A Few Words First

Audio Connection –Please mute phone (*6 toggle) –or your GM left-side name

Phone connections may be muted during presentation. Put questions in chat box.

Upcoming Meetings:

- December 11: Tutorial – How to write a SEMP to ensure it delivers value – Becky Reed and Ian Pressland
- January 8: TBD
- February 12: Dr. Ali Raz, Purdue Technology Center – A Definition Abstraction and Implementation Process for SoS Engineering

CSEP Courses by *Certification Training International:*

Course details(with more locations and dates)
Upcoming Course Schedule (somewhat nearby):
2020 June 1-5 | San Diego, CA
2020 Sep 28-Oct 2 | Austin, TX
Chapter SEP mentors: Ann Hodges alhodge@sandia.gov and Heidi Hahn hahn@lanl.gov

First slide, not retained in recording but retained in pdf presentation.

And now - introductions

Vitech

Enchantment Chapter Monthly Meeting

13 Nov 2019 – 16:45–18:00 MT

MBSE 2.0: The Future of MBSE

David Long, ViTech President, INCOSE Past President and Fellow

Abstract: Model-based systems engineering (MBSE) is a term that has become "loaded" with meanings – many not intended in the original concept of MBSE, some of them even contradictory with it and with each other. As originally conceived, MBSE was the practice of basing the systems engineering (be that design, redesign or improvement) on a common, shared model of the system design. But the loading down of the term has resulted in confusion in engineering enterprises about what MBSE is and how it is practiced.
There is a path forward – to an MBSE 2.0 where the hurdles and missteps are behind us. In plotting this path, we don't reject the journey and the progress that has brought us to this point in time. Instead, we embrace them in all their richness – the strengths and successes to reinforce, the challenges to address and resolve. This involves understanding that a broad vocabulary consisting of representations that will communicate to a wide audience of customers and not just to a narrow segment accustomed to one way of representing systems. It requires connecting to a variety of analytical models (e.g.- physics-based performance models) without thinking of them as the systems architecture model that makes systems engineering truly "model-based."

Download slides today-only from the Library at www.incose.org/enchantment

NOTE: This meeting will be recorded

Vitech

Today’s Presentation

Things to think about

- How can this be applied in your work environment?
- What did you hear that will influence your thinking?
- What is your take away from this presentation?

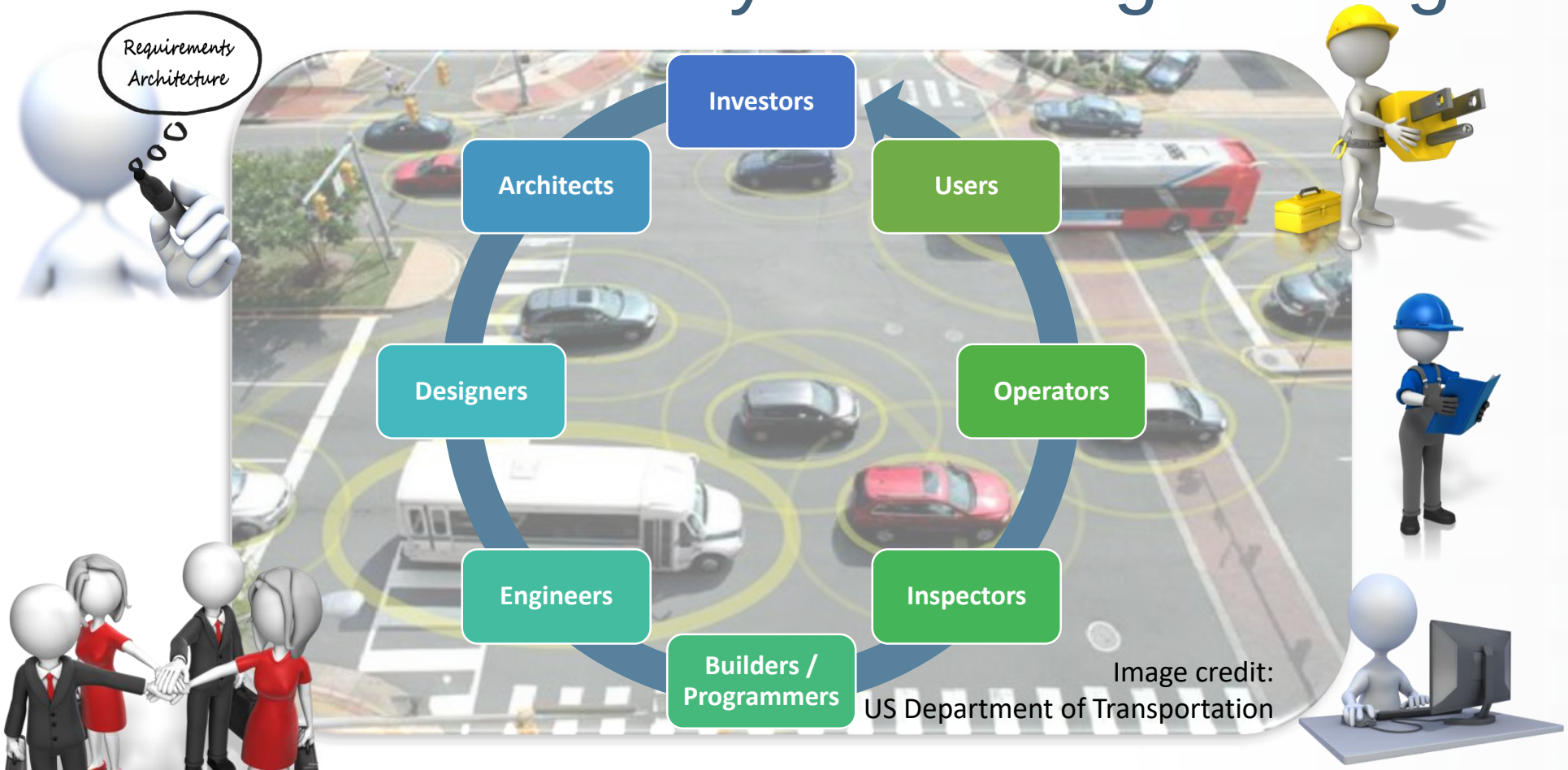
Speaker Bio

For over twenty-five years, David Long has focused on helping organizations increase their systems engineering proficiency while simultaneously working to advance the state of the art. David is the founder and president of Vitech where he leads the team in delivering innovative, industry-leading methods and software (CORE™ and GENESYS™) to help organizations engineer next-generation systems. David is a frequent presenter at industry events worldwide delivering keynotes and tutorials spanning introductory systems engineering, the value of SE, the advanced application of MBSE, digital engineering, and the future of engineering systems. His experiences and efforts led him to co-author the book *A Primer for Model-Based Systems Engineering* to help spread the fundamental concepts of this key approach to modern challenges. An INCOSE Fellow and Expert Systems Engineering Professional (ESEP), David was the 2014/2015 president of INCOSE.

MBSE 2.0:
The Future of MBSE

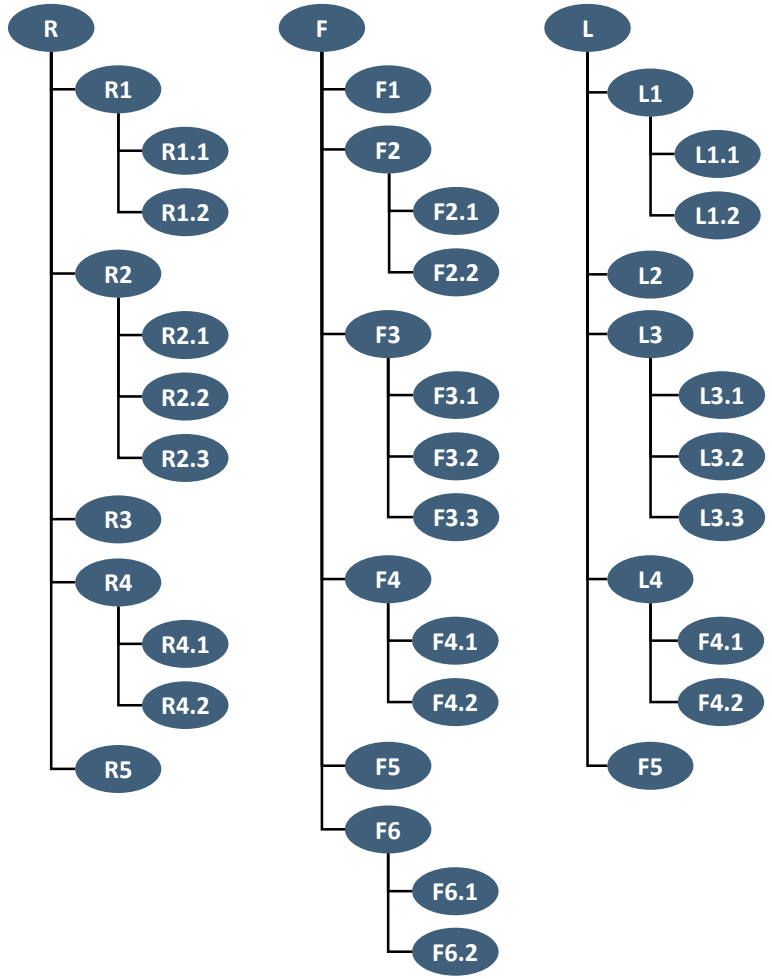
David Long
President, Vitech Corporation
Past President and Fellow, INCOSE
david.long@vitechcorp.com

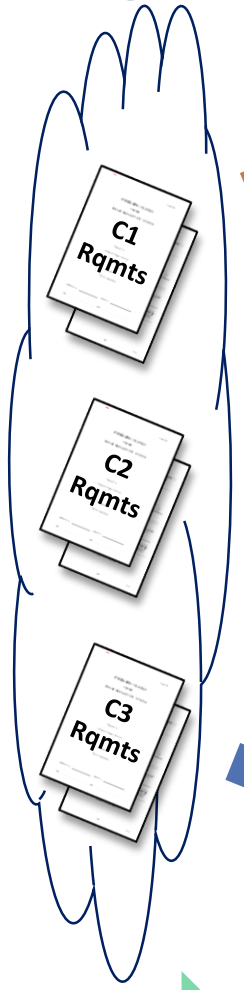
Connecting People, Disciplines, and Insights: Essential Context for Systems Engineering

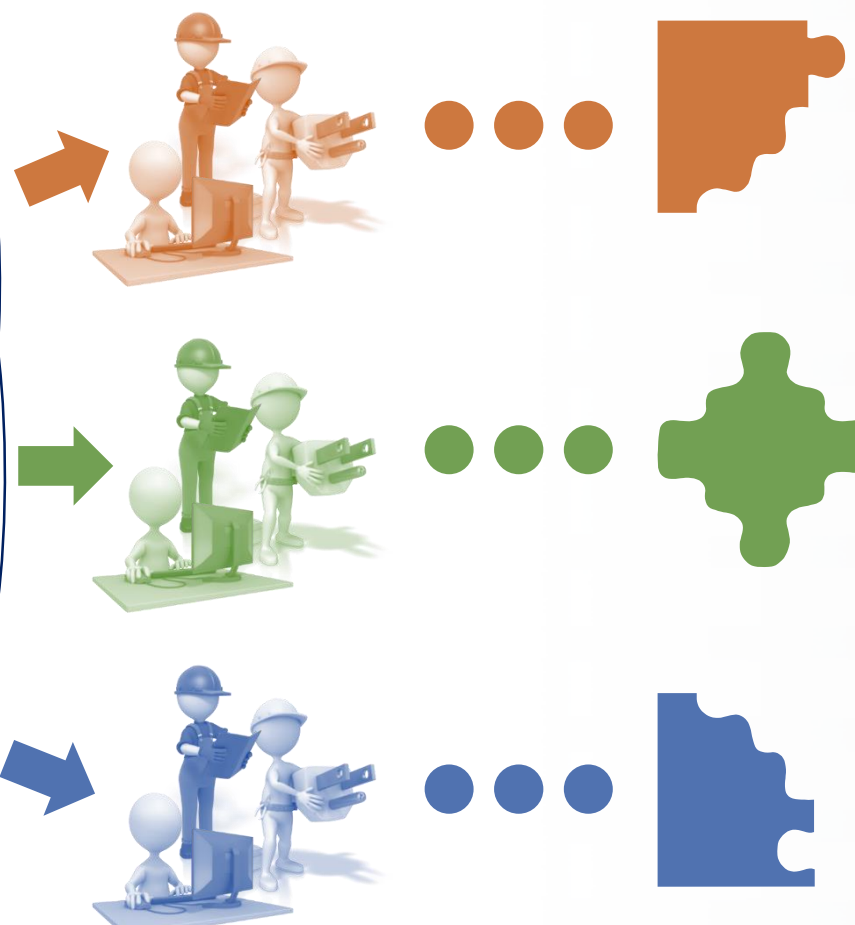


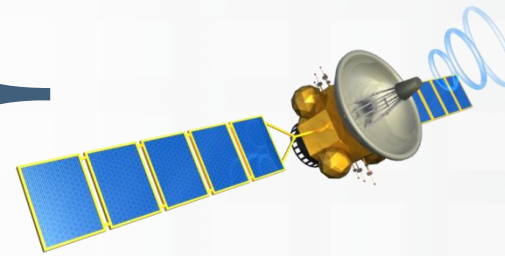
Systems engineering focuses on ensuring the pieces work together to achieve the objectives of the whole.

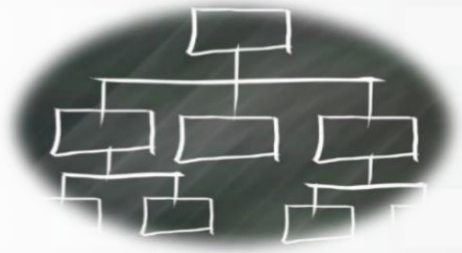
Classical Engineering in a Complicated World











REQUIRED BEHAVIOR STRUCTURE

CONCEPT DEVELOPMENT

Systems Challenges in Today's World: Exceeding the Capabilities of Traditional (S)E

1. Mission complexity is growing faster than our ability to manage it . . . increasing mission risk from inadequate specifications and incomplete verification.

2. System design emerges from pieces, rather than from architecture . . . resulting in systems that are brittle, difficult to test, and complex and expensive to operate.

3. Knowledge and investment are lost at project life cycle phase boundaries . . . increasing development cost and risk of late discovery of design problems

4. Knowledge and investment are lost between projects . . . increasing cost and risk: dampening the potential for true product lines.

