Sandia National Laboratories

Nuclear Deterrence

HOW TO ASSESS YOUR CURRENT MBSE MATURITY
AND DEVELOP A ROADMAP TO MEET YOUR TARGETS

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INCOSE Enchantment Chapter

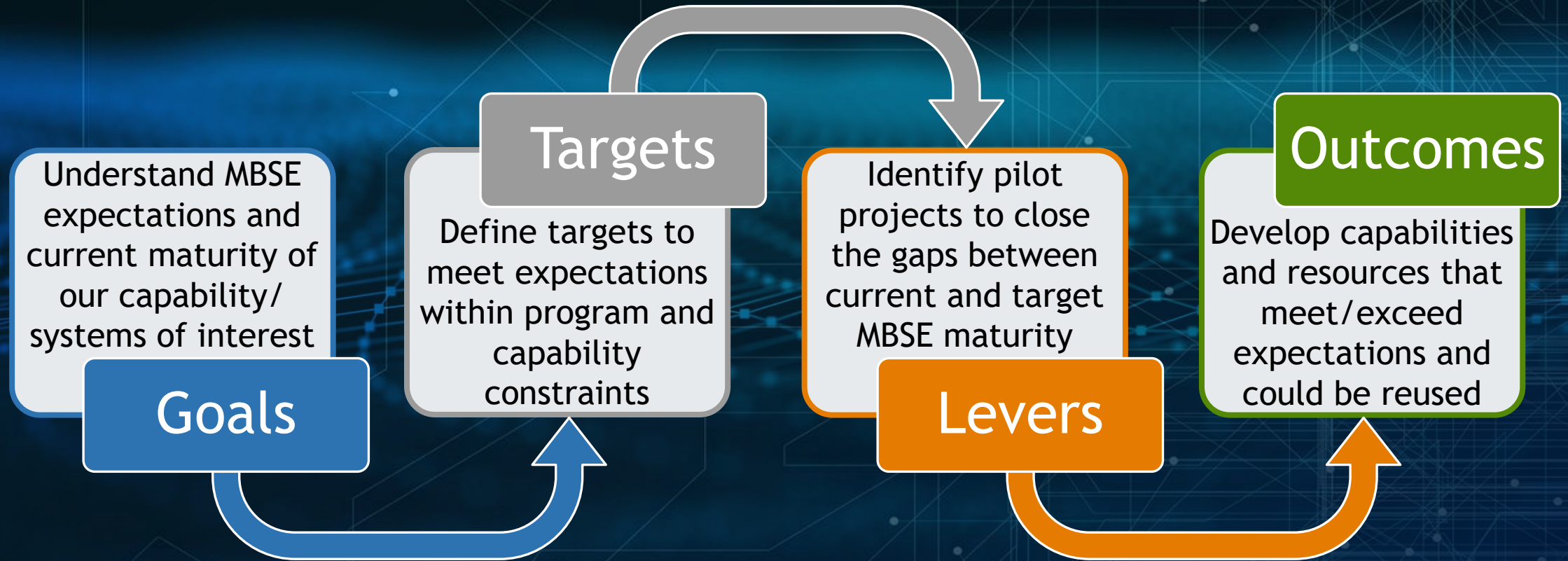Controlled by: Sandia National Laboratories, Marissa A. Conroy

AGENDA

- MBSE Maturity Matrix Development
  - Overall Goals
  - Barriers to Maturity
  - Standardized Levels & Establish a Team
  - Criteria, Categories, Topics, and Facets

- Performing an Assessment
  - Defining Targets
  - Rating Facets
  - Example Assessment and Highlights

- Visualizing Assessment Results
  - Creating an MBSE Roadmap
  - Radar Charts

- Q&A

How Do We Mature MBSE Systematically?

Goals
Understand MBSE expectations and current maturity of our capability/ systems of interest

Targets
Define targets to meet expectations within program and capability constraints

Levers
Identify pilot projects to close the gaps between current and target MBSE maturity

Outcomes
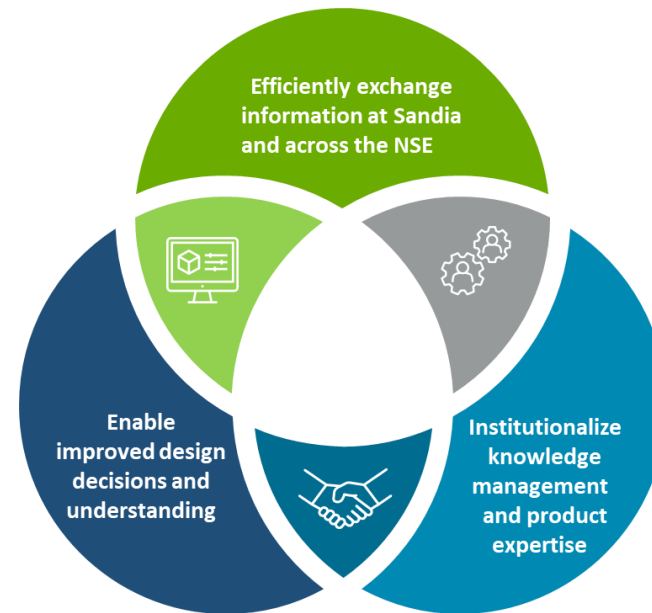Develop capabilities and resources that meet/exceed expectations and could be reused

