



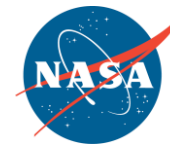
Model-Based Capabilities Matrix

NDIA SE ME Conference Session 22159

Al Hoheb,
The Aerospace Corporation,
albert.c.hoheb@aero.org



Joe Hale,
NASA/MSFC,
joe.hale@nasa.gov



What is the INCOSE Model-Based Capabilities Matrix?

- It is an assessment tool used to characterize an organization's current and desired model-based capabilities
 - In its simplest form, a **capability statement** is a **statement** about your organization and its **capabilities** and skills that defines what its able to do by employing model-based effort.
- A capability:
 - Produces an outcome
 - Activated by resources
 - Has both and input and output
 - Changes over the life cycle
- Solves the problems of:
 - What model-based capabilities does my organization need?
 - What capabilities do my enterprise team members need?
 - How do we ensure we've thought of everything?
 - How can we characterize the capabilities needed and their evolution?
 - What capabilities should my PM, SE, IT, Modelers, and contracts staff need?

Model-Based Capability Matrix (MBCM)

Challenge Team Effort – Started in January 2018

- Co-Leads:
 - Al Hoheb, The Aerospace Corporation/SED, albert.c.hoheb@aero.org
 - Joe Hale, NASA/MSFC, joe.hale@nasa.gov
- Challenge team:
 - Federation of those willing to assist in the development and deployment of the products; now [162](#) and growing
 - As a challenge team member you are on the mailing list to receive product updates, notices for meetings and workshops
 - Request feedback on products and after you apply it
- Products
 - Model-Based Capabilities Matrix (MBCM) excel-based Matrix
 - User's Guide
 - Workshop charts
 - INCOSE Challenge Team Technical Project Plan (TPP) version 2.2
- Resources:
 - <http://wiki.omg.org/MBSE/> references provide an on-line overview of the products and the Challenge team efforts
 - INCOSE Connect – member download area
 - Soon to be available from the INCOSE Store

Matrix Effort Pedigree and Plan

The products have come a long way in a short time

- ✓ Nov 2016 Aerospace MBSE Community Roadmap
- ✓ Oct 2017 NASA MFSC MBSE Maturity Matrix
- ✓ Nov 2017 OSD Digital Engineering Working Group – presentation and co-lead kickoff
- ✓ Jan 2018 INCOSE IW Breakout **Workshop** – presentation and workshop; – 2 half day session with over 50 participants, resulted in draft [INCOSE matrix version 1.0](#)
- ✓ Mar 2018 INCOSE Challenge Team Inputs -- comments
- ✓ May 2018 Aerospace System Engineering Forum -- presentation and **workshop**; draft INCOSE matrix version 1.1
- ✓ May 2018 USAF DE Working Group presentation – presentation, draft version 1.2
- ✓ June 2018 INCOSE Challenge Team Inputs -- draft version 1.3 in, draft users guide
- ✓ July 2018 INCOSE IS **workshop** -- draft version 1.3 in, [draft users guide](#)
- ✓ Aug 2018 version 1.4, [wiki site initially populated](#)
- ✓ Sept 2018 1.5, updated users guide
- ✓ Oct 2018 [OSD Cross-check against the OSD DE Strategy](#) – all strategy elements covered
- ✓ Oct 2018 NDIA SE Conference **workshop** – [first fully populated matrix. Ver 1.5](#)
- ✓ Nov 2018 Presentation to MIT/LL
- ✓ Dec 2018 INCOSE Challenge Team Inputs – [matrix ver1.6a](#), [TPP 2.1 \(signed\)](#), [User's Guide 4](#)
- ✓ Jan 2019 INCOSE IW Outbrief and Breakout **workshop** -- [matrix ver 1.7](#)
- ✓ Feb 2019 Aerospace System Engineering Forum **workshop** – [workshop program acquisition scenario](#)
- ✓ Mar 2019 Aerospace internal and customer **workshop** -- [matrix ver 2.0](#), [organized to the OSD DE Strategy](#)
- ✓ Jun 2019 Challenge Team meeting – matrix ver. 2.0b, additional capabilities, UG 5.2, [INCOSE Connect document download](#)
- ✓ July 2019 INCOSE IS **workshop** – FAQs
- ✓ [Aug 2019 INCOSE document publication approval submittal](#)
- ✓ Sept 2019 INCOSE Western Region - presentation
- [Oct 2019 NDIA SE ME Conference presentation and workshop](#)
- [Oct 2019 Begin design for an on-line assessment tool, launch in Jan 2020, benchmark results in May 2020](#)
- [Jan 2020 INCOSE IW presentation and workshop \(approved community documents for INCOSE Store download\)](#)
- [May 2020 Aerospace Systems Engineering Forum – Northern VA, outbrief benchmarking](#)

