SYSTEMS ENGINEERING RESEARCH CENTER

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# WRT-1043: DAU Digital Engineering Simulation

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**Sponsor: DAU**

WASHINGTON DC VIRTUAL

ANNUAL SPONSOR RESEARCH REVIEW

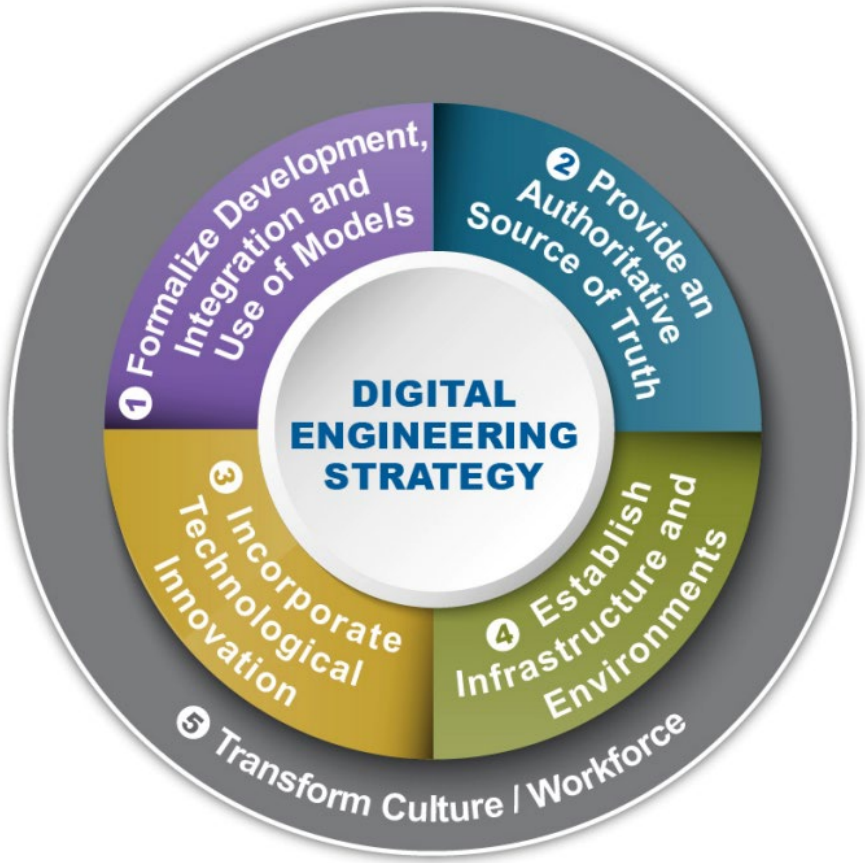
NOV. 2-4 2021

# Outline

- Intro/Background
- Context
- Vision
- SERC DE Portfolio
- Current Case Studies and Approaches

