SAND2023-04181C

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DEVELOPING PARALLEL PROGRAMS WHILE MATURING AND IMPLEMENTING DIGITAL ENGINEERING CAPABILITIES

Max Danik and Evan Richardson

June 6th, 2023

Integrate23: The Digital Engineering Symposium

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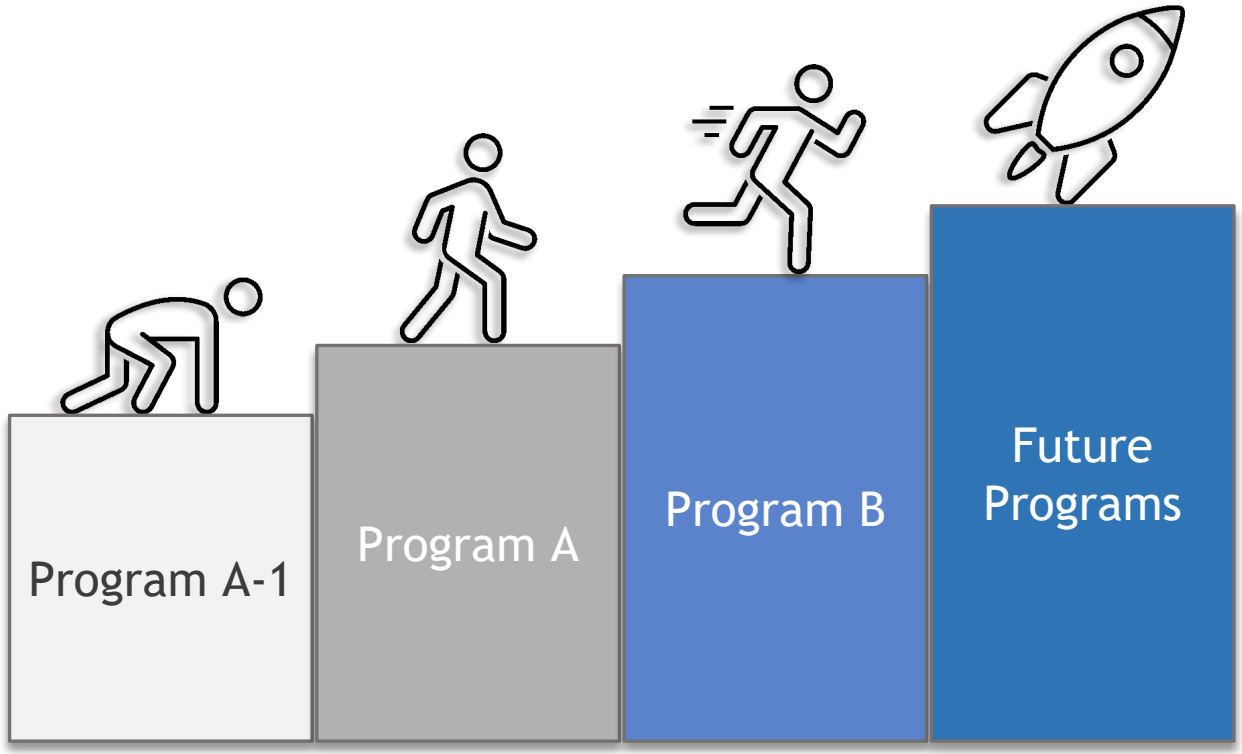
AGENDA

- Program Overviews
- Common Terminology
- Digital Engineering Objectives
- Collaboration Examples
- Efficiencies Observed

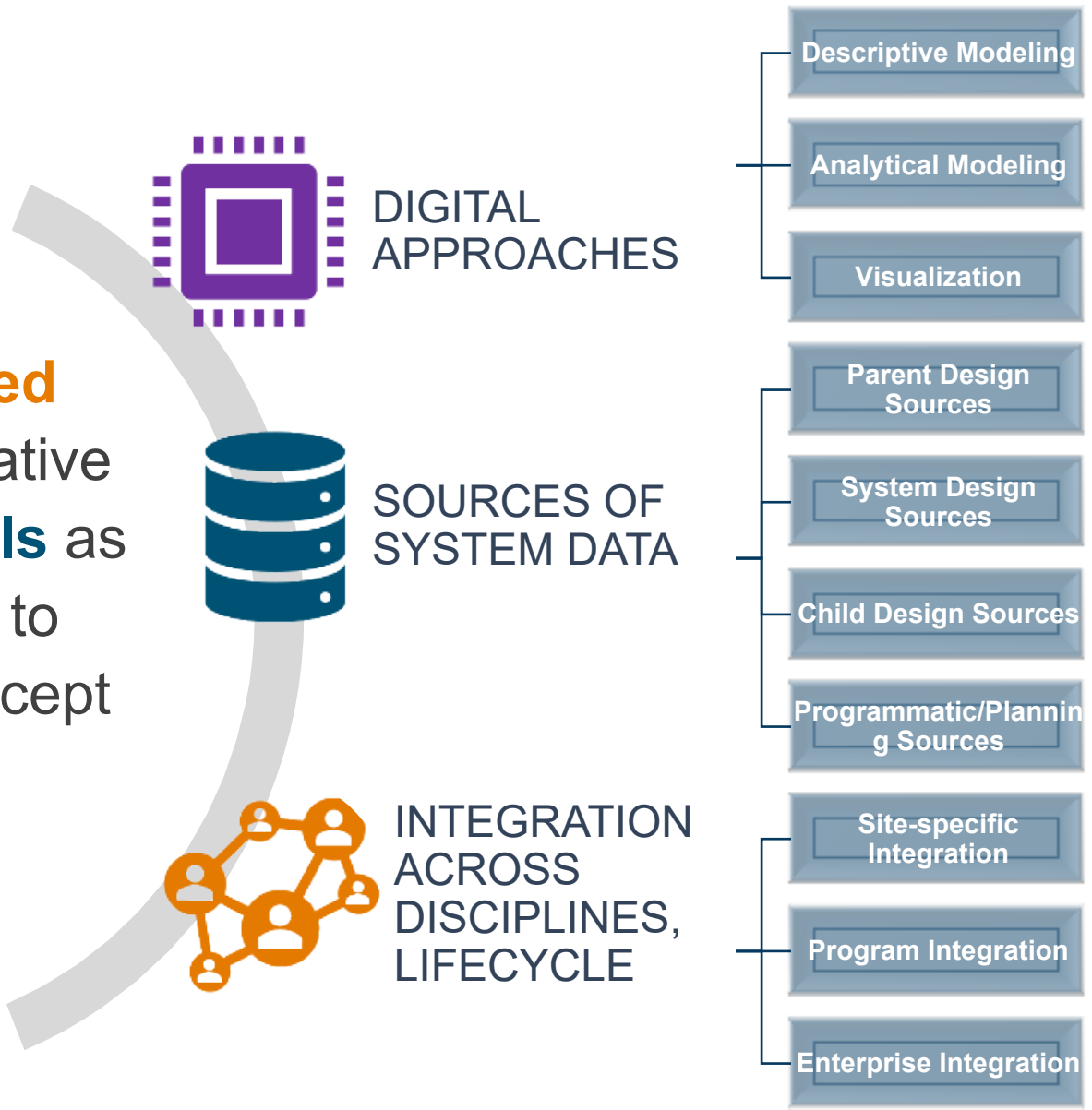


PROGRAM OVERVIEWS

Program Characteristics	Program A	Program B
Program Need	Extend life and improve functionality of existing system	Design a system for an uncertain future
Lifecycle Phase	Development → Production	Concept Study → Feasibility Study
Willingness to try new processes/techniques	Low	Medium-High
Customer Risk Tolerance	Very Low	Low
Format of Design Artifacts	Document-based with supporting models	Model-based to create required Document deliverables
Customer Expectations for Digital Engineering	Improved communication between Design Teams and Production Teams (MBD), Improved Internal Communication (MBSE)	Build on the baseline created by Program A

