OBJECT MANAGEMENT GROUP®

Model-Based Systems Engineering (MBSE) Acquisition Reference Model (ARM)

Lowering the Barrier to MBSE

Laura E Hart UAF co-chair
Yvonne Bijan

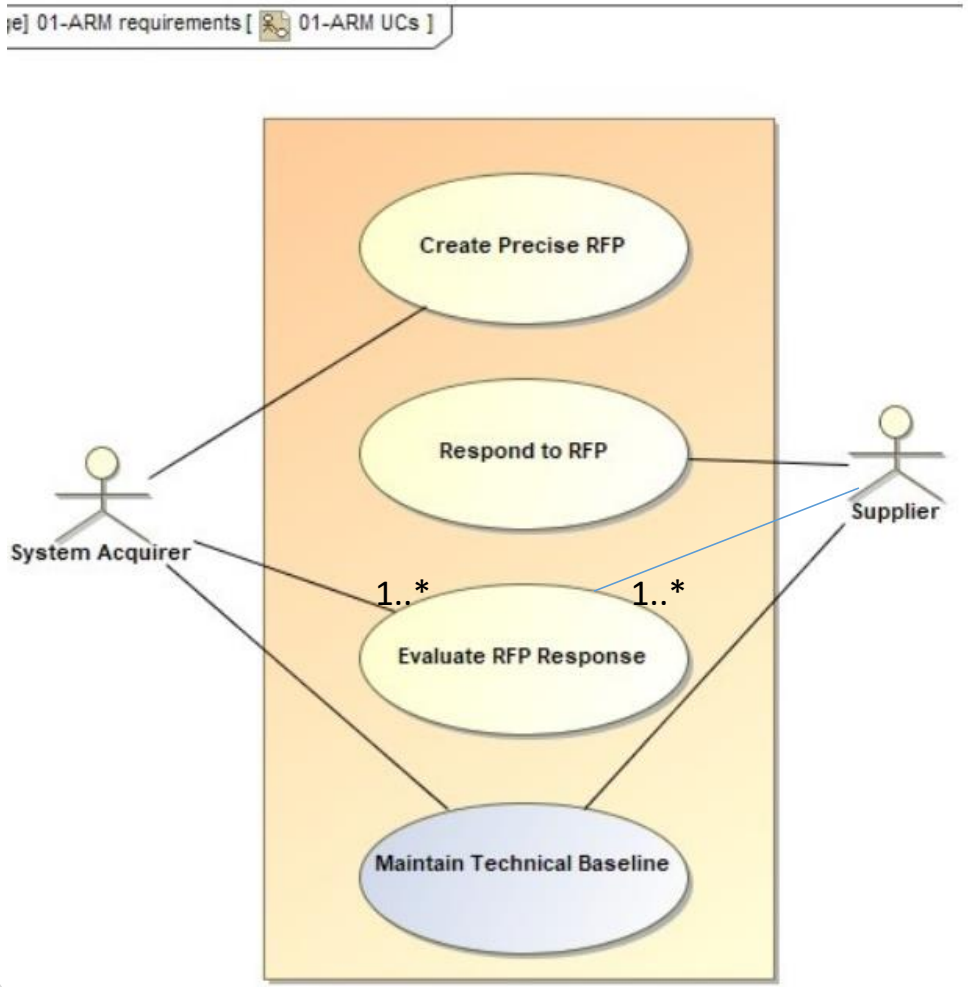
What is an ARM?

- **Provide reusable template model that supports data driven decisions**
- **ARM will used by**
  - **Gov** to communicate RFP content:
    - architectural constraints, key driving requirements, pattern for demonstrating supporting analysis
    - traceability to government operational expectation
    - pattern for bidder performance evidence
    - templates and guidance for responding
  - **Bidders** to respond to an RFP providing the rational and required evidence of analysis to support proposal
  - **Gov** to evaluate bidder response and manage project lifecycle and technical baseline
- **Maintain and use to OTB throughout program lifecycle**

© 2017 The MITRE Corporation. All rights reserved.

Use Cases

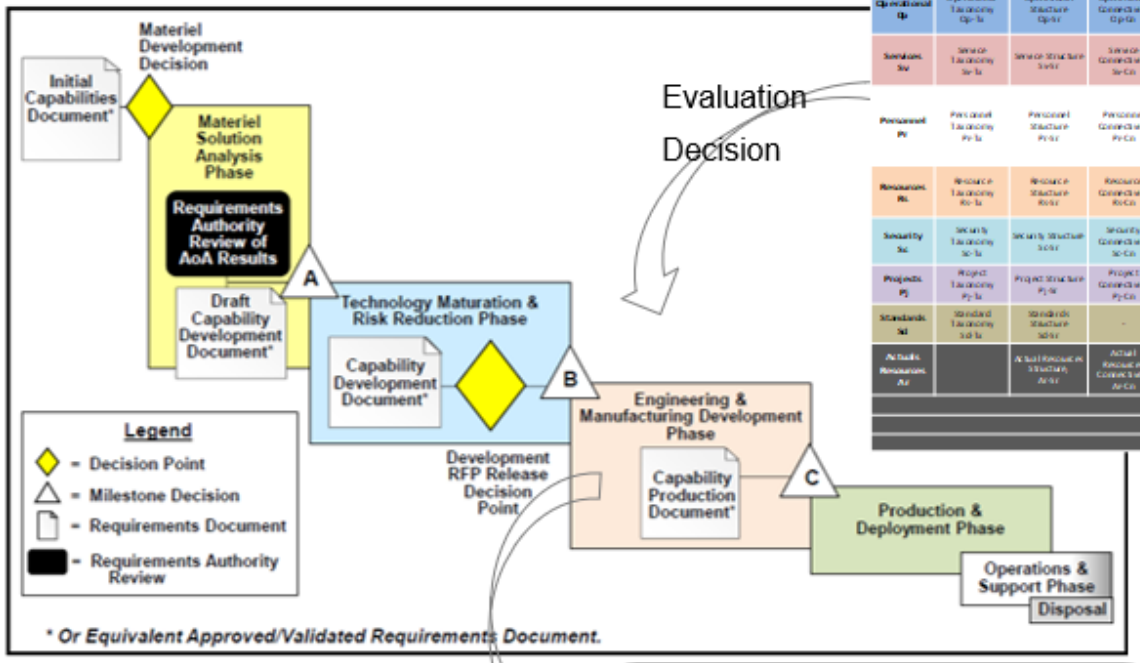
- Create Precise RFP
- Respond to RFP
- Evaluate RFP Response
- Maintain Technical Baseline



