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GETTING IT RIGHT

COLLABORATING FOR MISSION SUCCESS

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SYSTEMS ENGINEERING FORUM

By AL HOHEB
The Aerospace Corporation

Digital Engineering (DE) agile development and open systems form the basis for of the government's digital acquisition approach to meet emerging threats. The Aerospace Systems Engineering Forum (SEF) provides an opportunity for community members to share their DE and Model-Based Systems Engineering expertise, share their successes, note areas of improvement, and plan a way forward. Since 2016, four physical SEF working interchange multi-day events have been conducted and proceedings were archived as Aerospace technical reports. For 2021 the SEF has gone virtual with six public events that provide best practices to address key digital engineering needs. The registration site is available for the remaining 2021 events and contain an archive of presentations and associated reports *https://aerospace.org/events/sef.* The videos of presentations can be viewed on the Aerospace YouTube channel.

Delivery of virtual sessions is now serving the community in ways that face-to-face meetings couldn't. The SEF has attracted a very large pool of interested organizations and individuals that benefit from the live information and the archive information. The archive pdfs and online YouTube videos provide immediate information access.

The following topics are offered in the 2021 SEF:

February 24, 2021 Enterprise Architecture Using UAF: UAF Overview, EA Guide for UAF, and EA Process for UAF

March 16, 2021 Overview of the Model Assurance Levels (MALs) for Systems and Software Models

May 11, 2021 Model Portfolio Management (MPM) Guide

June 15, 2021 InDEPTH Overview

July 20, 2021 Designing for Principles (DfP)

September 14, 2021 Model Based Mission Assurance and Flight Worthiness (MBMA & FW)

A complete description and registration is available on our *Systems Engineering Forum website*.

For more information contact Al Hoheb, SEF Chair, albert.c.hoheb@aero.org.

HOW GOOD IS YOUR MODEL?

By JULIE S. FANT, KAREN E. MCSHANE, RONALD NUSSBAUM, ROBERT G. PETTIT, VINEET VELMURUGAN, AND TOM M. BOTTEGAL
The Aerospace Corporation

Model-based systems engineering (MBSE) in on the rise across industry and the government. Models are essential to achieving the DOD Digital Engineering (DE) vision, enabling them to be digitally linked to each other to inform technical decisions and linked to acquisition and program data to make acquisition and program decisions. The possible wide-range of MBSE-based activities requires focus to ensure that the models are built for purpose. Currently there are no standard means to express the value, depth, breadth, and quality of a MBSE model. Thus, it can be difficult for those without detailed knowledge of MBSE to understand numerous acquisition questions about a model, such as

- Are the models adding enough value and risk reduction to the program?
- Are they of high quality so I can be confident in the information they are providing?
- Are the models progressing as needed to meet their intended purpose and risk reduction?
- Are the models mature enough for the acquisition or development phase?
- How much technical depth is in my model?

To address these concerns, we developed a rating scale for models, called Model Assurance Levels (MALs). A MAL level is used to concisely express the value, depth, breath, and quality of the model, as well as risks associated with the model. MALs are based on a scale from one to three, with three being the highest to reflect increasing value and risk reduction of the model, as conceptually depicted in Figure 1. Within each MAL level there are also sublevels to show incremental growth. Each level also has a set of associated risks, which help aid in the selection of the MAL level. As Figure 1 depicts, a lower MAL level equates to a model that has less depth and breadth, reducing risk in the program. As a MAL level increases, the risk is further reduced. When applying MALs, not every program needs to achieve the highest MAL level. Instead, a MAL goal should be selected based on the amount of risk a program is willing to accept.

A quantitative and repeatable assessment approach was developed to consistently determine a MAL level regardless of who is performing the assessment. We are

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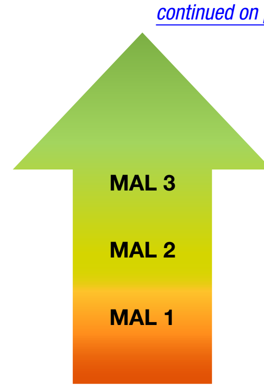

Figure 1. Conceptual MAL Scoring

MODEL-BASED MISSION ASSURANCE AND FLIGHT WORTHINESS

By HETAV PATEL
The Aerospace Corporation

Model-Based Systems Engineering (MBSE) has been successfully breaking ground in systems engineering for all aspects of an ever-increasing complex space enterprise lifecycle. Mission assurance for space systems and flight worthiness for airborne systems are no exception. Model Based Mission Assurance/Flight Worthiness (MBMA/FW) paves the way for the conduct of rigorous mission assurance in a digital engineering (DE) environment. The concept of MBMA/FW is to leverage descriptive models to conduct MA/FW tasks that are large in number, require acute specificity, and may be automated.

