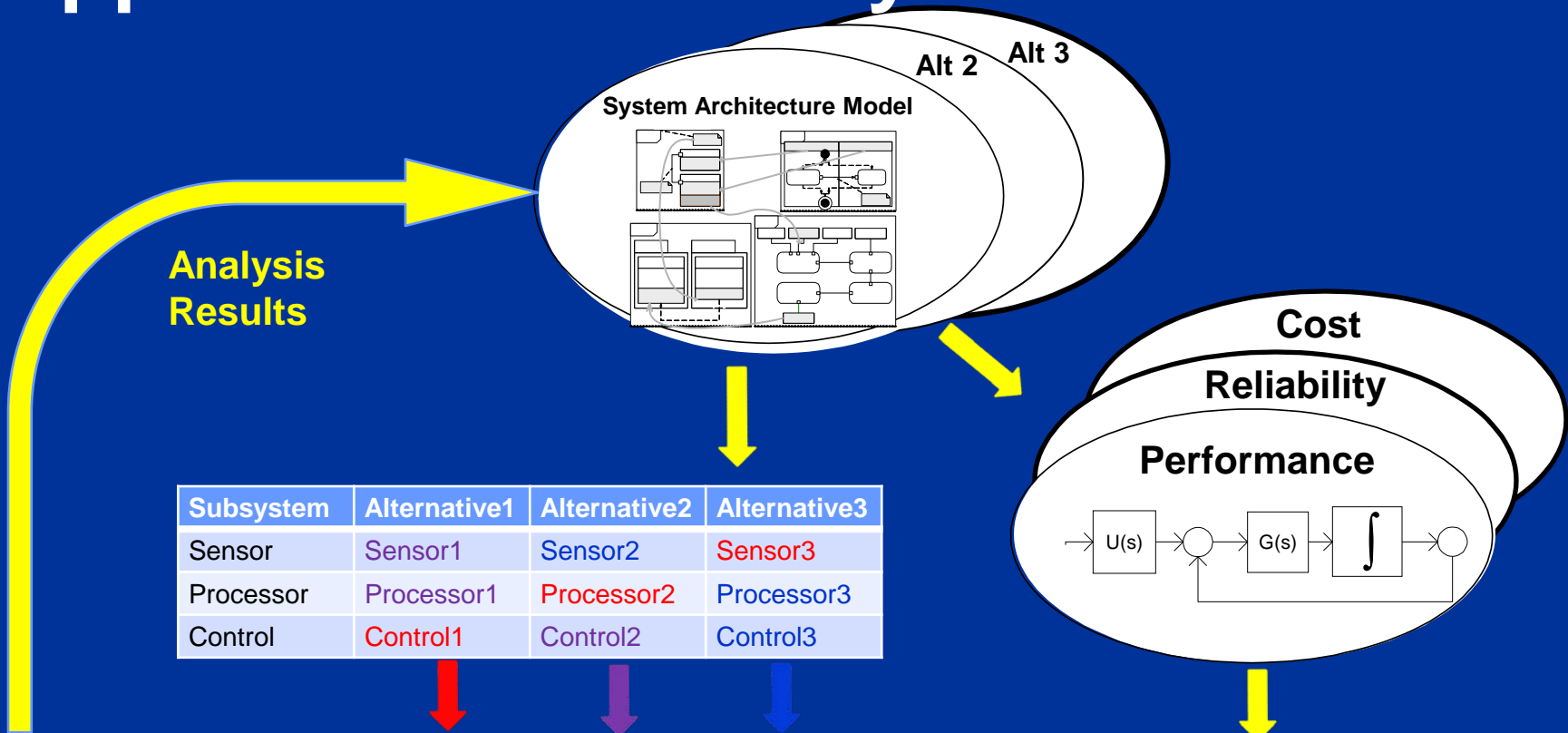
Behavior, Structure & Requirements



System Decomposition Process using SysML



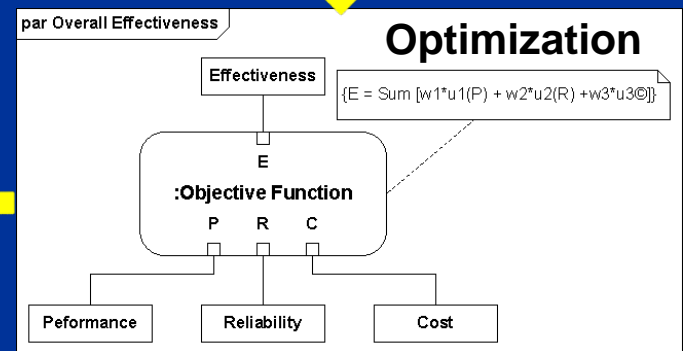
System Architecture Model to Support Tradeoff Analysis