COMMON TERMINOLOGY

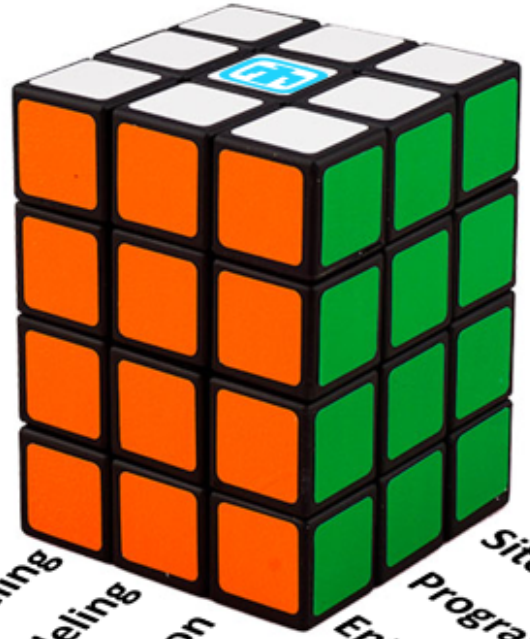
Digital Engineering is an **integrated digital approach** that uses authoritative **sources of system data and models** as a **continuum across disciplines** to support **lifecycle** activities from concept through disposal



Decompose the definition of digital engineering for our application

COMMON TERMINOLOGY FROM ANOTHER PERSPECTIVE

- Digital Engineering is a complex puzzle to solve
- You cant solve a puzzle by only moving some of the pieces



Parent Design Sources

System Design Sources

Child Design Sources

Programmatic/Planning Sources

SOURCES OF SYSTEM DATA

Descriptive Modeling

Analytical Modeling

Visualization

Site-specific Integration

Program Integration

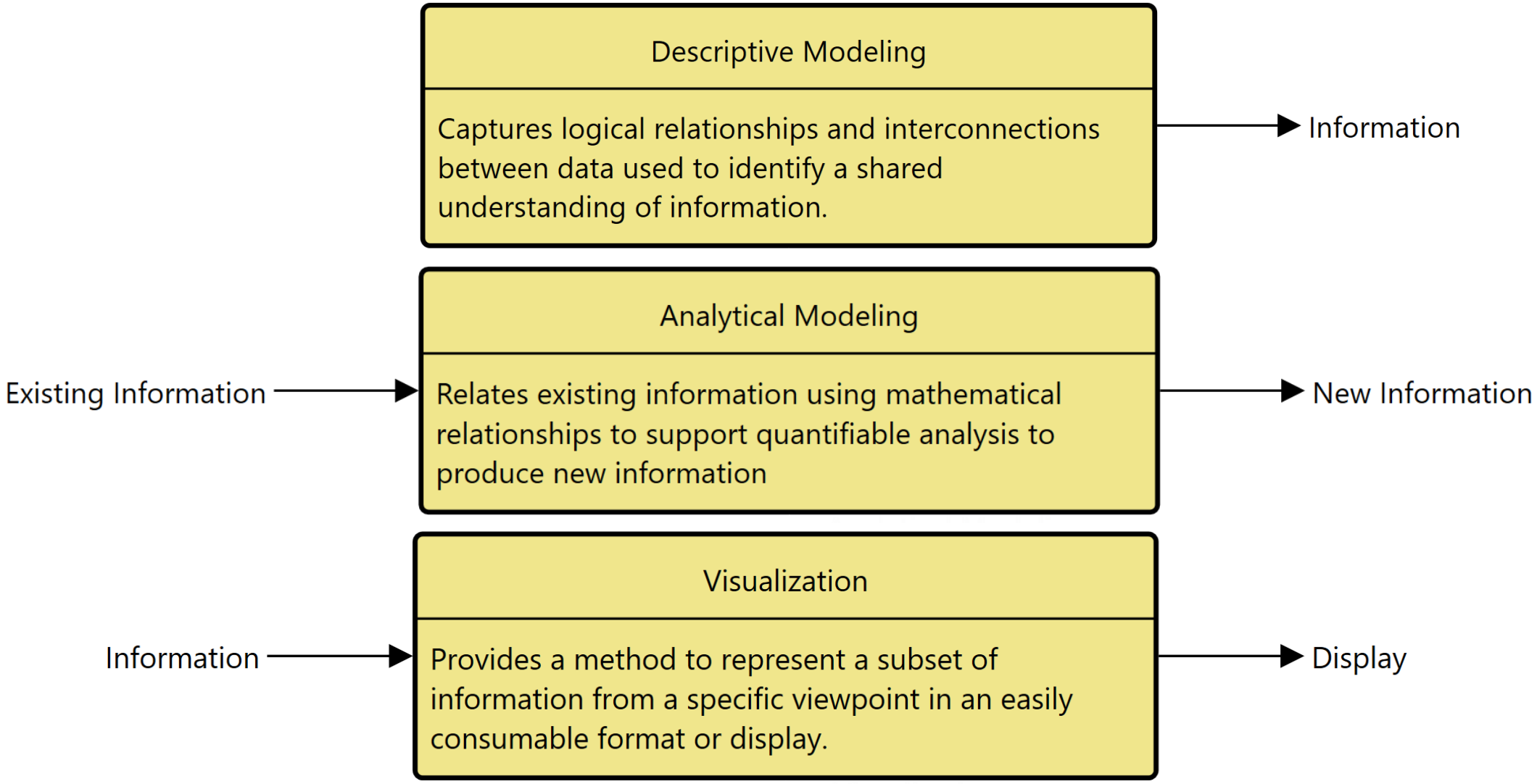
Enterprise Integration

DIGITAL APPROACHES

INTEGRATION ACROSS DISCIPLINES, LIFECYCLE

COMMON TERMINOLOGY:

DIGITAL APPROACHES



COMMON TERMINOLOGY:

SOURCES OF SYSTEM DATA

Parent Design Sources

Information is managed by a higher-level entity such as the customer or external system stakeholder

System Design Sources

Information about the system-of-interest that is owned and managed by the team

Child Design Sources

Information managed by the team intended to define/constrain lower-level design teams