The Daytime Atmospheric and Ionospheric Limb Imager (DAILI) is based on a 6U CubeSat that has a two-year build time. Its primary mission is to measure the daytime thermospheric oxygen densities and ionospheric densities at high brightness conditions. This new mission required significant changes to the standard AeroCube architecture and operating systems, including AeroCube mission assurance.

The MBMA team went to work updating the AeroCube MBSE models and implemented key mission assurance processes in the systems modeling environment:

- Requirements verification and verification activity allocations throughout the design, build, and test phases of the CubeSat project

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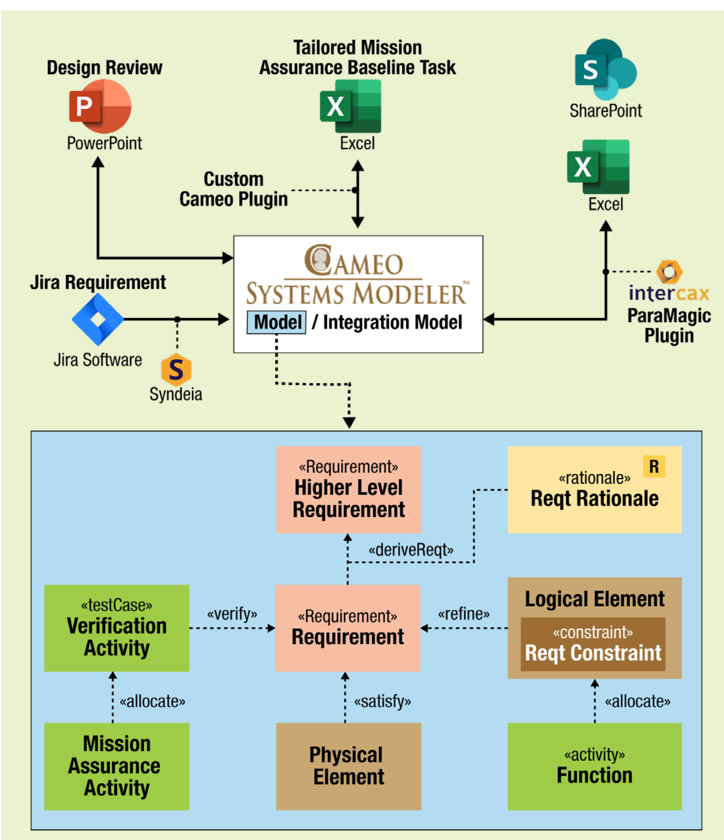
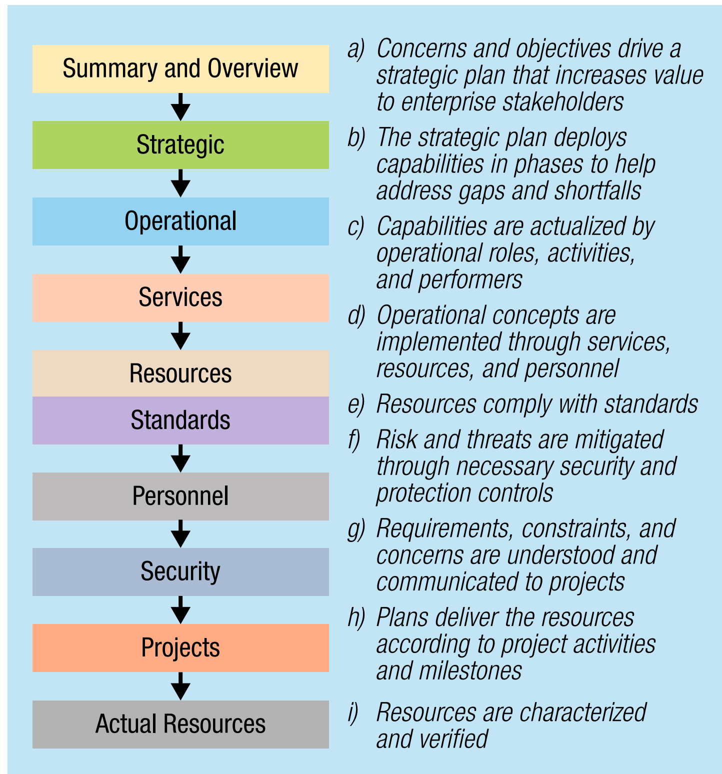


Illustration of Demonstrated Software Framework and Model Architecture on AeroCube.