The MBSE Maturity Matrix was developed referencing industry standard matrices, but designed to meet the needs of non-MBSE practitioners. The intent is to allow an entity to assess their MBSE maturity, set targets based on expectations, and identify efforts to close gaps and mature capabilities
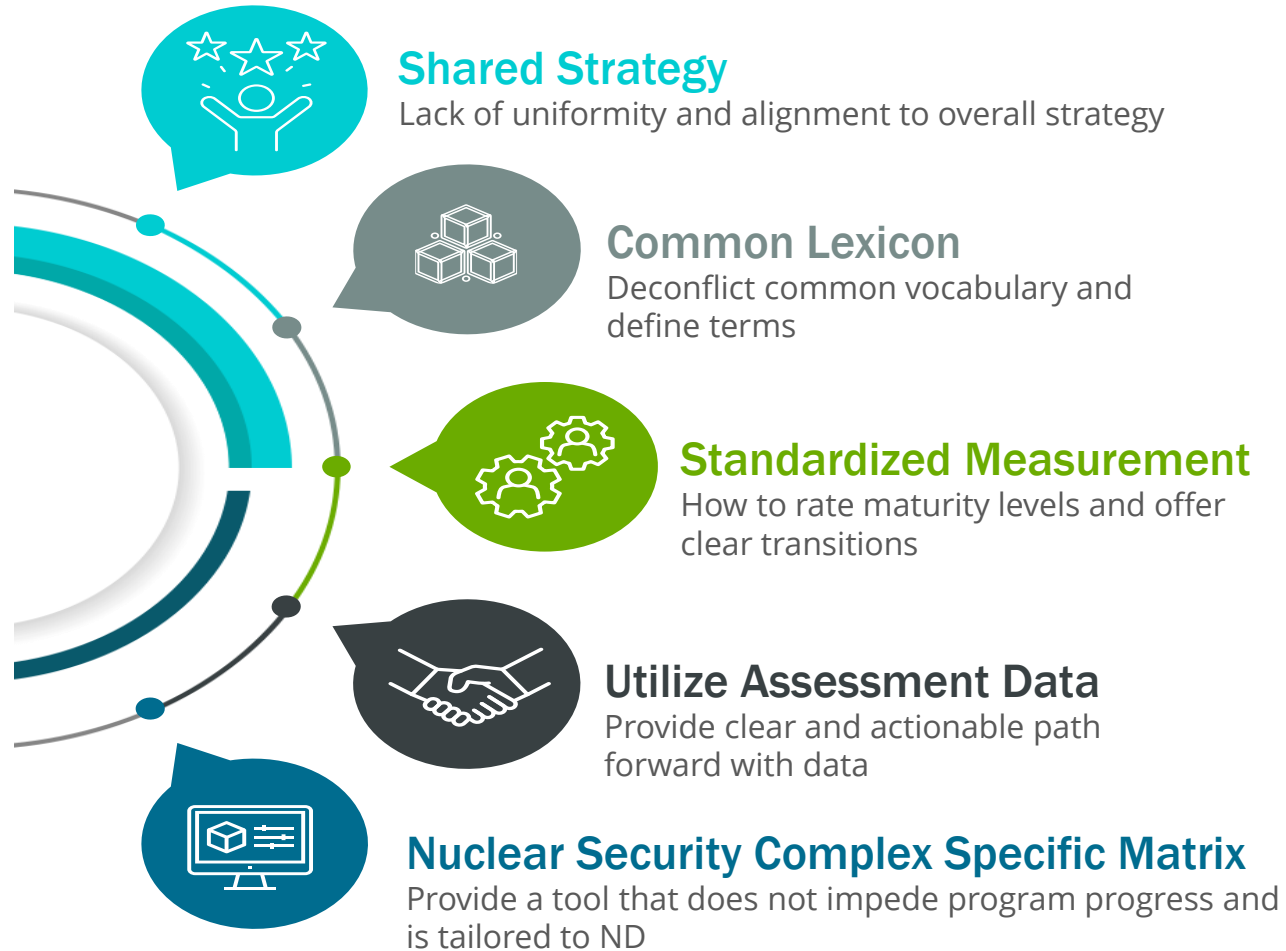
Overall Goals of the MBSE Maturity Matrix

1. Identify current state
   (*As-Is levels*)

2. Determine future state
   (*Target levels*)

3. Identify, develop, and
   communicate plans to close
   gaps between As-Is and
   Target Levels

   i. *Radar Charts* – visualize
      assessment ratings

   ii. *Roadmap* – communicate
       path forward

Efficiently exchange information at Sandia and across the NSE

Enable improved design decisions and understanding

Institutionalize knowledge management and product expertise

Barriers to Maturity

Shared Strategy
Lack of uniformity and alignment to overall strategy

Common Lexicon
Deconflict common vocabulary and define terms

Standardized Measurement
How to rate maturity levels and offer clear transitions

Utilize Assessment Data
Provide clear and actionable path forward with data

Nuclear Security Complex Specific Matrix
Provide a tool that does not impede program progress and is tailored to ND