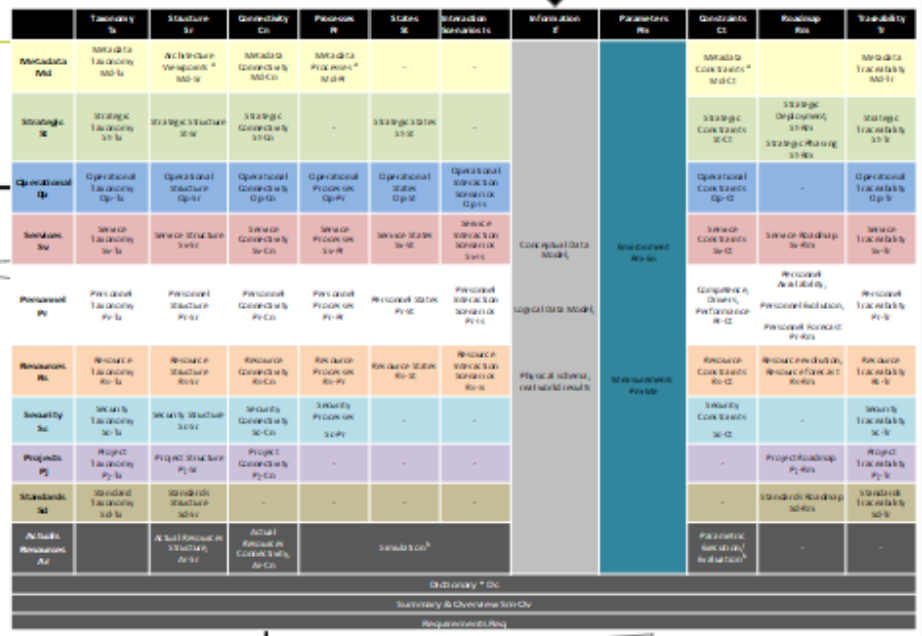
Copyright © 2018 OMG. All rights reserved.

Technical Approach

Interaction between the Capability Requirement Process and the Acquisition Process



Unified Architecture Framework (UAF)



Evaluation

Decision

Generated

RFP Package

Response with

Updated Model

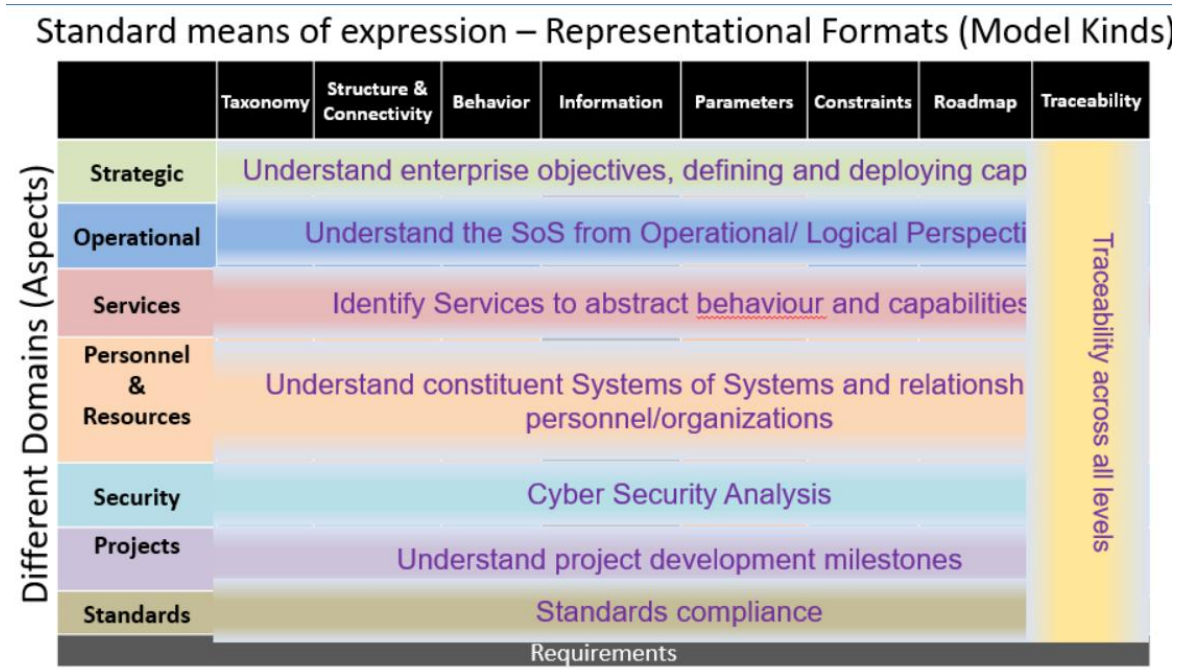
Approved for Public Release Distribution
Unlimited Case Number 17-1179 Page-5

© 2017 The MITRE Corporation. All rights reserved.

Why use Frameworks?

Frameworks such as UAF:

- Support semantic interoperability through the use of a common vocabulary enabling:
  - Portfolio and capability management
  - SoS Operational planning and Mission Engineering
- UAF is methodology-agnostic (structured, OO, etc.)
- Extends UPDM with additional architectural dimensions: Security, Personnel, Requirements, Analysis, Simulation with full cross-cutting Traceability using a common semantic vocabulary



Architecture Framework: Conventions, principles and practices for the description of architectures established within a specific domain of applications and/or community of stakeholders. ISO/IEC/IEEE 42010:2011