UNIFIED ARCHITECTURE FRAMEWORK (UAF)

By JAMES N MARTIN
The Aerospace Corporation

The Unified Architecture Framework (UAF) published by the Object Management Group (OMG) defines a complete set of stakeholder domains as the basis for creating the variety of necessary architecture views of an enterprise, as well as the systems that make up the enterprise. These domains allow for a logical and systematic flow of architecting activities:



UAF is a successor to the DOD Architecture Framework (DODAF) and will automatically create DODAF-compliant architecture views as well as a few dozen other useful views. The UAF specification consists of three main components. The Domain Metamodel (DMM) establishes the underlying foundational modeling constructs to be used in modeling an enterprise, as well as major entities within the enterprise. View specifications provide direction to the tool vendors and to those who are creating the architecture views regarding which DMM elements are pertinent to those views. The UAF Profile (UAFP) is an implementation of the DMM that specifies how the UAF views can be modeled using SysML notation.

The UAF grid (Figure 2) has rows that represent typical stakeholder domains (or perspectives) that can be used when modeling an enterprise architecture. The grid has columns that represent the architecture aspects (in UAF these are called model kinds) that correspond to "part of an entity's character or nature (e.g. structural and behavioral aspects)". [42010 2021]. This grid is provided in the UAF standard as a structuring formalism for organizing the 71 view specifications defined within the UAF.

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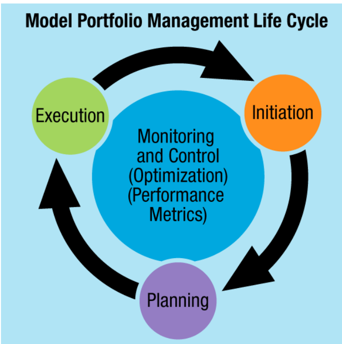
DEFEAT ENTROPY: A GUIDE TO MANAGING YOUR MODEL PORTFOLIO

By MISAK ZETILYAN
The Aerospace Corporation



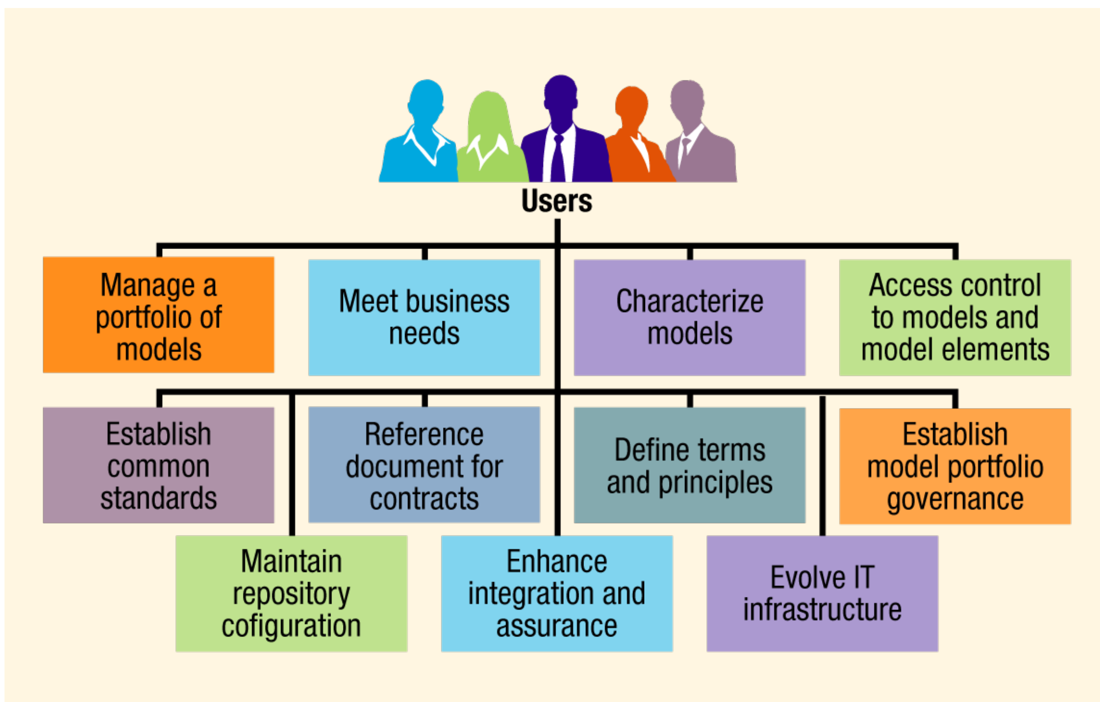
Models enable the DOD Digital Engineering (DE) strategy to support engineering activities throughout the lifecycle. Some organizations have responded by defining a DE implementation plan that addresses their own DE strategy. However, the lack of a standard or guidance that directly addresses managing a collection models has created an "ad-hoc" approach.