Programmatic/Planning Design Sources

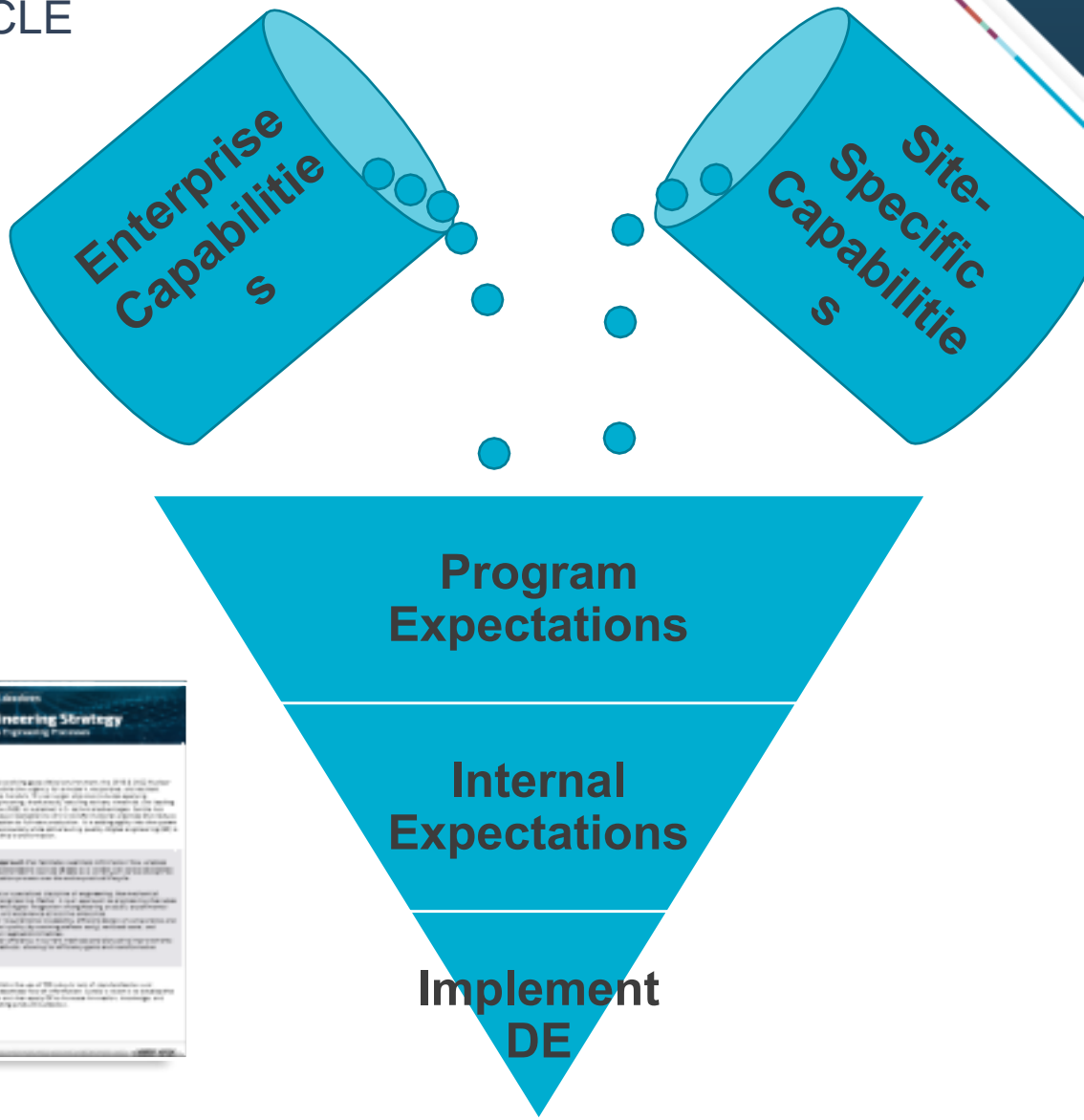
Source for all programmatic information about the work that is expected, not the technical needs of the system

Data, Information, and Artifacts	Source Category	Edit Location (Source)	Storage of Approved Release
Source Requirements	Parent Design	DOORS Next	PDMLink
System Functional Architecture	System Design	GENESYS	PDMLink
Component Verification Architecture	Child Design	GENESYS	PRIME
Program Schedule	Programmatic/ Planning	P6	*NA*

COMMON TERMINOLOGY:

INTEGRATION ACROSS DISCIPLINES, LIFECYCLE

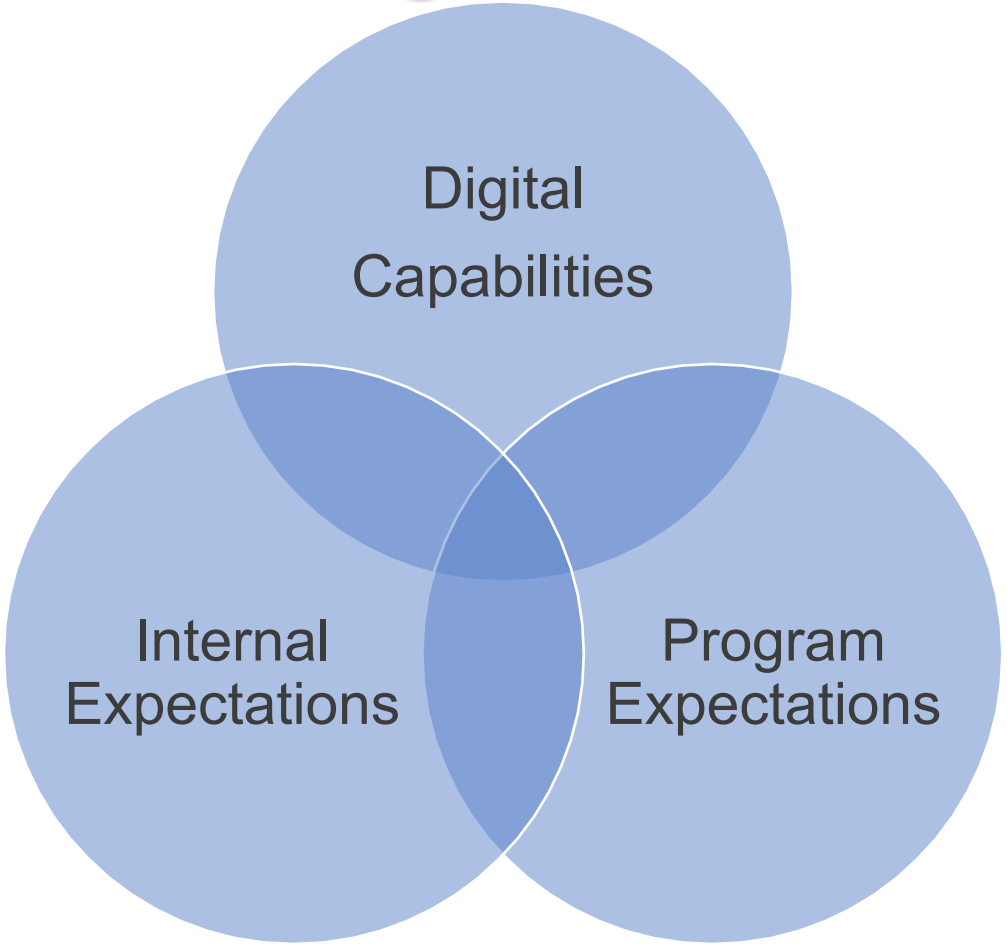
- Enterprise Integration
  - Provide DE capabilities across the enterprise
  - Recommend guidance to accelerate DE implementations
- Program Integration
  - Identify program expectations for DE implementation
- Site-Specific Integration
  - Provide site-specific capabilities
  - Identify internal expectations for DE implementation
  - Implement DE