UAF OMG UNIFIED ARCHITECTURE FRAMEWORK	Taxonomy Tx	Structure Sr	Connectivity Cn	Processes Pr	States St	Interaction Scenarios Is	Information If	Parameters Pm	Constraints Ct	Roadmap Rm	Traceability Tr
Metadata Md	Metadata Taxonomy Md-Tx	Architecture Viewpoints [a] Md-Sr	Metadata Connectivity Md-Cn	Metadata Processes [a] Md-Pr	-	-			Metadata Constraints [a] Md-Ct		Metadata Traceability Md-Tr
----------Acquisition----------											
Strategic St	Strategic Taxonomy St-Tx	Strategic Structure St-Sr	Strategic Connectivity St-Cn	-	Strategic States St-St	-	Conceptual Data Model, Logical Data Model, Physical Data Model	Environment Pm-En Measurements Pm-Me	Strategic Constraints St-Ct	Deployment, St-Rm Strategic Phasing St-Rm	Strategic Traceability St-Tr
Operational Op	Operational Taxonomy Op-Tx	Operational Structure Op-Sr	Operational Connectivity Op-Cn	Operational Processes Op-Pr	Operational States Op-St	Operational Interaction Scenarios Op-Is			Operational Constraints Op-Ct	-	Operational Traceability Op-Tr
Services Sv	Service Taxonomy Sv-Tx	Service Structure Sv-Sr	Service Connectivity Sv-Cn	Service Processes Sv-Pr	Service States Sv-St	Service Interaction Scenarios Sv-Is			Service Constraints Sv-Ct	Service Roadmap Sv-Rm	Service Traceability Sv-Tr
Personnel Pr	Personnel Taxonomy Pr-Tx	Personnel Structure Pr-Sr	Personnel Connectivity Pr-Cn	Personnel Processes Pr-Pr	Personnel States Pr-St	Personnel Interaction Scenarios Pr-Is			Competence, Drivers, Performance Pr-Ct	Personnel Availability, Personnel Evolution, Personnel Forecast Pr-Rm	Personnel Traceability Pr-Tr
Resources Rs	Resource Taxonomy Rs-Tx	Resource Structure Rs-Sr	Resource Connectivity Rs-Cn	Resource Processes Rs-Pr	Resource States Rs-St	Resource Interaction Scenarios Rs-Is			Resource Constraints Rs-Ct	Resource evolution, Resource forecast Rs-Rm	Resource Traceability Rs-Tr
Security Sc	Security Taxonomy Sc-Tx	Security Structure Sc-Sr	Security Connectivity Sc-Cn	Security Processes Sc-Pr	-	-			Security Constraints Sc-Ct	-	Security Traceability Sc-Tr
Projects Pj	Project Taxonomy Pj-Tx	Project Structure Pj-Sr	Project Connectivity Pj-Cn	Project Processes Pj-Pr	-	-			-	Project Roadmap Pj-Rm	Project Traceability Pj-Tr
Standards Sd	Standard Taxonomy Sd-Tx	Standards Structure Sd-Sr	-	-	-	-			-	Standards Roadmap Sd-Rm	Standards Traceability Sd-Tr
Actuals Resources Ar		Actual Resources Structure, Ar-Sr	Actual Resources Connectivity, Ar-Cn	Simulation [b]					Parametric Execution/ Evaluation [b]	-	-
Dictionary * Dc											
Summary & Overview Sm-Ov											
Requirements Req											

RFP Content

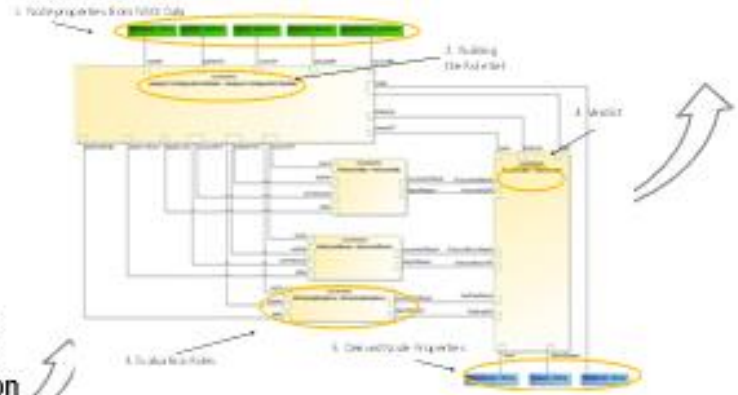
- Instructions
- Conditions

- Evaluation Factors\KPPs
  - Factor 1 Technical Approach
  - Factor 2 Cost

Provided In RFP	Provided In Proposal		Included In Contract At Award
Contract Schedule Sections A-K + Attch	→	Contract Schedule Sections B-K + Attch	→ Contract Schedule Sections B-J + Attch
Contract Schedule Section L	→	Proposal Volumes	→ Integrated Master Plan
Contract Schedule Section M		Int Master Plan Int Master Sched	
Training System Reqmts Doc (TSRD)	→	Statement Of Work	→ Statement Of Work
Statement Of Objectives			
Preliminary WBS	Expand →	Contract WBS	→ Contract WBS
Applicable Documents	Propose Additions →	Applicable Documents	→ Applicable Documents
CDRLs	Add (optional) →	CDRLs	→ CDRLs
CLINs	Propose Options →	CLINs	→ CLINs

Precise RFP with Evaluation Criteria

Support Solution Evaluation



Approved for Public Release Distribution Unlimited Case Number 17-1179 Page-25

© 2017 The MITRE Corporation. All rights reserved.

MITRE

OBJECT MANAGEMENT GROUP®

Digital Strategy Goals and Focus Areas

Strategy & Service Plans

Outlines DoD's five strategic goals for Digital Engineering initiatives

Service Implementation Plans

U.S. ARMY

U.S. AIR FORCE

Digital Engineering (DE) Vision:
Modernizes how the Department conceives, builds, tests, fields, and sustains our national defense systems.