This lack of references, guidance, or standards inhibit model integration and model reuse. The Model Portfolio Management (MPM) guide identifies goals and tasks necessary to manage an organization's portfolio of models. It defines the actions and products to ensure that the collection of models meets organizational needs, has a planned evolution, and meets integration targets. It ensures that risks, quality objectives, and modeling best practices and standards are consistent across the portfolio.

The MPM guide is for all organizational sizes; the driving criteria for use is whether an organization has a collection of models and modeling resources to manage. The guide can help acquirers manage their model libraries, encourage reuse, and provide suppliers a reference for further model development. Acquirers may use the guide as a reference document for requests for proposals to ensure that model management is adequately addressed. Suppliers can organize and communicate their management plans to assure their customers that their model efforts are well-managed, trusted, and designed to meet acquisition objectives.

Implementation of this guide can take many forms. It may start with writing and conducting tasks according to a written organizational MPM plan. Adopting organizations may also establish MPM management tools such as stakeholder agreements, governing bodies, model repositories, or MPM reports, as a few examples. Regardless of the implementation, the guide serves to provide organizations a starting point to develop a plan of action from a compiled list of considerations. The goal is to streamline and organize the management of models across a portfolio so that models are accessible, relevant, and the full breadth of models is known.

Where to get the guide? Contact Misak Zetilyan at 310.336.6914; misak.zetilyan@aero.org.



HOW GOOD IS YOUR MODEL?

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in the process of automating the assessment process to improve the practical application of MALs.

MALs can be used on a program several different ways. First, they can be used to set goals to determine the potential model investment. The MAL scale can be used to set goals and expectations for a model early in a program. Second, MALs can be used to monitor the progress of a customer's MBE effort. The MAL score can be determined multiple times throughout the development or acquisition lifecycle to determine if the model development is on-track. Finally, MALs can be used to understand and manage risks resulting from the model—to determine if the model is suitable for use. The risks associated with a MAL level can be identified and a strategy for mitigating risks can be developed.

Published information includes:

Conference Proceedings

https://dl.acm.org/doi/abs/10.5220/0007697505420549

https://www.computer.org/csdl/proceedings-articleisor/2019/015100a069/1bzYDotzwgE

SEF Forum 2021 Charts and Presentation:

https://www.dropboxcom/sh/Inlgtixlyqo3wjh/AAd1tt8PbQg2wdPh-6QLjxrja?dl=0

https://www.youtube.comv=bfslhsehn-JM&list=PLFEXcXJhNDQ5hx9VWtkE-SCWINhxKIR9gM&index=2

For more information contact Julie Fant at julie.s.fant@aero.org.

UNIFIED ARCHITECTURE FRAMEWORK (UAF)

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To help facilitate use of the UAF, an Enterprise Architecture Guide for UAF is being developed that provides a generalized workflow to implement these architecting activities. Each step in the workflow conveys the architecture information to iteratively produce a definition of the problem space along with a definition of the solution space (i.e., implementation and instantiation). Trade-offs are identified along the way and architectural decisions are captured in the architecture views as they are fleshed out.

For more information contact James Martin at james.n.martin@aero.org.

