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Model-Based Capabilities Matrix

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Model-Based Capability Matrix Workshop

Agenda

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

30 minutes Workshop out briefs

Gain experience on applying the Matrix and User's Guide

Model-Based Capability Matrix

Challenge Team Effort

- 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 139 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
- Model-Based Capabilities Matrix (MBCM) INCOSE Challenge Team Technical Project Plan (TPP) version 2.2
  - Approved
- 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 (population of products is TBD)

Products and Status

- 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 instead of PPTX charts used for UG versions 1-4
  - Frequently Asked Questions (FAQs) – new!
    - Useful for newcomers

- Potential products
  - Template workshop charts so you as a champion can run a workshop
  - Introductory video

- What other products would be useful to you?

Overview of the Matrix and Concept of Operations

Matrix Structure

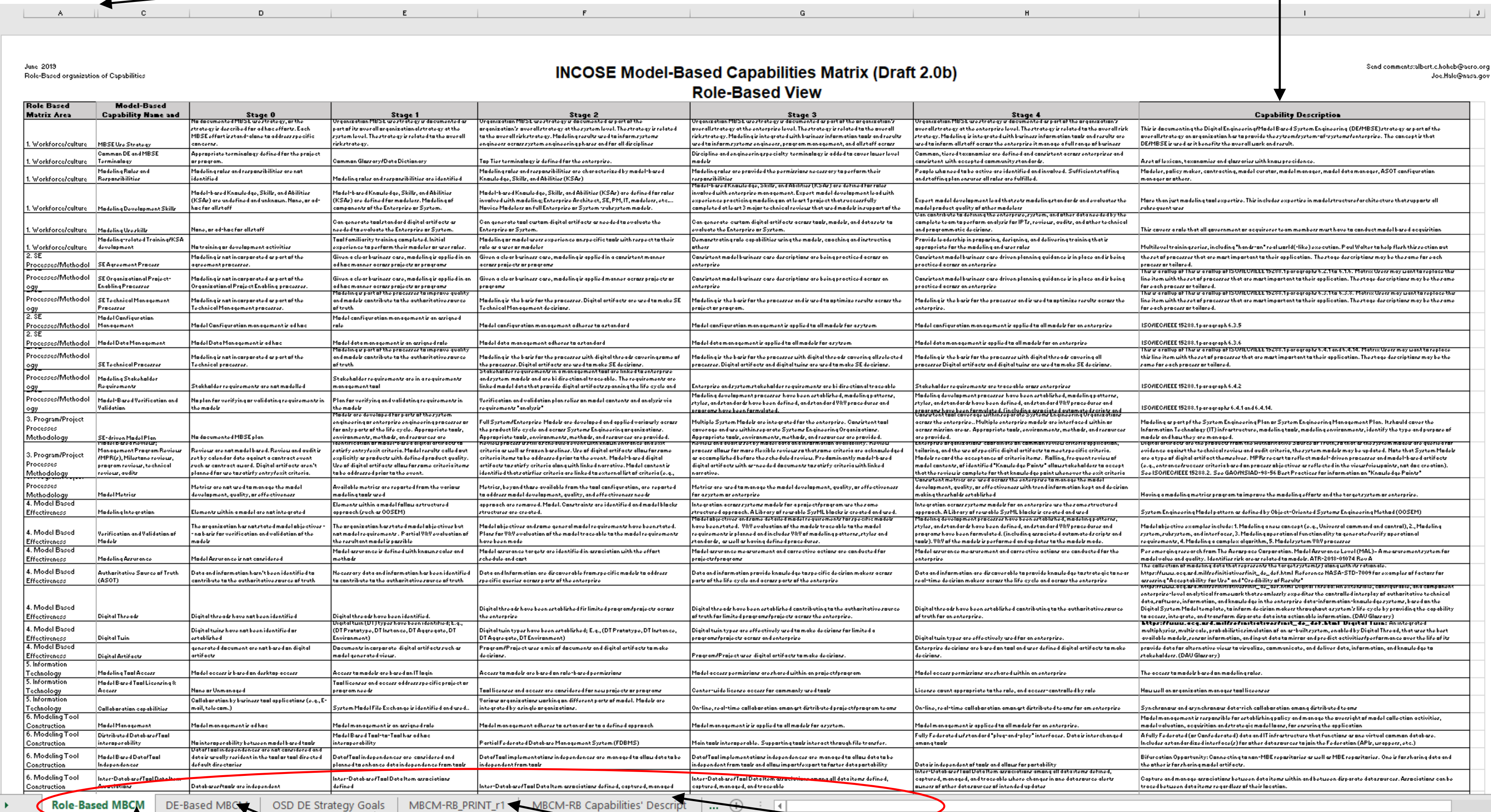
- Rows: Organization modeling capabilities for an organization
  - Role-Based view or Digital Engineering (DE) goal view – same capabilities
  - Each view has the capabilities sorted by the role-based or DE goal key field
- Columns: Increasing Stages of Capability generally defined as:
  - Stage 0: No 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

Capabilities	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4
Cap 1					
Cap 2					
Cap 3					
Cap 4					