MBSE Maturity Matrix was developed with these barriers in mind to help overcome and avoid them

Standardized Levels & Establish a Team

- *Levels serve as the benchmark to measure progress during an assessment*

- *Select Assessment Team – Core technical team*

- *Includes subject matter experts in applicable engineering domains and facilitated by MBSE/SE Lead*

Document-Centric Systems	Model-Centric Systems	Verified Model-Centric Systems	Formalized Model-Based Systems	Validated Model-Based Systems	Integrated Model-Based Systems	Extended Model-Based Enterprise
L0	L1	L2	L3	L4	L5	L6
Documents used for all SE activities	Descriptive model used to aid some SE activities	Select areas of descriptive model content are reviewed and authorized	Defined processes support descriptive model usage for SE activities	Descriptive model permissions, confidence in modelers, and peer review	Descriptive model utilizes relationships between architectures and other models	Descriptive model institutionalized and accessible across the enterprise

Categories, Topics, and Facets

Category 1. MBSE at Sandia

C1: Model Based Systems Engineering (MBSE) (DA ONLY)

C2: Systems Engineering Data Sharing (DA/PA)

C3: Production Integration and Testing (PA ONLY)

T1: MBSE Culture

F1: MBSE Institutional Adoption
F2: MBSE Model Methodology

T2: MBSE Methodology and Management

F1: MBSE Agreement Process
F2: MBSE Lifecycle Management

T3: MBSE Architecture Application

F1: Requirement Architecture Development
F2: Requirement Architecture Traceability

Criteria Being Assessed

> *THREE "As-Is Levels" and ONE "To-Be Level" are evaluated*

Capability refers to the tools, technology, and standards available for use

Readiness refers to the processes, policies, and procedures that are ready to be exercised

Adoption refers to the degree that people in the organization are actually using those tools and processes

Target refers to where do want to go

AS-IS Level			TO-BE Level
Capability: Tools are Available?	**Readiness:** Processes are Ready?	**Adoption:** People are Using?	**Target:** To-be Maturity

Maturity Matrix Version 1.0

MBSE Category / Topic / Facet / (Context) SAND2022-11886 O	Description: How the organization . . .	Transition: As maturity increases, the organization's . . .	Document-Centric Systems (L0)	Model-Centric Systems (L1)	Verified Model-Centric Systems (L2)	Formalized Model-Based Systems (L3)	Validated Model-Based Systems (L4)	Integrated Model-Based Systems (L5)	Extended Model-Based Enterprise (L6)	AS-IS Level: Capability (Tool)	AS-IS Level: Readiness (Process)	AS-IS Level: Adoption (ND Use)	TO-BE Level: Target	POC	Comment
Assessment Identifier (AID): [organizationally unique identifier]	**Organization under assessment (OUA):**	**Description of Environment:**						**Assessor:**		**Assessment Date:**	**Target Date/Event:** [when implemented]		**Version of Assessment:** [version]		

											AS-IS Level			TO-BE Level	Assessor comments below.	
Joint MBSE Maturity Matrix V1.0			**Document-Centric Systems**	**Model-Centric Systems**	**Verified Model-Centric Systems**	**Formalized Model-Based Systems**	**Validated Model-Based Systems**	**Integrated Model-Based Systems**	**Extended Model-Based Enterprise**	Capability: Tools are Available?	Readiness: Processes are Ready?	Adoption: People are Using?	Target: To-be Maturity	POC	Comment	
Maturity Level Name	Description: How the organization . . .	Transition: As maturity increases, the organization's . . .	**L0**	**L1**	**L2**	**L3**	**L4**	**L5**	**L6**	N/A	N/A	N/A	N/A		
Categories (e.g., C1) Level # └─Topics (e.g., T3) └─Facets (e.g., F2)															
C1: Model Based Systems Engineering (MBSE) (DA ONLY)	Uses models to define all aspects of system requirements, behavior, hardware, and V&V	utilization of a system model to drive digital engineering	Documents used for all SE activities	Descriptive model used to aid some SE activities	Select areas of descriptive model content are reviewed and authorized	Defined processes support descriptive model usage for SE activities	Descriptive model permissions, confidence in modelers, and peer review	Descriptive model utilizes relationships between architectures and other models	Descriptive model institutionalized and accessible across the enterprise	N/A	N/A	N/A	N/A		
C2: Systems Engineering Data Sharing (DA/PA)	Shares enterprise systems engineering data	Recreation of systems engineering data is removed maturing towards authoritative information	Recreation of models based on released static documents	Getting data directly from Systems Engineering tools	Standard method developed and implemented	Defined site specific and federal processes support systems engineering data sharing between sites	Model based processes used to ensure systems engineering data was imported into requirements management correctly	Systems engineering data tools are integrated communicating consistent information	Authorized single source of systems engineering data across the enterprise	N/A	N/A	N/A	N/A		
C3: Production Integration and Testing (PA ONLY)	Uses digital engineering data to manufacture, test and V&V product definition requirements	Utilization of digital engineering data informs decisions and drives increased lifecycle efficiencies	Documents used for all Production and Testing activities	Digital engineering data used to aid some Production and Testing activities	Select digital engineering data content is reviewed and authorized into business data streams	Defined processes support digital engineering data usage for Production and Testing activities	Confidence in digital engineering data format, outputs, and usage	Digital engineering data utilizes relationships with other software for a connected digital thread	Digital engineering data is institutionalized and accessible across the enterprise	N/A	N/A	N/A	N/A		