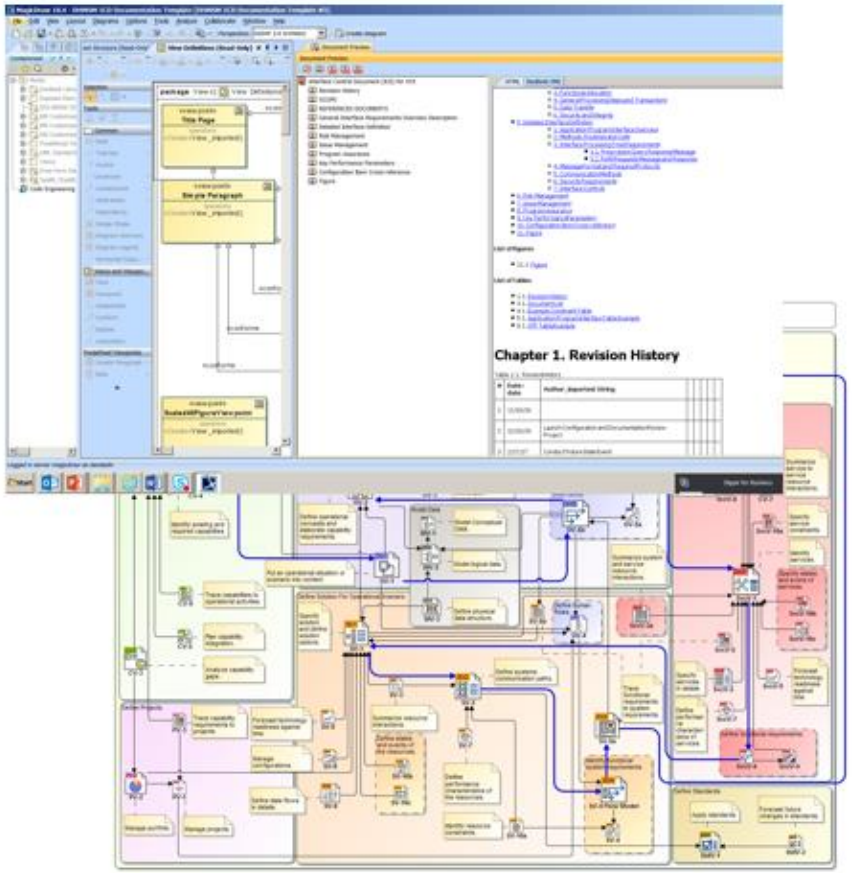
GOALS	1 Formalize the development, integration, and use of models to inform enterprise and program decision making	2 Provide an enduring, authoritative source of truth	3 Incorporate technological innovation to improve the engineering practice	4 Establish a supporting infrastructure and environments to perform activities, collaborate, and communicate across stakeholders	5 Transform the culture and workforce to adopt and support digital engineering across the lifecycle	GOALS
FOCUS AREAS	Formalize the planning for models to support engineering activities and decision making across the lifecycle	Plan and develop the authoritative source of truth	Establish an end-to-end digital engineering enterprise	Develop, mature, and use digital engineering IT infrastructures	Improve the digital engineering knowledge base	FOCUS AREAS
	Formally develop, integrate, and curate models	Govern the authoritative source of truth	Use technological innovations to improve the digital engineering practice	Develop, mature, and use digital engineering methodologies	Lead and support digital engineering transformation efforts	
	Use models to support engineering activities and decision making across the lifecycle	Use the authoritative source of truth across the lifecycle		Secure IT infrastructure and protect intellectual property	Build and prepare the workforce	
MEANS	METHODS, PROCESSES, TOOLS, TECHNOLOGY, DATA, PEOPLE					MEANS

Source Ms. Philomena Zimmerman Office of the Under Secretary of Defense for Research and Engineering

Distribution Statement A: Approved for public release. Distribution is unlimited. DOPSR Case #18-S-2365

Document Generation from Model

- **Define Reusable document templates (CDD, AoA Plan…)**



Generate Required Documents and Reports

Approved for Public Release Distribution
Unlimited Case Number 17-1179 Page-8

© 2017 The MITRE Corporation. All rights reserved.

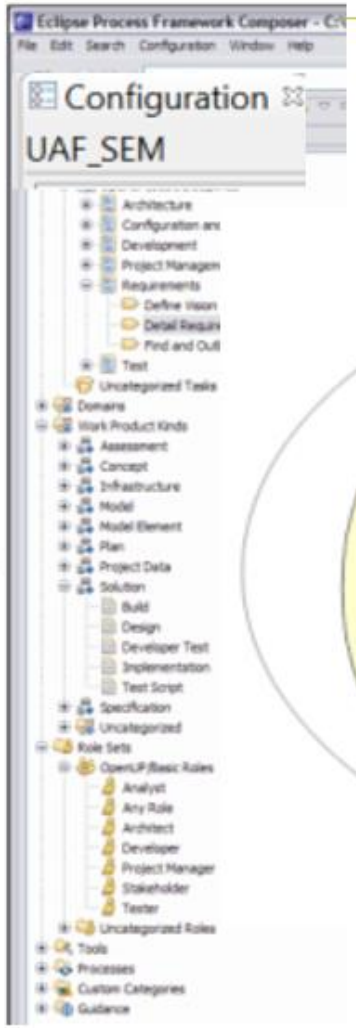
Provide Process Guidance using Eclipse Process Framework (EPF) UAF_SEM

IC / Best Practices

Books / Publications

Standards / Regulations

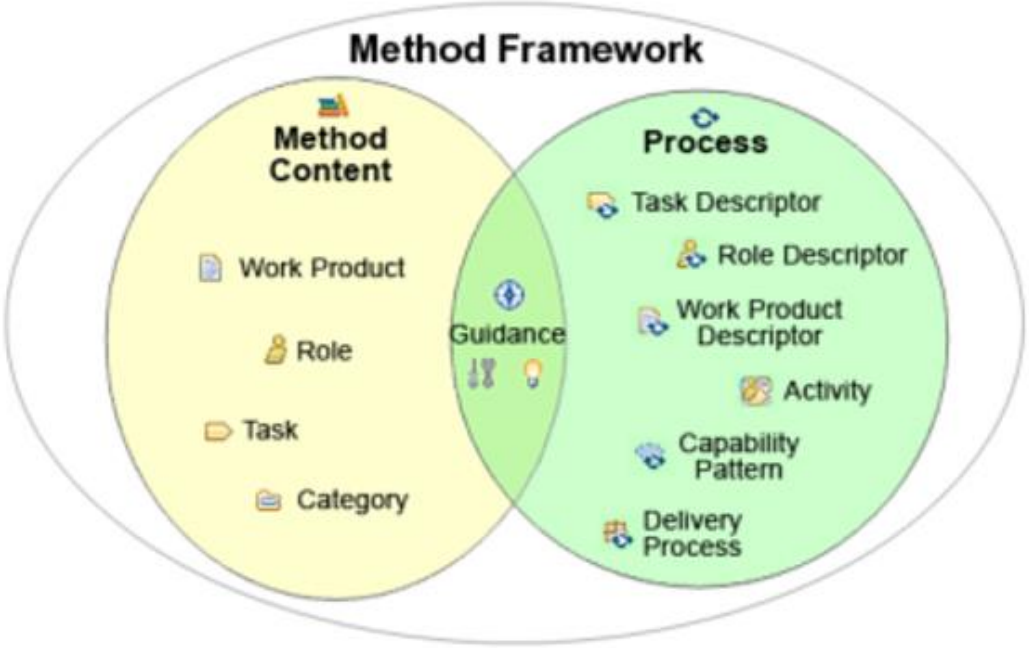
Homegrown Methods



Unified Architecture Framework (UAF)

