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For Open Publication

May 23, 2022

Department of Defense
OFFICE OF PREPUBLICATION AND SECURITY REVIEW



Mission Engineering

SLIDES ONLY
NO SCRIPT PROVIDED

NDIA Systems Engineering Division Meeting

Marc Goldenberg
Chief Engineer, Mission Engineering
OUSD (R&E), MC, Mission Integration

Washington, DC
26 May 2022

Dr. Judith Dahmann
Technical Fellow
MITRE Labs
The MITRE Corporation
Phone: 703-298-6694



Genesis of Mission Engineering

NDAA 2017 Sec. 855. 10 U.S.C.2358 Mission Integration Management

The Secretary of Defense shall establish mission integration management activities for each mission area specified in subsection (b).

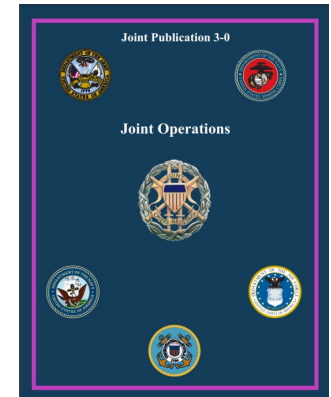
(b) COVERED MISSION AREAS.—The mission areas specified in this subsection are mission areas that involve multiple Armed Forces and multiple programs and, at a minimum, include the following:

(c) QUALIFICATIONS.—Mission integration management activities shall be performed by qualified personnel from the acquisition and operational communities.

(d) RESPONSIBILITIES.—The mission integration management activities for a mission area under this section shall include—

- (1) Close air support.
- (2) Air defense and offensive and defensive counter-air.
- (3) Interdiction.
- (4) Intelligence, surveillance, and reconnaissance.
- (5) Any other overlapping mission area of significance, as jointly designated by the Deputy Secretary of Defense and the Vice Chairman of the Joint Chiefs of Staff for purposes of this subsection.

Responsibility
1) development of technical infrastructure for engineering, analysis, and test, including data, modeling, analytic tools, and simulations;
2) the conduct of tests, demonstrations, exercises, and focused experiments for compelling challenges and opportunities;
3) overseeing the implementation of section 2446c of title 10, United States Code;
4) sponsoring and overseeing research on and development of (including tests and demonstrations) automated tools for composing systems of systems on demand;
5) developing mission-based inputs for the: requirements process, assessment of concepts, prototypes, design options, budgeting and resource allocation, and program and portfolio management; and
6) coordinating with commanders of the combatant commands on the development of concepts of operation and operational plans.



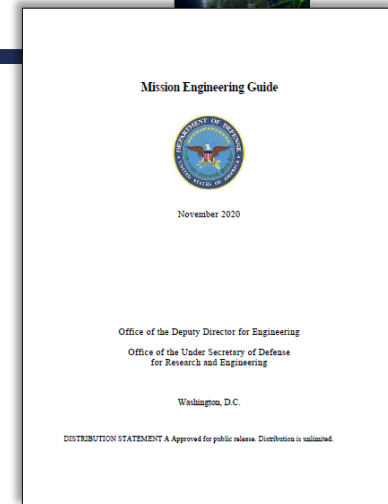
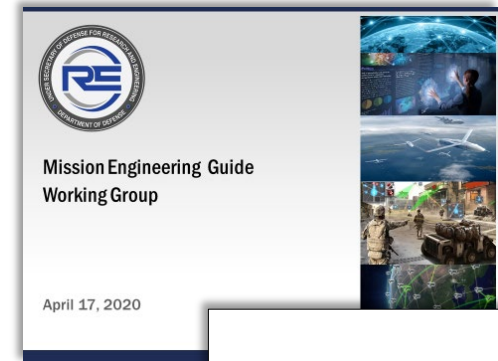
***The DoD Joint Publication 3-0 (Joint Operations) defines mission as the task, together with the purpose, that clearly indicates the action to be taken and the reason thereby. More simply, a mission is a duty assigned to an individual or unit. ***

ME is the technical sub-element of MIM as a means to provide engineered mission-based outputs to the requirements process, guide prototypes, provide design options, and inform investment decisions



Mission Engineering Guide (MEG)

- OUSD (Research and Engineering) has published the Mission Engineering Guide in December 2020
- The MEG speaks to a novice that is required to conduct ME
- Invokes critical thinking throughout the ME process
- Provides overarching guidance and information on ME by:
 - Explaining what is and what is not ME
 - Describing the best practices, principles, and attributes for ME
 - Elaborating on the benefits of using ME
 - Establishing a set of common terms and definitions
 - Provides standardized artifact templates used to present conclusions
- Enables practitioners to formulate problems and build a firm understanding of the main principles involved in performing analysis in a mission context
- Provides users with insight as to how to document and portray results or conclusions via a set of products that help inform key decisions
- Next Steps/Upcoming Initiatives:
 - Release ME Training; Update ME Guide; Establish ME CoP

