



Electronic Warfare Mission Engineering Analysis – Framework for a Reference Architecture

Joel Patton, Virginia Tech - ARC and Dr. James Moreland, Virginia Tech
University/Hume Center

Sponsor: OUSD(A&S) A/P&WPM-EW

WASHINGTON DC VIRTUAL

NOV. 2-4 2021

ANNUAL SPONSOR RESEARCH REVIEW

Problem and Work Scope

➤ Problem Statement

The acquisition process must address the accelerated operational nature of response to evolving future threats.

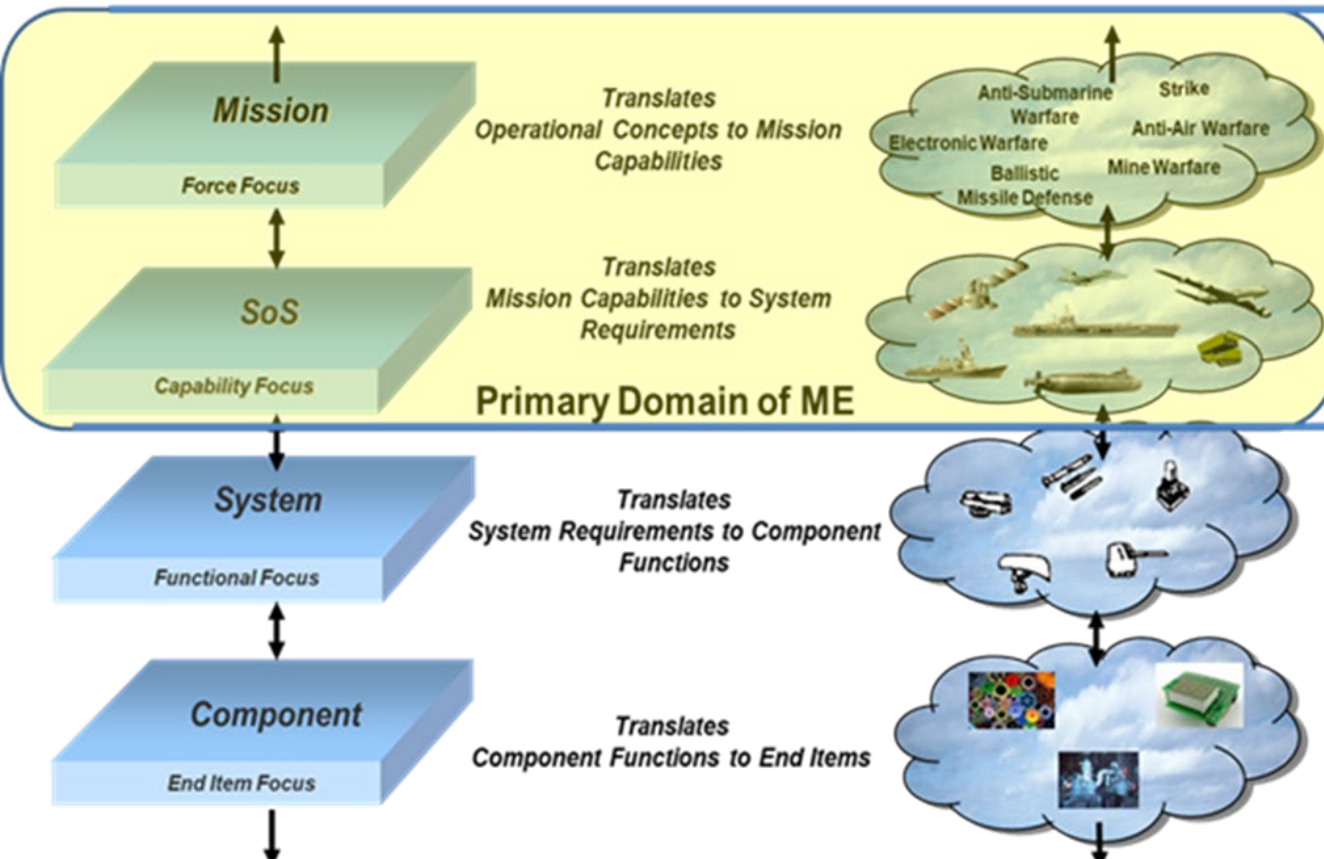
“How does the acquisition process need to be modified in response to a Mission Engineering analysis and integration approach that delivers well-engineered composable mission architectures that foster resilience, adaptability and rapid insertion of new technologies?”

Can there be a set of mission-derived metrics/measures of success/measures of performance that can support the acquisition process in deriving requirements?