Snapshot of Matrix – Role Based View

Column B "DE Goals" is hidden

Capability Descriptions have been added



"Role-Based capabilities definition handout"

"Role-Based View"

Example "Role-Based Print Layout"

"DE Goals-Based View"

"DE Goals and Focus Areas"

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"

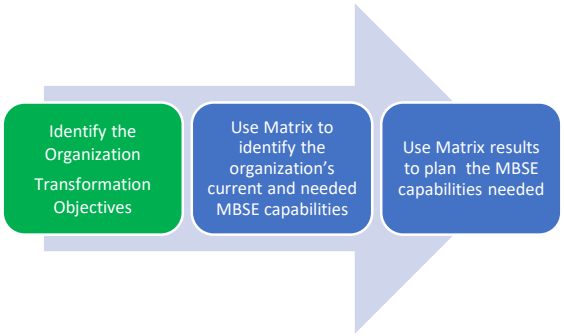
Use Matrix results to plan the MBSE capabilities needed to meet the Transformation Objectives

- 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



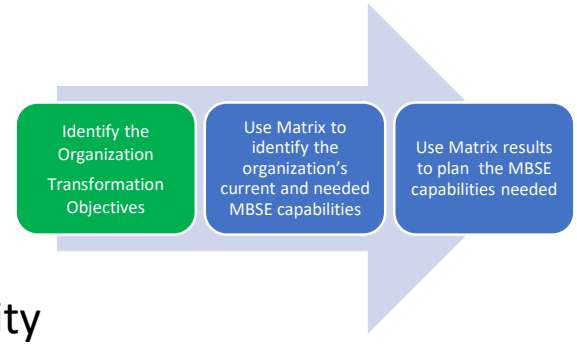
- Enhance enterprise resilience
- Enhance enterprise technical performance
  - Technology injection
  - Re-allocation of existing assets
- Enhance enterprise sustainment
- Enhance enterprise flexibility to use assets for new missions or changing mission priorities
- Move to an intelligent enterprise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

New!



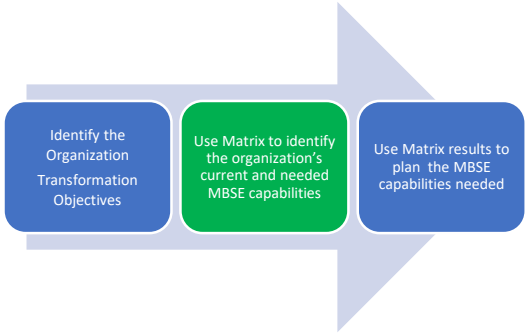
- Enhance consolidation of product lines or products
- Extend the product line or products through new features
- Extend the installed products through new features
- Examine/ensure product line backward or forward compatibility
- Enhance maintenance, service, and repair through standardization
- Minimize 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

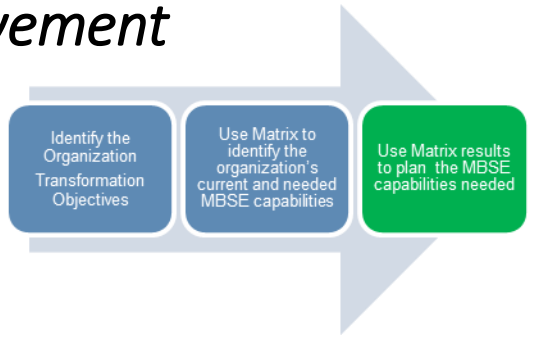


Role Based Matrix Area	DoD DE Strategy Goal	Model-Based Capability Name and Stages	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4
5. Information Technology Infastructure	Goal 4. Establish Environments	Collaboration cap	Collaboration by business tool applications (e.g., E-mail, telecom.)	System Model File Exchange 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
- 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
- Enhance processes with modeling capability
- Enhance workforce development to adopt and use modeling

Using the MBCM: Acceptance and Levels of Support

5 Stages of Acceptance Model

Kubler-Ross Grief and Loss Stages	MBCM Acceptance Stages*
Denial	Listen
Anger	Believe
Bargaining	Plan and accommodate
Depression	Conduct the plan
Acceptance	Assess and Plan

*From Al Hoheb, The Aerospace Corporation

5 Levels of Support Model

Level of Support	Behavior
Maximum	"I'll lead it" "Find a way to get it done" "Here's the Money"
Proactive	"I'll help and implement it" "Go the extra mile"
Moderate	"I'll look for things to support this"
Minimal	"I'll do what is necessary" "Do what I'm told"
None	"Go through the motions" "Wait and see" "Refuse"

Requires loss of "old ways" with a potential for grief with various levels of support

Matrix Effort History

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
- July 2019 INCOSE IS **workshop** -- FAQs
- Sept 2019 INCOSE Western Region - presentation
- Oct 2019 NDIA SE ME Conference presentation and **workshop**
- Jan 2020 INCOSE IW presentation and **workshop**
- TBD Draft INCOSE document approval submittal