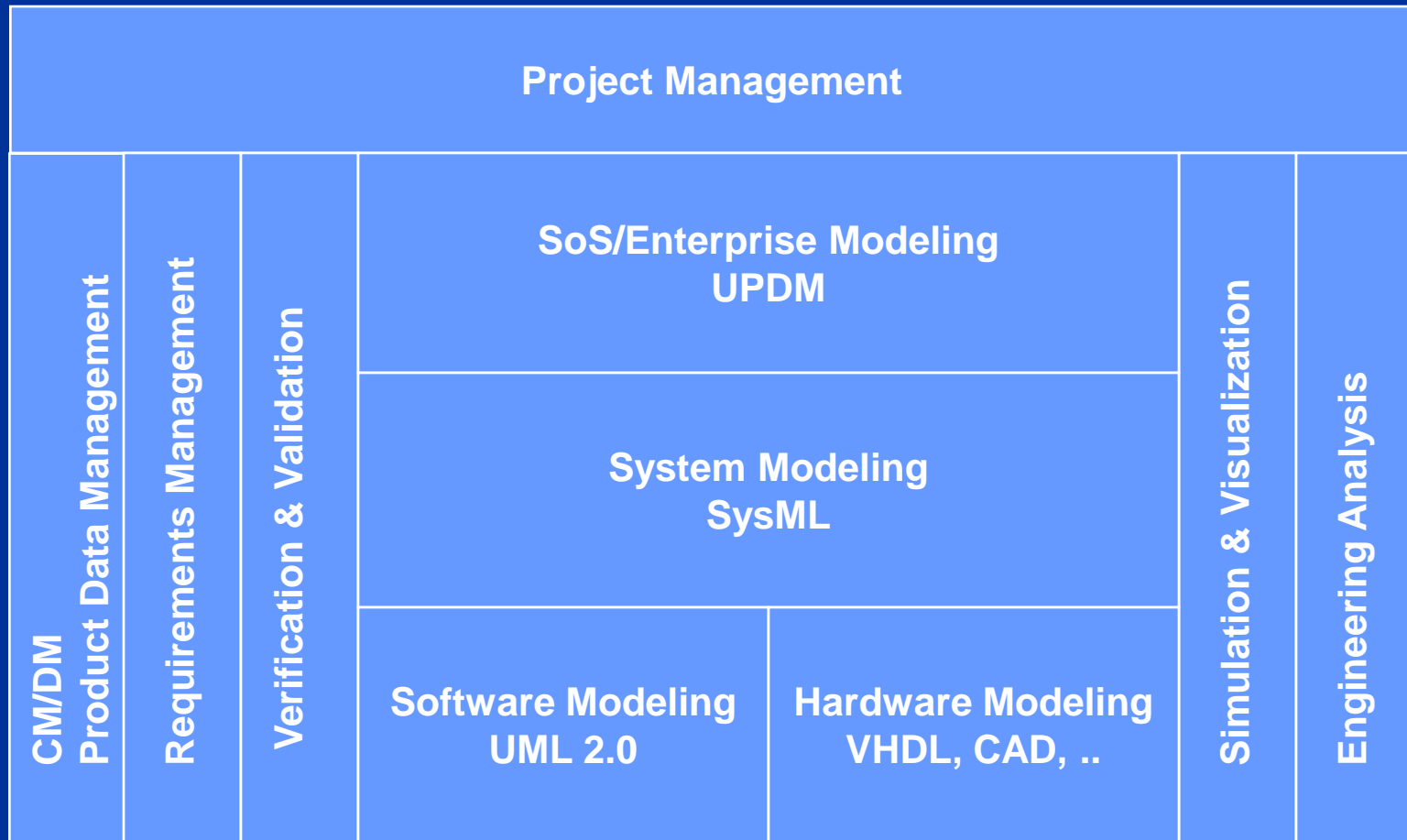
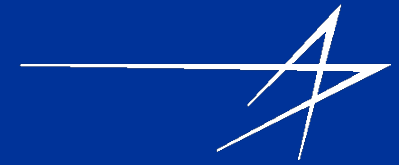
Analysis Results

Subsystem	Alternative1	Alternative2	Alternative3
Sensor	Sensor1	Sensor2	Sensor3
Processor	Processor1	Processor2	Processor3
Control	Control1	Control2	Control3