Approach/Methodology

- Electronic Warfare Mission Engineering Framework – development of mission engineering methodologies specific to EV, and the general incorporation of these methodologies into the overarching DoD mission processes across other mission areas.
- Electronic Warfare Mission Engineering – validation of this mission engineering methodology leveraging existing EW effects chains, as well as existing operational mission threads developed for other warfare areas.
- Electronic Warfare Capability Analysis – using mission engineering methodology identify EW capability gaps against actual or derived EV capability effectiveness data and develop of a general reference architecture framework in support of mission engineering.
- Electronic Warfare Effects Chain Assessment – evaluate the EW mission thread assumptions and recommend modifications to Integrated Fires mission threads based on assessments.
- Portfolio Management Framework – provide recommendations for implementing a government reference architecture regarding the utilization of mission engineering for the Office of the Secretary of Defense level Integrated Fires Capability Portfolio Management.

Mission / System Alignment through Architectures and Defined by Measures of Success/Performance



Measures of Operational Success

Campaign

Effects/Kill Web

Measures of Success

Individual Mission

Effects/Kill Chain Mission Thread

Measures of Effectiveness

Tasks/Subtasks

Measures of Performance

System/Platform Elements

System Performance

Component/Subsystems

Mission Engineering Approach builds framework for Technical Trade-off Studies in Support of the Operational Mission

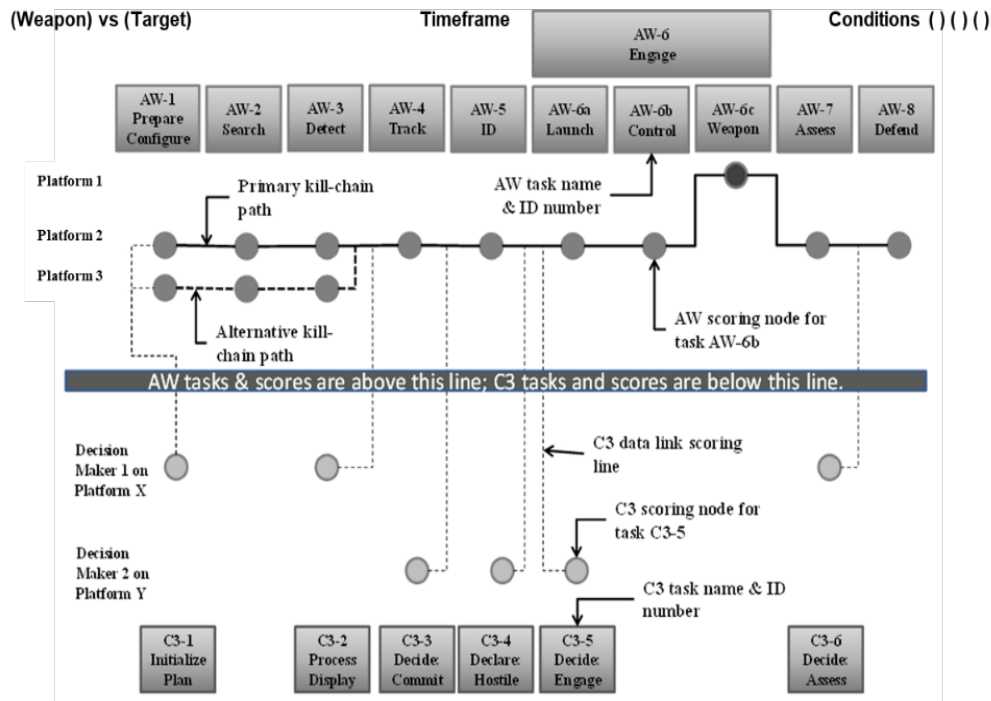
Relationship of Kinetic and Non-Kinetic Mission Threads – An Integrated Fires Approach



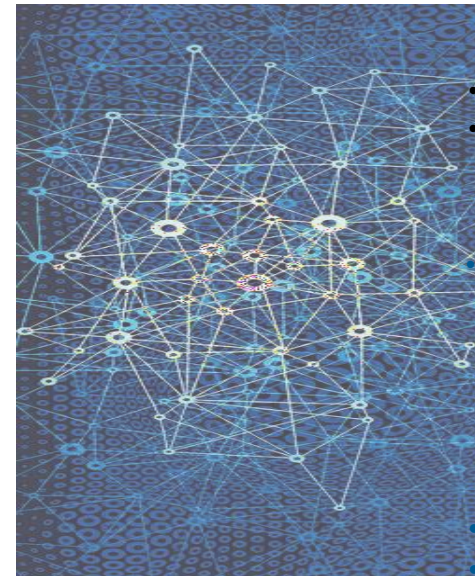
The level of complexity and dependences of one mission success on another is readily apparent. Each mission is executed independently while still coordinated as part of the overall mission.