Link to Joint MBSE Maturity Matrix V1.0 and site assessments accessible to NSE members via PRIDE Program site

MBSE and Digital Engineering Expectations

The combination of internal and external expectations along with your capabilities will help set your targets.
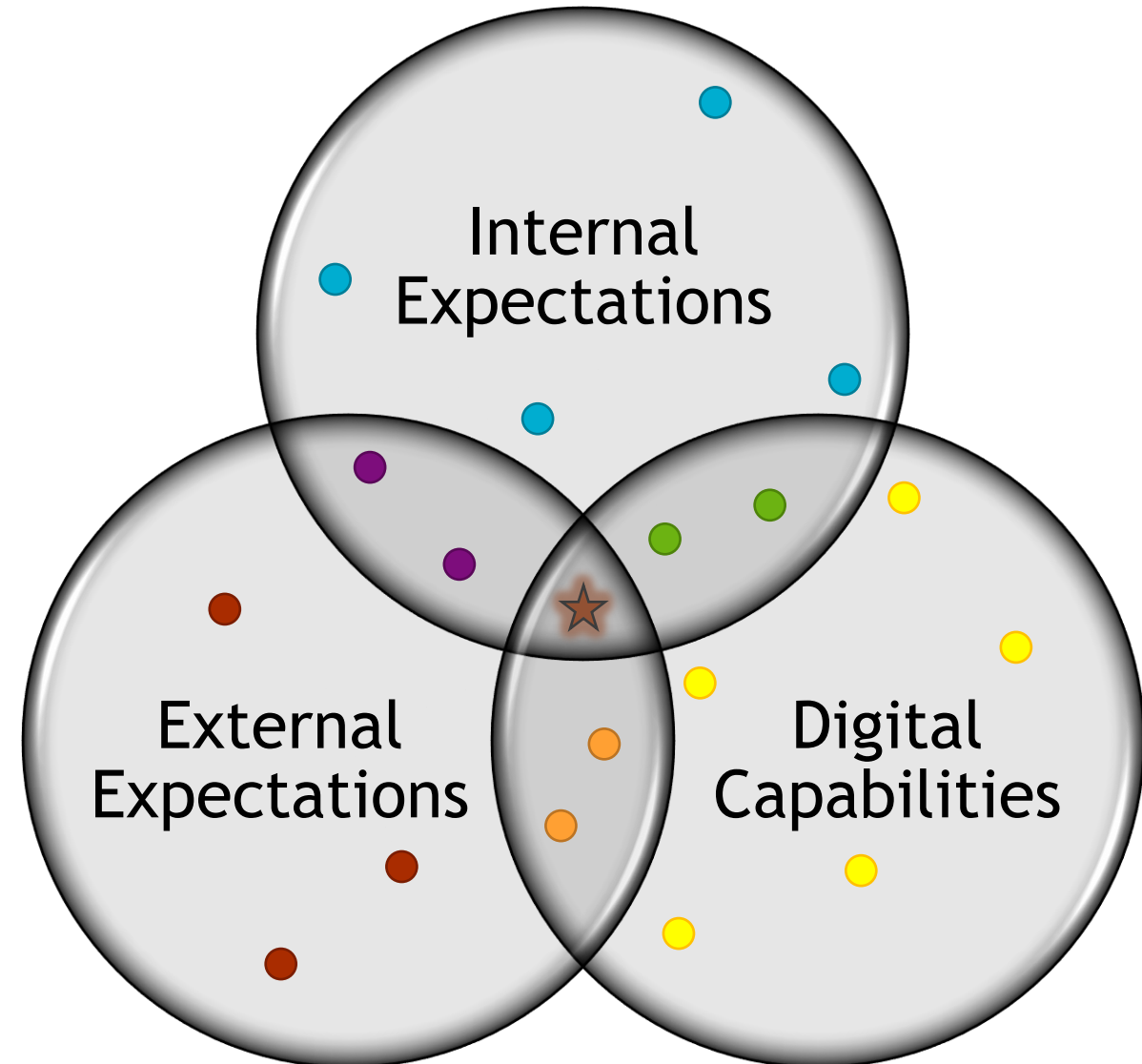
Internal Expectations:

- Corporate MBSE/DE Strategy

- Program specific requirements

External Expectations:

- Customer contract requirements

- MBSE review criteria

Digital Capabilities:

- Tool interoperability

- Digital artifact processes

Rating Facets

MBSE Culture will be assessed according to the Capability, Readiness, and Adoption

Matrix automatically calculates average for each category

Maturity Level Name	Description: How the organization . . .	Transition: As maturity increases, the organization's . . .	Document-Centric Systems	Model-Centric Systems	Verified Model-Centric Systems	Formalized Model-Based Systems	Validated Model-Based Systems	Integrated Model-Based Systems	Extended Model-Based Enterprise	AS-IS Level			TO-BE Level
										Capability: Tools are Available?	Readiness: Processes are Ready?	Adoption: People are Using?	Target: To-be Maturity
Categories (e.g., C1) Level # └─Topics (e.g., T3) └─Facets (e.g., F2)			L0	L1	L2	L3	L4	L5	L6	N/A	N/A	N/A	N/A
C1: Model Based Systems Engineering (MBSE) (DA ONLY)	Uses models to define all aspects of system requirements, behavior, hardware, and V&V	utilization of a system model to drive digital engineering	Documents used for all SE activities	Descriptive model used to aid some SE activities	Select areas of descriptive model content are reviewed and authorized	Defined processes support descriptive model usage for SE activities	Descriptive model permissions, confidence in modelers, and peer review	Descriptive model utilizes relationships between architectures and other models	Descriptive model institutionalized and accessible across the enterprise	N/A	N/A	N/A	N/A
T1: MBSE Culture													
F1: MBSE Institutional Adoption	Uniformly adopts MBSE across the organization	Support, usage, and benefits of MBSE increase	No MBSE use	Pilot projects funded to demonstrate the MBSE methodology and benefits	MBSE adopted by systems engineering departments and incorporated into projects/programs	MBSE best practices and approach established and used to meet program specific needs. Consistent MBSE tool coverage and usage	Consistent MBSE approach across programs using the same ontology driven by policy, practices and methods	System and subsystem MBSE models are linked allowing for full system integration	Consistent MBSE approach, tool, and policies across the enterprise	N/A	N/A	N/A	N/A

Assessment Team Fills in white boxes

(Ratings are NA as default)

Example Assessment

Example Assessment Highlights

Assessment Identifier (AID): [organizationally unique identifier]	Organization under assessment (OUA): [system of interest for this assessment]		Assessment Date: [when assessment kicked off]	Target Date/Event: [target implementation]

Joint MBSE Maturity Matrix V1.0			AS-IS Level			TO-BE Level

Maturity Level Name

Categories (e.g., C1) Level #
 └Topics (e.g., T3)
  └Facets (e.g., F2)

	Description: How the organization . . .	Transition: As maturity increases, the organization's . . .	Capability: Tools are Available?	Readiness: Processes are Ready?	Adoption: People are Using?	Target: To-be Maturity
			4.6	2.2	2.4	4.0
C1: Model Based Systems Engineering (MBSE) (DA ONLY)	Uses models to define all aspects of system requirements, behavior, hardware, and V&V	Utilization of a system model to drive digital engineering aslo increases	4.6	2.2	2.4	4.0
T1: MBSE Culture			4.8	1.8	3.2	4.0
T2: MBSE Methodology and Management			5.1	2.0	2.4	4.0
T3: MBSE Architecture Application			5.0	1.4	1.6	4.0
T4: MBSE Tool Interoperability			3.1	2.0	2.1	4.0
T5: MBSE Information Technology Infrastructure			5.0	3.8	2.9	4.0