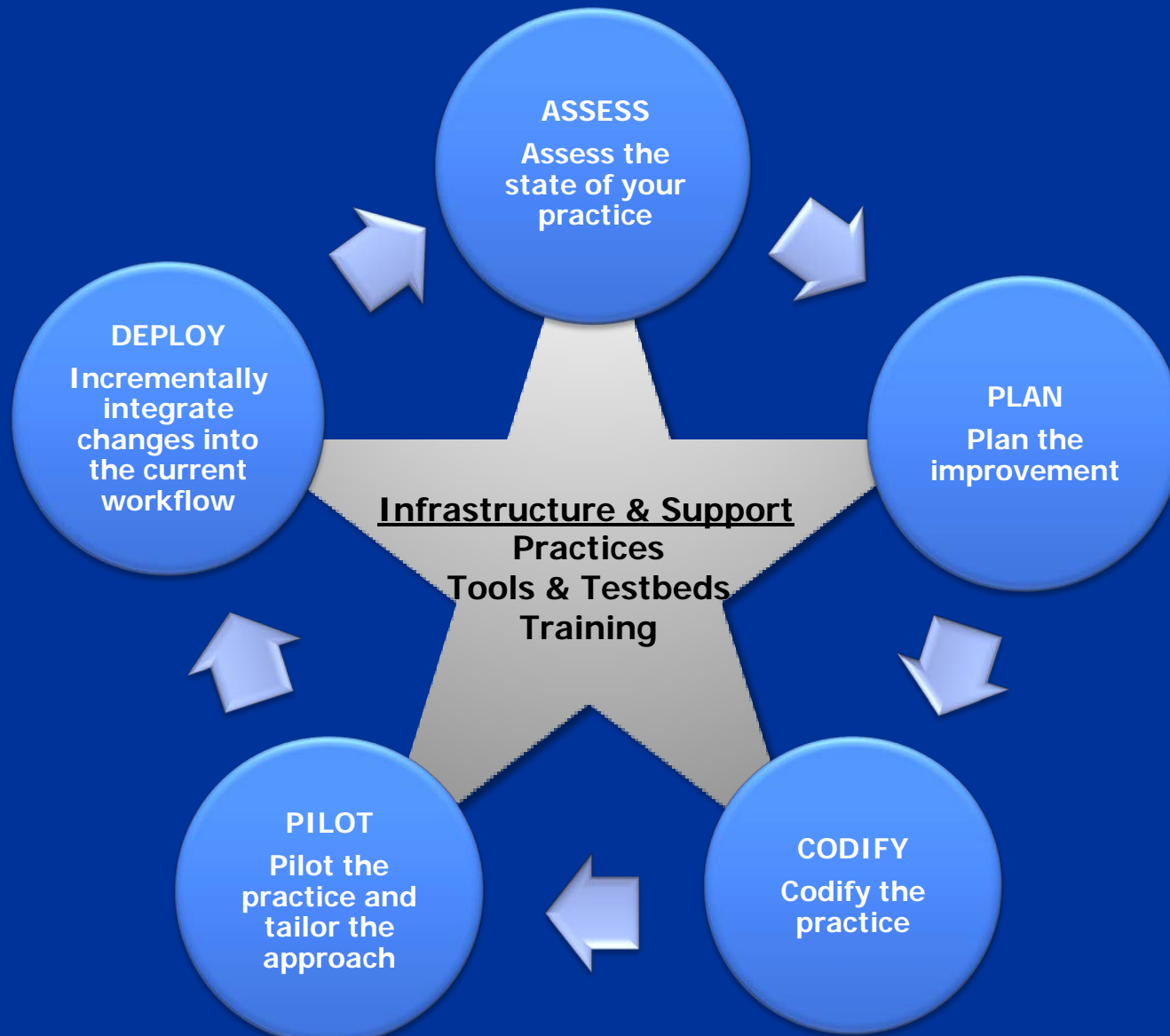
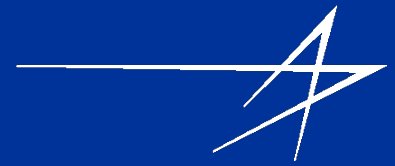
Criteria	Weight	Alt 1	Alt 2	Alt 3
Performance	0.5	7	5	5
Reliability	0.2	4	6	5
Cost	0.3	3	5	8
Effectiveness		5.2	4.2	5.9



Typical Integrated Tool Environment



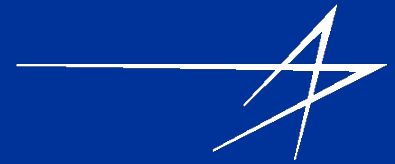
Deploying MBSD as part of Improvement Process





Observations and Summary

MBSE Observations

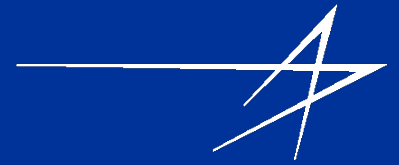


- **Transition from document-centric to model-centric is a cultural change**
- **Well defined MBSE method is essential**
- **Multiple tool vendors provide a range of price point, capability, and standards conformance**
- **MBSE training should include language, method, and tools**
- **Employ pilots to validate your MBSE approach**
- **Need buy-in from program and customer on MBSE benefits, approach and deliverables**
- **Scope model to support program objectives and within program constraints**
- ***A lot has been learned, but much more remains***