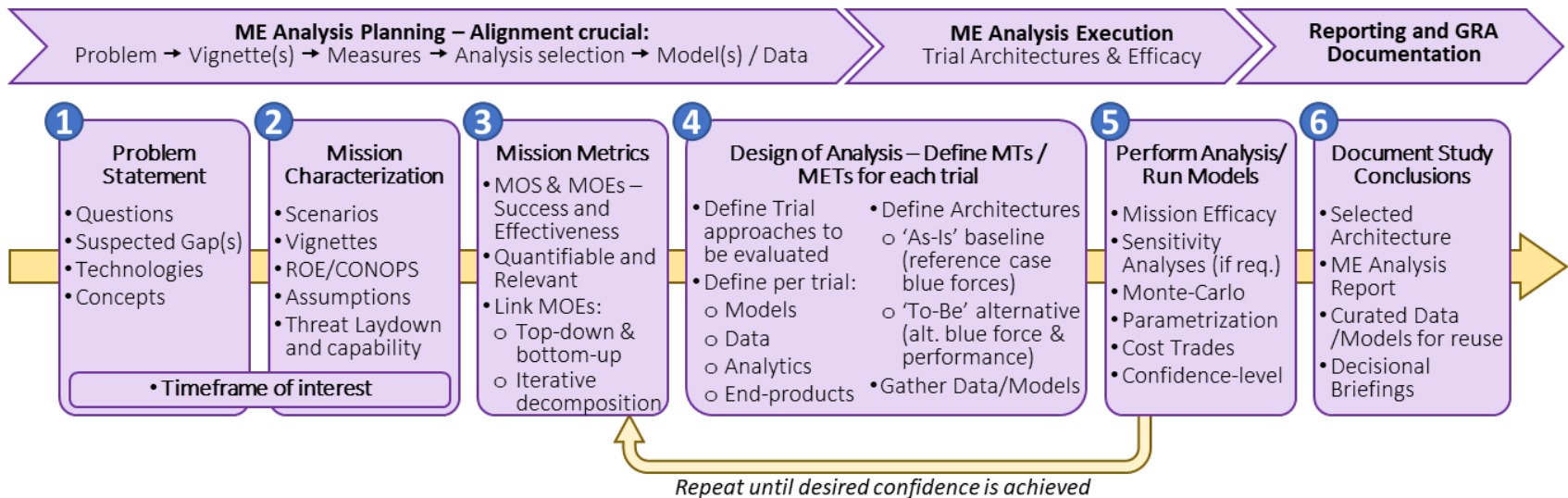


Obtain a copy of the DoD ME Guide
<https://ac.cto.mil/mission-engineering/>
<https://www.dau.edu/tools/t/DoD-Mission-Engineering-Guide/>



Mission Engineering Methodology

Process for Executing Mission Engineering

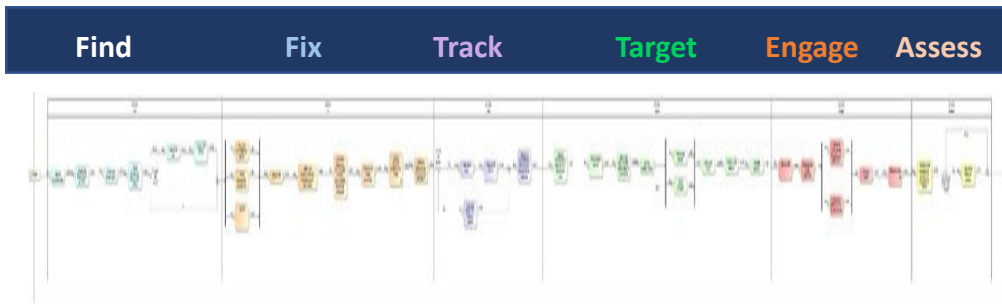


ME process begins with the end in mind, a carefully articulated problem statement, the characterization of the mission and identification of metrics, and working through the collection of data and models needed to analyze the mission and document the output results.

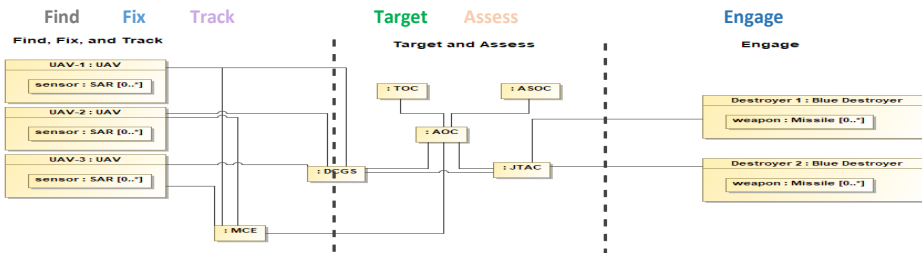


Mission Threads (MTs) and Mission Engineering Threads METs

Mission Thread (MT): An end-to-end sequence of tasks, activities and events to execute a mission.



Mission Engineering Thread (MET): Mission threads that include the technical details of the capabilities and systems utilized and/or required to execute the tasks/activities for a mission.