INCOSE document approval and publication slated for end of 2019

Matrix Development Decision Points

1. Areas/categories cover the topic groups and can be allocated to Users Guide Roles
2. Row identification
 1. Row is unique (e.g., no overlap with other rows)
 2. Are rows needed (unique cell information, e.g., “SE functions” or “PM functions”)
3. All cells filled in, provide a gradient from least amount of modeling application to the most desirable modeling application
4. Update for reasonableness and consistency
 1. Terminology used consistently.
 2. Word and phrase clarity and agreement.
5. First use to see if it’s usable and establish candidate reports
 1. 2019 January, INCOSE IW
 2. 2019 February, Aerospace System Engineering Forum
6. Pilot use
 1. Challenge Team action item and feedback
7. General use and feedback
 1. Enterprise, program, project, and role based use and feedback
8. Establish candidate reports
9. Establish candidate metrics

Decision Points are identified where the available information is of sufficient quality to claim success and the development can continue

Current Use

- Government Organizations that are applying the Matrix
 - MDA
 - GBSD
 - AF/SMC
 - AF ASE
 - NAVAIR
 - USA
 - JPL
 - others
- All have tailored the matrix to suit their needs
- Getting feedback on results is desired
- Positive outcomes
 - Provides an excellent tool to communicate across roles; PM, SE, IT, Modelers, Contracts
 - Comprehensive to catch items
 - Easily captures gaps and characterizes opportunities
 - Tailorable
 - Workshop helps to ensure that the modeling capabilities are linked to the enterprise/program goals and modeling objectives
 - Assists in identifying how much modeling capability is “enough”
 - Satisfies many use cases

Overview of the Matrix and Concept of Operations


Matrix Structure

- Rows: Organization modeling capabilities for an organization (42 Capabilities)
 - Role-Based view or Digital Engineering (DE) goal view – same capabilities
 - Each view has the capabilities sorted by the role-based or DE goal key field
- Columns: Increasing Stages of Capability generally defined as:
 - Stage 0: No MBSE capability or MBSE applied ad hoc to gain experience
 - Stage 1: Modeling efforts are used to address specific objectives and questions
 - Stage 2: Modeling standards are applied; ontology, languages, tools,
 - Stage 3: Program/project wide capabilities; model integrated with other functional disciplines, digital threads defined and digital twin
 - Stage 4: Enterprise wide capabilities: contributing to the enterprise, programs/projects use enterprise defined ontologies libraries, standards

Capability Statements	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4
Cap 1					
Cap 2					
Cap 3					
Cap 4					

Matrix Detail for One Capability Row

DoD DE Strategy Goal	Model-Based Capability Name	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4
Goal 1. Use of Models	Model Management	Model management is ad hoc	Model management is an assigned role	Model management adheres to a standard or to a defined approach	Model management is applied to all models for a system.	Model management is applied to all models for an enterprise.



Capability Description
Model management establishes policy to manage model development, model configuration management, model collection activities, model valuation, acquisition and strategic model loans, and for ensuring the proper application

Model-Based Capabilities Matrix CONOPS

Per the User's Guide

Identify the Enterprise, Program, or System Transformation Objectives

- Pre-work to apply the matrix

Use Matrix to identify the organization current and needed MBSE capabilities to meet the Transformation Objectives

- “Half-day workshop”

Use Matrix results to plan the MBSE capabilities needed to meet the Transformation Objectives

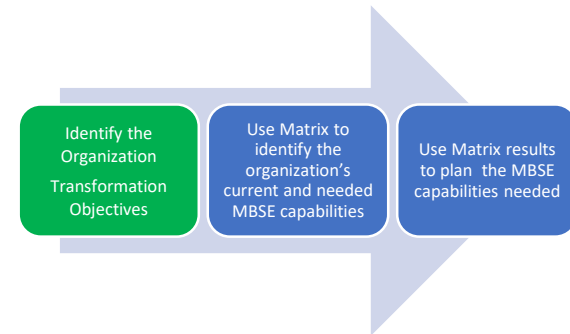
- Organization's transformation Plan
- Plan new capabilities
- Enhance processes
- Org DE compliance Plan
- SEP/SEMP
- Multi-year roadmap
- Pre-source selection Acquisition strategy
- Qualifying sources
- MBSE roles and responsibility definition