Complexity exceeding the bounds of traditional siloed approaches

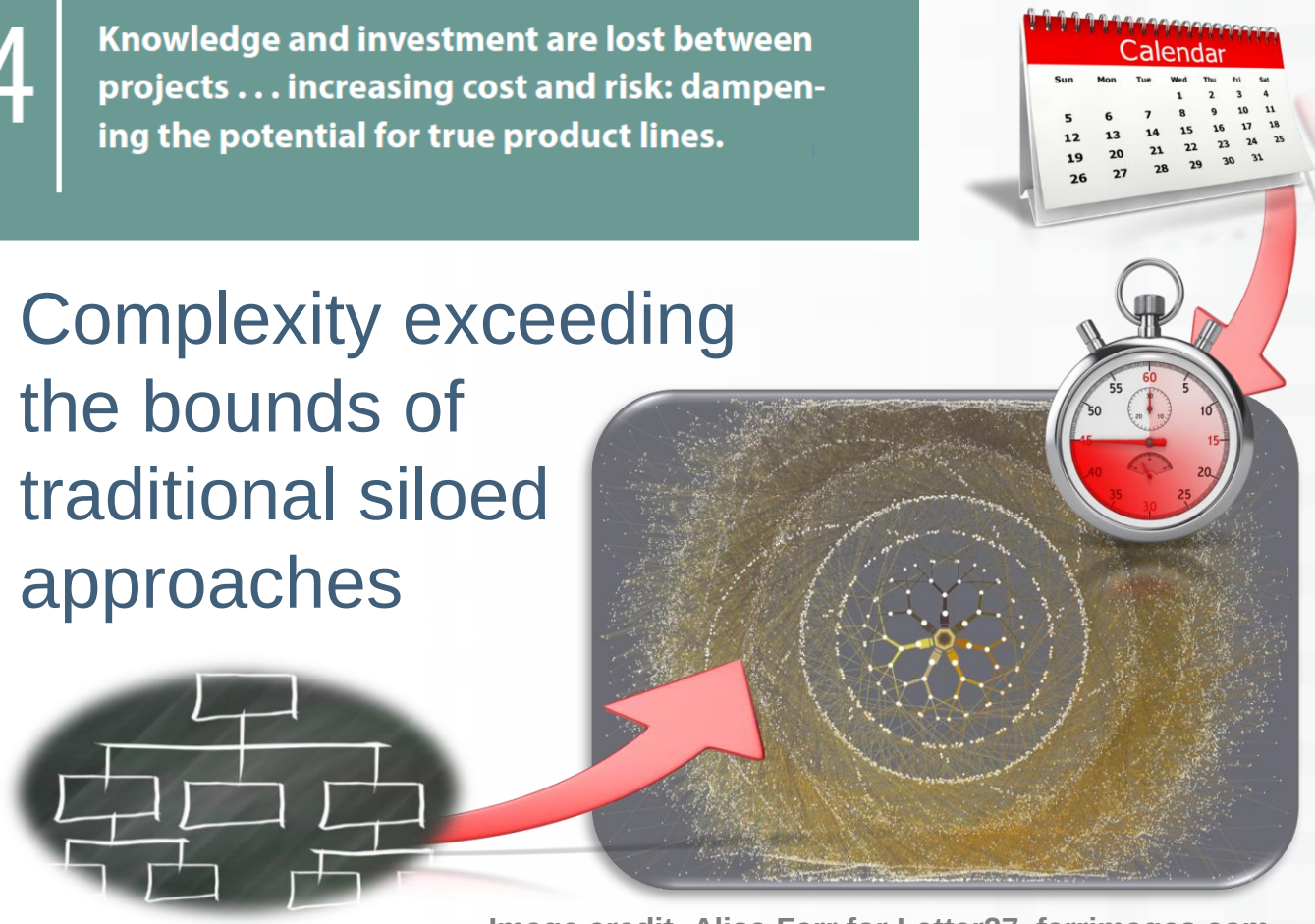


Image credit: Alisa Farr for Letter27. farrimages.com

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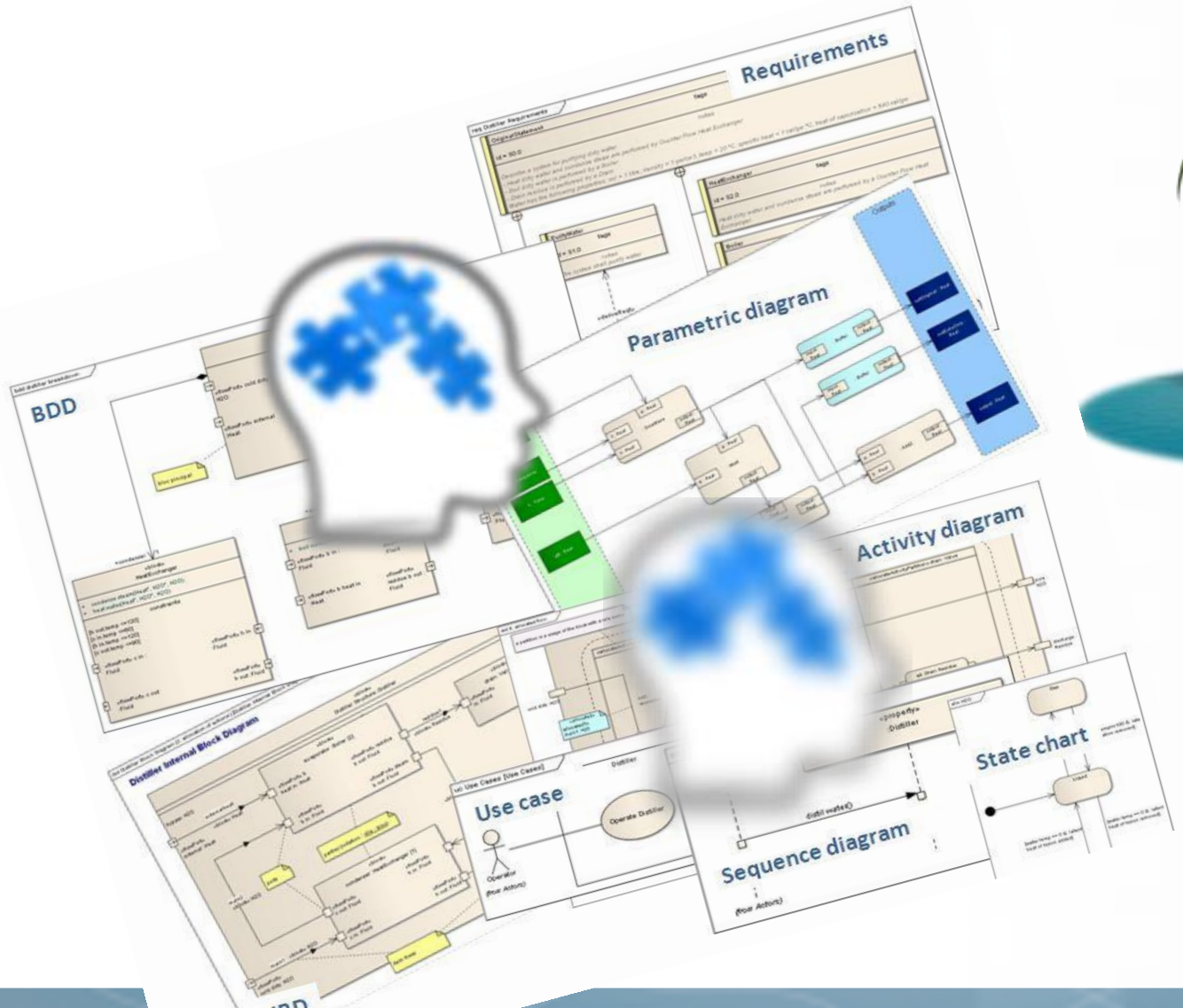
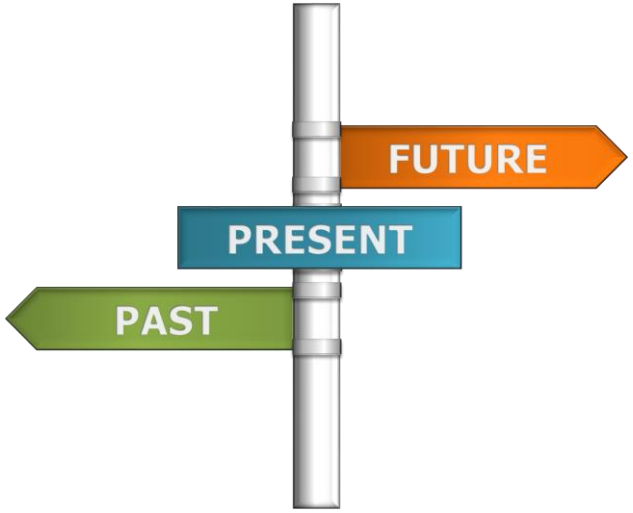
MBSE 1.0:
A Well-Intentioned – but flawed – Approach



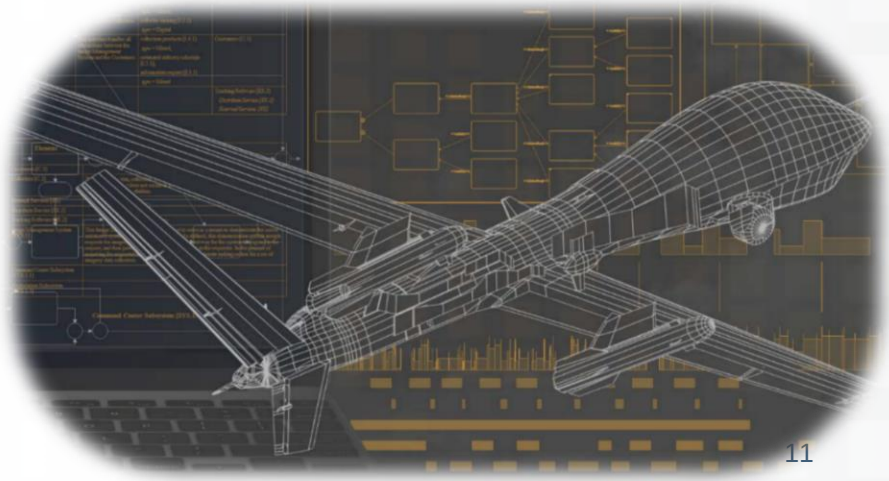
Seeing the Bigger Picture: What MBSE Should Be All About

- Making system descriptive and analytical models explicit, coherent, consistent, and actionable
  - Evolution from low-fidelity representations in documents to higher-fidelity, richer representations
  - Improved granularity of knowledge capture for management, analysis, and learning
  - One architectural model connecting multiple analytical models
- Leveraging models for communication and analysis
- Developing an “authoritative source of truth” for system design and specification
- Ensuring consistent design and specification (when done well)
- Providing an explicit system model to engineering teams

An evolution – not revolution – in thinking and approach…
An evolution that offers transformative results



Transforming the Engineering Enterprise through MBSE 2.0



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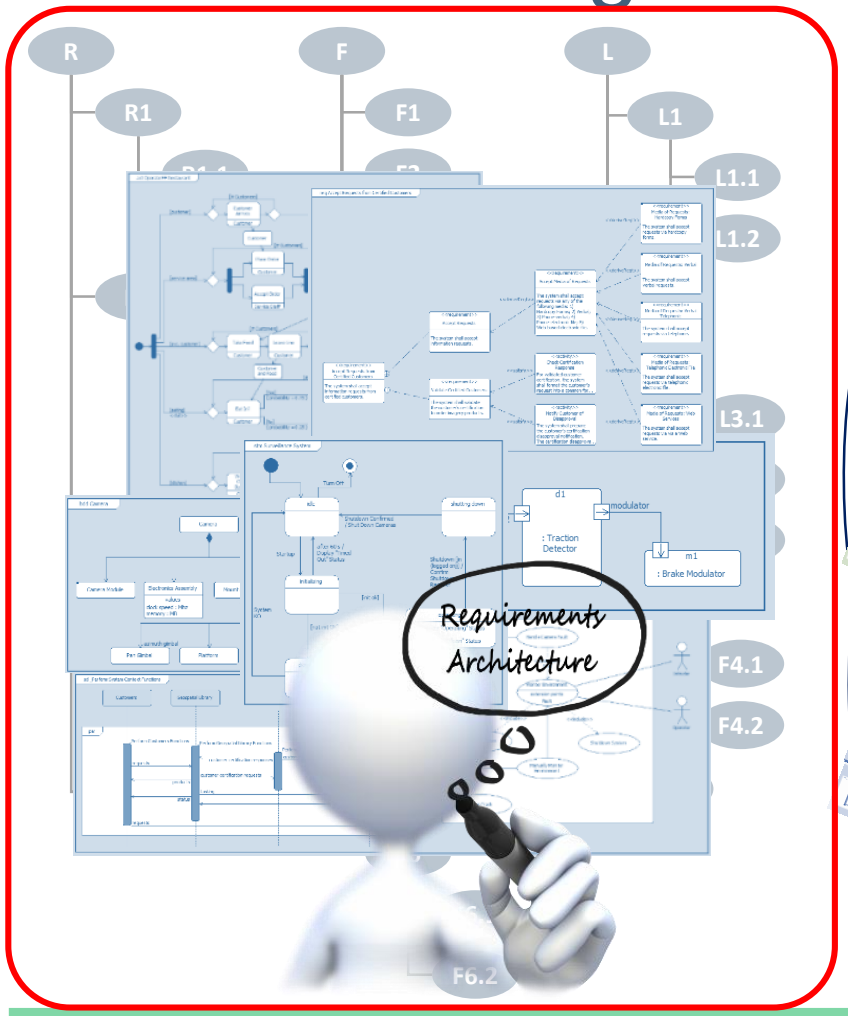
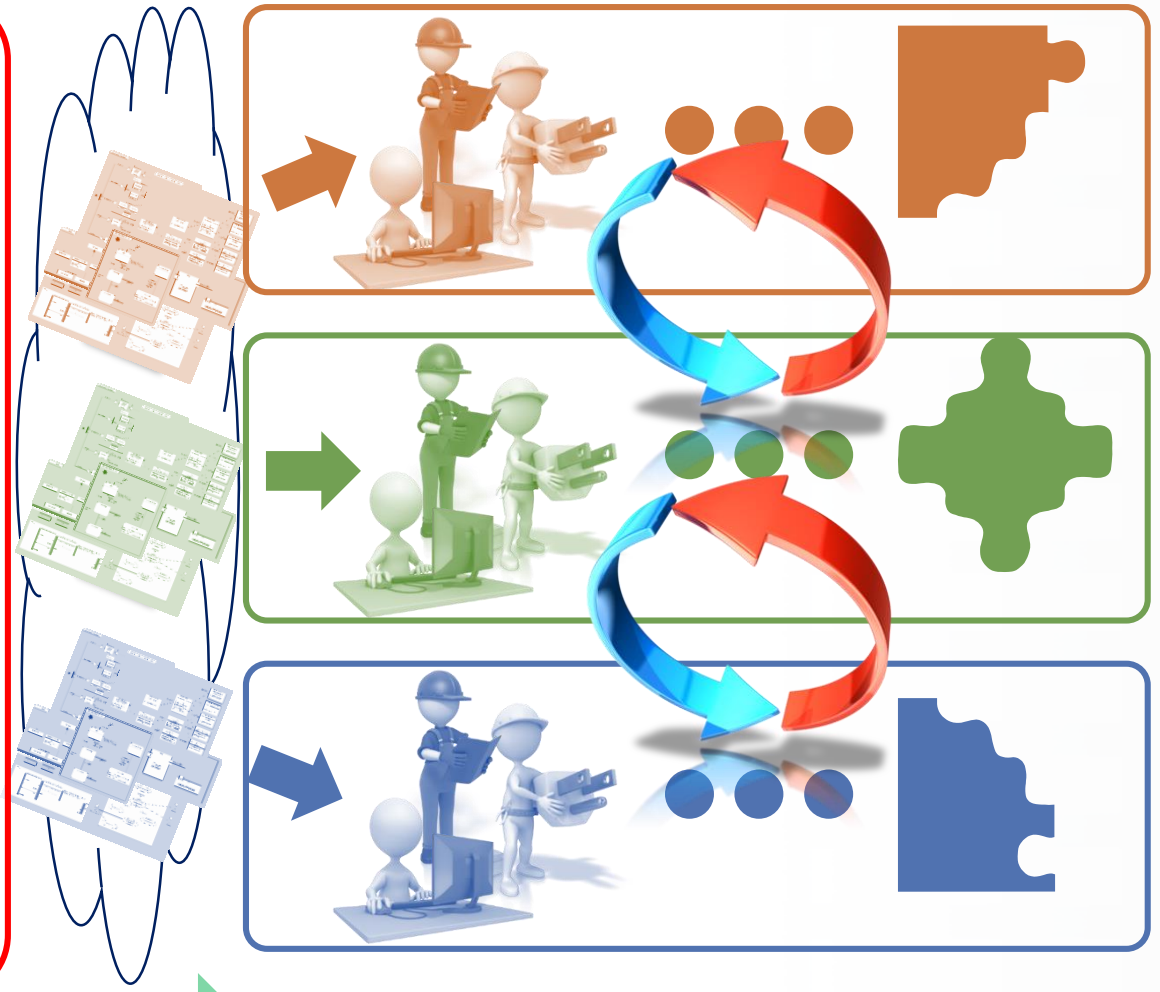
Transforming from Siloed Engineering (MBSE 1.0)