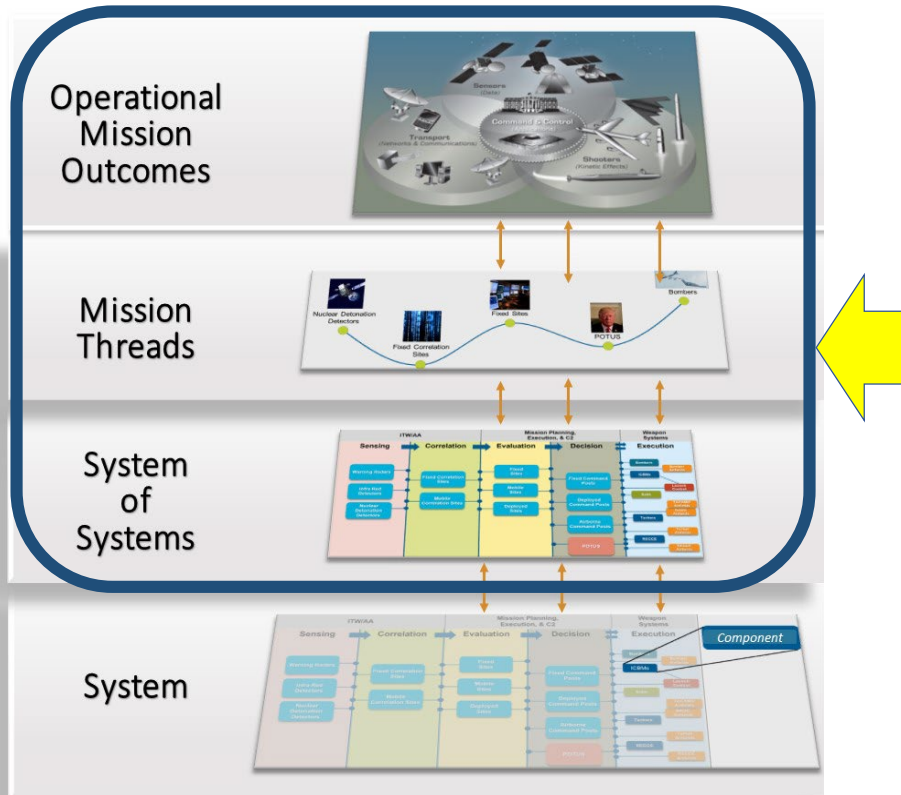


- In executing ME:
 - MTs define the essential sequence of activities / tasks in the execution of the mission – key elements of the *operational mission architecture*
 - METs are used to define the systems / SoS in the execution of the mission activities / tasks – key elements of the *systems of systems architecture* (“within/under” the operational mission architecture)
 - MTs/METs are analyzed to assess the extent to which
 - Baseline achieves the mission outcome(s)
 - Alternative (options) changes to the systems and/or activities impact (i.e., improve) mission outcomes
 - The baseline and alternatives (options) are analyzed using appropriate analysis tools to assess mission outcomes under varying conditions
 - Results are used to support decisions related to technology, systems and operations to improve mission outcomes in the near and long term



Why are MTs and METs important for ME?

MISSION ENGINEERING



Mission engineering is the “the deliberate planning, analyzing, organizing, and integrating of current and emerging **operational and system** capabilities **to achieve desired warfighting mission effects**”