- **T1: Adoption>Readiness** Need to formalize processes people are using
- **T2: Adoption>Readiness** Develop MBSE roadmap and track program metrics
- **T3: Adoption>Readiness** Develop process exporting MBSE support drawings
- **T4: Capability<Target** Reevaluate MBSE and supporting tools or develop needed capability
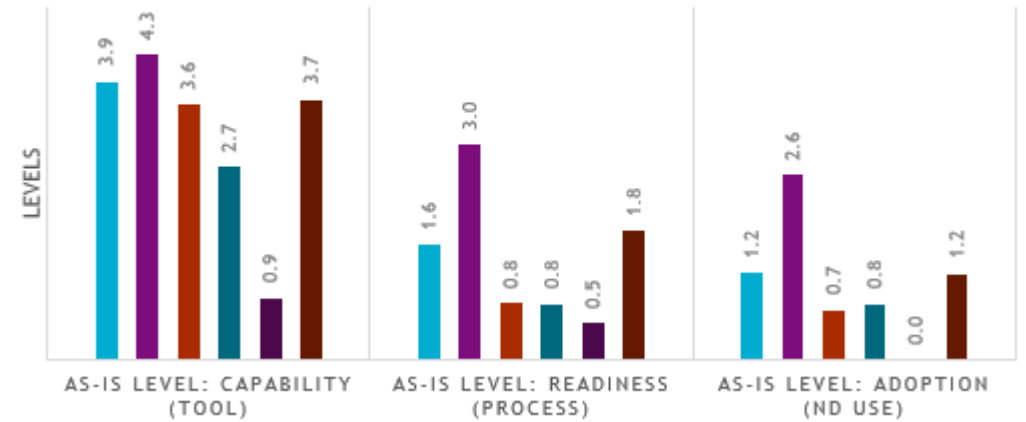- **T5: Readiness>Adoption** Improve MBSE tool performance across sites
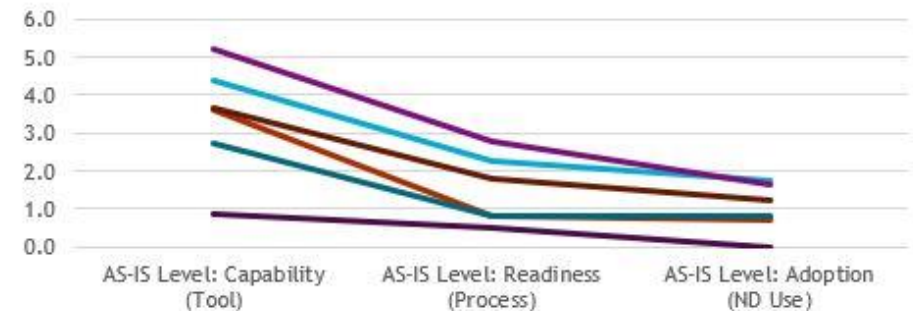
Visualizing Assessment Data

Radar Charts

C1: Model Based Systems Engineering (MBSE)
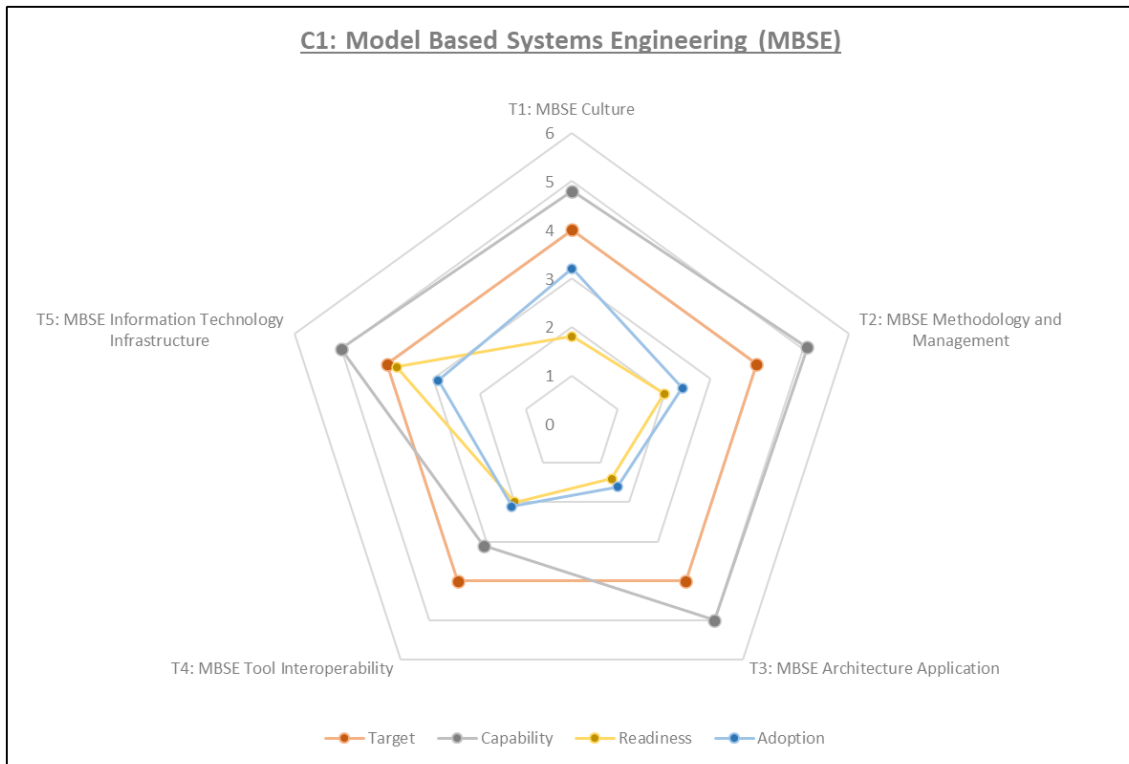
Maturity Matrix Assessment of Multiple Sites

Maturity Matrix Assessment: Total Comparison

Utilizing Matrix Data to Model a Roadmap

- Use GENESYS program activity class to populate Tasks/Events needed on roadmap visualization

- Add attribute data for planned tasks (task IDs, Swim lanes, Tasks, and Start/End Dates)