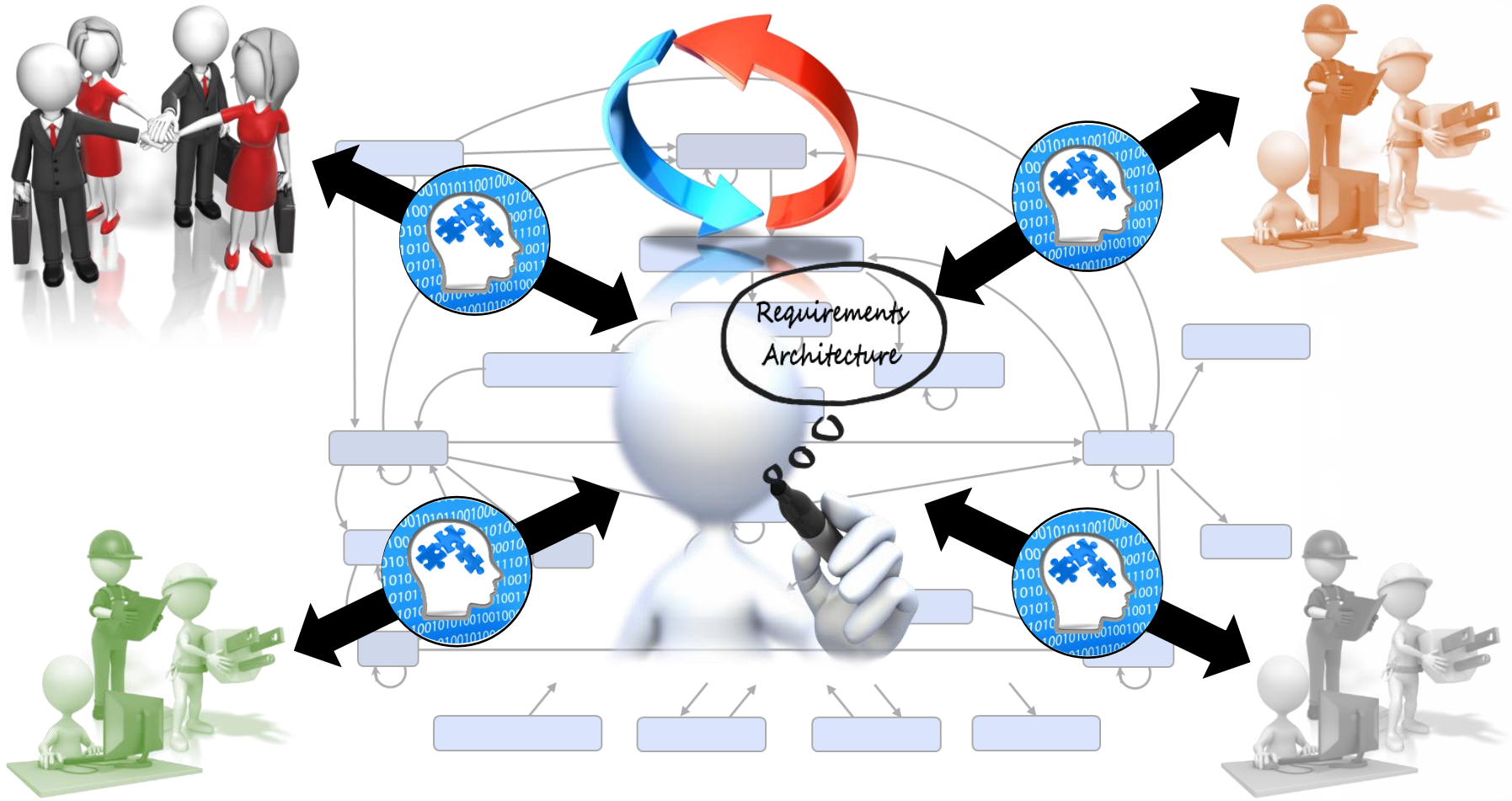




REQUIRED BEHAVIOR STRUCTURE

CONCEPT DEVELOPMENT

to Concurrent Engineering of Systems (MBSE 2.0)



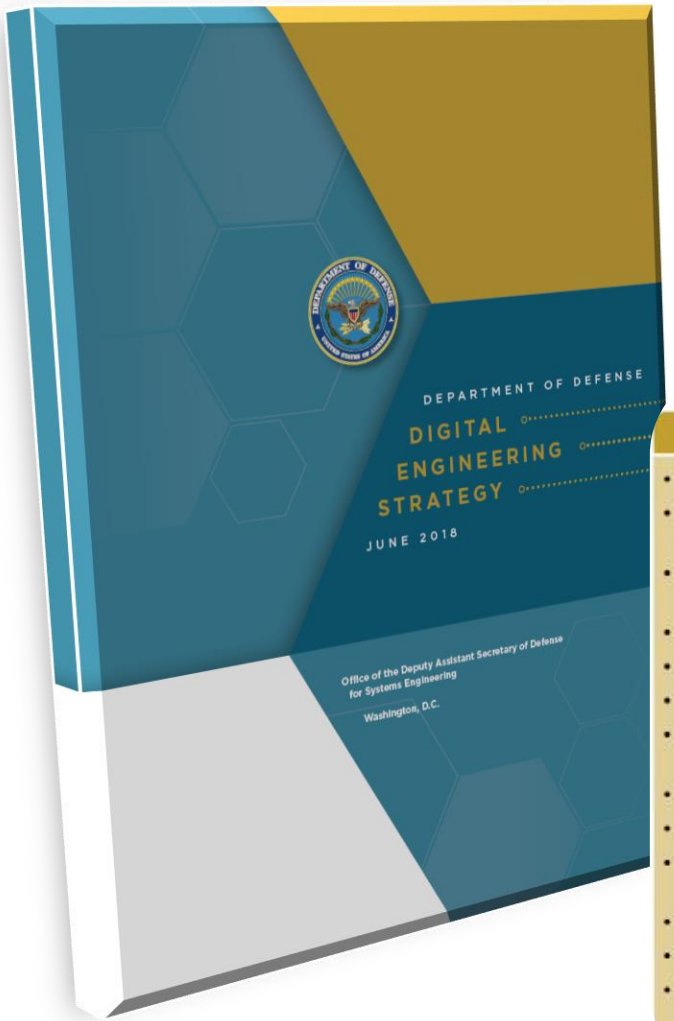
Functioning in an interdependent environment requires that every team possess a holistic understanding of the interaction between all the moving parts.

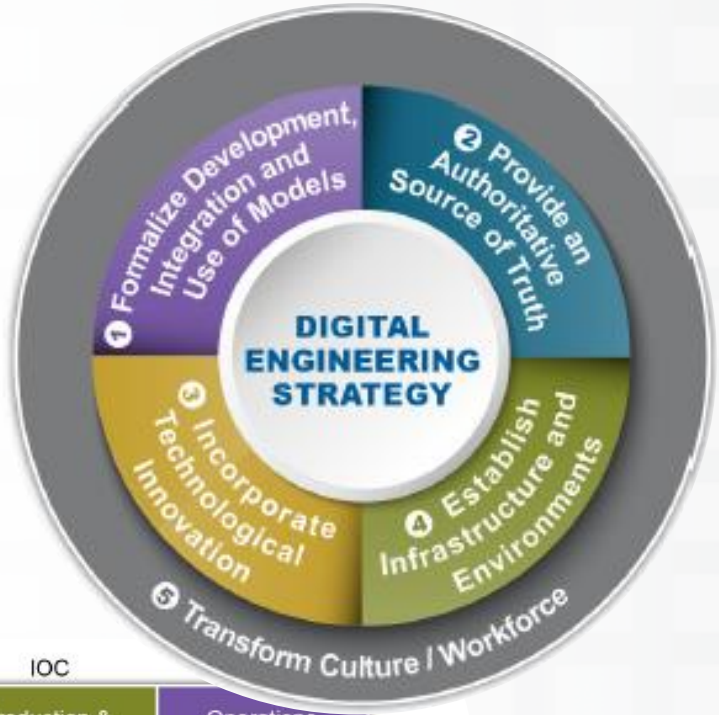
***Team of Teams*, 2015**

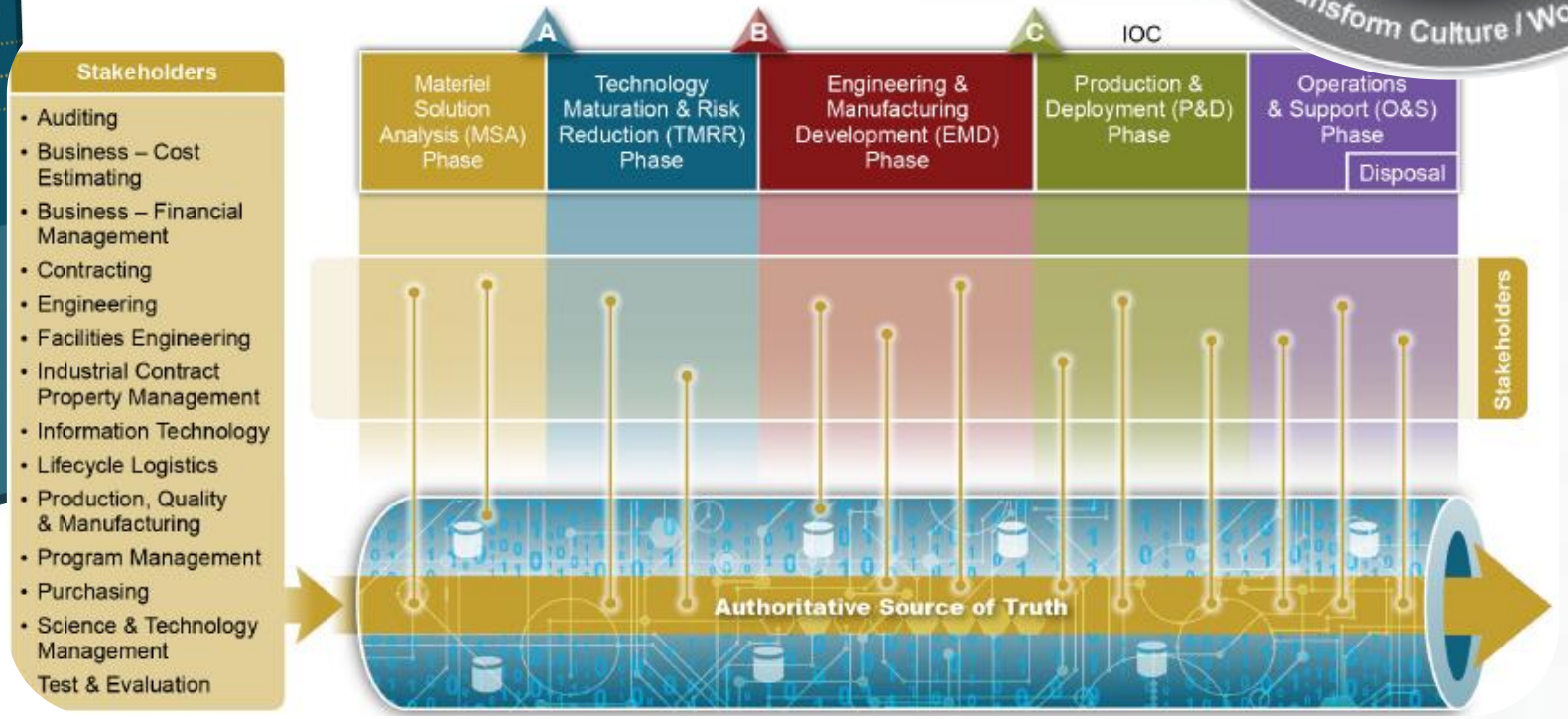
REQUIRED BEHAVIOR STRUCTURE AS DESIGNED AS ORDERED AS BUILT AS DELIVERED AS SERVICED

CONCEPT DEVELOPMENT PRODUCTION UTILIZATION & SUPPORT RETIRE

A New Digital Engineering Strategy (June 2018)







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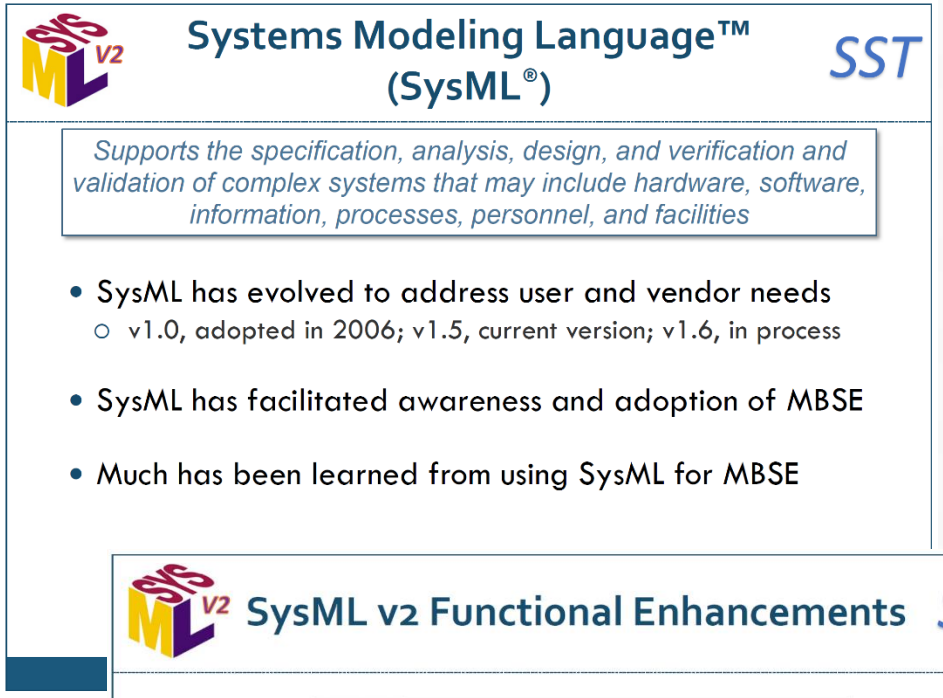
A Notable Shift for SysML: The Vision for SysML v2

- Increase adoption and effectiveness of MBSE by enhancing
  - Precision and expressiveness of the language
  - Consistency and integration among language concepts
  - Interoperability with other engineering models and tools
  - Usability by model developers and consumers
- Key elements
  - New metamodel that is not constrained by UML
  - Robust visualizations based upon flexible view and viewpoint specification and execution
  - Standardized API to Access the Model
- Proposed timeline
  - Initial submission May 2020; final May 2021

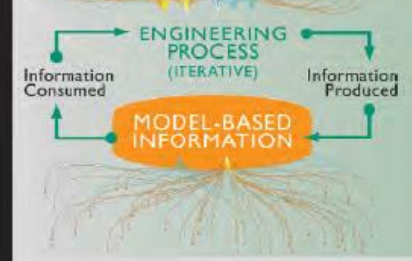


Credit Sandy Friedenthal, 2019 INCOSE International Workshop

Transforming Engineering: A New Manifesto

A MODEL-BASED ENGINEERING (MBE) MANIFESTO

PURPOSE: *To motivate the transformation to Model-Based Engineering.*



Faced with increasing system complexity, interdependencies, breakdown of document-based methods, and other challenges, MBE provides the transformation in which we value:

1. ***Information** over **artifacts***
2. ***Integration** over **independence***
3. ***Expressiveness with rigor** over **flexibility***
4. ***Model usage** over **model creation***

We value the items on the right, but not at the sacrifice of the items on the left.