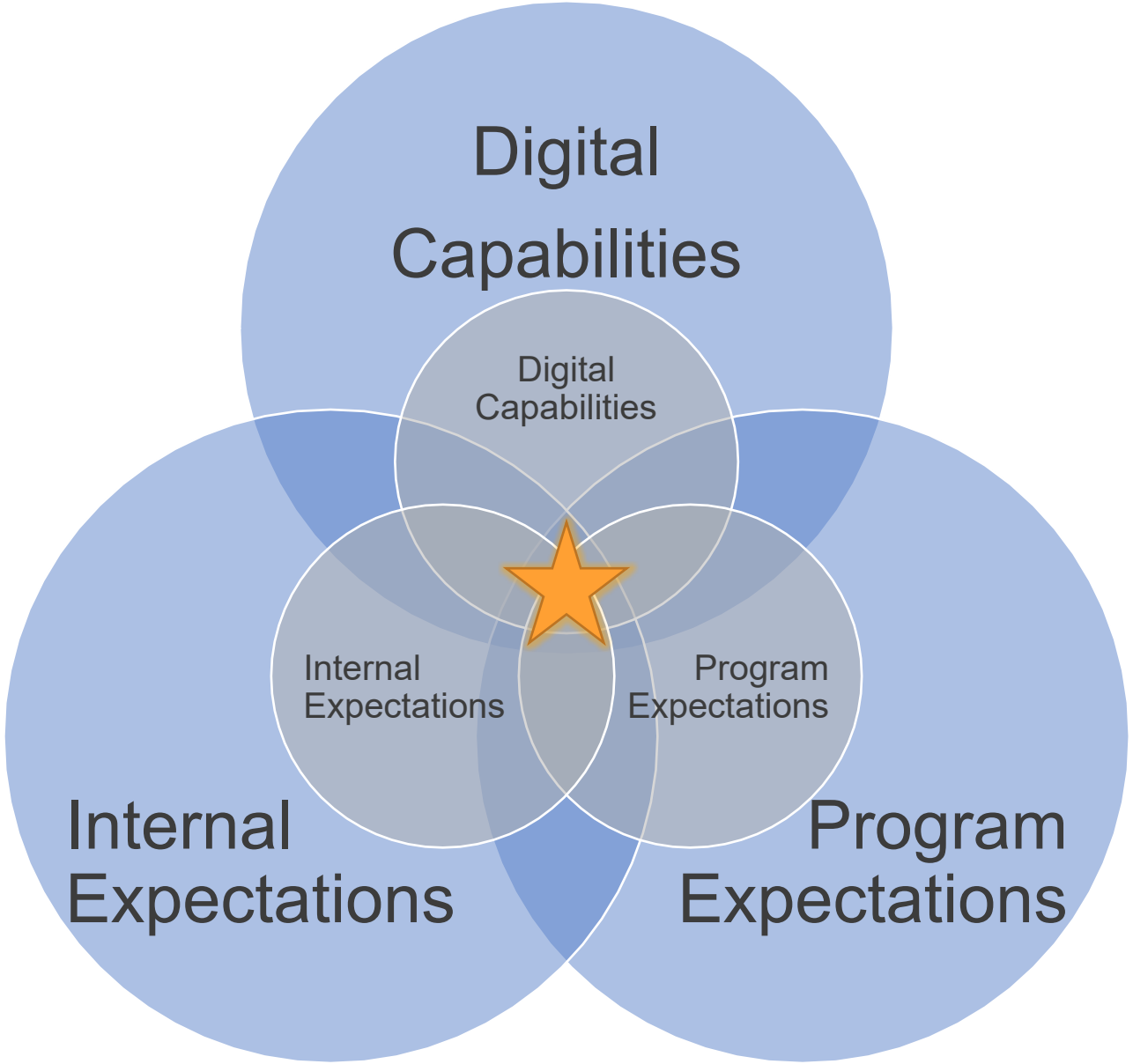
DIGITAL ENGINEERING EXPECTATIONS FOR EACH PROGRAM

Program A

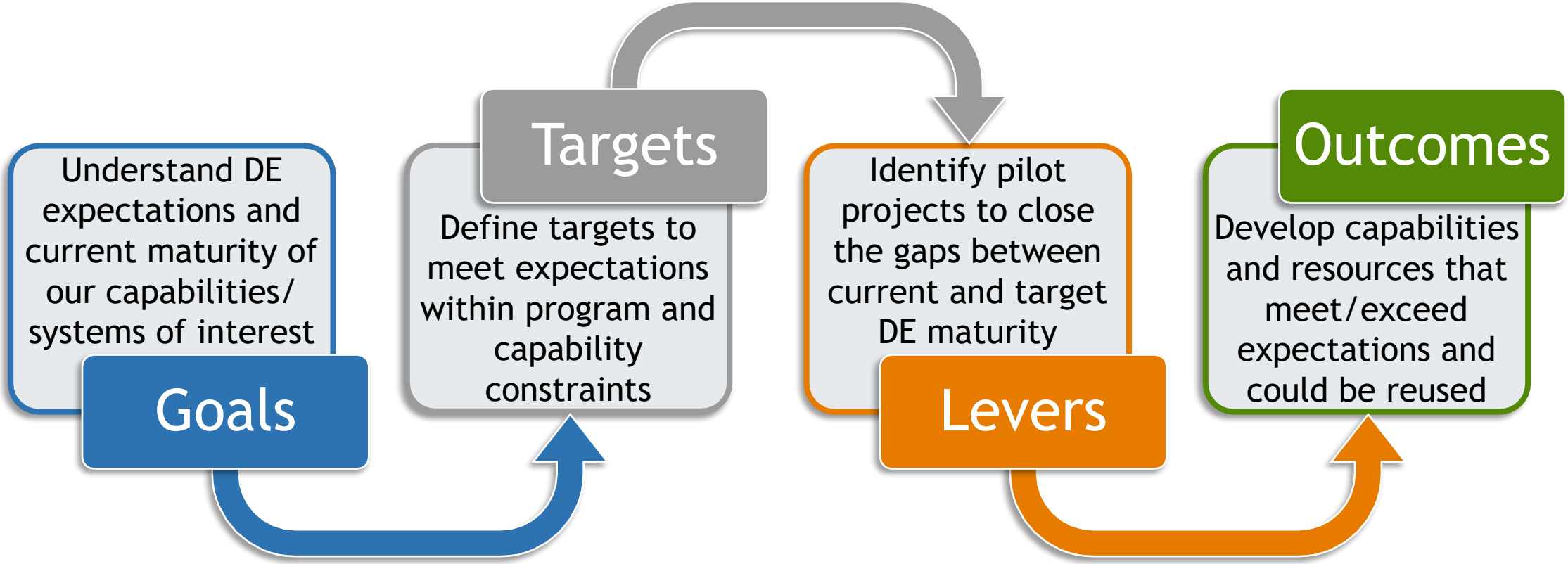
Program B



DIGITAL ENGINEERING EXPECTATIONS FOR EACH PROGRAM



HOW DO WE MATURE DIGITAL ENGINEERING SYSTEMATICALLY?



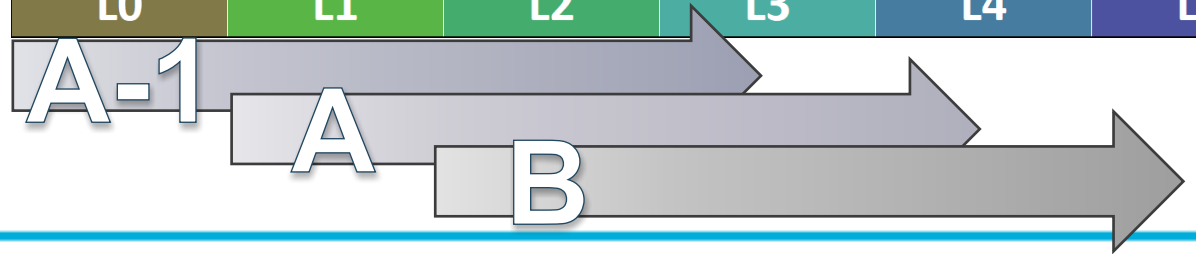
The Joint MBSE and MBE Maturity Matrices allow an entity to assess their DE maturity, set targets based on expectations, and identify efforts to close gaps and mature capabilities.

MBSE MATURITY MATRIX VERSION 1.0

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]

Joint MBSE Maturity Matrix V1.0									AS-IS Level			TO-BE Level	Assessor comments below.	
Maturity Level Name / Categories (e.g., C1) / Topics (e.g., T3) / Facets (e.g., F2)	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	Capability: Tools are Available?	Readiness: Processes are Ready?	Adoption: People are Using?	Target: To-be Maturity	POC	Comment
			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		
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		

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



Movement across the Maturity Matrix

IDENTIFYING DIGITAL ENGINEERING OBJECTIVES

- All areas of the DE Ecosystem are matured as identified by internal expectations
- The focus for a program is placed on the areas identified by the program expectations
- Use cases are developed to identify capabilities and integrations to prioritize efforts

DE ECOSYSTEM

MODEL BASED ANALYSIS (MBA)

Using computational models, integrated with other model-based techniques, to analyze and inform design, testing, production and sustainment decisions

MODEL BASED TESTING &

Using model-based techniques in the testing and experimentation part of the design process

MODEL BASED PRODUCTION

The approach of using authoritative models as the source of truth for defining production activities and ensuring production-related requirements are fed back into other model based scope

MODEL BASED DEFINITION

The systematic use of models to capture the design, architecture, and implementation that can be verified and validated to meet requirements through common framework (thread**) throughout the design process**