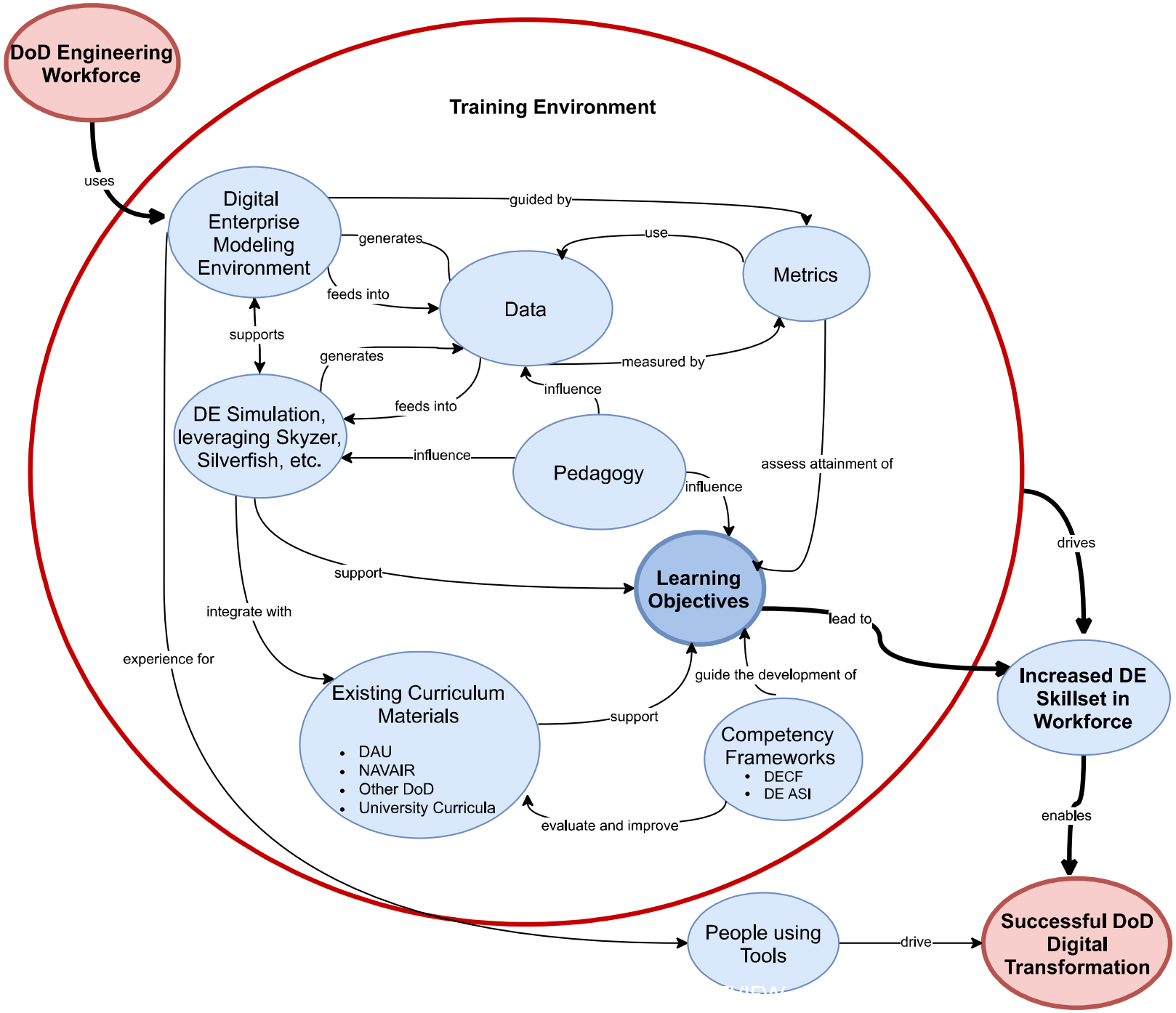
# Background


Specialty Engineering Models
Product Support Models
Management Models
Authoritative Source of Truth
System Models
Design Models
Verification and Validation Models
Manufacturing Models
Key: Data