THE TEAM:

The team was assembled by invitation, intentionally drawing together different perspectives.

Sandia National Laboratories

Ed Carroll
Team lead-Sandia National Laboratories– Engineering Methods Research

Nancy Hayden
SNL– Autonomous Systems/ Engineering Policy

Sharon Trauth
SNL-Systems Engineering/ MBSE Practice

Dana Grisham

Which Resets the Equation for MBSE

Engineering of Systems / Digital Thread / Digital Twin / Digital Engineering

requires

Concurrency

requires

Concurrent MBSE / MBSE 2.0

is maximized by

Re-engineering the Engineering Enterprise

built upon

A Holistic Systems Perspective

Understanding Concurrency and Concurrent MBSE

MBSE 2.0
(aka Concurrent MBSE)

concurrent MBSE
(the ability for a team of systems engineers to work on their systems model in parallel)

concurrent MBSE
(the ability for a systems team to effectively engage all members and stakeholders)

concurrent MBSE
(the ability to effectively engage detailed design within the Engineering of Systems framework while eliminating the air gap)

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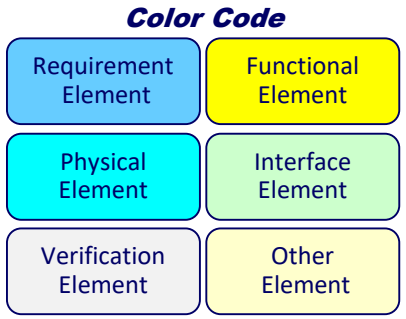
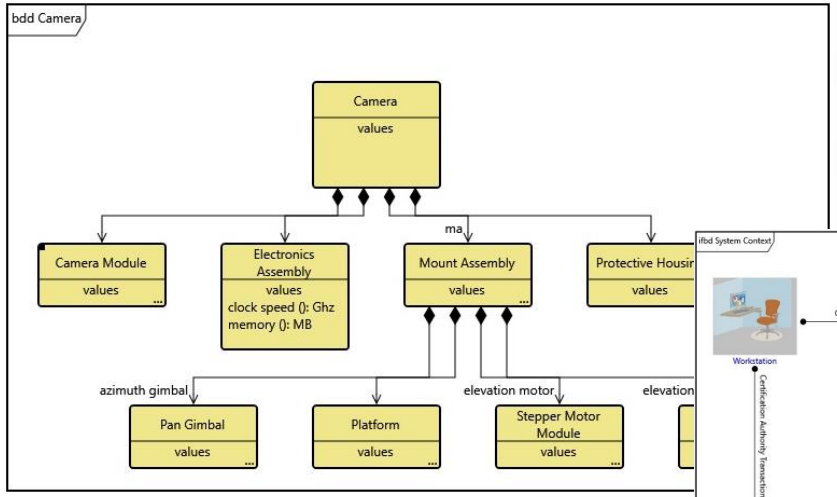
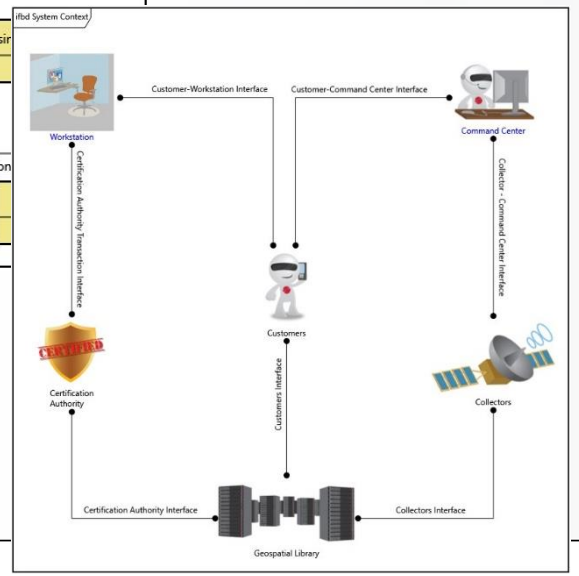
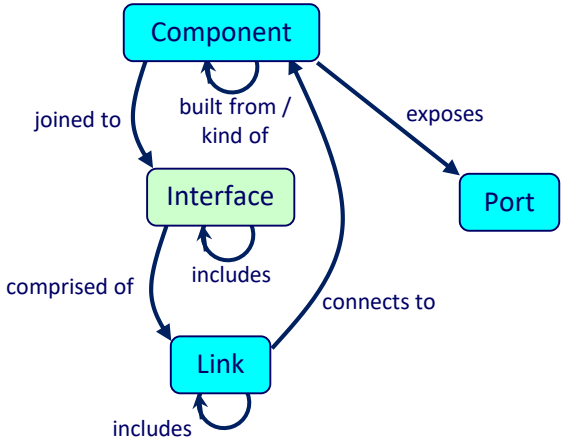
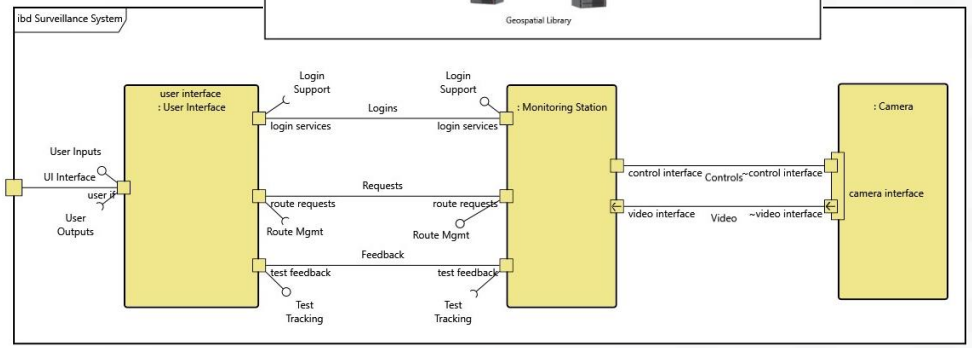
Identifying the Foundation: The Systems Metamodel



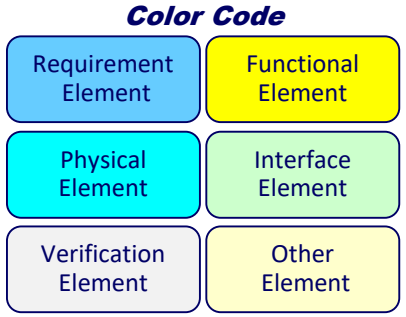


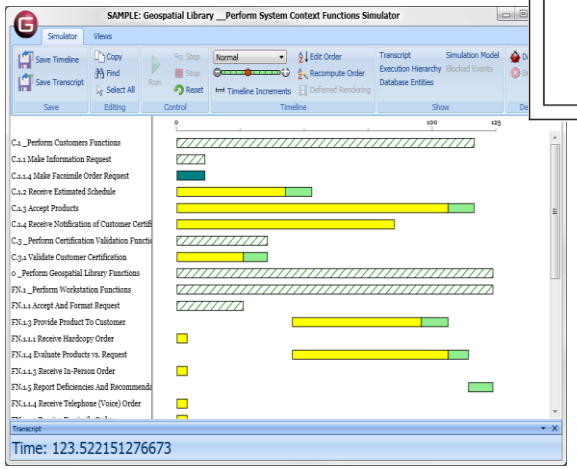


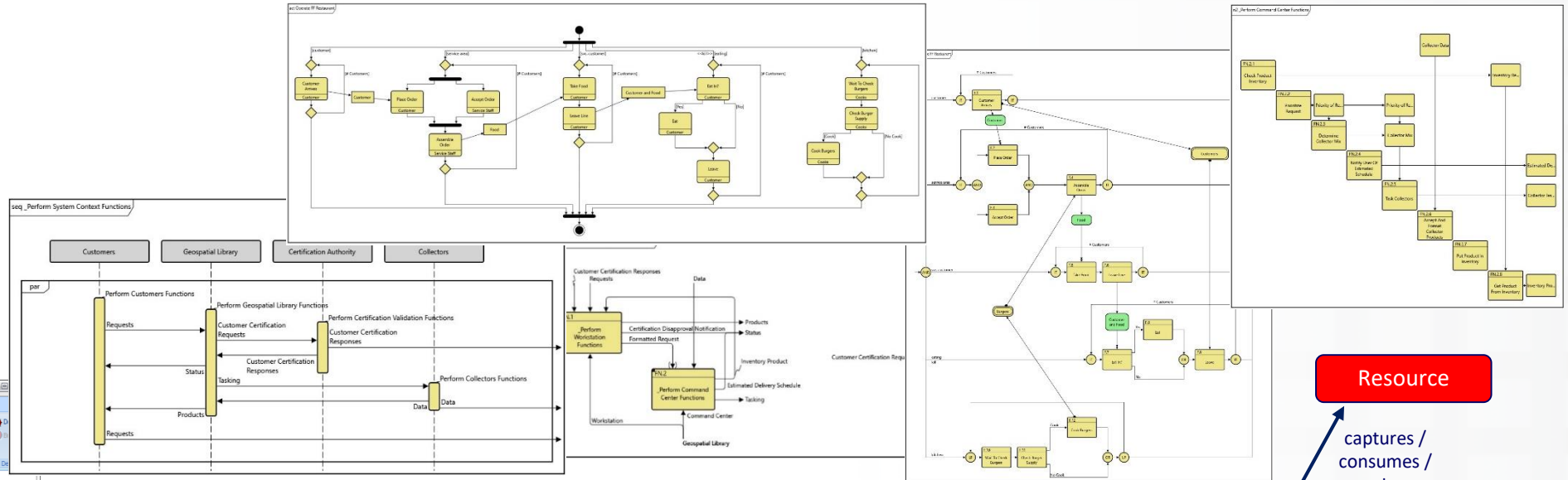


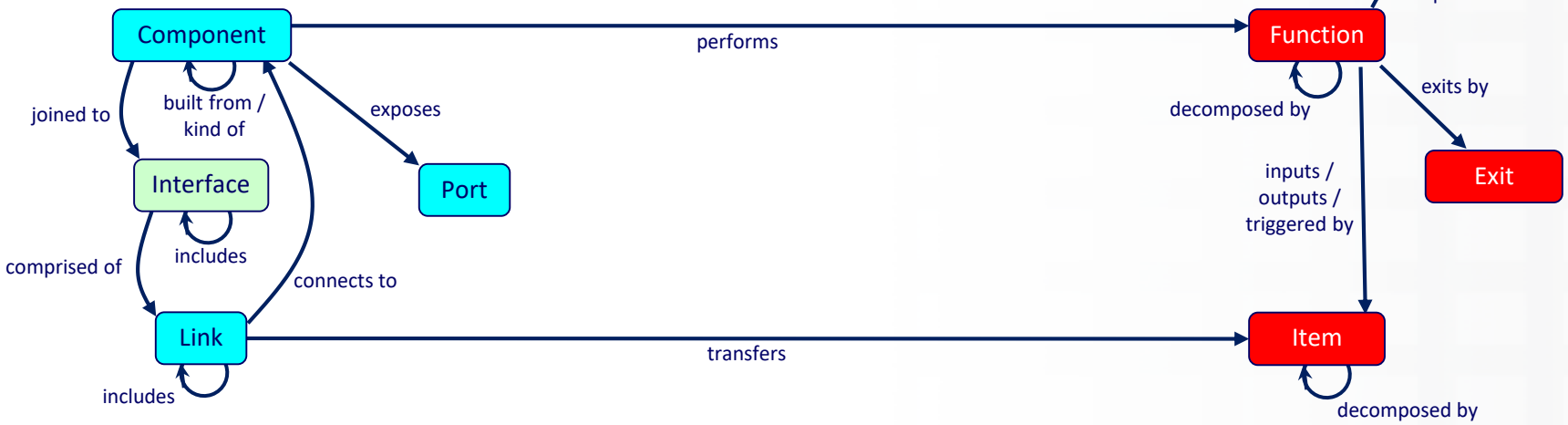


Identifying the Foundation: The Systems Metamodel





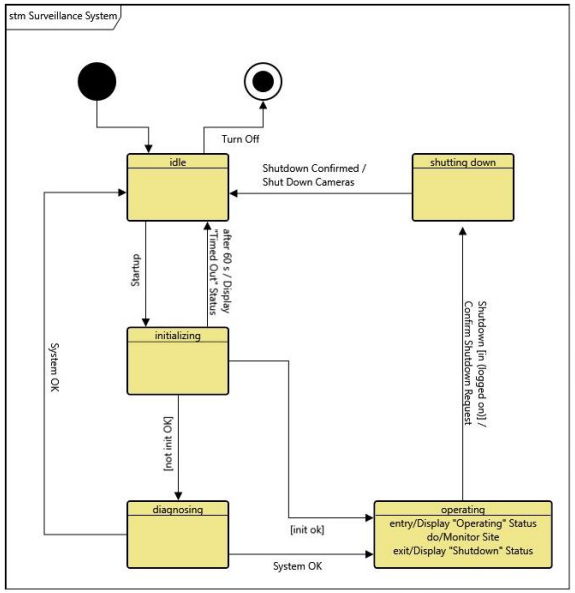


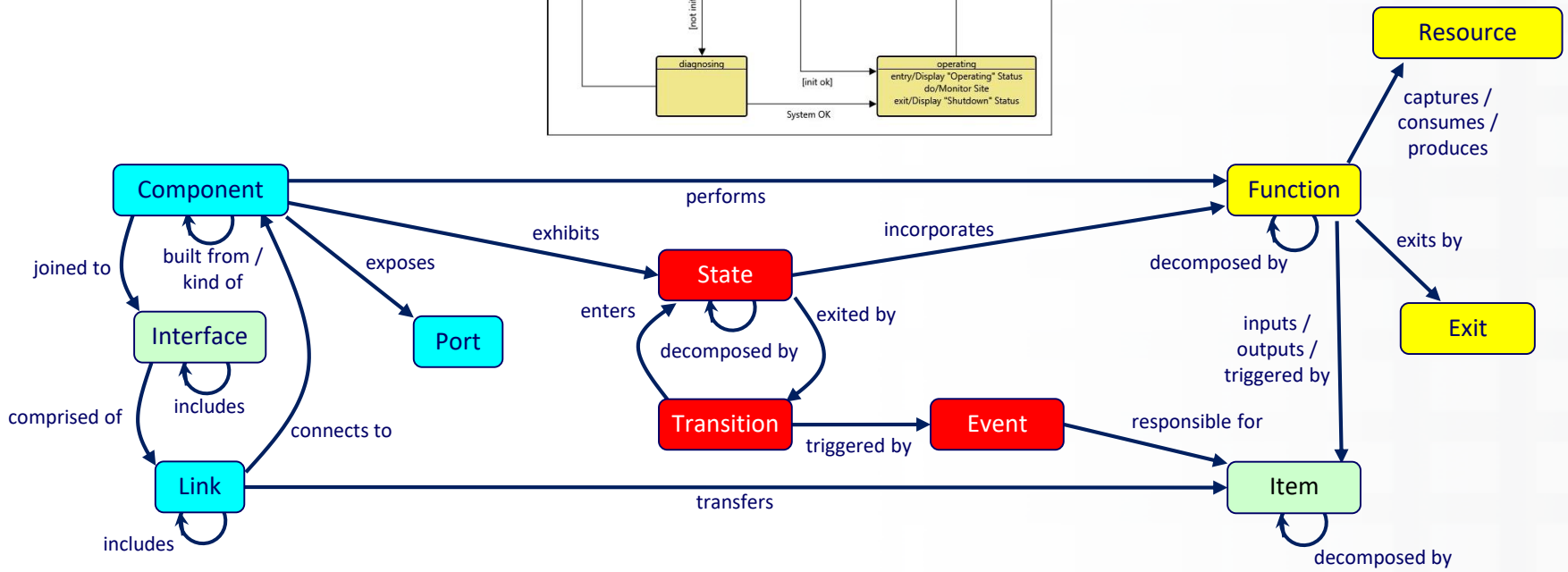


Identifying the Foundation: The Systems Metamodel

Color Code

Requirement Element	Functional Element
Physical Element	Interface Element
Verification Element	Other Element