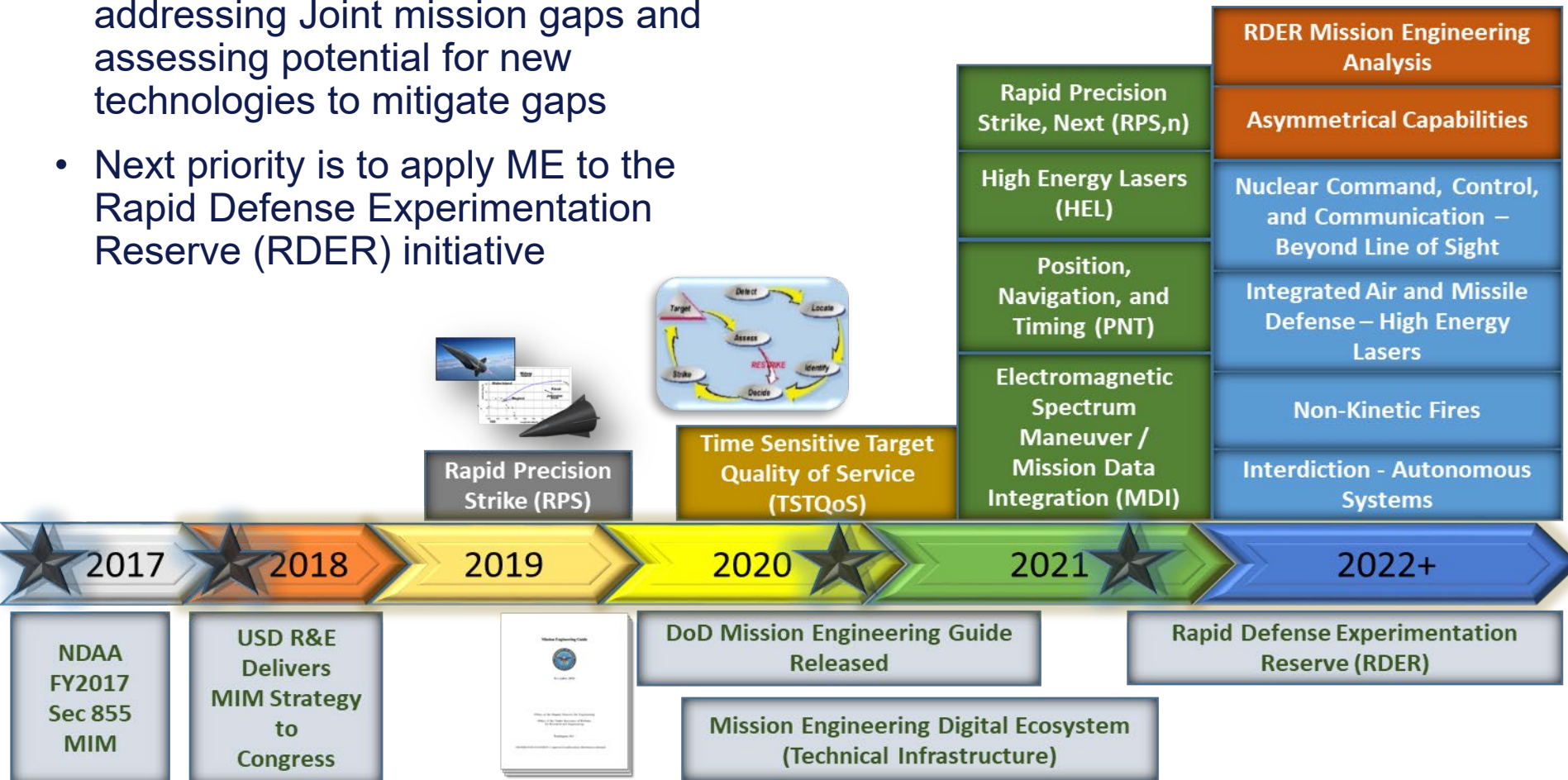
Mission threads are the construct which links systems of systems (composed of **systems and technology**) **to warfighting mission outcomes**

MTs/METs link systems engineering to mission analysis – Mission Engineering



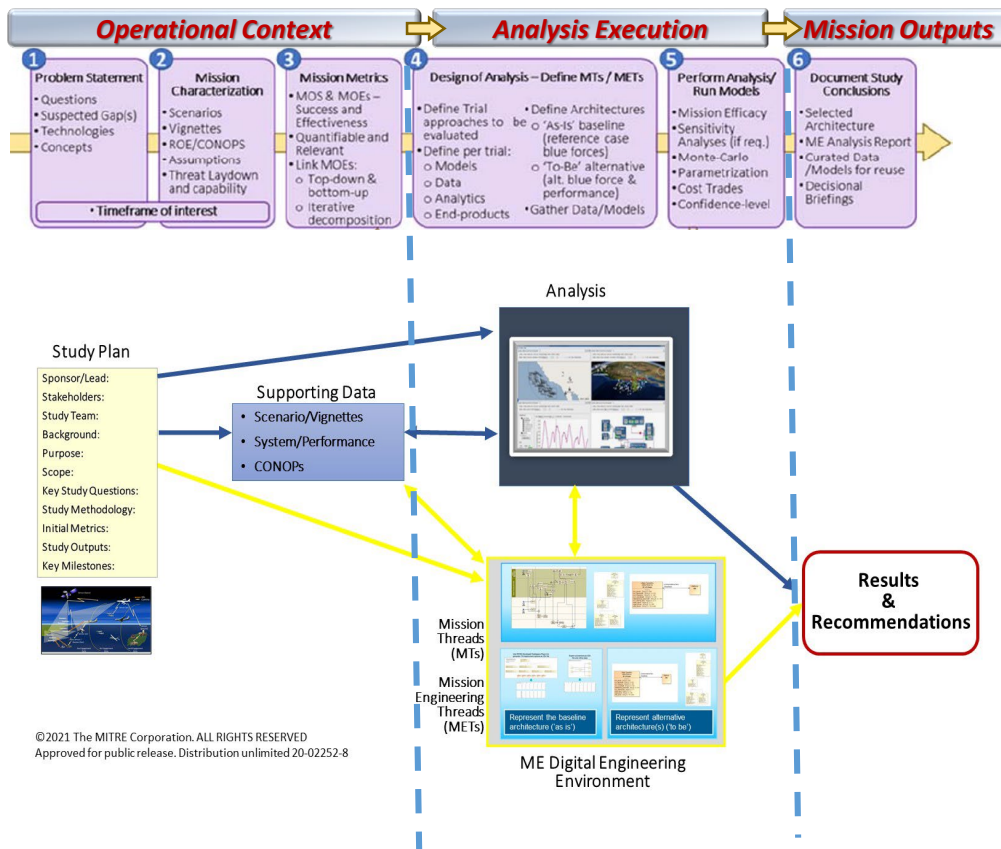
R&E Mission Engineering Implementation

- R&E has been implementing ME in a series of ME studies addressing Joint mission gaps and assessing potential for new technologies to mitigate gaps
- Next priority is to apply ME to the Rapid Defense Experimentation Reserve (RDER) initiative