- Export data using table definition

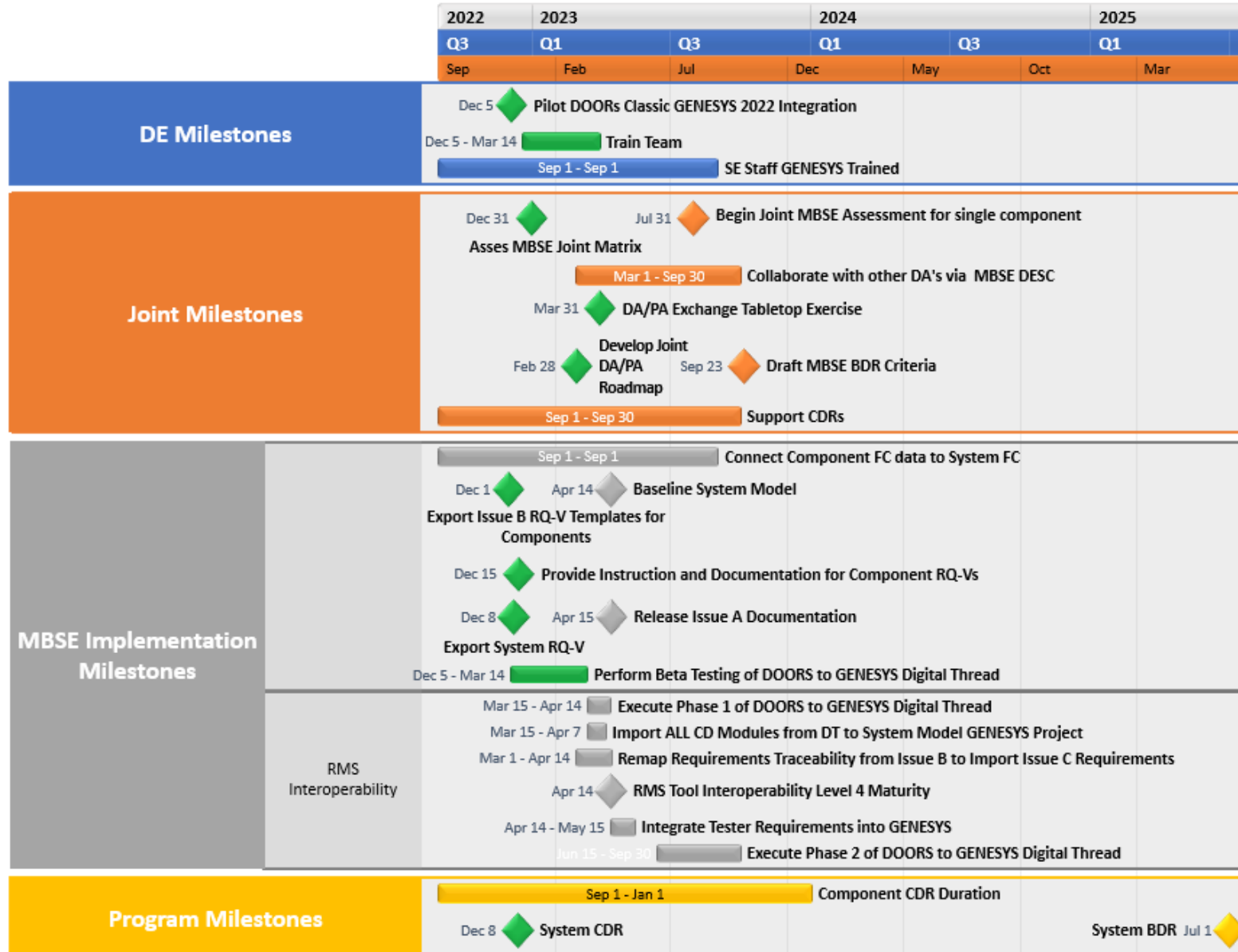- Analyze Data MS Office Timeline (PowerPoint add-in)

Roadmap Structure Mapped to Matrix Structure:
- Parent Swim lanes = Category
- Sub Swim lanes = Topics
- Milestones = Facets