Identifying the Foundation: The Systems Metamodel

Color Code

Requirement Element	Functional Element
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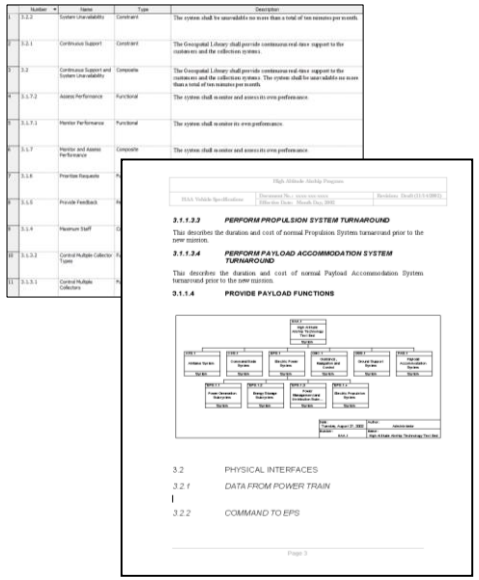
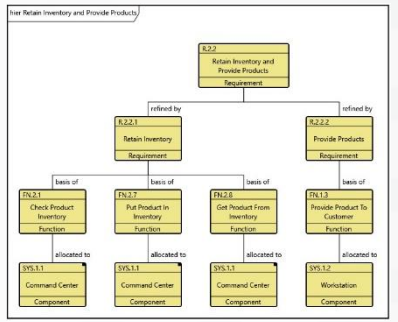


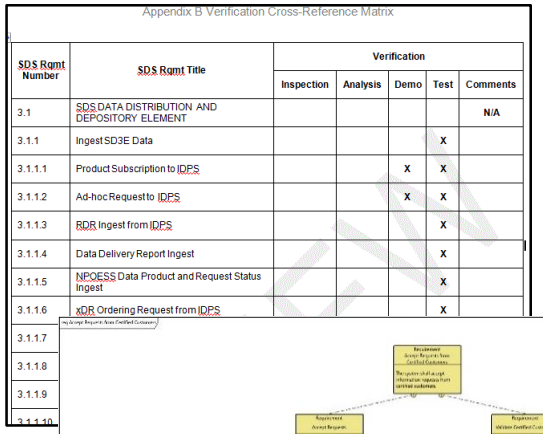


Use Case
elicits
Requirement
refined by
includes / extends / kind of
specified by
based on / specified by
elaborated by
involves / describes
Component
performs
Function
Resource
captures / consumes / produces
joined to
built from / kind of
exposes
exhibits
incorporates
decomposed by
exits by
Exit
State
enters
exited by
decomposed by
Interface
Port
inputs / outputs / triggered by
comprised of
includes
connects to
Transition
triggered by
Event
responsible for
Link
transfers
Item
includes
decomposed by

Identifying the Foundation: The Systems Metamodel

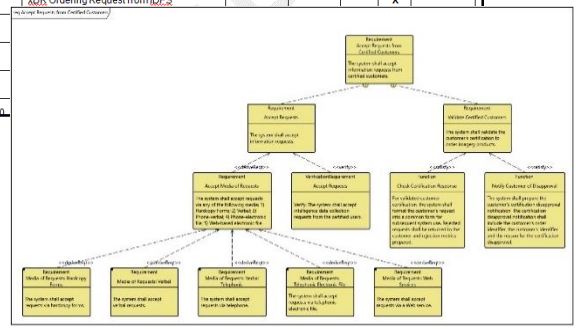
Color Code

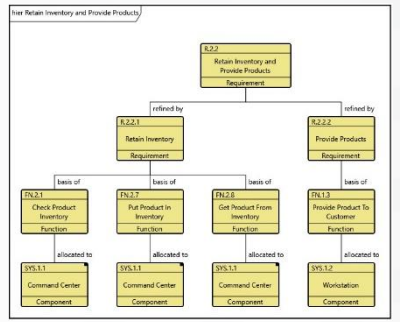
Requirement Element	Functional Element
Physical Element	Interface Element
Verification Element	Other Element



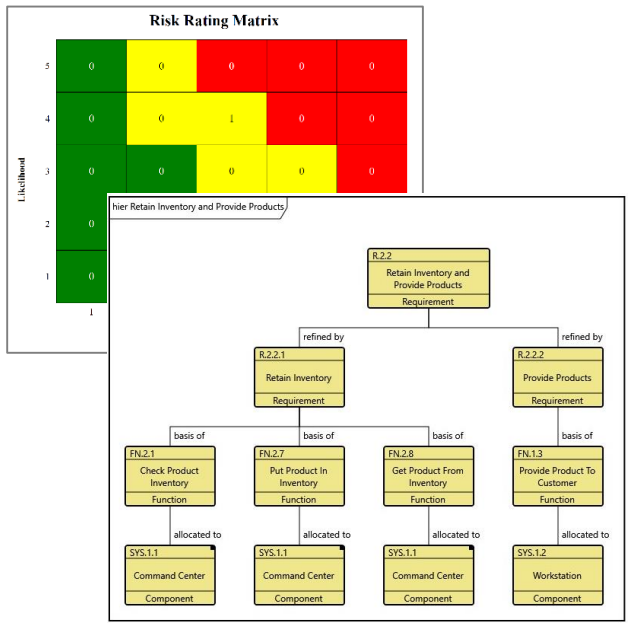
Appendix B Verification Cross-Reference Matrix

SDS Rqmt Number	SDS Rqmt Title	Verification				
		Inspection	Analysis	Demo	Test	Comments
3.1	SDS DATA DISTRIBUTION AND DEPOSITORY ELEMENT					N/A
3.1.1	Ingest SD3E Data				X	
3.1.1.1	Product Subscription to IDPS			X	X	
3.1.1.2	Ad-hoc Request to IDPS			X	X	
3.1.1.3	RDR Ingest from IDPS				X	
3.1.1.4	Data Delivery Report Ingest				X	
3.1.1.5	NPOESS Data Product and Request Status Ingest				X	
3.1.1.6	xDR Ordering Request from IDPS				X	
3.1.1.7						
3.1.1.8						
3.1.1.9						
3.1.1.10						