Integrated Fires Mission Thread

mission thread illustrating each essential task for effects/kill-chain



mission thread illustrating each essential task for kill-chain (F2T2 EA)

[illegible]

Mission Web

Multiple Mission Threads compose Mission Web Temporal Interdependencies

- Actions can have delayed consequences
- Actions can have repeated consequences

Feedback loops

- Feedbacks on the different levels
- Feedbacks between the different layers
 - From upper layers to lower layers
 - From lower layers to upper layers
 - Feedback is not limited to neighbored layers

Nonlinear relationships

Dynamic re-composition to address real-time thread

Government Reference Architecture (GRA) Definition

- The ISO Standard defines the term in this way:

“An Architecture Framework: conventions, principles and practices for the description of architectures established within a specific domain of application and/or community of stakeholders ”

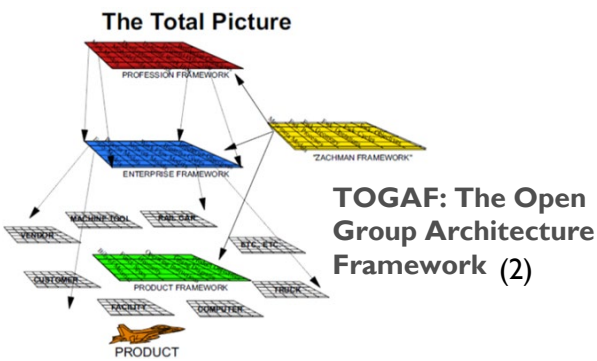
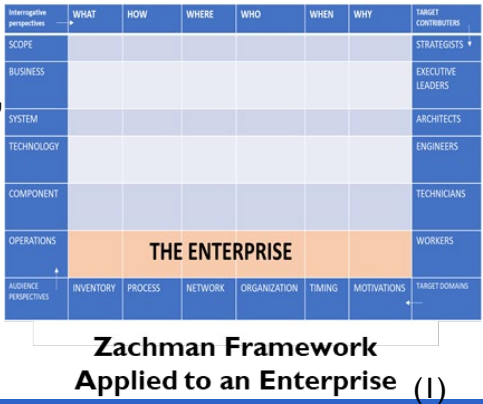
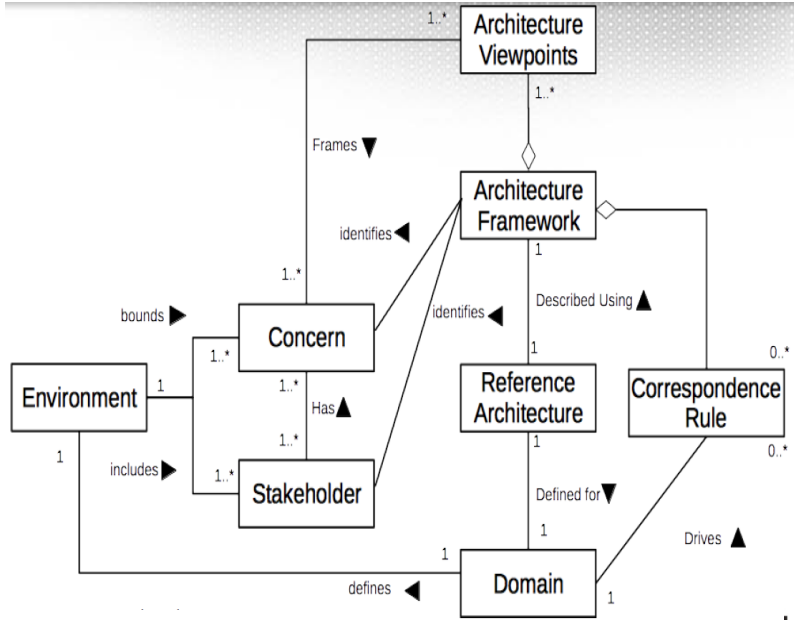
- Establishing a reference architecture is necessary to define minimum requirements on any framework, as one means of ensuring a consistent process in support of standards.
- These requirements are expressed in terms of the conceptual model of Architecture Description introduced in 2000, in the first edition of the Standard, IEEE 1471.
- A fundamental goal of an architecture framework is to codify a common set of practices within a community.
- This is typically done, especially in the DoD to promote interoperability and to enhance understandability, commonality and most importantly reducing the need for individual architects to “re-invent the wheel”.
- To achieve this goal, its necessary to establish baseline requirements on architecture frameworks in terms of their content and presentation:
 - Information identifying the architecture framework mapped back to an integrated capability framework.
 - Identification of one or more gaps or deficiencies related to the systems performance.
 - Identification of one or more stakeholders that have responsibility for that system(s).
 - One or more architecture viewpoints that frame those gaps/deficiencies.
 - Any corresponding operational or system limitations.