R&E ME Studies Follows ME Methodology



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Study Plan (Terms of Reference)

- The scope: stakeholders, background, problem statement, key questions, hypothesis, methodology/approach, mission context, products/deliverables

Supporting Data

- Mission Characterization: Detailed data on the mission scenario and vignette (context for the analysis), threat, systems and their role in execution the mission, etc., assumptions

ME DEE

- Digital representation of the mission architecture (MTs, METs) for baseline and the alternatives

Mission Analysis

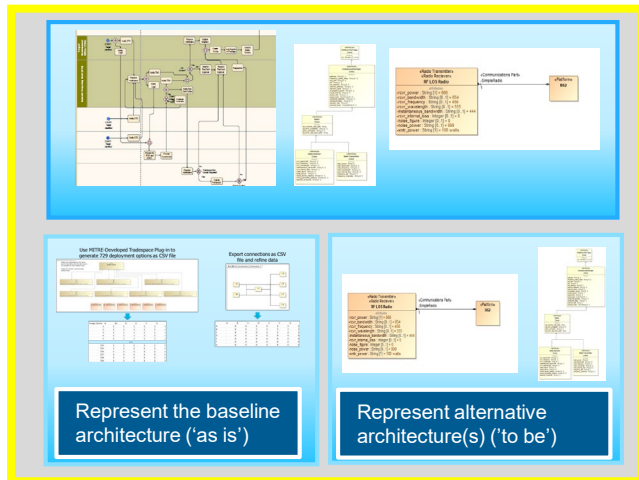
- Implementation of scenario, systems and activities in operational analysis tool(s)
- Simulation runs for baseline and alternatives; outputs quantitative metrics

Results

- Results, trends, observations, and recommendations based on mission analysis



R&E ME Digital Engineering Environment



- SysML models Implemented in CAMEO Magic Draw

Provides a digital environment to develop, retain and reuse mission architectures across R&E ME studies based on

ME Study Plans

Agreed upon collection of data

Models represented in DEE are instantiated in selected analysis tools to address specific goals of each ME study – architecture products for studies

Currently hosted, for shared access, in:

MITRE McLean Classified Lab; and

R&E Mission Engineering Digital Ecosystem (MEDE)

Standard repeatable, accessible digital representation of architectures separate from specific instantiations in selected analysis tools (e.g., embedded in AFSIM scripts)

DEE's value is rapid generation of consistent, reusable digital representations of mission architectures across studies, independent of specific analysis approaches