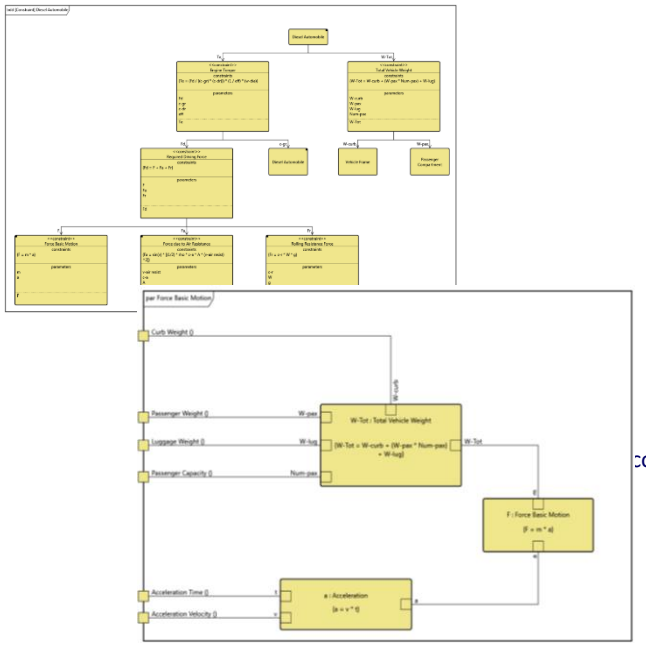


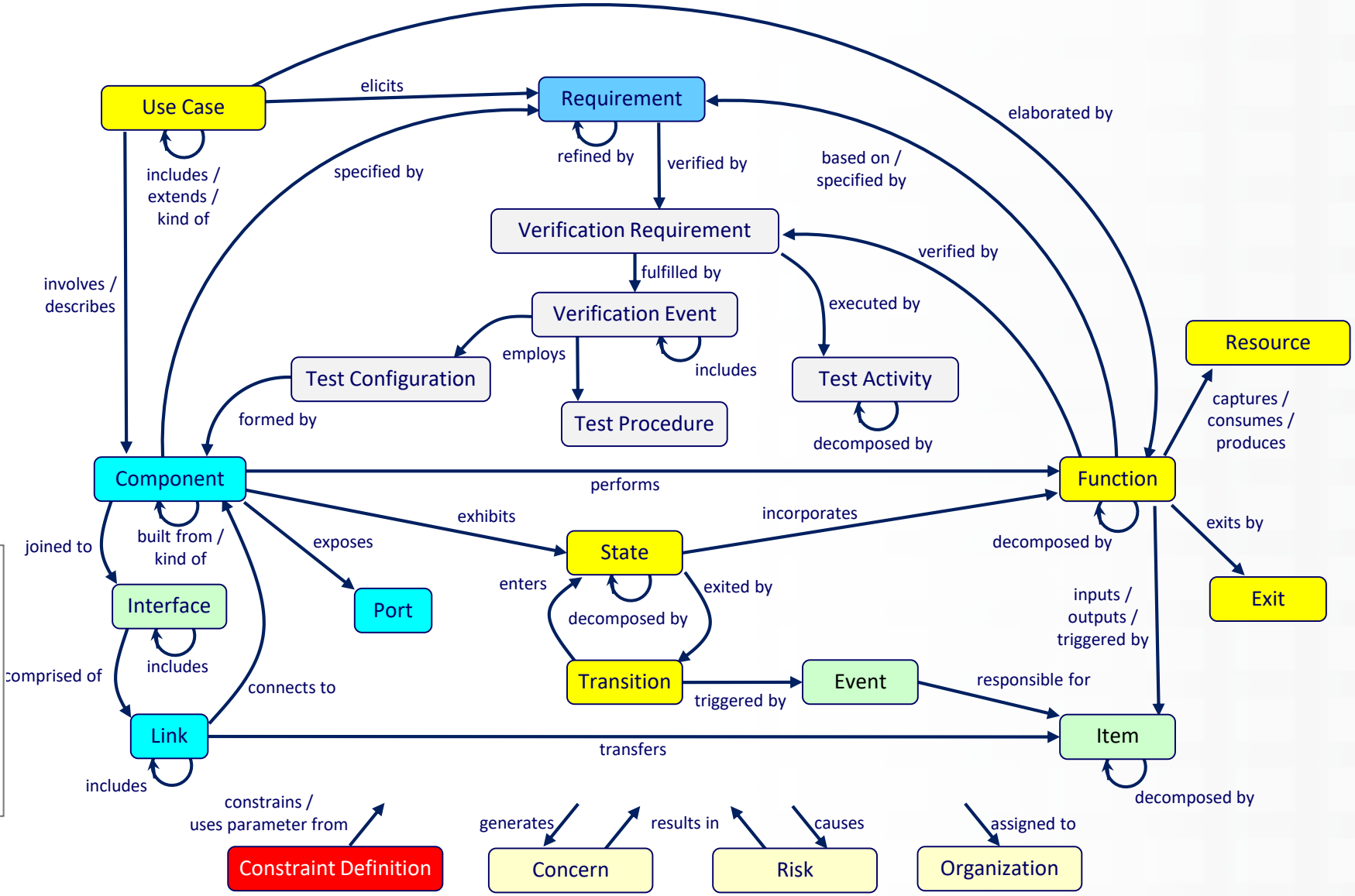


Identifying the Foundation: The Systems Metamodel

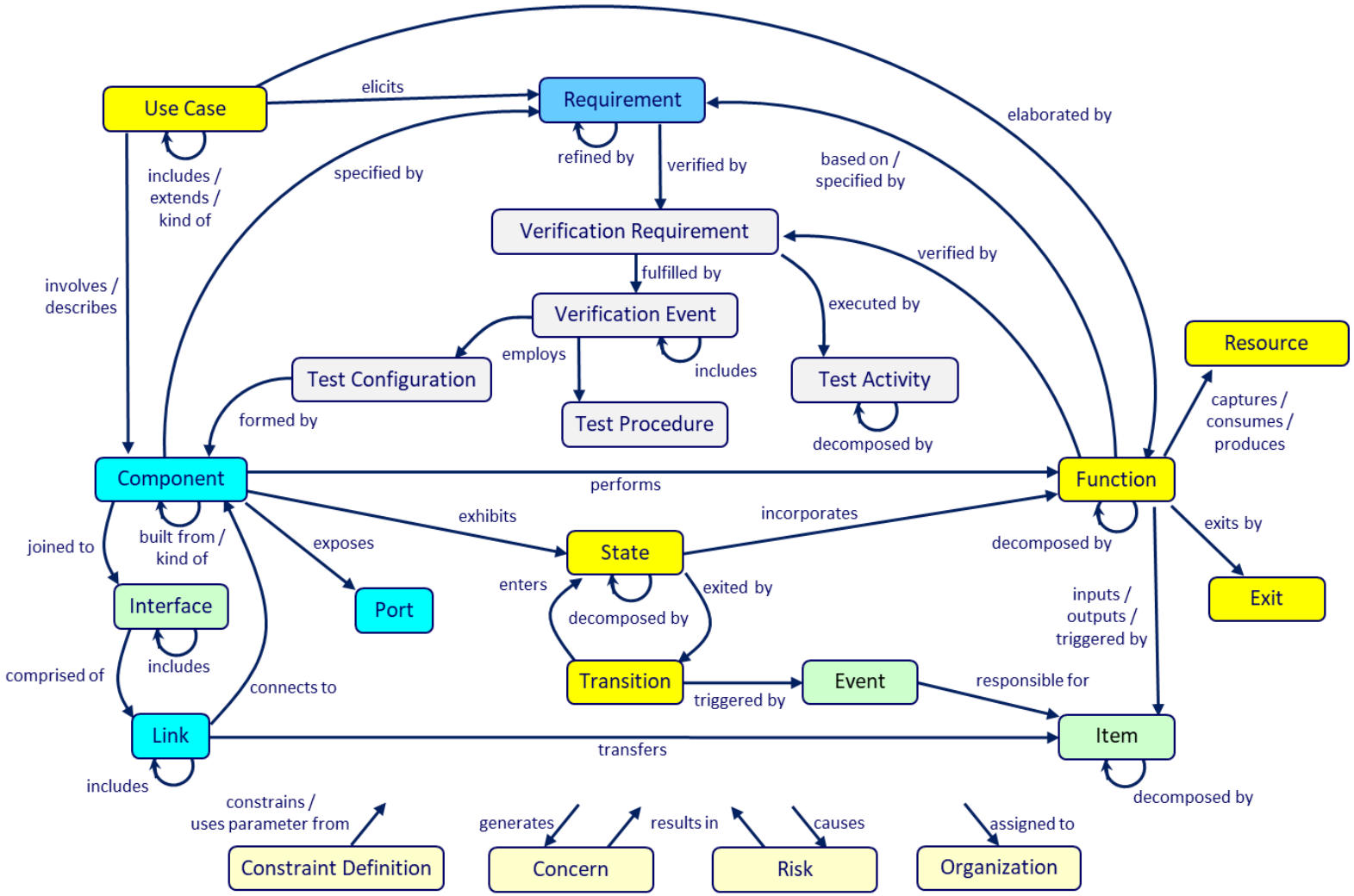


Identifying the Foundation: The Systems Metamodel





Identifying the Foundation: The Systems Metamodel



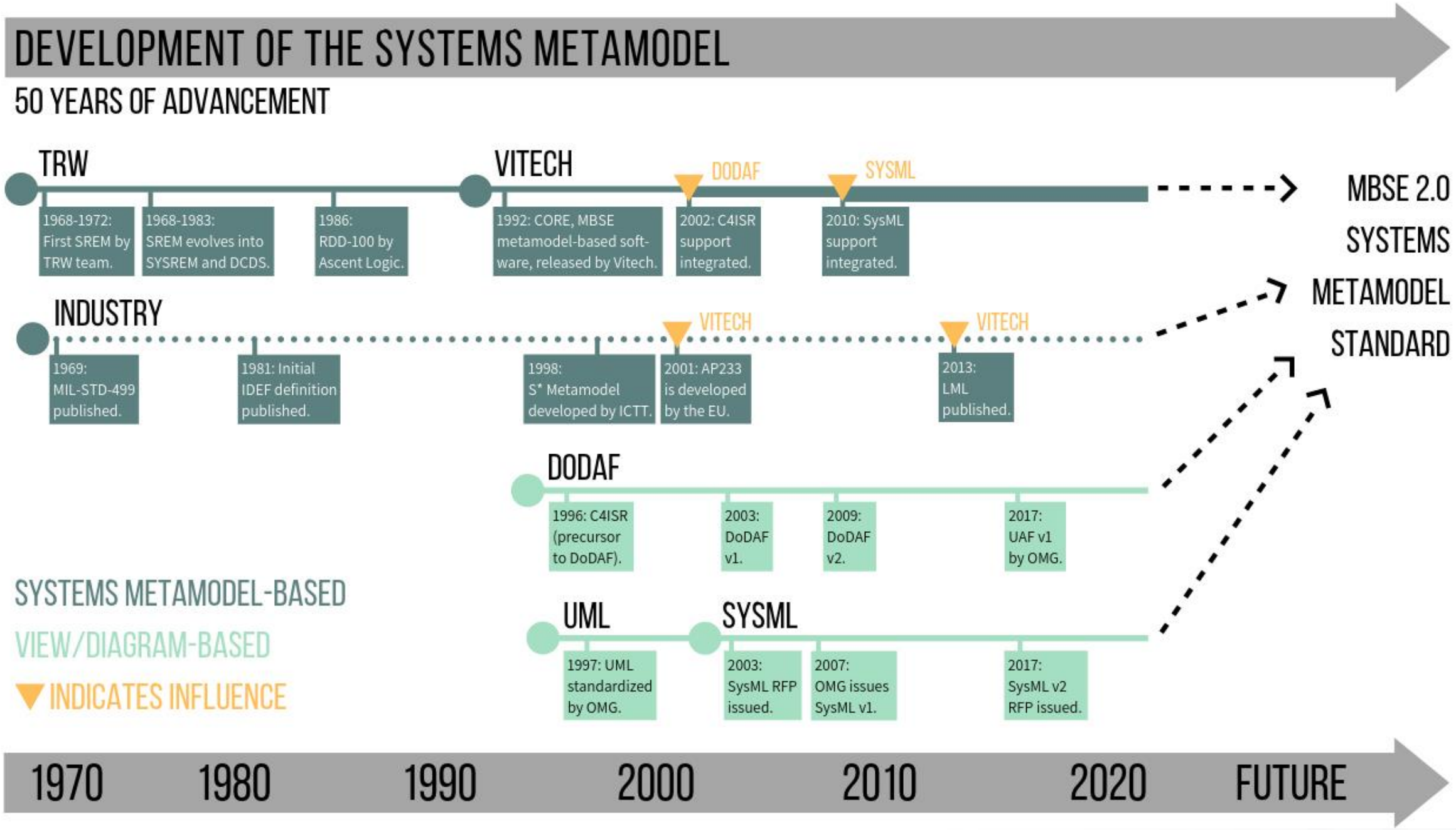
…more than diagrams

…more than a data dictionary

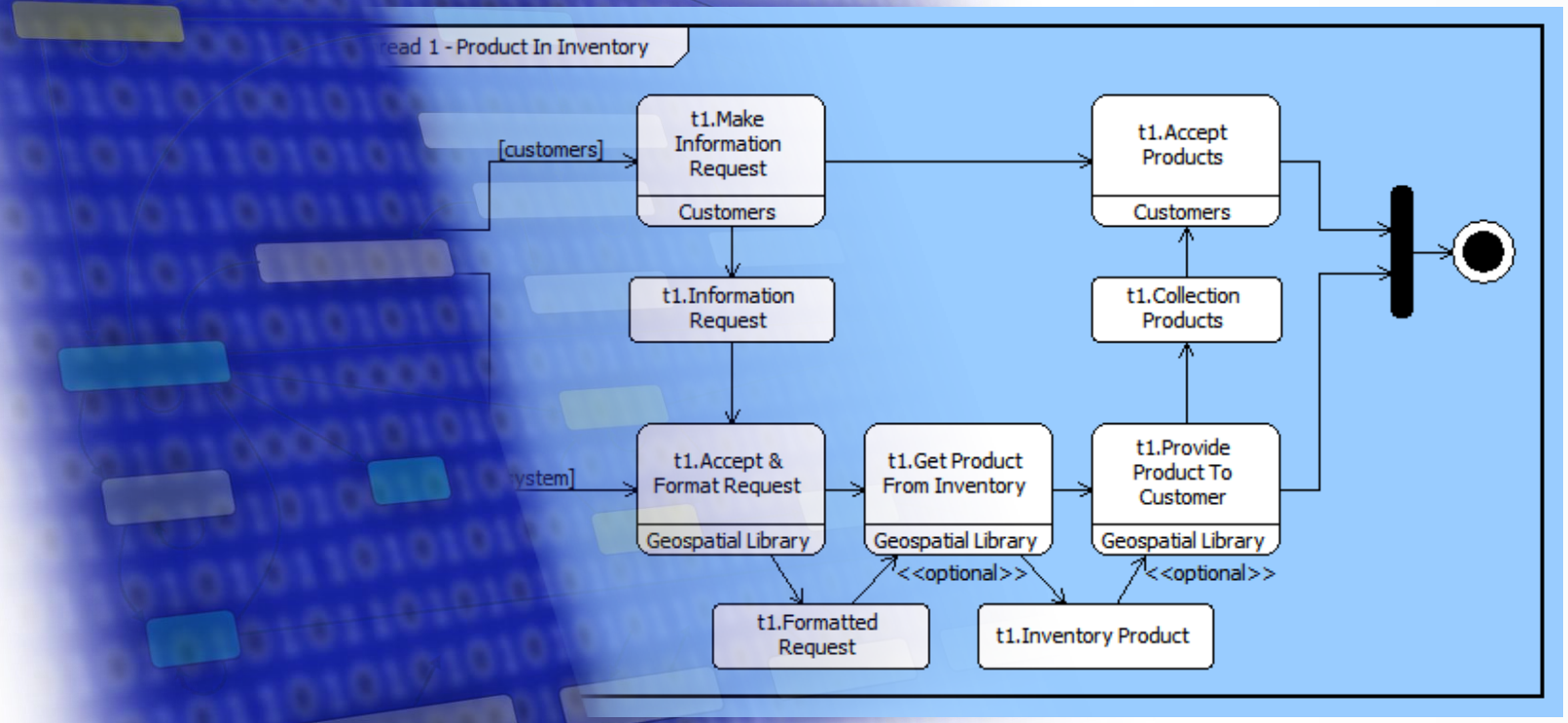
…more than capture

…more than specification

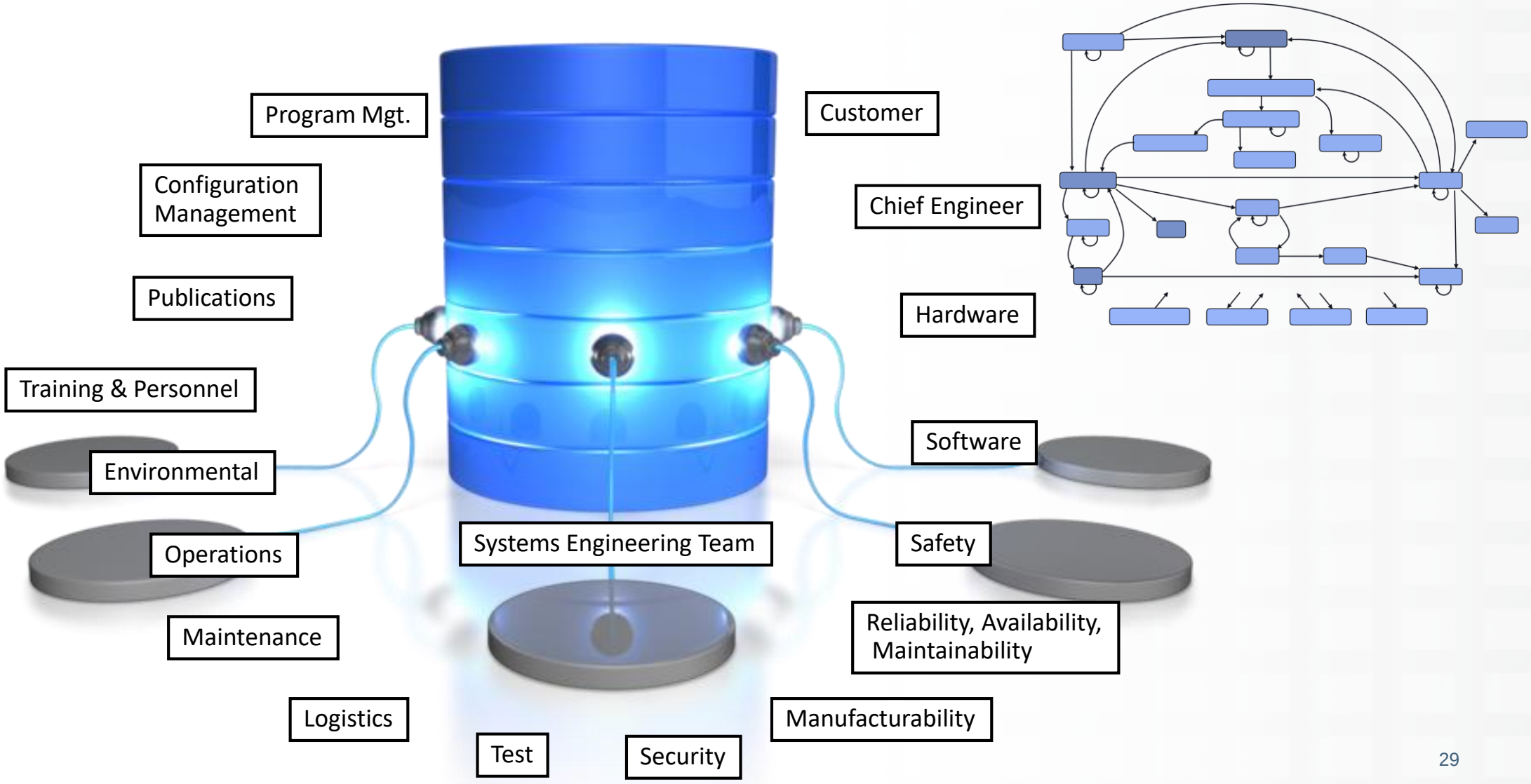
…more than the system of interest


DEVELOPMENT OF THE SYSTEMS METAMODEL
50 YEARS OF ADVANCEMENT
TRW
1968-1972: First SREM by TRW team.
1968-1983: SREM evolves into SYSREM and DCDS.
1986: RDD-100 by Ascent Logic.
VITECH
1992: CORE, MBSE metamodel-based software, released by Vitech.
DODAF
2002: C4ISR support integrated.
SYSML
2010: SysML support integrated.
MBSE 2.0
SYSTEMS
METAMODEL
STANDARD
INDUSTRY
1969: MIL-STD-499 published.
1981: Initial IDEF definition published.
VITECH
1998: S* Metamodel developed by ICTT.
2001: AP233 is developed by the EU.
VITECH
2013: LML published.
DODAF
1996: C4ISR (precursor to DoDAF).
2003: DoDAF v1.
2009: DoDAF v2.
2017: UAF v1 by OMG.
UML
1997: UML standardized by OMG.
SYSML
2003: SysML RFP issued.
2007: OMG issues SysML v1.
2017: SysML v2 RFP issued.
SYSTEMS METAMODEL-BASED
VIEW/DIAGRAM-BASED
INDICATES INFLUENCE
1970
1980
1990
2000
2010
2020
FUTURE

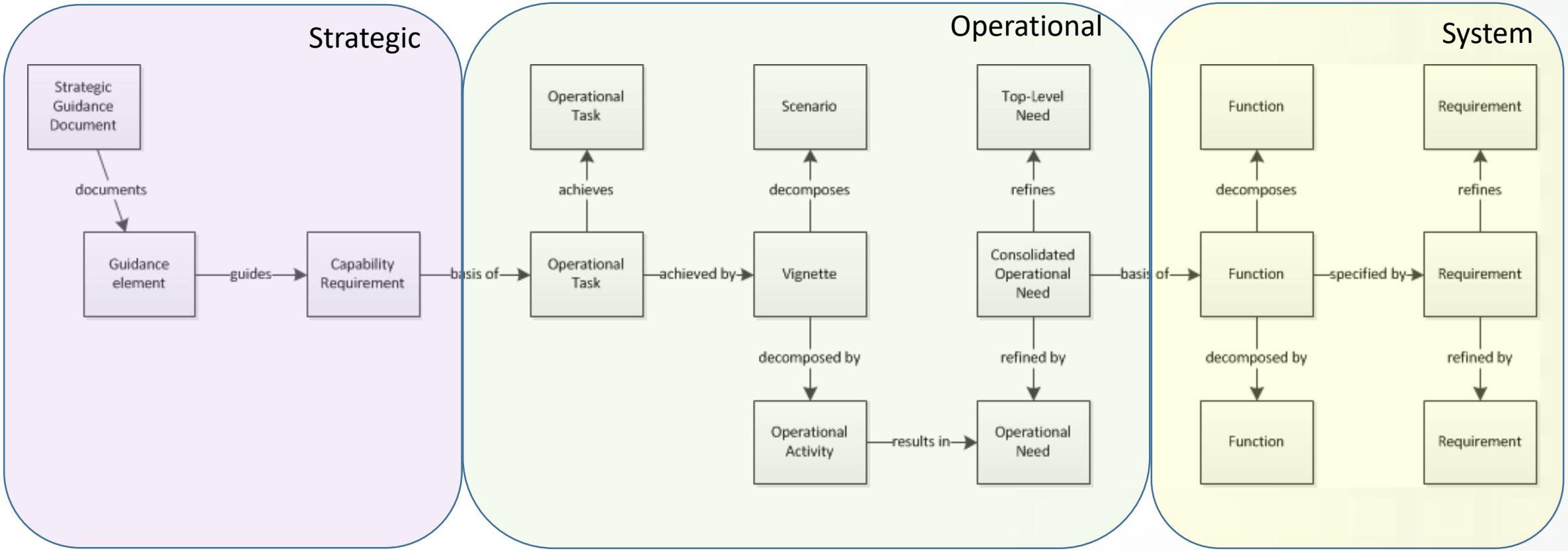
Moving the Focus from Engineering Artifacts to Engineering Systems