System Engineering Method (SEM)

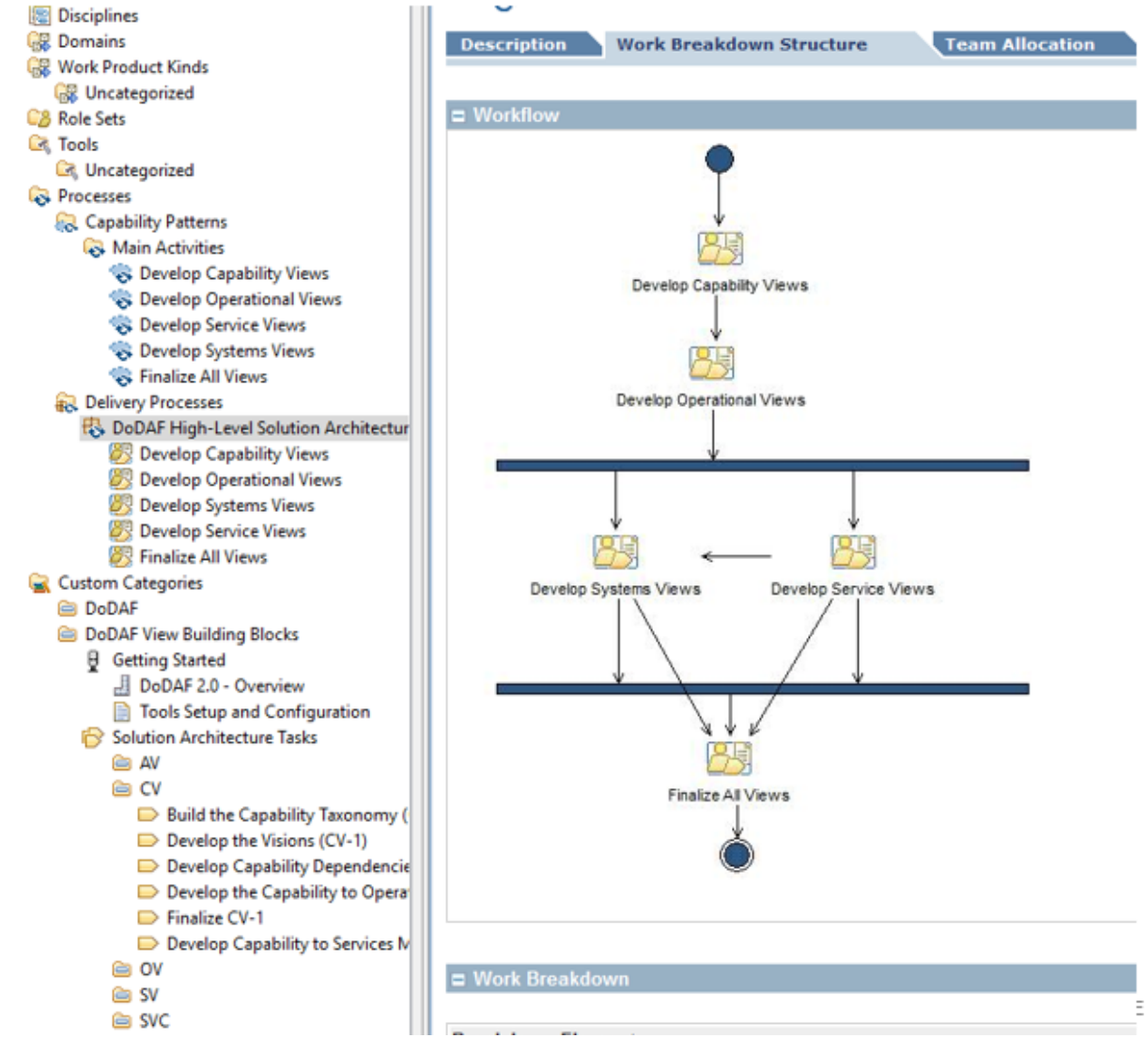
UAF_SEM



Approved for Public Release Distribution
Unlimited Case Number 17-1179 **Page-9**

© 2017 The MITRE Corporation. All rights reserved. MITRE

Processes using Task and workflow



E Corporation. All rights reserved.

Responsibility based on Roles

Role: Chief Enterprise Architect

Owner of the overall Architecture for all the DoDAF 2 views: Capability, Operational, Services, and System Views.

Role Sets: DoDAF Roles

Relationships

Primary Performs	• Develop Constraining Environment • Develop the Visions (CV-1) • Finalize CV-1 • Finalize the AV-1
Additionally Performs	• Develop Operational Rules Model (OV-6c) • Develop Service Rules Model (SvcV-10a) • Develop Standards Profile (StdV-1) • Develop Systems Rules Model (SV-10a)
Modifies	• AV-1: Overview and Summary Information • CV-1: Vision • Environment Constraints

Approved for Public Release Distribution
Unlimited Case Number 17-1179 **Page-11**

© 2017 The MITRE Corporation. All rights reserved.

Desired Outcome

Increase acquisition success, decision confidence & quality

Reduce Time, Cost & Risk

Acquisition Reference Model (ARM) that can be used as a template by the government for communicating RFP content within a consistent and repeatable process.