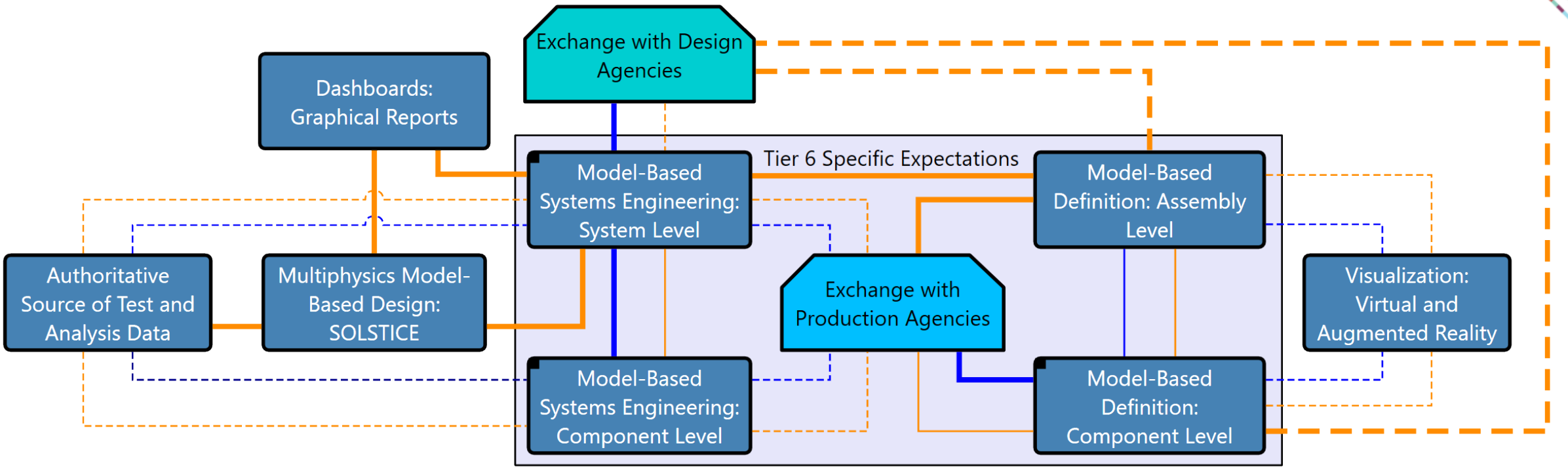
NUCLEAR DETERRENCE DATA, MODELS, & IT

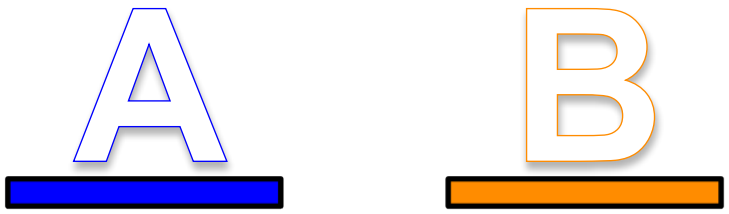
The application of model-based technologies to Systems Engineering activities such as requirements analysis, functional analysis, and allocation to physical components, system architecture specification, and verification and validation.

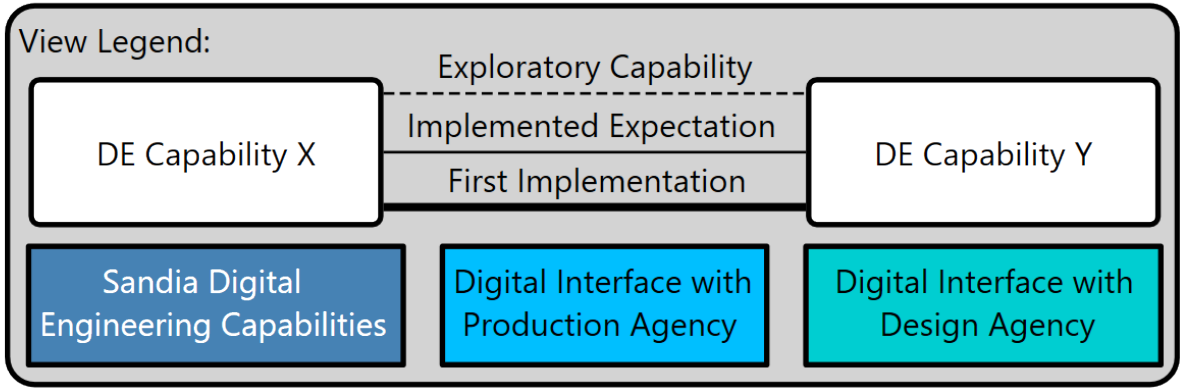
MODEL BASED SYSTEMS ENGINEERING

The application of model-based technologies to Systems Engineering activities such as requirements analysis, functional analysis, and allocation to physical components, system architecture specification, and verification and validation.