This workshop will provide sample scenarios to apply the matrix

Sample Enterprise Transformational Objectives

Government Organization

- Enhance enterprise resilience
- Enhance enterprise technical performance
 - Technology injection
 - Re-allocation of existing assets
- Enhance enterprise sustainment
- Enhance enterprise flexibility to use assets for new missions or changing mission priorities
- Move to an intelligent enterprise
 - Reducing manpower or level of expertise

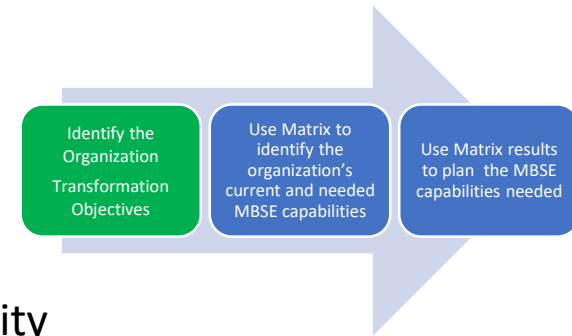


Making more-with-less, more-with-existing, more-with-more, or preserving what is possible under stressors

Sample Enterprise/Business Unit Transformational Objectives

Commercial Organization

- Enhance consolidation of product lines or products
- Extend the product line or products through new features
- Extend the installed products through new features
- Examine/ensure product line backward or forward compatibility
- Enhance maintenance, service, and repair through standardization
- Minimize maintenance, service, and repair facilities, personnel, or training
- Examine if the products may be used in ways not originally intended

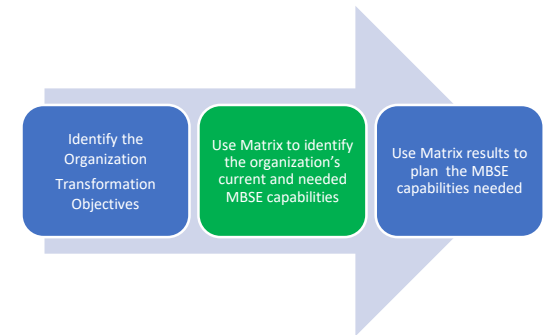


Transforming the organization to make better business decisions

Example of Matrix Assessment

Green = attribute capability is operational,

Yellow = attribute capability in active development

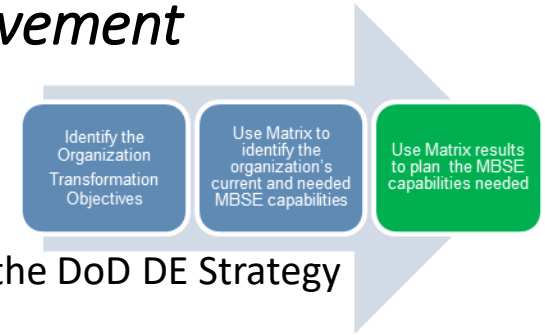


Role Based Matrix Area	DoD DE Strategy Goal	Model-Based Capability Name and Stages	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4
5. Information Technology Infrastructure	Goal 4. Establish Environments	Collaboration cap	Collaboration by business tool applications (e.g., E-mail, telecom.)	System Model File Exchange is identified and used..	Various organizations working on different parts of model. Models are integrated by a single organizations.	On-line, real-time collaboration amongst distributed project/program teams	On-line, real-time collaboration amongst distributed teams for am enterprise
6. Modeling Tool Construction	Goal 1. Use of Models	Distributed Database/Tool interoperability	No interoperability between model based tools	Model Based Tool-to-Tool has ad hoc interoperability	Partial Federated Database Management System (FDBMS)	Main tools interoperable. Supporting tools interact through file transfer.	Fully Federated w/ standard "plug-and-play" interfaces. Data is interchanged among tools
6. Modeling Tool Construction	Goal 1. Use of Models	Inter-Database/Tool Data Item Associations	Databases/tools are independent	Inter-Database/Tool Data Item associations defined	Inter-Database/Tool Data Item associations defined, captured, managed	Inter-Database/Tool Data Item associations among all data items defined, captured, managed, and traceable	Inter-Database/Tool Data Item associations among all data items defined, captured, managed, and traceable where changes in one data source alerts owners of other data sources of intended updates
6. Modeling Tool Construction	Goal 1. Use of Models	User Interface (UI), Viewpoint/Views, and visualization	Model are not used to identify or define the user interface or view/viewpoints	Models allow document generation, generation of views/viewpoints	Models allow document generation, generation of views/viewpoints and custom visualization	UI supports Interrogation across the federated systems Authoritative source of truth and provides visualizations for decision making	UI supports Interrogation across the federated enterprise Authoritative source of truth and provides visualizations for decision making