Government Reference Architecture (GRA) Methodology

Using the ISO/IEC/IEEE 42010 – Systems and software engineering — Architecture description [1] as starting point to illustrates the relationships between the elements and standards associated with a reference architecture.

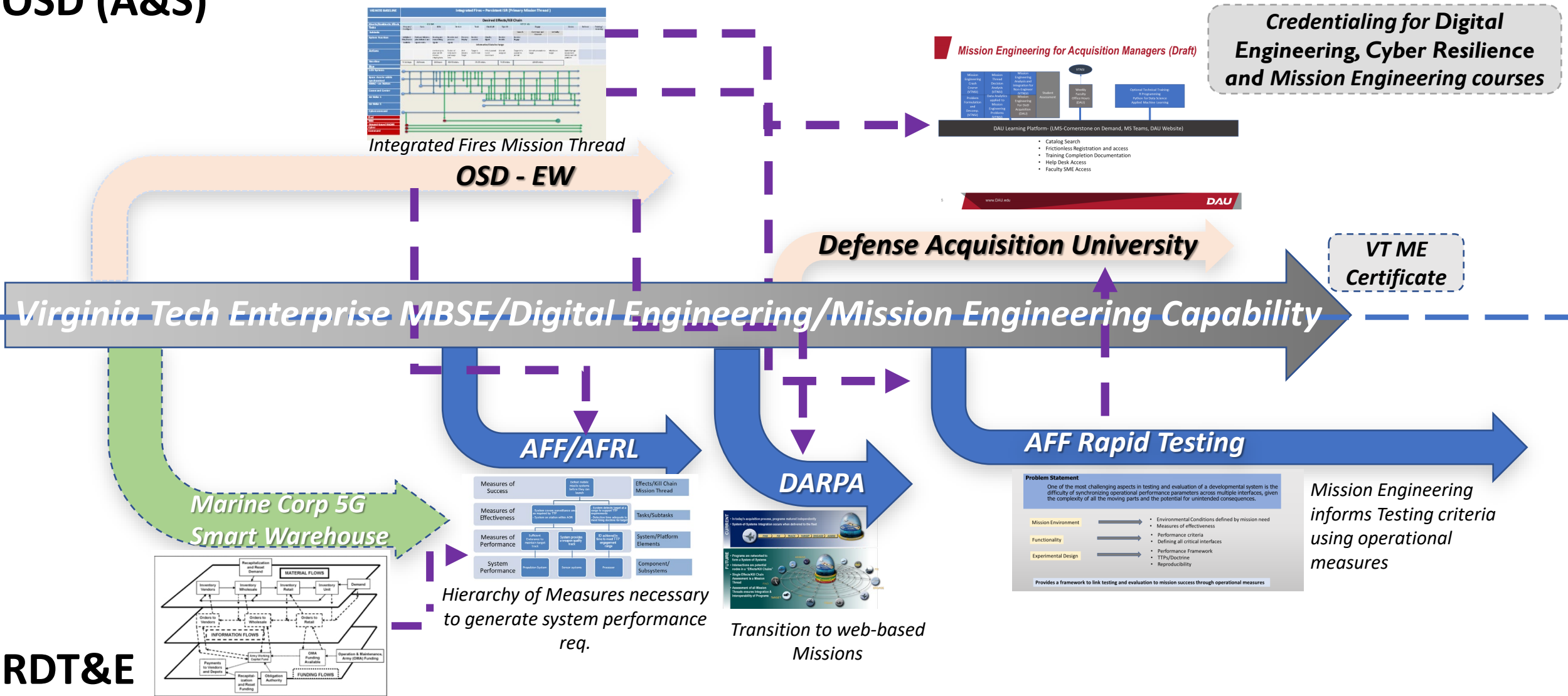
Objectives:

- Provides a common language for the various stakeholders;
- Encourages adherence to common standards, specifications, and patterns for those performing the analysis;
- Provides consistent methods for implementation of technology to solve similar problem sets;
- Illustrates and improves understanding of the various Mission Engineering components, processes, and systems, in the context of a vendor- and technology-agnostic *GRA* conceptual model;
- Provides a technical reference for U.S. government departments, agencies, and other consumers to understand, discuss, categorize, and compare **Mission Engineering solutions**; and
- Facilitates analysis of candidate standards for interoperability, portability, reusability, and extendibility.



Virginia Tech Enterprise Engineering Shared Environment

OSD (A&S)



RDT&E