DIGITAL ENGINEERING OBJECTIVES





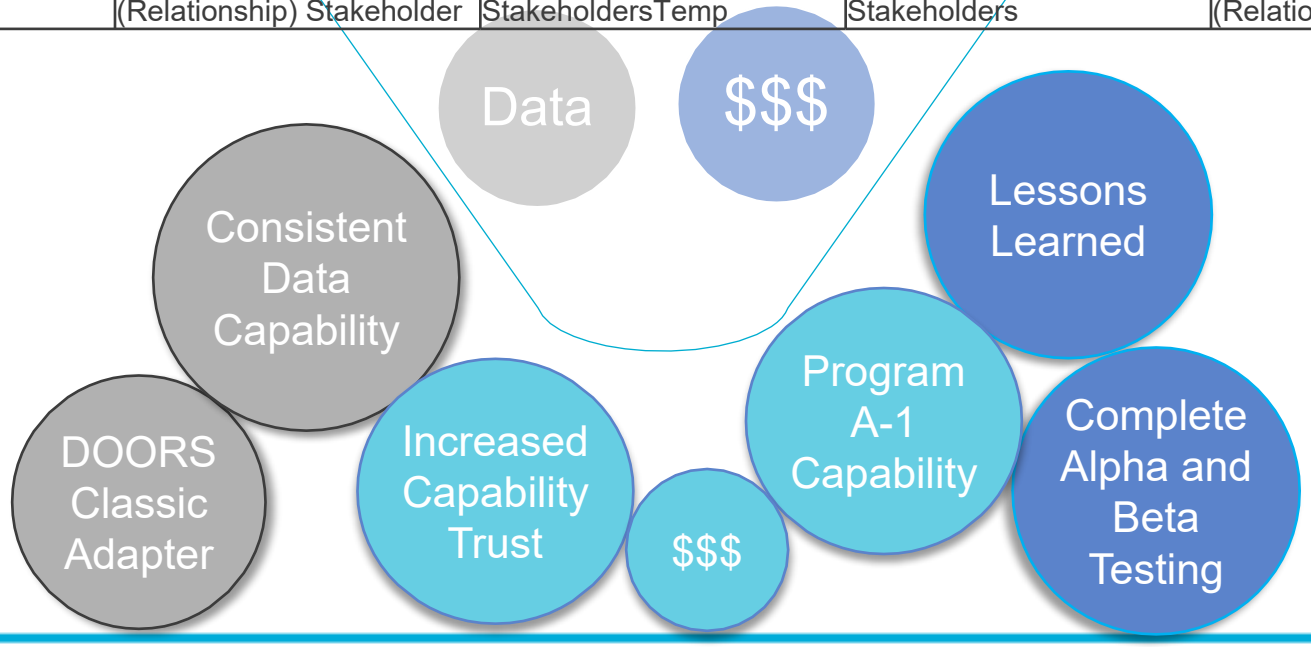


REQUIREMENTS ADAPTER DEVELOPMENT

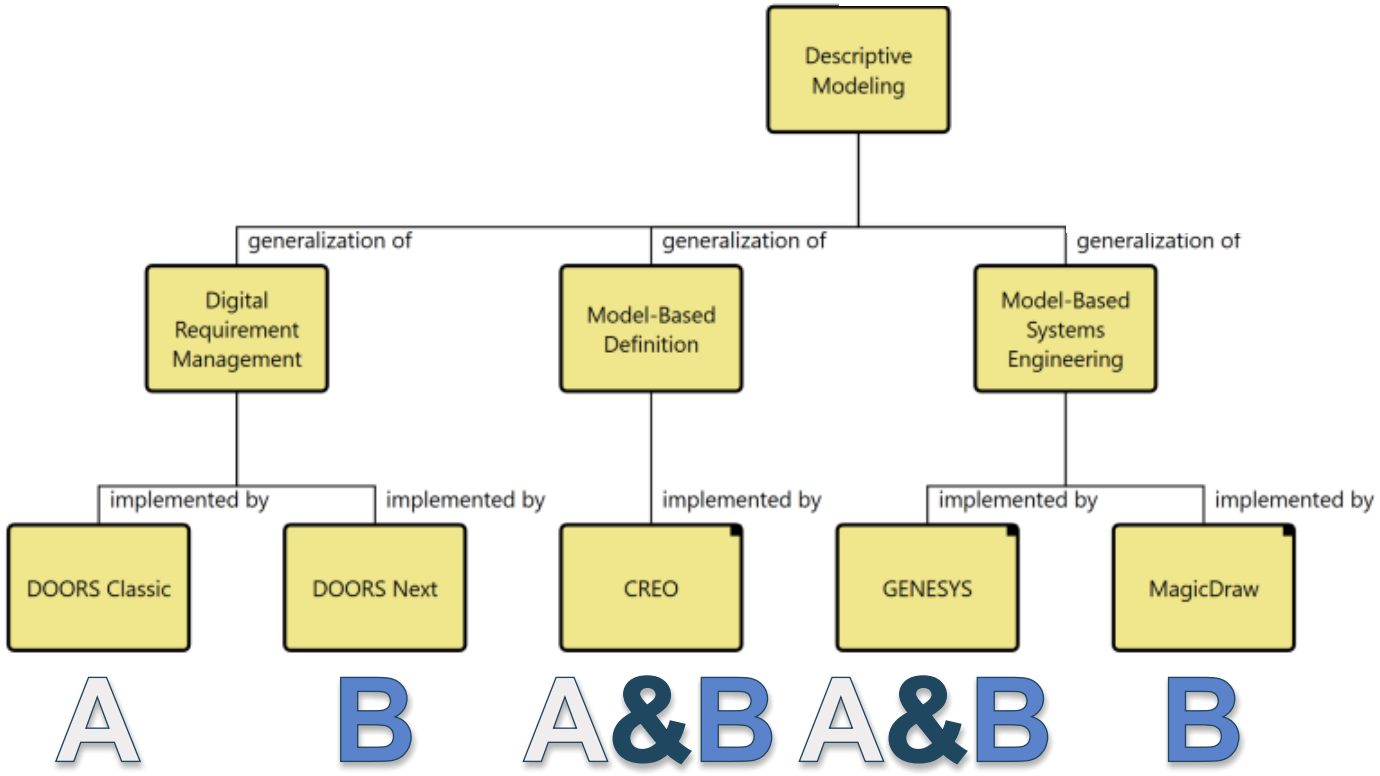
Program A

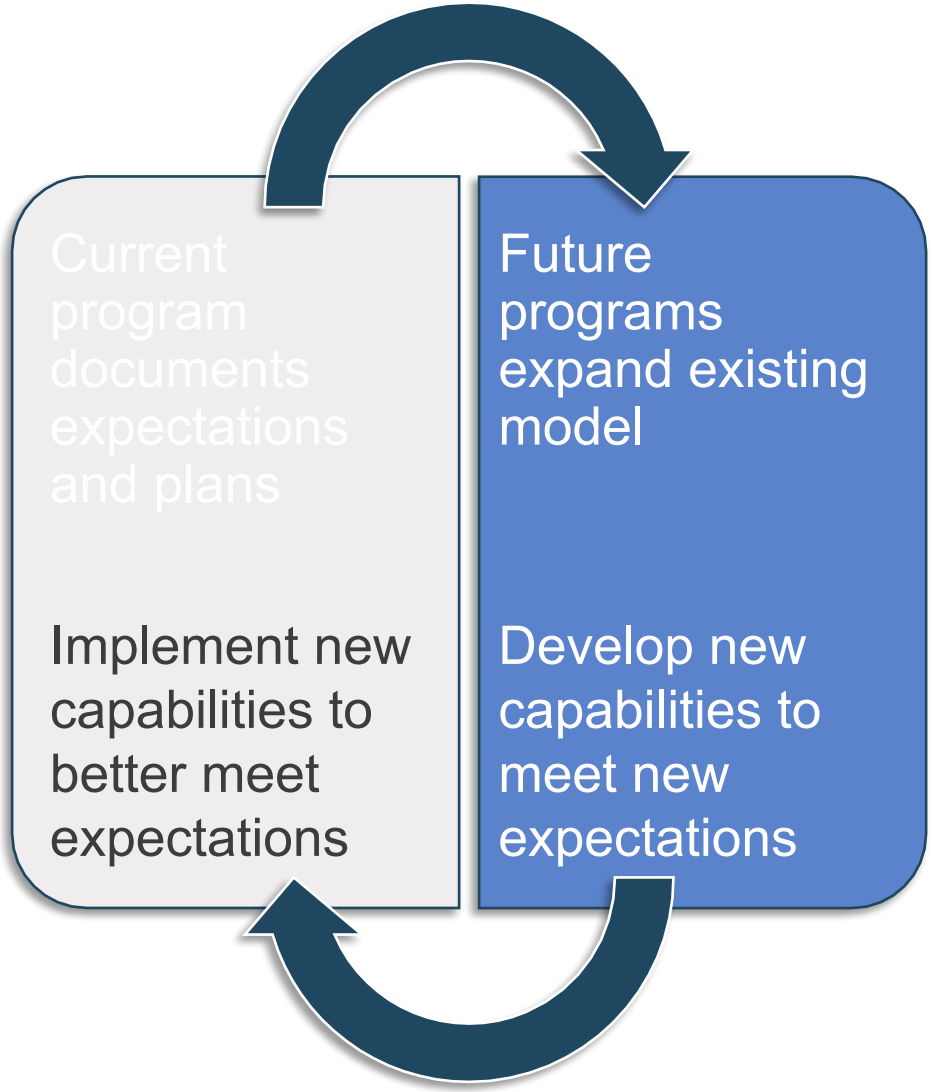
Program B

Program A		DEE Ontology	Program B	
DOORS Classic	Genesys (Program A Schema)		DOORS Next	Genesys (Program B Schema)
dxl.ReqID (Object ID)	name	Requirement Identifier	Requirement Identifier	puid
_Req Name	paragraphTitle	Requirement Name	Name	name
Object Text	description	Requirement Text	Primary Text	description
_Rationale	rationale	Rationale	Rationale	rationale
	type	Requirement Type	Requirement Type	type
_Verifier/Stakeholder	(Relationship) Requirement Owner	(Relationship) Requirement Owner	Requirement Owner	(Relationship) Requirement Owner
_Stakeholders	(Relationship) Stakeholder	StakeholdersTemp	Stakeholders	(Relationship) Stakeholder