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

Pilot Uses

- Government Organizations that have reported applying the work
  - MDA
  - GBSD
  - AF/SMC
  - AF ASE
  - NRO
  - NAVAIR
  - USA
  - MDA
- All have tailored the matrix to suit their needs
- Getting feedback on results is desired

Workshop Activity

Choose to participate in either scenario

Workshop Scenario 1 and Instructions

Government/Industry: Split into teams of 4-6

- Scenario: You are the Program/Project Manager or Lead System Engineer on an existing satellite program within a portfolio of satellite programs that is acquiring a new satellite to add to the fleet. The satellite needs to be procured quickly and needs to be of the same or greater performance.
- Instructions:
  - Determine the driving objectives (see next page) – select, tailor, add objectives if needed
  - From the objectives, review the matrix rows and identify the needed stage to accomplish the objectives.
  - Recommend your team identify
    - A lead moderator and a recorder
    - Scoring method (check the cell, color the cell, weight the cell, use the stage number)
    - how to capture results (e.g., bullets, chart, etc..) to outbrief
  - Prepare for discussion
    - What was the approach used to map Scenario Objectives-to-Capability Rows?
    - What results did you get? Where they useful?
    - What additional preparation would you have liked if you were doing this on your program?
    - What difficulties did you have? What results were surprising?

Scenario 1: Candidate Driving Objectives

A satellite program portfolio acquiring a new satellite to the fleet

1. Minimize enterprise or system configurations
2. Minimize requirement-design errors to meet cost/schedule goals and field capabilities quicker.
3. Minimize development time to get to production by replacing paper-based SE reviews and audits.
4. Ensure the enterprise or system meets strict surety, safety, security, or effectiveness requirements.
5. Minimize verification and validation effort and “test” time.
6. Create the Authoritative Source of Truth (ASOT) data, information, knowledge, wisdom needed to either re-compete work or product development.
7. Utilize standardization and common interfaces across the enterprise to enhance its open nature, enable alternate solutions, minimize development and enhance manufacturing flexibility.
8. Enhance servicing and management of fielded capabilities.
9. Assess existing fielded systems to plan service life extensions.
10. Optimize acquisition, program/project management and system engineering collaboration effectiveness

Determine those that are important and supplement with others if needed

Workshop Scenario 2 and Instructions

New!

Commercial Team: Split into teams of 4-6

- Scenario: You are the Program/Project Manager or Lead System Engineer on an existing product line that would like to add a new product. The product needs to be developed quickly to bring new features to market.
- Instructions:
  - Determine the driving objectives (see next page) – select, tailor, add objectives if needed
  - From the objectives, review the matrix rows and identify the needed stage to accomplish the objectives.
  - Recommend your team identify
    - A lead moderator and a recorder
    - Scoring method (check the cell, color the cell, weight the cell, use the stage number)
    - how to capture results (e.g., bullets, chart, etc..) to outbrief
  - Prepare for discussion
    - What was the approach used to map Scenario Objectives-to-Capability Rows?
    - What results did you get? Where they useful?
    - What additional preparation would you have liked if you were doing this on your program?
    - What difficulties did you have? What results were surprising?

Scenario 2 Candidate Driving Objectives

New product in a product line with new features

New!

1. Minimize product line components and configurations
2. Minimize requirement-design errors to meet time-to-market goals
3. Minimizing development time to get to production via paperless review activity and acceptance
4. Ensure the product meets strict government regulations for safety and meets trade group certifications (e.g., “Underwriters Laboratory” to be consumer safe)
5. Minimize test time to meet time-to-market goals.
6. Create the Authoritative Source of Truth (ASOT) data, information, knowledge, wisdom needed to outsource to various suppliers.
7. Enhanced standardization and common interfaces across the produce line enable alternate suppliers, minimize development and integration while enhancing the ability to manufacture the product.
8. Enhance ease of service and repair of products in-use.
9. Determine if enhancements or service life extensions by examining all the collection of associated engineering and service data
10. Optimize processes efficiencies across the product life

Determine those that are important and supplement with others if needed

Workshop Out Briefs

Workshop Participation Wrap-Up and Feedback

- Ideas for running the workshop for a sponsor
- If you'd like to be added to the Challenge Team mailing list, please let us know
- What else would you need in order to bring this to your organization, become the motivational champion, and use it?
- Send us ideas and comments!
  - Albert.c.hoheb@aero.org
  - Joe.Hale@Nasa.gov

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.

Thank You

Your participation and other participation like this has made this all possible

Sample Modeling Objectives

1. Modeling use cases for CONOPs validation
2. Modeling operational functionality to generate/verify operational requirements
3. Modeling System Architecture for function allocation
4. Modeling a new concept (e.g., Universal command and control)
5. Modeling enterprise, system and subsystem performance
    1. Ensure requirements traceability
    2. Assess design maturity
    3. Assess integration
6. Modeling specialty engineering threads to verify performance
    1. Reliability, security features, safety, surety, or effectiveness
7. Modeling interfaces
8. Modeling a complex algorithm
9. Model for manufacturing
10. Model system V&V processes to verify by analysis
11. Model test and/or maintenance suite compatibility
12. Model the baseline for alternative sourcing