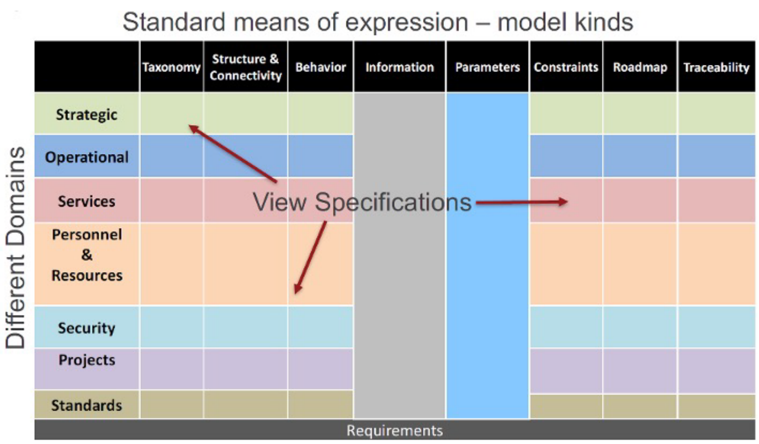

Figure 2. Unified Architecture Framework grid showing domains for enterprise and system architecture models.

RECENT GUIDANCE AND RELATED MEDIA

Supply Chain Risk Management for the USG Space Enterprise by D.C. Meshel; TOR-2020-01003; USGC

Mass Properties Control for Space Systems: Space Vehicles GAP Analysis by Y. Tam; TOR-2020-02648; USG

Learning the Right Lessons from the Space Community's Resourcing Past by R.R. Rumbaugh; TOR-2021-00492; USGC

Risk Assessment for Decision Support and Resilience in Space Systems by S.B. Guarro; ATR-2020-00733; USGC

A Framework for Trusted Artificial Intelligence by P.C. Slingerland; ATR-2020-00876; PR

Revisiting the Class Agnostic Mission Assurance Process at Aerospace by P.S. Chang, TOR-2019-02173; PR

2019 Satellite Lifetime Study by K.L. Ferrone; TOR-2019-02620; PR

A National Spaceport Strategy by R.L. Schoonmaker; TOR-2020-00912; USGC

Supply Chain Risk Management for the USG Space Enterprise by D.C. Meshel; TOR-2020-01003; USGC

Model Portfolio Management Guide by A.C. Hoheb; TOR-2020-01577; PR

PR = Approved for public release
USG = Distribution authorized to U.S. government agencies only
USGC = Approved for release to U.S. government agencies and their contractors

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MODEL-BASED MISSION ASSURANCE AND FLIGHT WORTHINESS

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- Instantiation of a software and model architecture for MBMA using Cameo Systems Modeler™, Syndeia and JIRA® (also a precursor to an enterprise mission assurance digital engineering framework)
- Modular implementation of model stereotypes for tailored risk assessment and management, as well as mitigation plan identification and responsibilities.

MBMA proved to be beneficial in identifying risks and gaps in requirement verification using enhanced descriptive models. These models can be utilized and tailored for any future AeroCube iteration.

In coordination with launch and the systems engineering teams, the MBMA team explored what it takes to update current enterprise mission assurance processes to accommodate a faster production cadence in a DE environment.

The teams conducted a pathfinder to determine scalable solutions for every launch verification activity. These solutions involve a combination of MBSE, software engineering, and engineering informatics.

The MBMA work showcased here provides a roadmap for agile digital mission assurance aimed for mission success.

For more information contact Hetav Patel at hetav.patel@aero.org.

2021 EVENTS

June 9–10 *NDIA Manufacturing Division, Virtual Meeting*

June 15 *2021 Systems Engineering Forum Virtual Series: InDEPTH Overview*

June 21-23 *Spacecraft & Launch Vehicle Dynamic Environments Workshop (SCLV)*

July 20 *2021 Systems Engineering Forum Virtual Series: DfP*

August 17 *Systems Engineering Forum Virtual Series: Model Based Mission Assurance and Flight Worthiness (MBMA & FW)*

August 18–20 *Space Warfighting Industry Forum (SWIF): Partnerships for the Future*

August 22–26 *Space Symposium 36*

September 14-17 *Advanced Maui Optical and Space Surveillance Technologies (AMOS) Conference, Maui, HI*

September 19 *2021 Systems Engineering Forum Virtual Series: Model Based Mission Assurance and Flight Worthiness (MBMA & FW)*

October 12–13 *Mission Assurance Summit, virtual meeting, by invitation only*

October 4–7 *32nd Aerospace Testing Seminar (ATS), Virtual Meeting*

October 5–7 *Satellite Innovation 2021, Mountain View, CA*

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Getting It Right is published every three months by the Corporate Chief Engineer's Office within the Office of the Executive Vice President of The Aerospace Corporation. Direct questions and comments to gettingitright@aero.org.

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