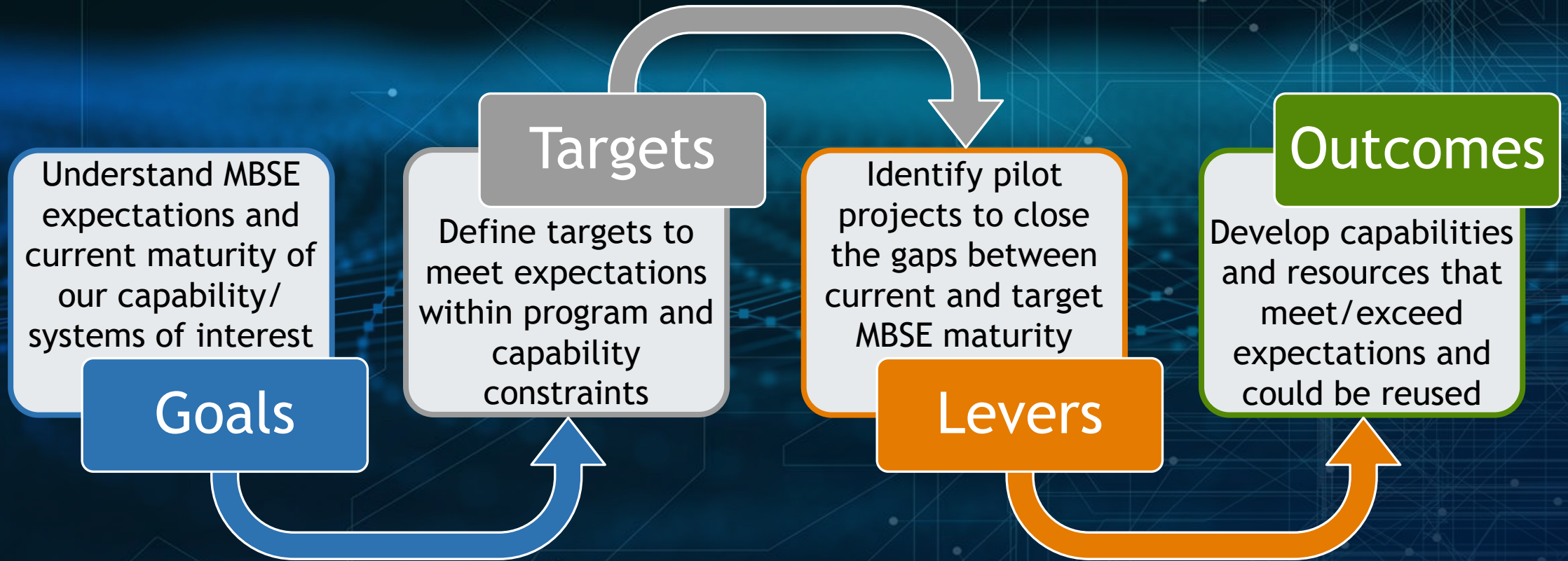# Roadmap Development using Matrix Data

How Do We Mature MBSE Systematically?

Goals

Understand MBSE expectations and current maturity of our capability/ systems of interest

Targets

Define targets to meet expectations within program and capability constraints

Levers

Identify pilot projects to close the gaps between current and target MBSE maturity

Outcomes

Develop capabilities and resources that meet/exceed expectations and could be reused

The Joint MBSE Maturity Matrix allows an entity to assess their MBSE maturity, set targets based on expectations, and identify efforts to close gaps and mature capabilities. Elevating this to an enterprise tool allows us to identify gaps and mature our MBSE capability at the highest NSE level.

Lessons Learned

- Maturity Matrix can be overwhelming, additional guidance needed

- Introduction of MBSE basics is helpful

- Utilizing POC and Comments section for SME review

- Showing the Dunning-Kruger Effect can help anchor the team lean towards conservative ratings to preserve the quality of the assessment

Dunning–Kruger Effect

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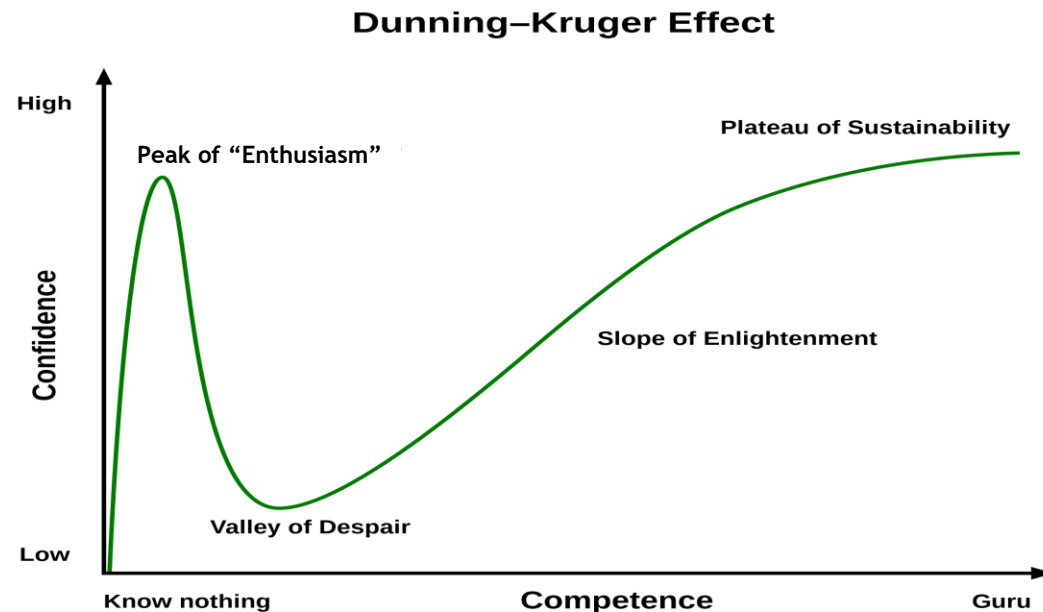
Thank You
Questions?

Timeline: MBSE Maturity Matrix Development