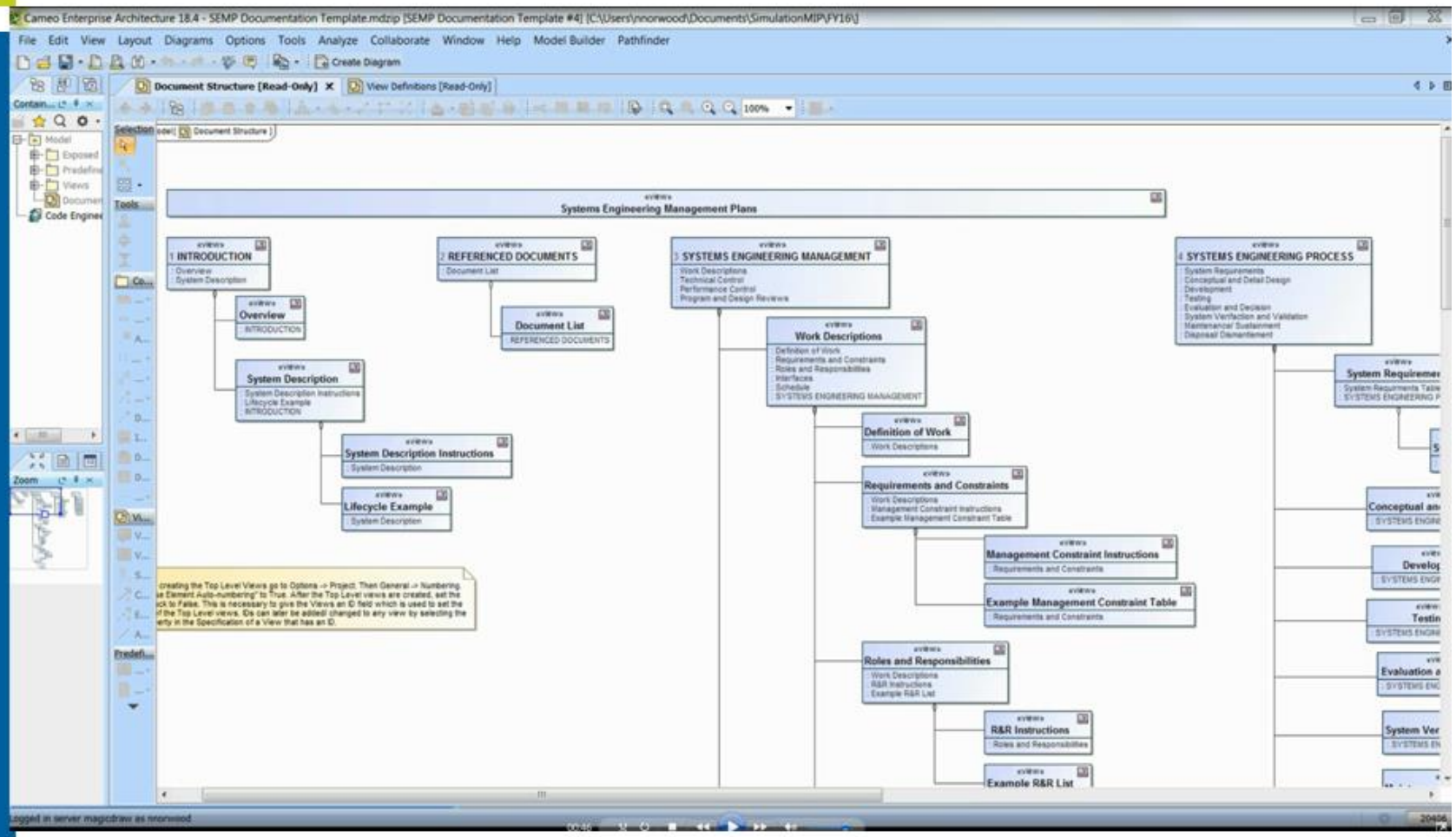
© 2017 The MITRE Corporation. All rights reserved.

Implementation Plan

1. ARM will be provided under the UAF RTF process
2. Implementation of ARM will require the following additions to UAF:
   - Additional acquisition and evaluation concepts
   - An acquisition domain (row) and associated model types (columns)
   - An example model with process guidance for using ARM

Copyright © 2018 OMG. All rights reserved.

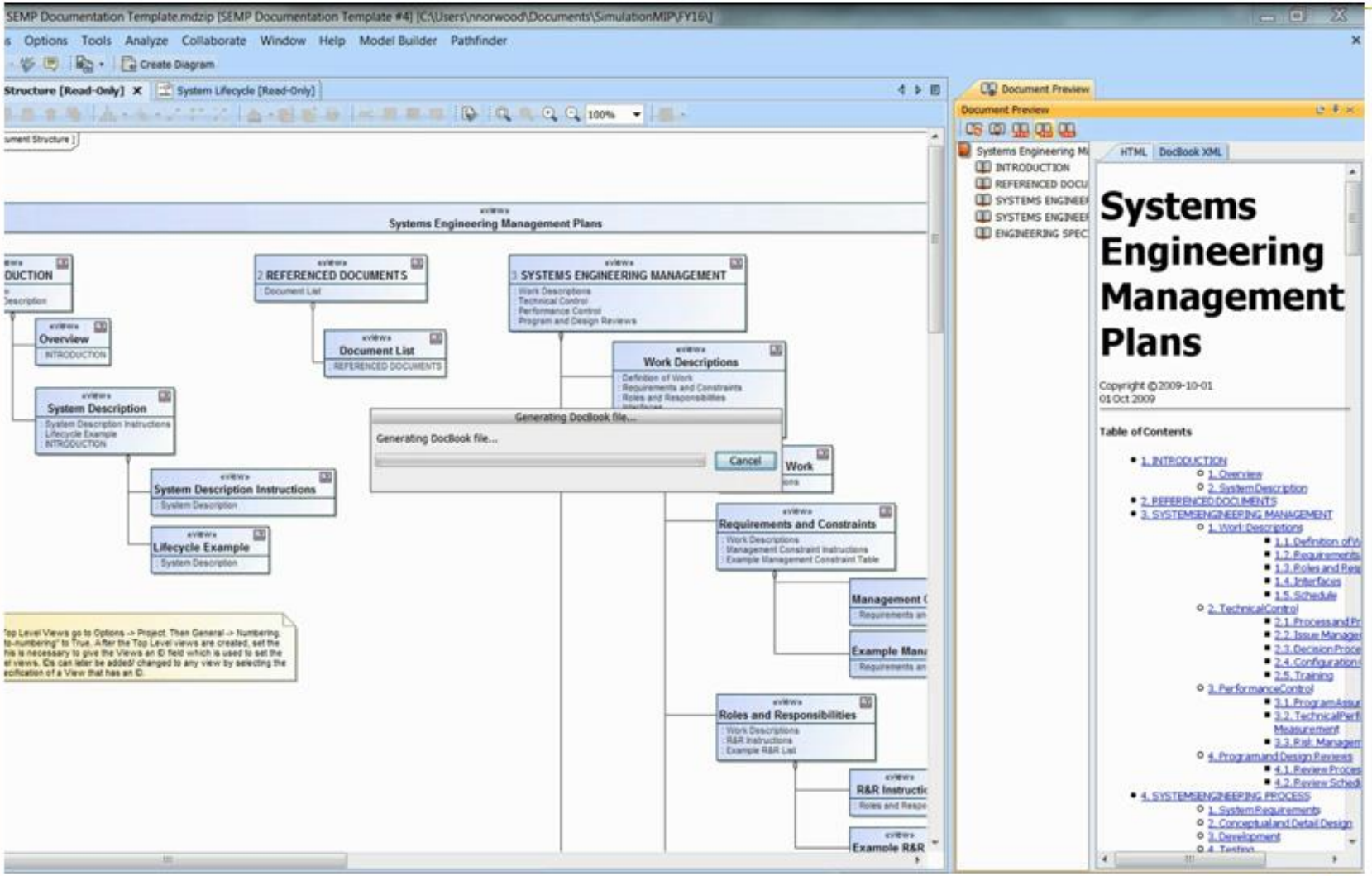
Document Generation from the Model - SEMP Template Example