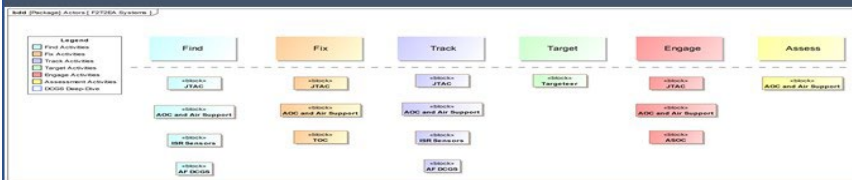
ME Digital Mission Models

Baseline MT and MET Models

Activities



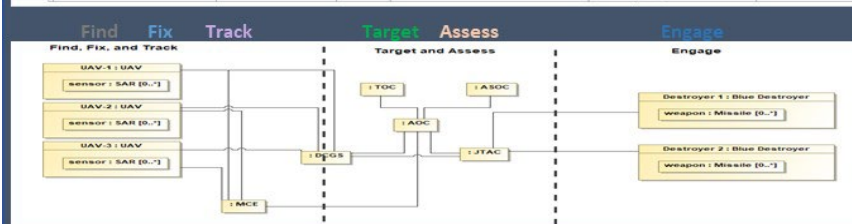
Systems supporting Activities



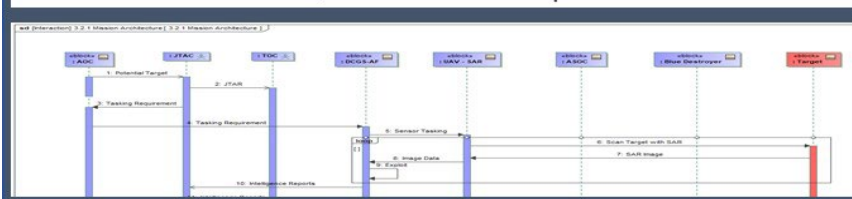
Organizations executing activities



End-to-end flow of SoS



Sequence of actions



For the Alternatives

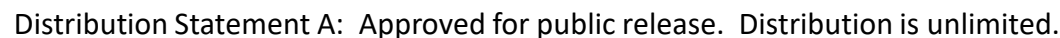
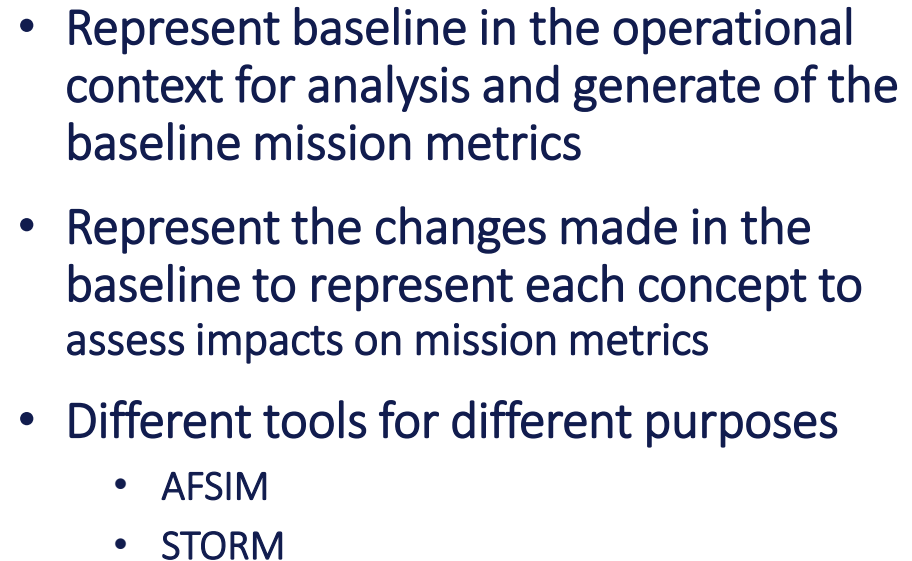
What **new activities** are now needed to execute the mission?

What **new systems** does the concept require?

What **different organizations** are now part of mission execution? Which activities do they execute?

How does this change the execution of the **E2E SoS**?

How does this change the **sequence** of actions?





Rapid Defense Experimentation Reserve (RDER)

The Secretary of Defense established RDER to:

- Focus multi-Component experimentation in a structured, multi-year campaign of learning.
- Proposed experiments based on alignment to Joint missions and potential to yield demonstrable warfighting utility in the near-term.
- Demonstrations and experiments will be conducted at key exercise venues (INDOPACOM Focused).
- Successful demonstrations and experiments can be quickly transitioned to the Components for fielding as new systems or approaches.



“RDER will drive efforts to compete with peer and near-peer adversaries through the development of capabilities that support the Joint Warfighting Concept (JWC) including, but not limited to, fires, command and control, logistics, and capabilities that will drive information advantage.” – Deputy Secretary of Defense Dr. Kathleen Hicks

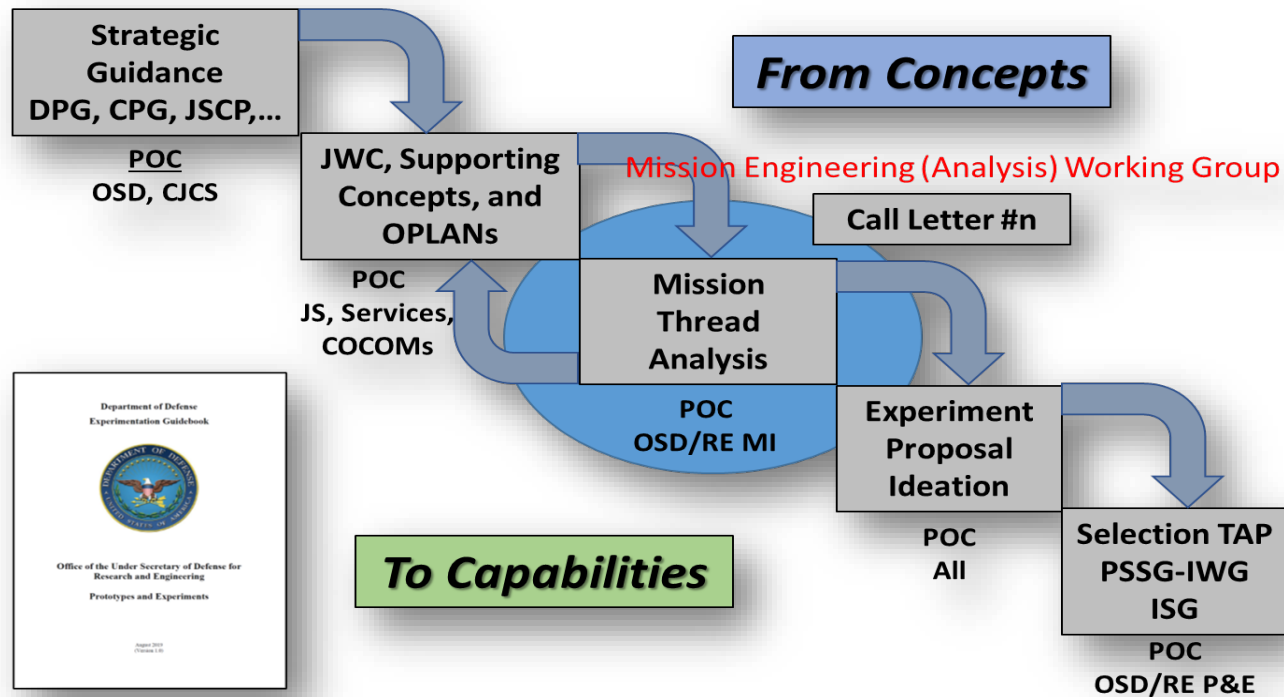
RDER will bring five benefits to DoD:

1. Accelerate Joint Warfighting Capability
2. Expand International Partnerships and Multi-lateral engagement
3. Focus Service experimentation to enable the JWC
4. Quickly demonstrate and assess innovative ideas
5. Provide feedback to future Warfighting concept development





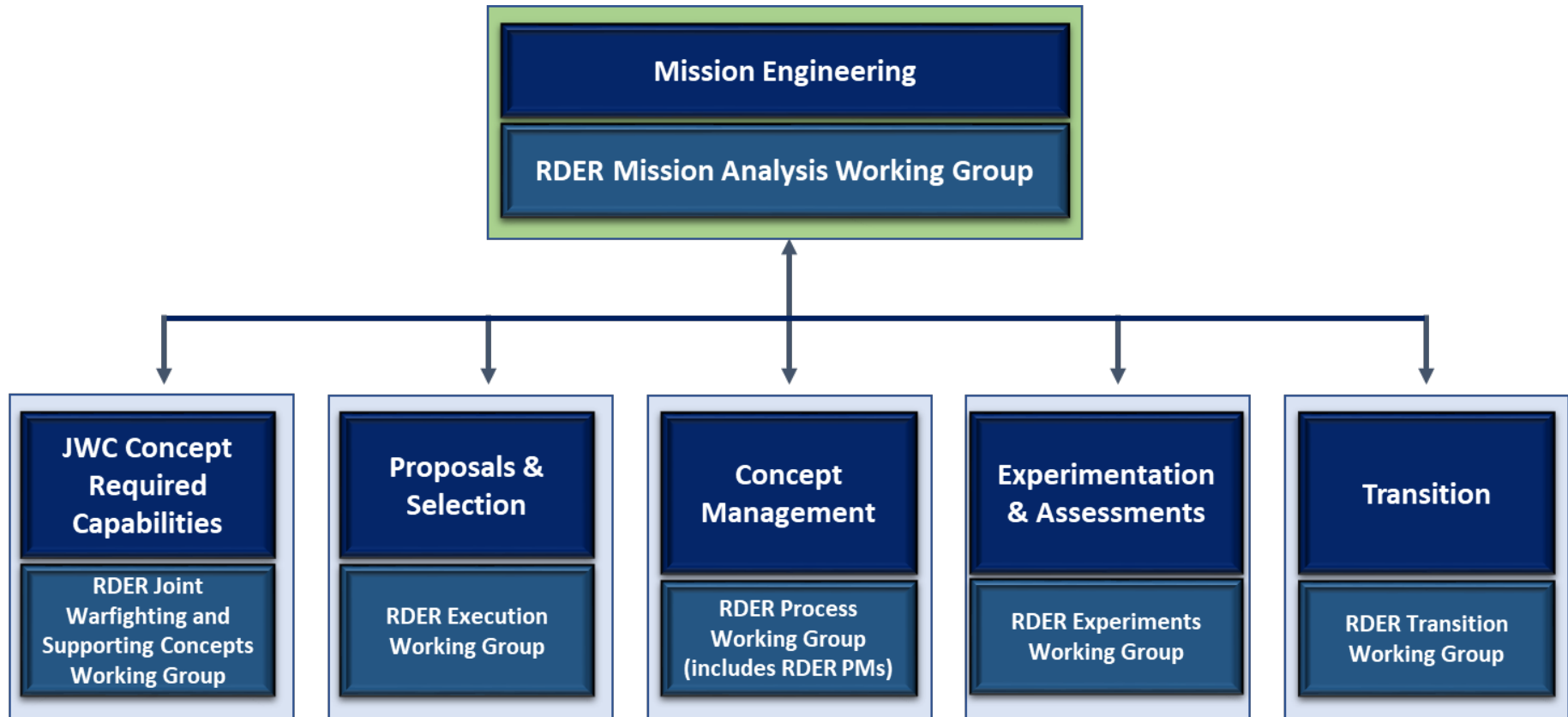
RDER Organizational Structure and Process



(U) The Rapid Defense Experimentation Reserve (RDER) activity will establish a [Mission Analysis Working Group \(MAWG\)](#) to discuss, coordinate, plan, and conduct [Mission Engineering](#) activities to ensure timely delivery of analytical results to inform RDER concept proposal selection and development, and experimentation