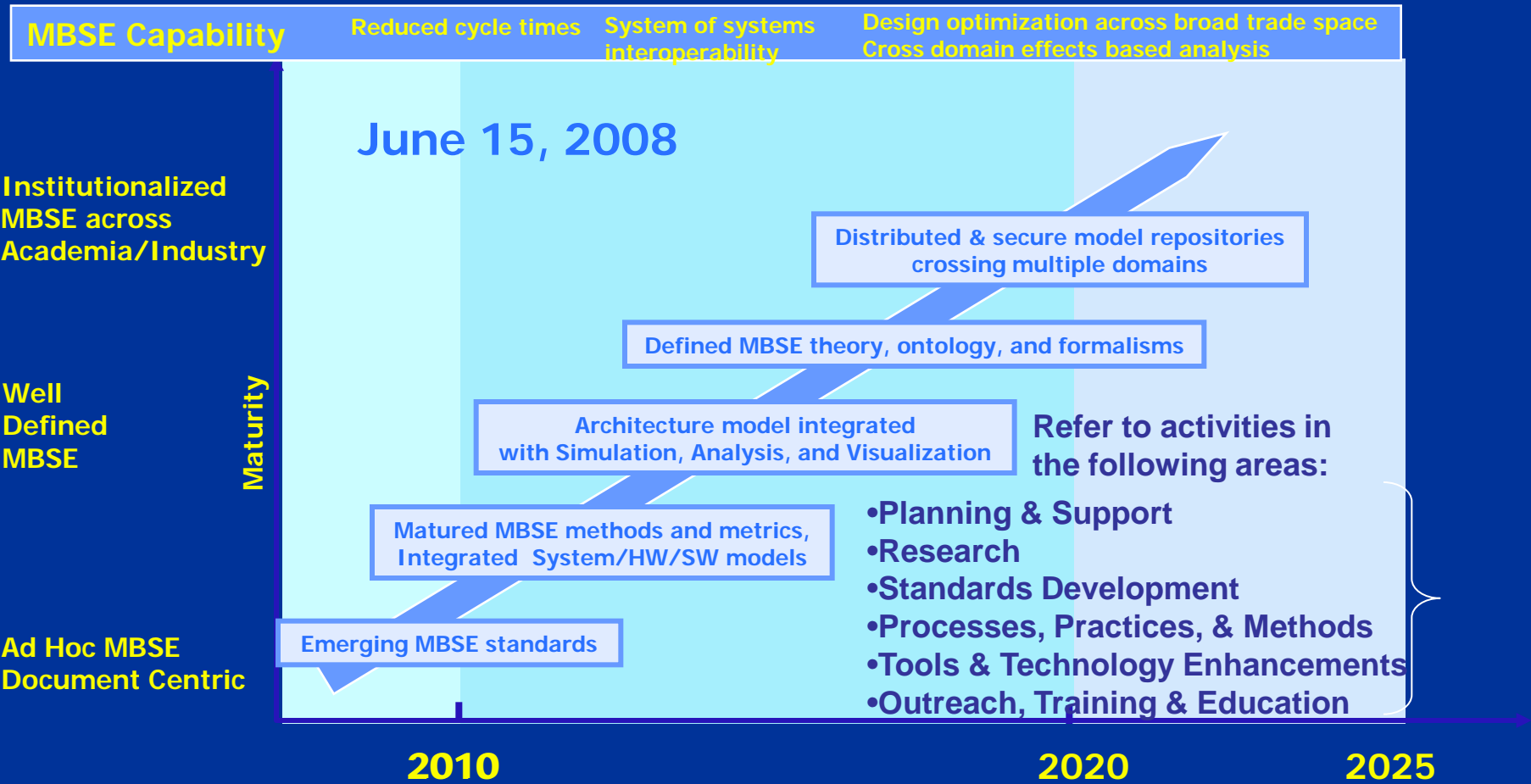
INCOSE MBSE Initiative

INCOSE MBSE Initiative Charter



- **Promote, advance, and institutionalize the practice of MBSE to attain the MBSE 2020 Vision through broad industry and academic involvement in:**
 - Research
 - Standards
 - Processes, Practices, & Methods
 - Tools & Technology
 - Outreach, Training & Education

INCOSE MBSE Roadmap



Summary



- **MBSE is a key practice to advance complex systems development**
- **Standards such as SysML are critical enablers of MBSE**
- **Multiple tool vendors implementing the standard**
- **System architecture model and standards based approach facilitate Integration across modeling domains**
- **Growing interest and application of MBSE**
- **INCOSE MBSE helping to advance and promote MBSE**