Approved for Public Release Distribution
Unlimited Case Number 17-1179 **Page-14**

© 2017 The MITRE Corporation. All rights reserved.

Preview of Document



© 2017 The MITRE Corporation. All rights reserved.

Generated Document Content

Table of Contents

1. INTRODUCTION 1
    1.1. Overview 1
    1.2. System Description 1
2. REFERENCED DOCUMENTS 2
3. SYSTEMS ENGINEERING MANAGEMENT 3
    3.1. Work Descriptions 3
        3.1.1. Definition of Work .....
        3.1.2. Requirements and Constraints .....
        3.1.3. Roles and Responsibilities .....
        3.1.4. Interfaces .....
        3.1.5. Schedule .....
    3.2. Technical Control .....
        3.2.1. Process and Procedures .....
        3.2.2. Issue Management .....
        3.2.3. Decision Process .....
        3.2.4. Configuration Control .....
        3.2.5. Training .....
    3.3. Performance Control .....
        3.3.1. Program Assurance .....
        3.3.2. Technical Performance Measurement .....
        3.3.3. Risk Management .....
    3.4. Program and Design Reviews 5
        3.4.1. Review Process 5
        3.4.2. Review Schedule 5
4. SYSTEMS ENGINEERING PROCESS 6
    4.1. System Requirements 6
    4.2. Conceptual and Detail Design 6
    4.3. Development 6
    4.4. Testing 6
    4.5. Evaluation and Decision 6
    4.6. System Verifaction and Validation 6
    4.7. Maintenance/ Sustainment 6
    4.8. Disposal/ Dismantlement 6
5. ENGINEERING SPECIALTY INTEGRATION 7
    5.1. Continuous Improvement 7
    5.2. Safety 7
    5.3. Security 7
    5.4. Environment and Health 7
    5.5. Standardization 7
    5.6. Sustainability 7
    5.7. System/Cost Effectiveness 7
    5.8. Assesment 7

List of Figures

1.1. Lifecycle Example 1

List of Tables

3.1. Example Management Constraint Table 3
3.2. Schedule Example 3
3.3. KPP Table Example 5
4.1. System Requirments Table Example 6

1. INTRODUCTION

1.1. Overview

Describe the purpose and scope of the SEMP.

1.2. System Description

At a high level, describe the system to be created, to include the entire system lifecycle from concept to dismantlement/retirement.

Figure 1.1. Lifecycle Example

© 2017 The MITRE Corporation. All rights reserved.

MITRE

Evaluation Criteria are Represented as Model Elements and Graded

RFP Builder
- Instructions
- Evaluation Criteria
  - Open Evaluation Criteria Spreadsheet
  - Import Evaluation Criteria
  - Grade
- MOSA
- Deliverable
- Reports...

Self Evaluation | Government Evaluation

Criteria — Element Type: Class, EvaluationCriteria — Scope (optional): Criteria

#	Name	Documentation	Satisfied By	Weight	Evaluator Tech Score	Evalutator Weighted Tech Score	Evaluator Risk Score	Evaluator Weighted Risk Score	Evaluator Comment	Evaluator Grade
1	Technical Approach/	Top level Technical Approach criteria								
2	SE and Integration	Systems Engineering ...	Resource Connectivity	3	3	9.0	5	15.0	Great!	Strength
3	Program Execution	Program Execution documentation	Projects	2	3	6.0	2	4.0	Missing X,Y and Z	Weakness
4	OTTB		Security	1	2	2.0	5	5.0	Like X, but need to change Y	Weakness
5	PM	Project Management...	Personnel	3	2	6.0	2	6.0	Missing A, B, C	Deficiency

Filter is not applied. 6 rows are displayed in the table.

Grade Report

Grading Legend: Outstanding, Good, Marginal, Unacceptable

«EvalCriteriaGrade» SelfGrade

«EvalCriteriaGrade» EvaluatorGrade

© 2017 The MITRE Corporation. All rights reserved.

MITRE

Modular Open Systems Approach (MOSA) Evaluation

Tools Analyze Collaborate Window Help Model Builder RFP Builder

Perspective: UAF Architect | Create Diagram

_MOSA Content

Add New | Add Existing... | Delete | Remove From Table | Export | 100% | Show Columns

Criteria

Element Type: Resource Artifact | Scope (optional): Resource Taxonomy | Filter:

Name	Business - Data Rights - Openness	Technical Openness	System Criticality - Weight
Sub-System A - Alterntative	3-Unlimited Data Rights Available with no IP claims	3-Commerical or DoD Standard	3
Sub-System B	1-Proprieatary Interface / Negotiated Data Rights	2-Fully Disclosed, Well Defined	1
Sub-System C	3-Unlimited Data Rights Available with no IP claims	2-Fully Disclosed, Well Defined	1
Sub-System D	3-Unlimited Data Rights Available with no IP claims	2-Fully Disclosed, Well Defined	2
Sub-System E	2-Gov Purpose Data Rights Available	3-Commerical or DoD Standard	1