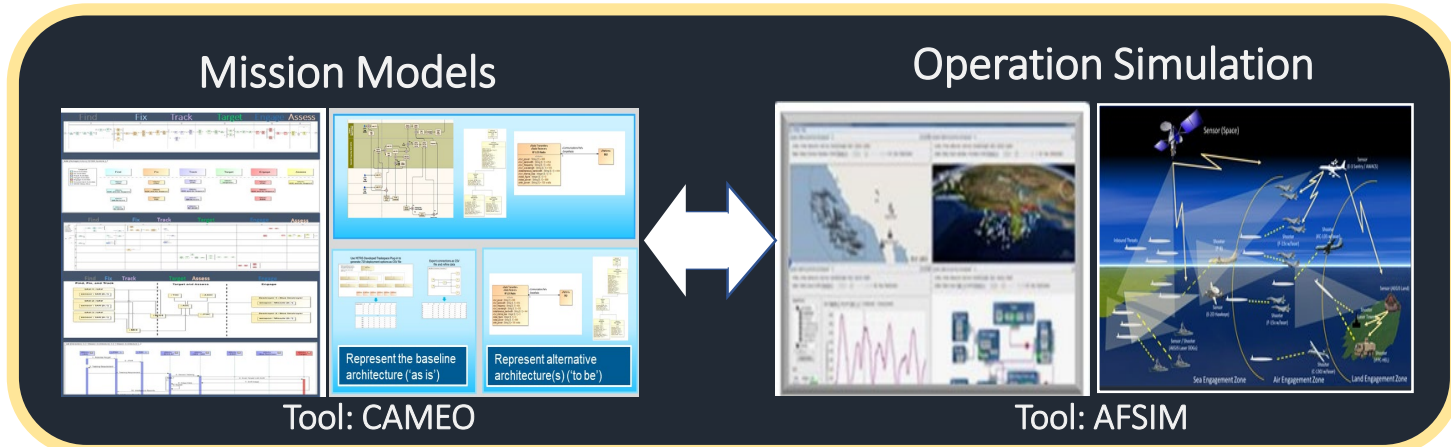
RDER Logical Workflow





RDER R&E Mission Engineering Activities and Products

Lines of Effort



Baseline

- Digital representation of the baseline [Mission Threads](#) (MTs) and [Mission Engineering Threads](#) (METs)
- Representation of the baseline MTs/METs within [scenario](#) including threat, systems' attributes and behaviors – conduct baseline analysis of [mission metrics](#)

Alternatives

- [Updated MTs and METs](#) to include **RDER Concepts** with associated changes
- Update the systems' attributes and behaviors as specified in **RDER concepts** and [assess impact on mission metrics](#)

**MISSION THREAD ALIGNMENT
[TRACEABILITY]**

**QUANTITATIVE ANALYSIS
[MISSION METRICS – OUTPUTS]**

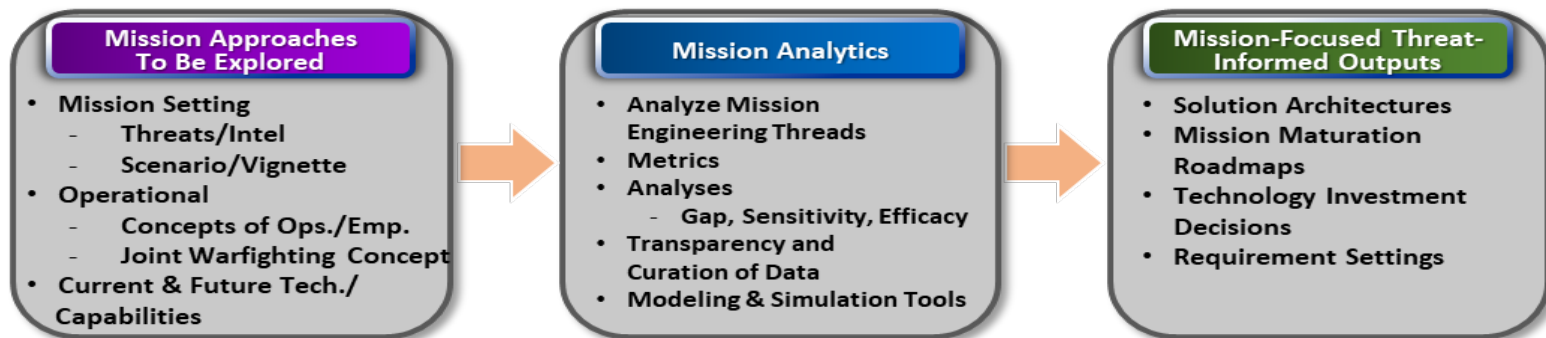
Socialized at RDER MAWG Working Groups to:

- Collect SME feedback to mature models (“*validate*”); and
- Allow RDER community to leverage and use products (“*traceability*”)



Summary

- Rapid Defense Experimentation Reserve
 - MTs/METs aligns the RdER concepts and put them into a mission context
 - ME analysis outputs quantitative results in terms of mission metrics
 - Results will support selection, prioritization and development of RDER Concepts
- ME Survey to assess “state of practice” across Industry and Government
 - NDIA will be distributing to Industry; and
 - R&E will be distributing amongst Government organizations
- ME Guide
 - Update will be released ~September/October 2022
 - R&E working with NDIA – reviewing feedback received from Industry
- ME Community of Practice
 - ME CoP led by R&E; work with NDIA ME Core team to invite industry to participate in future working group sessions





Contact

Office of the Under Secretary of Defense for
Research and Engineering

osd.r-e.comm@mail.mil

<https://www.cto.mil>