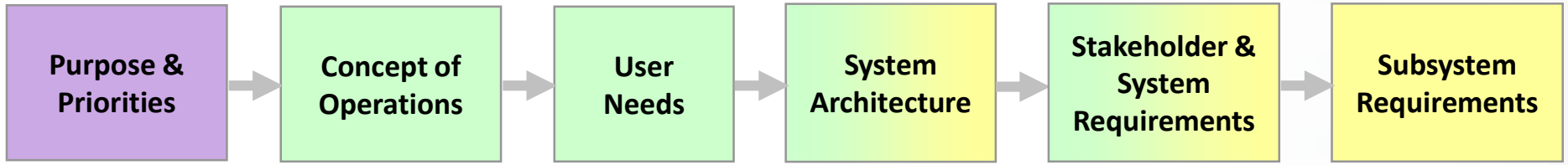


Aligning across the Engineering Enterprise:
Right Data, Right Place, Right Time, Right Presentation



Connecting from Strategy through to Requirements





Credit: Spencer Tech

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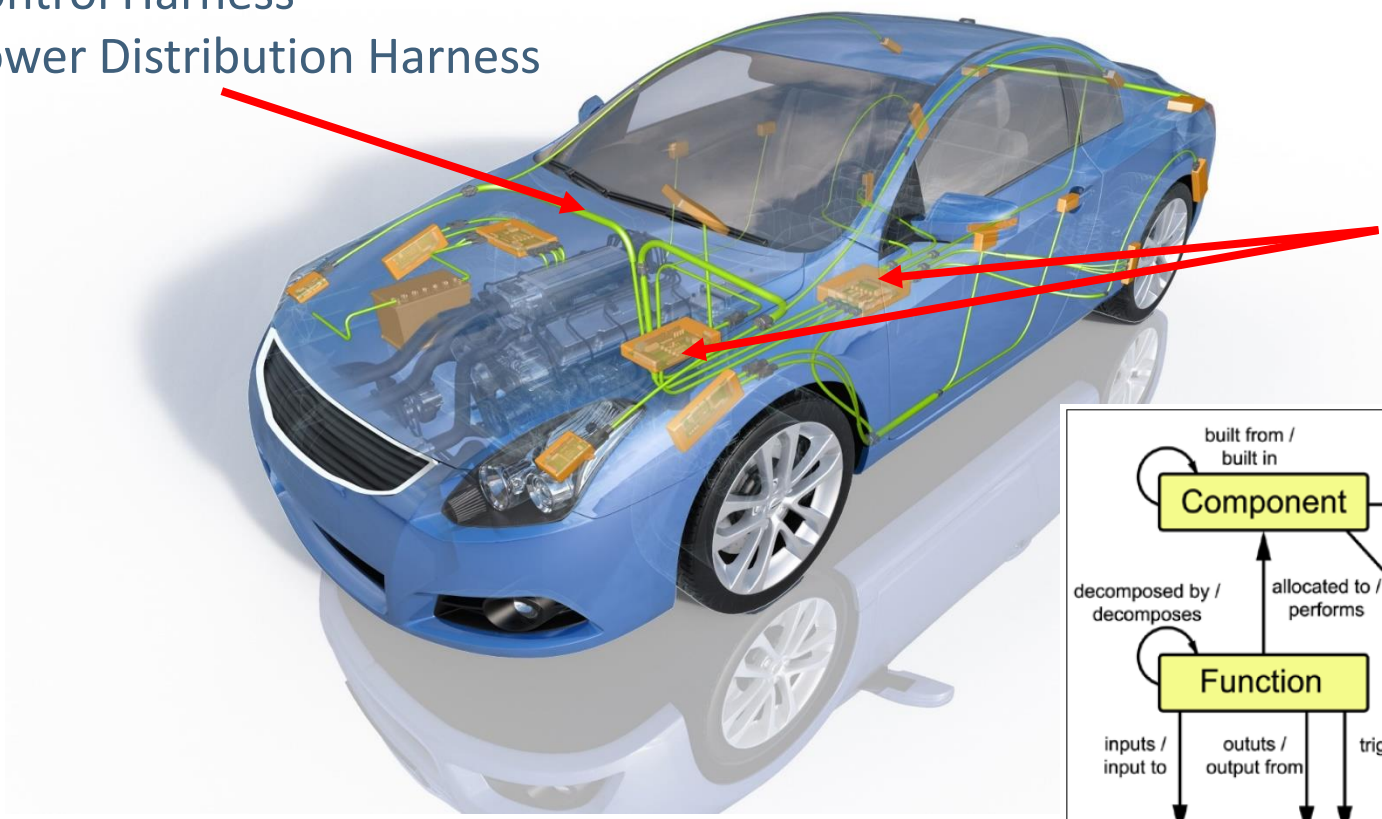
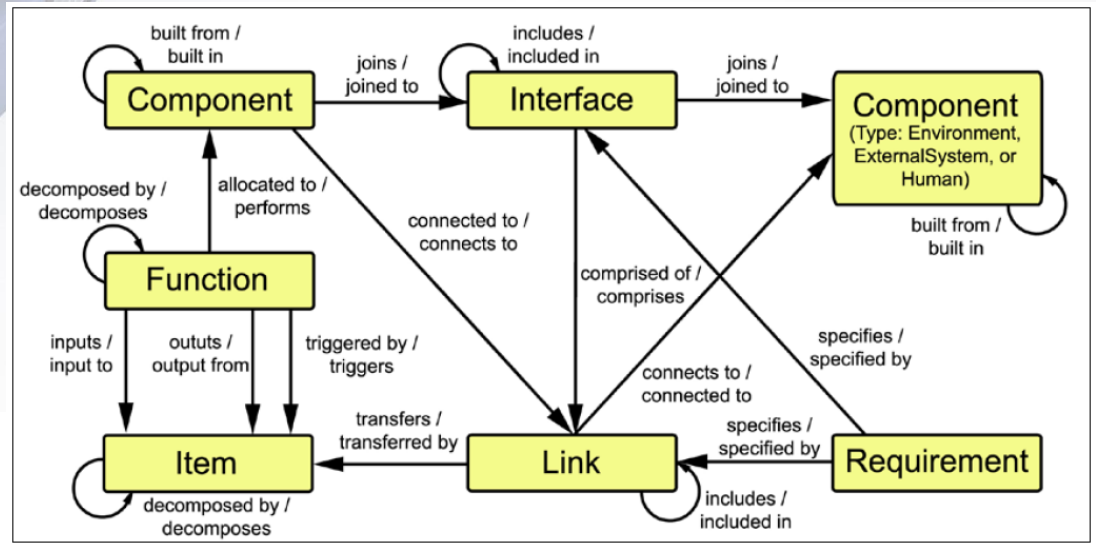
Power at the Systems Level:
Ensuring Consistency in Behavior and Structure

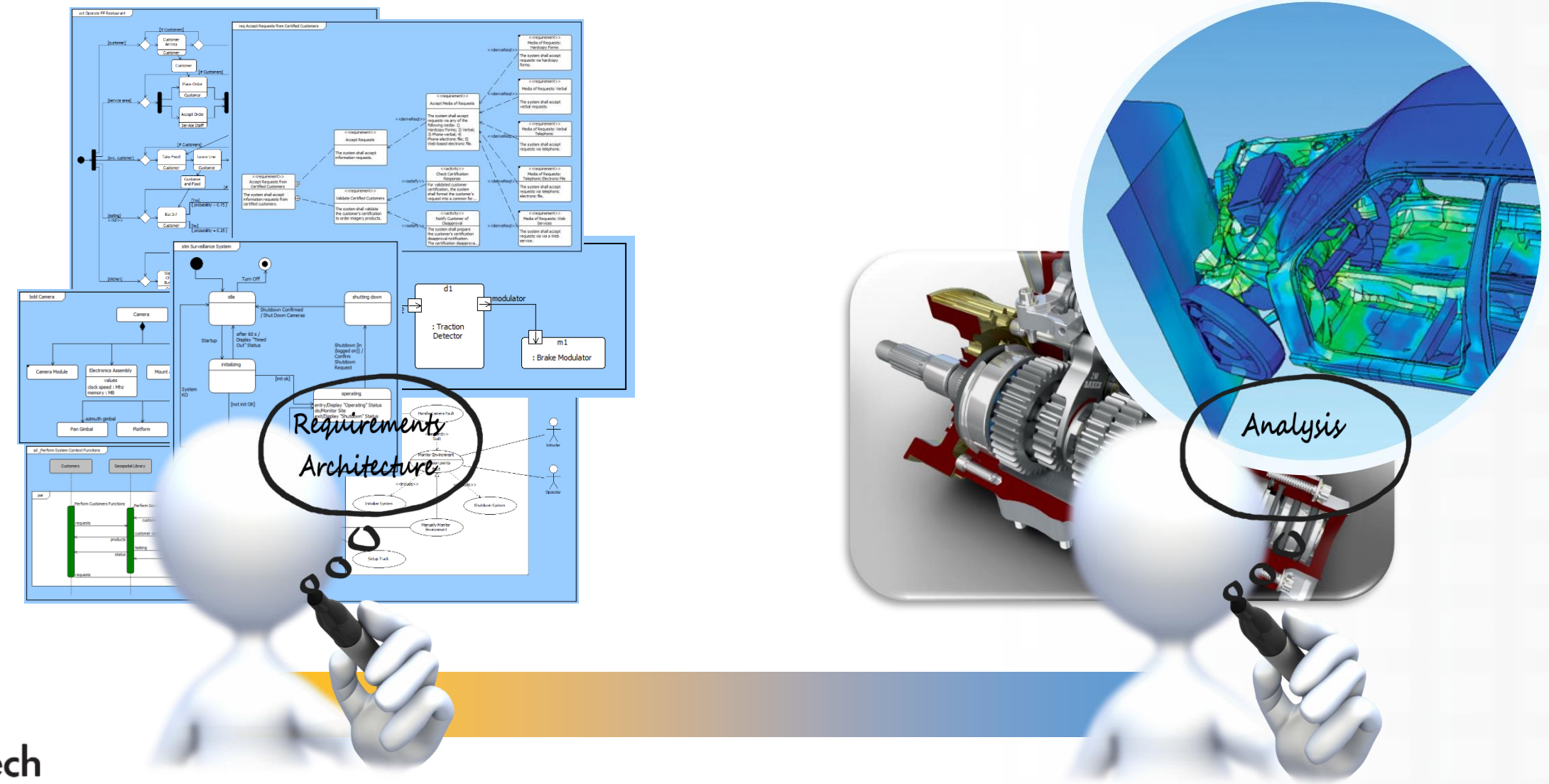
Electrical Subsystems
- Control Harness
- Power Distribution Harness



Electronic Subsystems
- Braking
- Collision detection
- Temperature Control



Connecting Architecture and Analysis:
Agility and Responsiveness with Rigor and Confidence