MOSA Documentation

"The Department of Defense's (DoD) modular" open systems approach (MOSA) is to design systems with highly cohesive, loosely coupled, and severable modules that can be competed separately and acquired from independent vendors. This approach allows the Department to acquire warfighting capabilities, including systems, subsystems, software components, and services, with more flexibility and competition. MOSA implies the use of modular open systems architecture, a structure in which system interfaces share common, widely accepted standards, with which conformance can be verified" - http://www.acq.osd.mil/se/initiatives/init_mosa.html

MOSA Scoring

Business (Data Rights) Openness

0- Proprietary interface/no data rights
1- Proprietary interface/negotiated data rights
2- Gov purpose data rights available
3- Unlimited data rights available with no IP claims

Technical Openness:

0 - Undisclosed Proprietary
1 – Proprietary with documented API
2 – Fully Disclosed, well defined
3 – Commercial or DoD standard

MOSA Benefits

DoD seeks five primary benefits of MOSA:

1. Enhance competition – open architecture with severable modules, allowing components to be openly competed.
2. Facilitate technology refresh – delivery of new capabilities or replacement technology without changing all components in the entire system.
3. Incorporate innovation – operational flexibility to configure and reconfigure

MOSA Grade

Selection | Tools

Technical Openness Values

Horizontal Axis

Business (Data Rights) Openness

Vertical Axis

Data Rights

Target Area

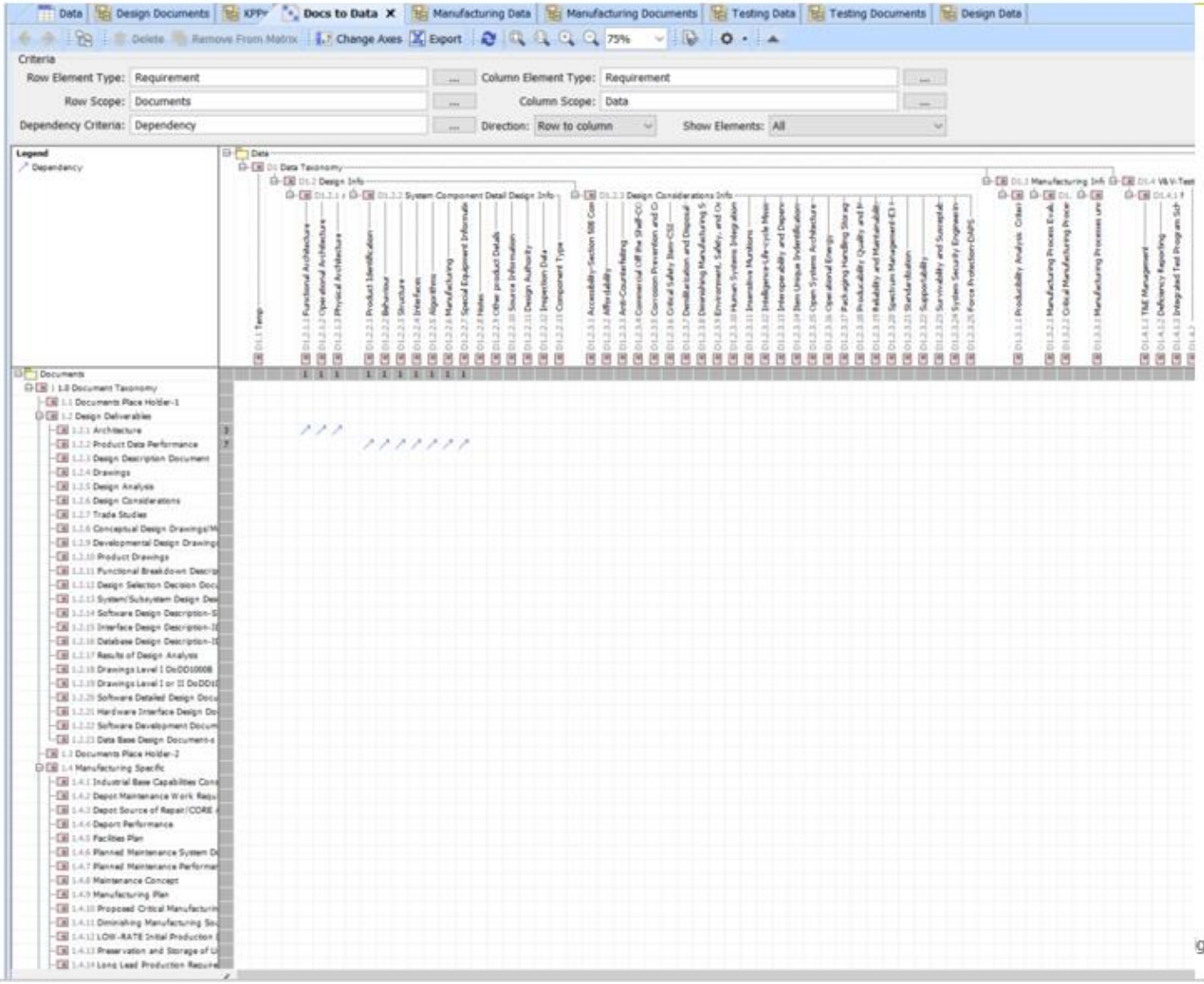
Technical

MOSAGrade
{Business Avg = 2.625,
Technical Avg = 2.5}

© 2017 The MITRE Corporation. All rights reserved.

MITRE

Lifecycle Document/Data Traceability Matrix



ights reserved.

MBSE in a Digital Environment

- Based on an integrated model repository as an authoritative source of truth
- Supports separation of concerns, modularity and reuse
- Provides foundation and context for analysis and data driven decisions
- Provides traceability and change impact across all dimensions
- Supports analysis of cross-cutting concerns with a structured approach (MOSA, OTTB, Cyber, SWAP, Certification…)
- Provides opportunity for process automation, reasoning and measuring completeness, consistency and accuracy
- Supports capability insertion and change impact to system and requirements
- Repository of institutional knowledge, decisions and rational
- Generation of consistent documentation and deliverables from the model

Copyright © 2018 OMG. All rights reserved.

Questions?

Thank You!

Copyright © 2018 OMG. All rights reserved.