Use any scoring method that your team agrees-to

Instead of color coding an "X" and "Check" could be used

Use Assessment Results to Plan Capabilities Improvement



- Organizational transformation strategy
 - Matrix DE view easily identifies organizational capabilities against the DoD DE Strategy
- Organizational model-based capability development roadmap
 - Community of interest roadmaps
- Acquisition strategy – define modeling capabilities of the acquirer and the needed capabilities of the supplier
 - Qualify potential bidders
 - Drive the RFP development and communication between acquirer/potential bidders
- Product development planning
- System engineering plans (SEP), system engineering management (SEMP) plans
- Modeling and information technology roadmaps to provide the modeling environments and tools for the digital engineering enterprise
- Identifies key roles and needed capabilities; PM, SE, IT, Modeler, Contracts
- Enhance processes with modeling capability
- Enhance workforce development to adopt and use modeling

Running the Workshop for a Sponsor

- Provide an overview brief to the sponsor and key advisors/stakeholder to
 - Identifies what the matrix is, how it can be useful, how long it takes (4 hours), and resource commitment
 - Agree on the output product; an assessment used to begin planning
 - Identify key people; PM, SE, IT, Modeler, Contracts, Training, etc..
- Develop a short project plan
 - Tasks, timeline, stakeholders, and have it signed off by the sponsor
- Identify/develop a customer scenarios (e.g., enterprise, program – new or existing) and identify their overall enterprise or program objectives
 - Create the objectives if they aren't available
- A-priori matrix tailoring
 - Use customer language if needed
 - Emphasize the right capability rows; tailor-out or create new row
 - Agree on scoring method and being generous (benefit of the doubt)
- Run the assessment in a half day
 - Using the enterprise or program objectives as a basis, review the row and stage for current capabilities and those needed to meet customer objectives.
 - Group the gaps and begin development of an organizational development plan. It could be a multi-year roadmap.

Model-Based Capability Matrix Workshop NDIA Session 22261

Thursday 11/24 Agenda 8-10am

10 minutes Welcome and self-Introductions, sign-in sheet

20 minutes Overview of the effort, matrix and it's user's guide

- Matrix and Users Guide purpose, history and their development plan

60 minutes Working session – apply the matrix against a scenario

- Two scenarios to choose from:
 - Gov't Satellite Acquisition
 - Commercial product added to an existing product line
- Instructions for attendees
- Split into groups of 4-6
- Apply the matrix
- Record findings

2 Hour workshop to gain familiarity

4 hours to get through a complete first pass

30 minutes Workshop out briefs

Gain experience on applying the Matrix and User's Guide

***Challenge Team
Matrix effort products
and download location***

Challenge Team Responsibilities

- Be willing to
 - Join and access the INCOSE Connect “working group” information folder (instructions follow)
 - Participate in the Skype meeting roughly once every three months
 - Be notified of new releases and upcoming workshops
 - Provide feedback to the co-leads on refinements and application
 - Potentially be the organization champion for you organization
 - Potentially use the planned upcoming web-based assessment tool and use associated benchmark data

INCOSE MBCM Products and Status

Available on INCOSE Connect


- Model-Based Capabilities Matrix (MBCM) version 2.0b r4
 - Two views; Role-based view, and OSD Digital Engineering Strategy goal view
 - Same capabilities allocated differently for the 2 views
 - Prints on 3 pages of 11"X17" paper
- User's Guide version 5.2d1 – **new!**
 - Word doc
 - Frequently Asked Questions (FAQs) – **new!**
 - Useful for newcomers or to explain the effort to potential sponsors
- Workshop charts so you as a champion can run a workshop

- To access products
 - Need to be an INCOSE member
 - INCOSE Login and add "Challenge Team" on your profile page
 - Clear Browser cache to ensure new web pages are loaded
 - Log out, then back in
 - Go to Connect, Working Groups, Challenge Team

Challenge Team site location

INCOSE.org INCOSE CONNECT INCOSE Store

BROWSE PAGE PUBLISH

 Working Group Sites

Connect Events ▾ Library ▾ Programs & Projects Chapters **Working Groups** Organization ▾ Help ▾ IT Issue Tracking

Site Contents

Connect > Working Groups > Working Group Sites

Working Groups will display the full listing of each WG and everyone will have Read Only capability within each WG. Only the

Working Group Sites

- [Affordability](#)
- [Agile Systems & SE](#)
- [Anti-Terrorism International](#)
- [Architecture](#)
- [Automotive](#)
- [Autonomous Systems Test & Evaluation \(Retired\)](#)
- [Challenge Team](#)

Thank You