Connecting Architecture and Analysis:
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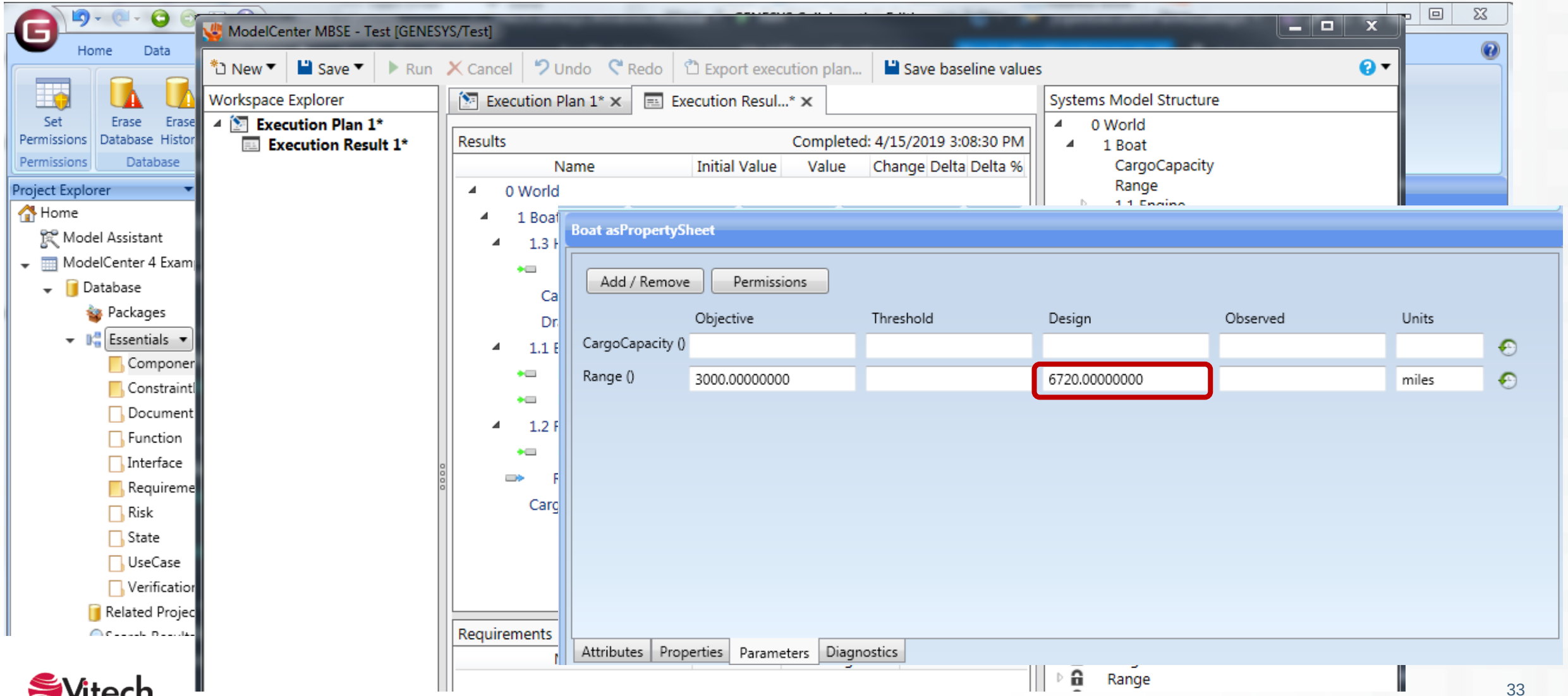
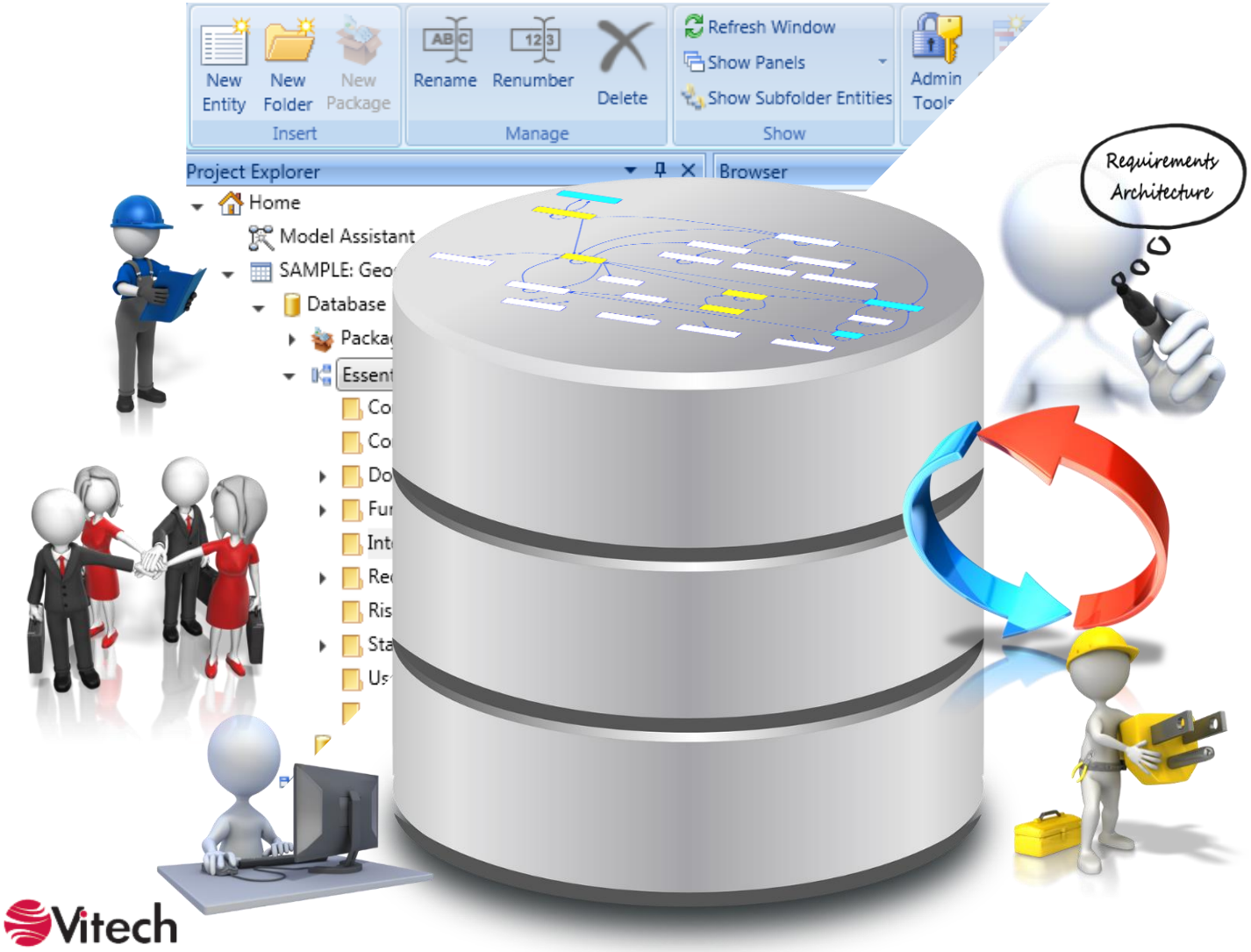
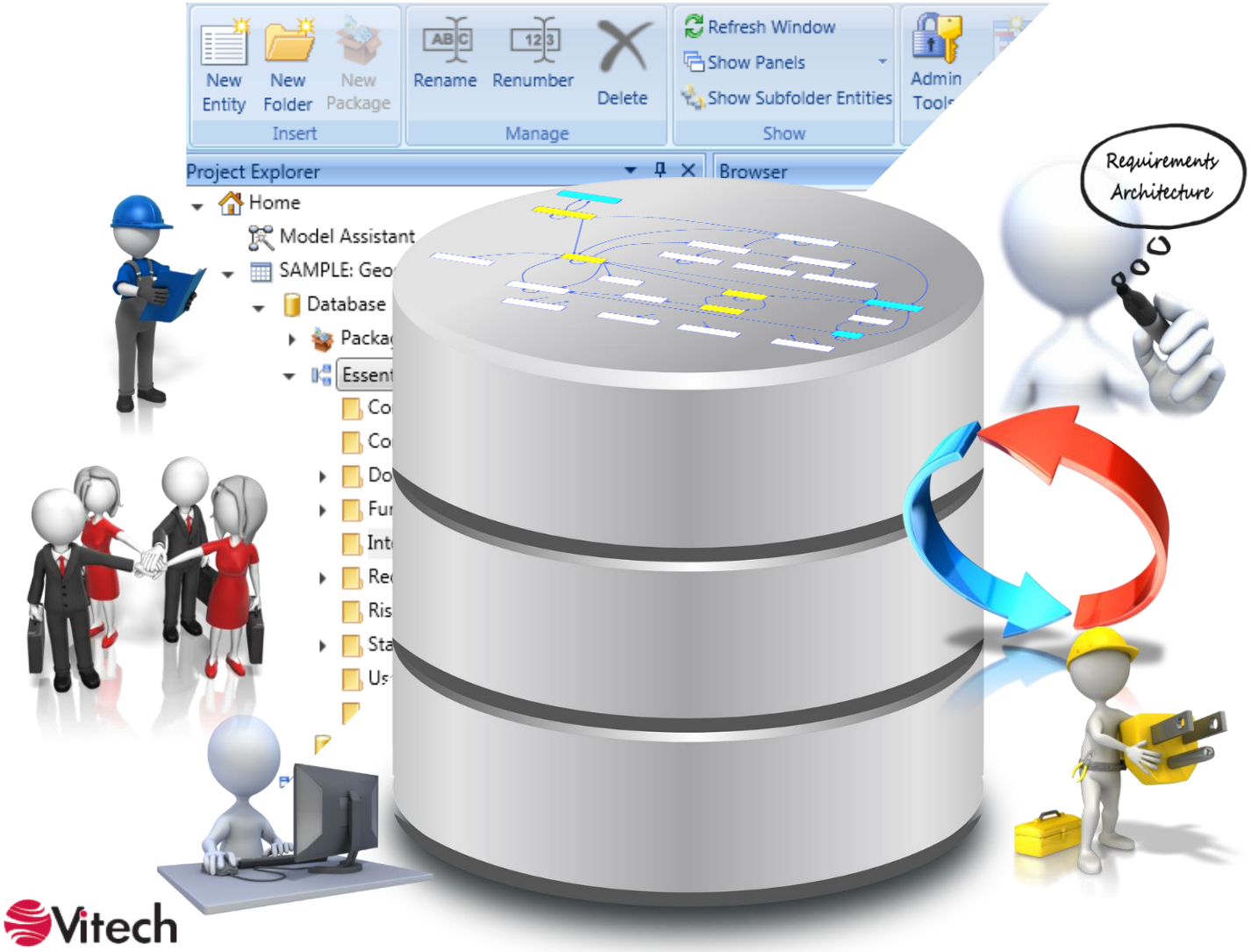


Power in Connecting Design:
Dynamic Technical Data Packages with Context



- Interface definitions
- Incoming and outgoing signals
- Required functionality
- Design constraints
- Associated requirements
- Test requirements

Power in Connecting Design:
Dynamic Technical Data Packages with Context



- Interface definitions
- Incoming and outgoing signals
- Required functionality
- Design constraints
- Associated requirements
- Test requirements
- *Physical and behavioral context*
- *Rationale and design history*
- *Analytical dependencies*
- *Multidimensional traceability*

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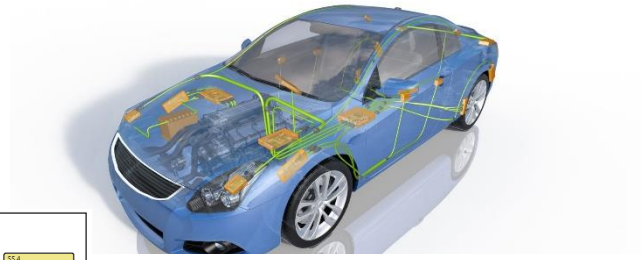
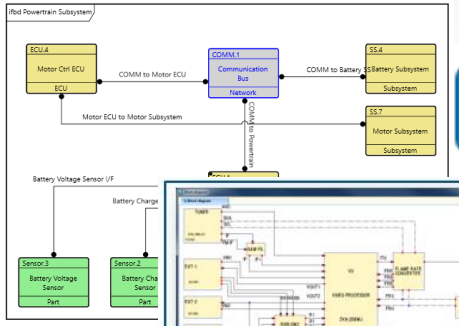
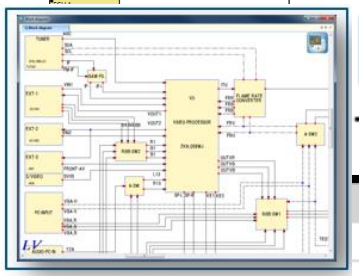
Eliminating the Air Gap:
Connecting Both Design and Verification







Number	
ECU.1.1	
ECU.1.2	ECU Max Power
ECU.1.3	ECU Dimensions
ECU.1.4	ECU Cost
ECU.1.5	ECU Processor
	FLASH Memory

	ent
Cable.1.1	Cable Weight
Cable.1.2	Cable Cost
Cable.1.3	Max Length
Cable.1.4	Max Curren
Cable.1.5	Shared Connect : Not Permitted

System Purpose

System Requirements

Subsystem Requirements

Subsystem Architecture Design

Electronic Detailed Design

Electrical Detailed Design

System

Subsystem Design

Subsystem Implementation

System Validation

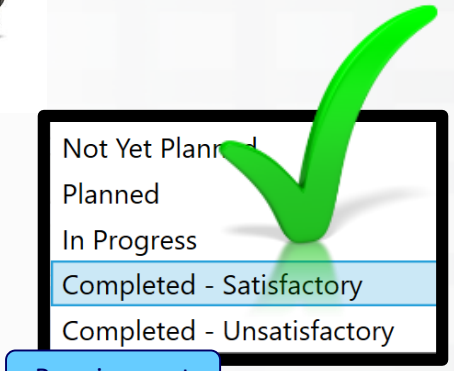
System Test

Subsystem Test

Integration Test

Unit Test

Manufacturing



Requirement

Verification Requirement

Test Configuration

Test Procedure

Verification Event

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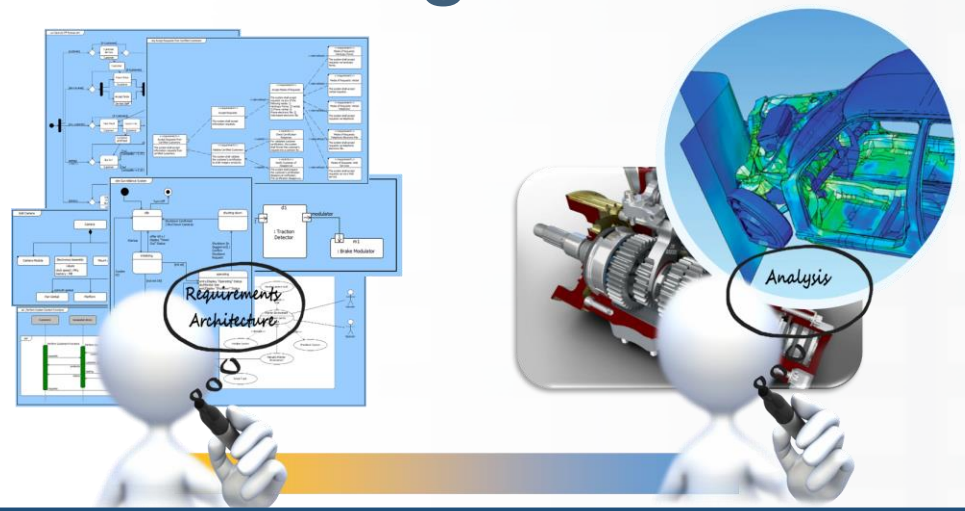
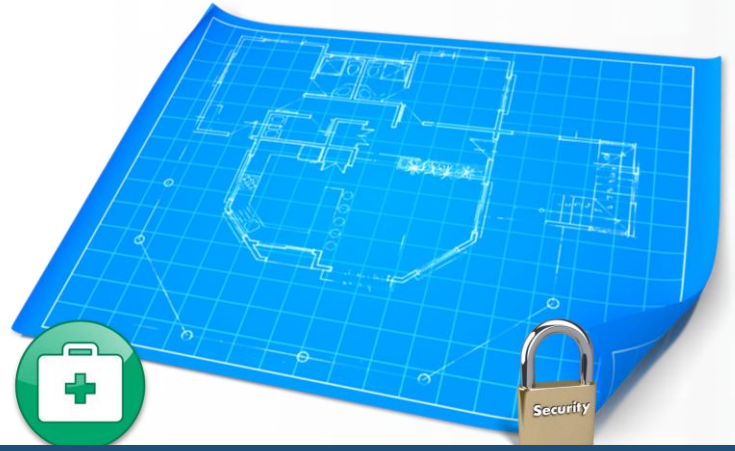
Enhancing Enterprise Performance through MBSE 2.0

Aligning through an “Authoritative Source of Truth”



Connecting architecture and analysis

Moving from custom built to composability



Leveraging patterns and architecture

Moving from Challenges to Success: Engineering Systems in the Age of Complexity

1. Insight into interactions and dependencies, both direct and indirect . . . equipping the team to respond effectively in the face of complexity and reduce mission risk.

2. Shared understanding of problem and solution across the team . . . resulting in resilient architectures and elegant solutions informed by the wisdom of multiple viewpoints.

3. Authoritative source of truth reflecting both design and rationale . . . accelerating programs and reducing costs by effective thru-life knowledge management.

4. Knowledge retention and organizational learning enabled by a proven metamodel . . . increasing effectiveness, reuse, and return on investment.

Advancing your organization's digital transformation

1. Look across the silos
2. Define the as-is and to-be for scope, context, and capabilities
3. Implement a semantically rich systems metamodel
4. Begin the journey for your engineering enterprise

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Questions

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Insight through integration

2270 Kraft Drive
Suite 1600
Blacksburg, VA 24060
USA
+1.540.951.3322 x107

David Long, ESEP
President

www.vitechcorp.com
david.long@vitechcorp.com

@thinkse

Today’s Presentation

Things to think about

- How can this be applied in your work environment?
- What did you hear that will influence your thinking?
- What is your take away from this presentation?

Please

The link for the online survey for this meeting is

- www.surveymonkey.com/r/2019_11_MeetingEval
- www.surveymonkey.com/r/2019_11_MeetingEval

Look in GlobalMeet chat box for cut & paste link

Slide presentation can be downloaded now/anytime from:

- The library page at: www.incose.org/enchantment
- Recording will be there in the library soon