SCALABLE MODEL OF MBSE IMPLEMENTATION





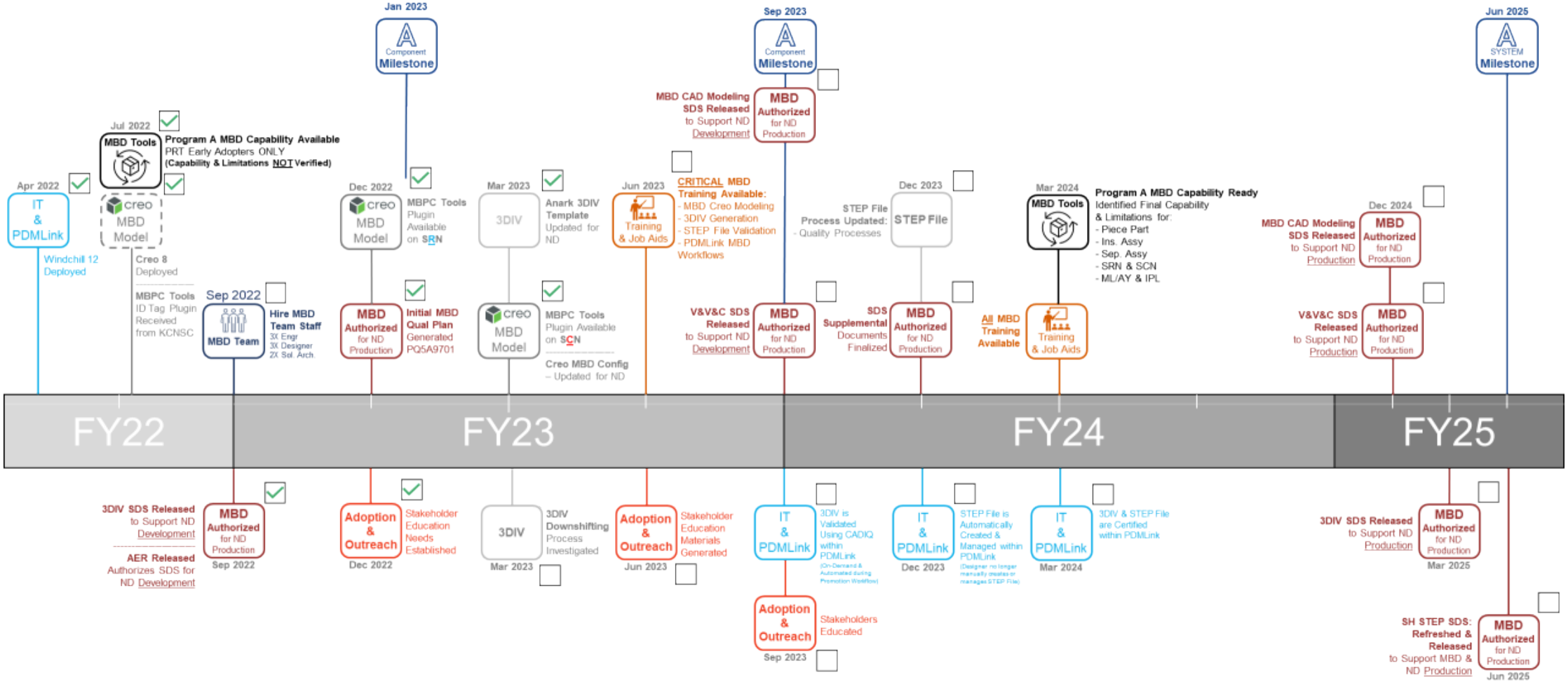
MBD ROADMAP

Model-based Definition

Program A

Milestones Exclusively Outside DE Scope/Control

- IT & PDMLink — PA Access to DA PDM
- IT & PDMLink — CM Workflow Located in PDM



LEGEND

- A/B COMP/SYST Milestone — Milestones denoting significant Weapon Program dates.
- Adoption & Outreach — Milestones related to MBD adoption and outreach activities which are critical for MBD/MBE success.
- 3DIV & STEP File — Milestones related to deployment of 3DIV definition (AY/IPL/ME) and STEP File Support Models (SH).
- Part-Centric (Automatically Established Upon PDMLink Check In) — Milestones related to deployment of Part-Centric Digital Part Objects linked to MBD artifacts (commonly referred to a "WT Parts" or "SNL Parts").
- Milestone — Critical Activities Performed First
- MBD Authorized for ND Production — Milestones related to documentation ensuring MBD may be used for ND Lifecycle including Production, Acceptance, & Qualification.
- creo MBD Model — Milestones related to deployment of Creo MBD 3D CAD Models which contain Combination States, 3D Annotations and Semantic PMI.
- CADIQ & Certified MBD — Milestones related to deployment of Certified 3DIVs and STEP Files using CADIQ and V&V Workflows.
- IT & PDMLink — Milestones related to deployment of IT and PDMLink functionality to ensure MBD can be created, Certified, configuration managed, released, and accessed by ND partners through appropriate access controls.
- Milestone — Dependent on Prior Milestones Outside DE Scope/Control

REV: **D**
STATUS: **WIP**
LAST UPDATED: **April 27, 2023**

MBD ROADMAP

Model-based Definition

Program A | Program B

Milestones Exclusively Outside DE Scope/Control

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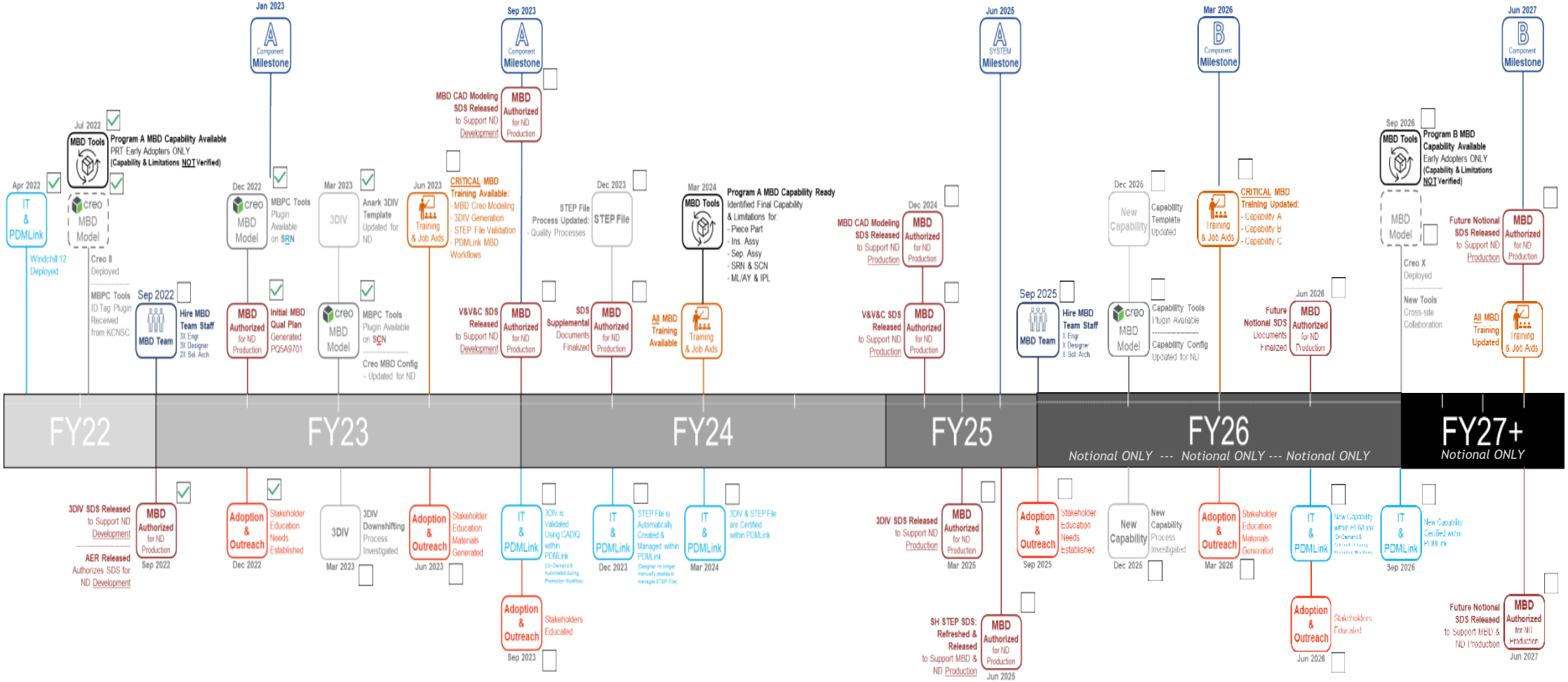

LEGEND

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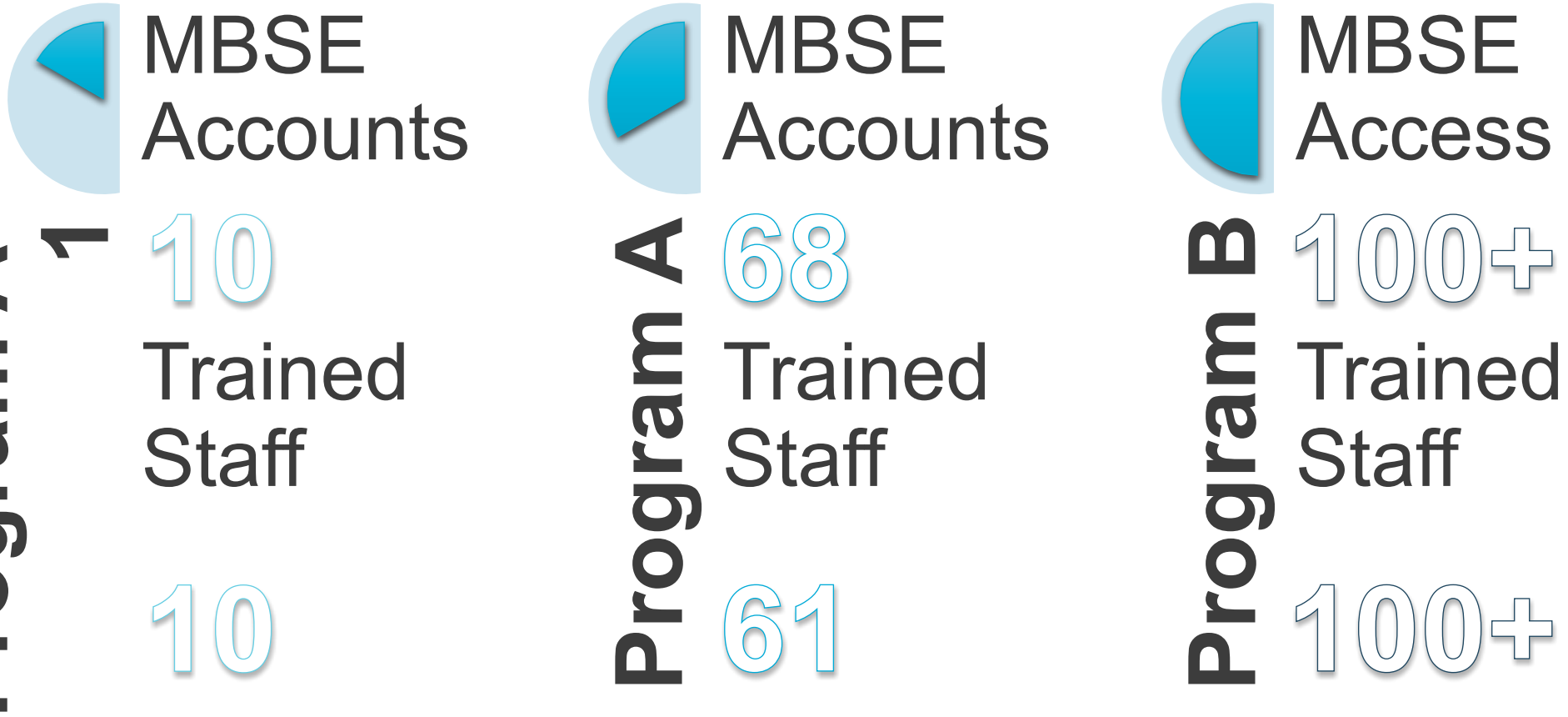
- Milestone — Dependent on Prior Milestones Outside DE Scope/Control

REV: **DRAFT FUTURE ROADMAP**
STATUS: **WIP**
LAST UPDATED: **May 1, 2023**

FUTURE GENERATIONS OF TRAINED PRACTITIONERS



Numbers represent program staff outside of MBSE capability subject matter experts who are getting engaged and contributing content directly to the associated models

EFFICIENCIES OBSERVED

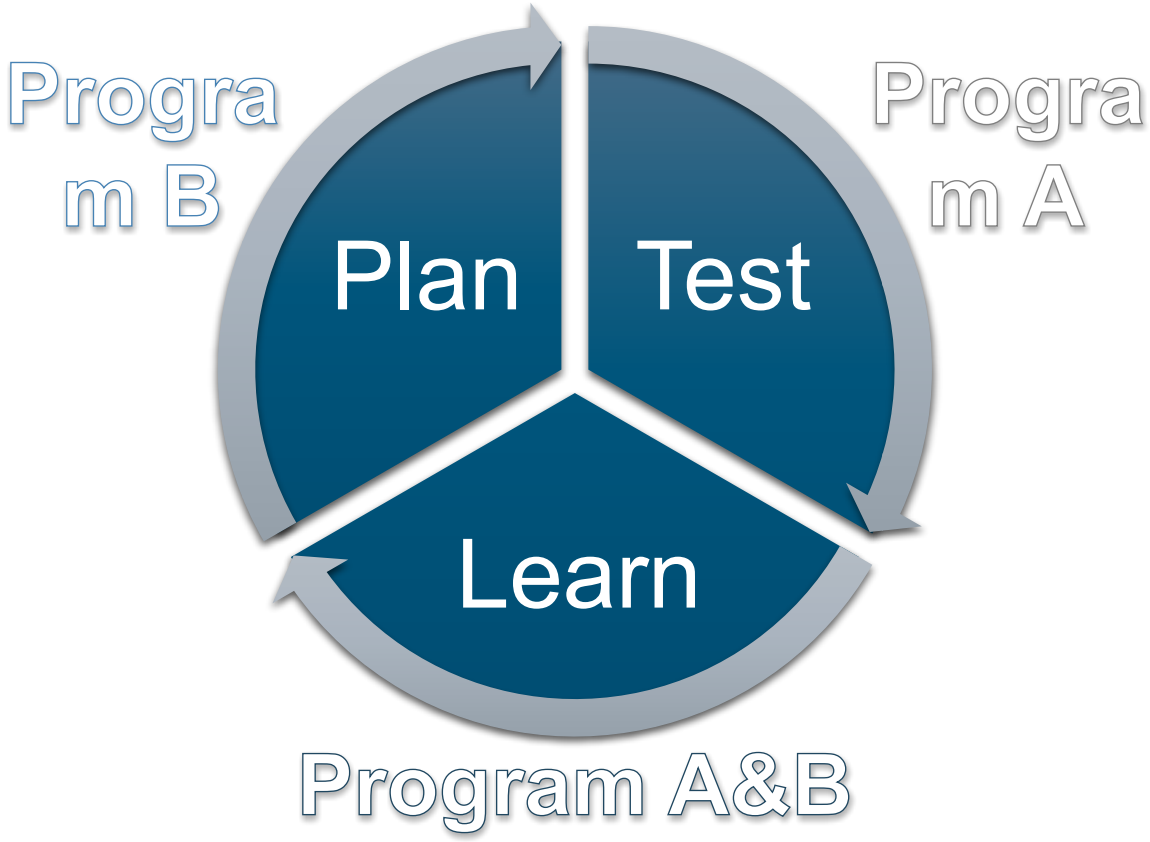
Enable capabilities to mature independently rather than trying to do everything at once, focus on the details that are needed

- Capability development is different than program implementation.

Heavily rely on trust with other programs

Reuse as often as possible

Focus and build on the similarities while acknowledging the differences



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