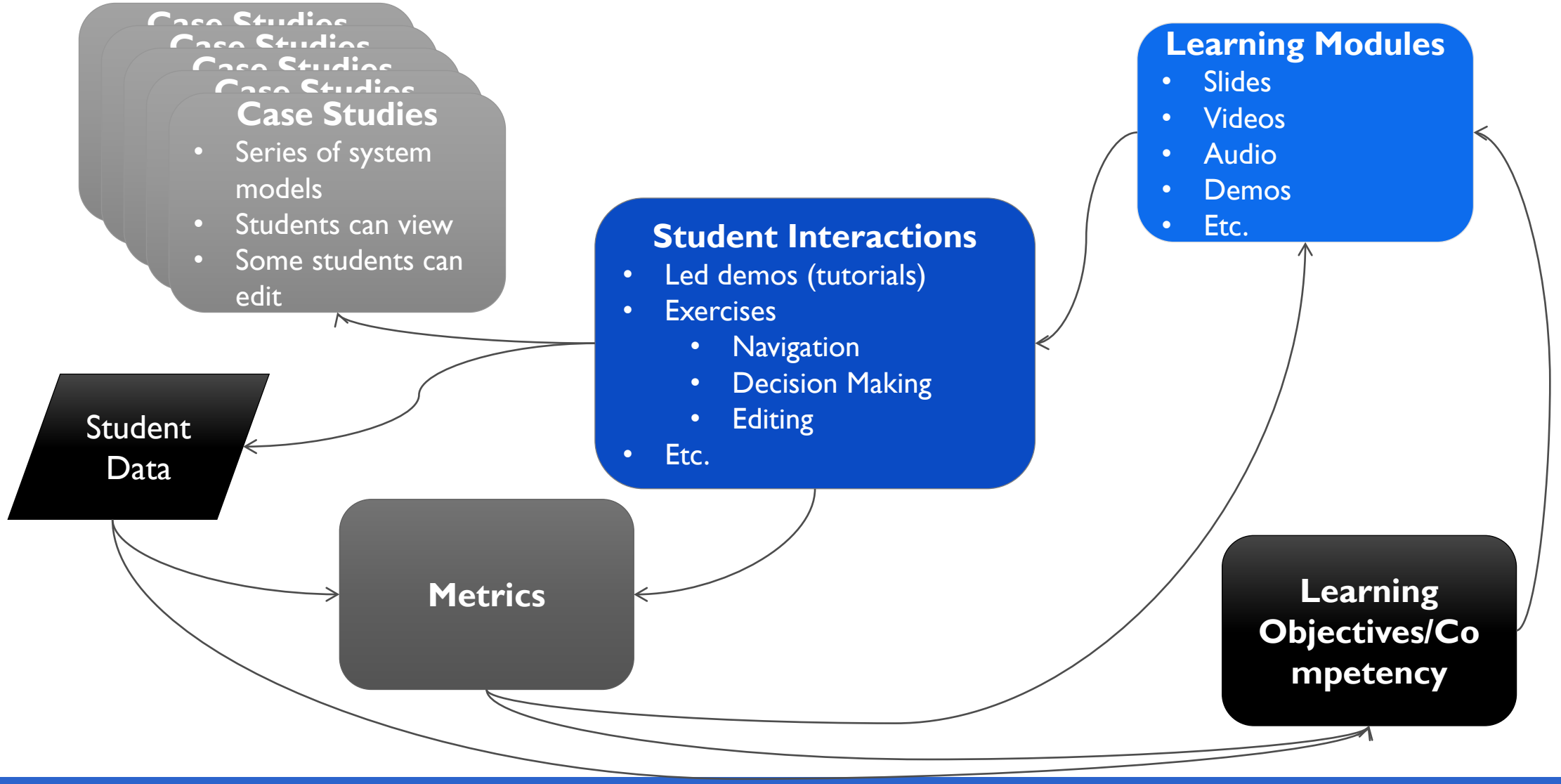

DIGITAL ENGINEERING STRATEGY
1 Formalize Development, Integration and Use of Models
2 Provide an Authoritative Source of Truth
3 Incorporate Technological Innovation
4 Establish Infrastructure and Environments
5 Transform Culture / Workforce

# Goal 5:

## Transform the Culture and Workforce to Adopt and Support Digital Engineering Across the Lifecycle


DoD Engineering Workforce
Training Environment
uses
Digital Enterprise Modeling Environment
guided by
generates
use
Metrics
feeds into
Data
supports
generates
measured by
influence
feeds into
DE Simulation, leveraging Skyzer, Silverfish, etc.
influence
Pedagogy
influence
assess attainment of
drives
support
Learning Objectives
integrate with
lead to
Increased DE Skillset in Workforce
experience for
guide the development of
Existing Curriculum Materials
DAU
NAVAIR
Other DoD
University Curricula
support
Competency Frameworks
DECF
DE ASI
evaluate and improve
enables
People using Tools
drive
Successful DoD Digital Transformation

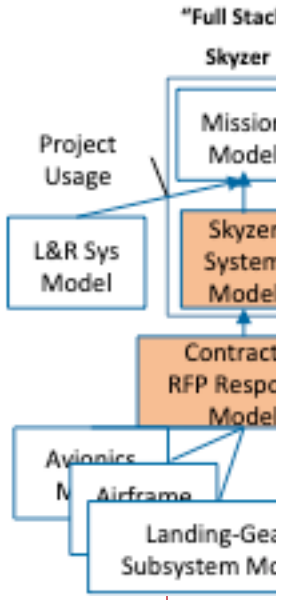
# Concept: Digital "Textbook"

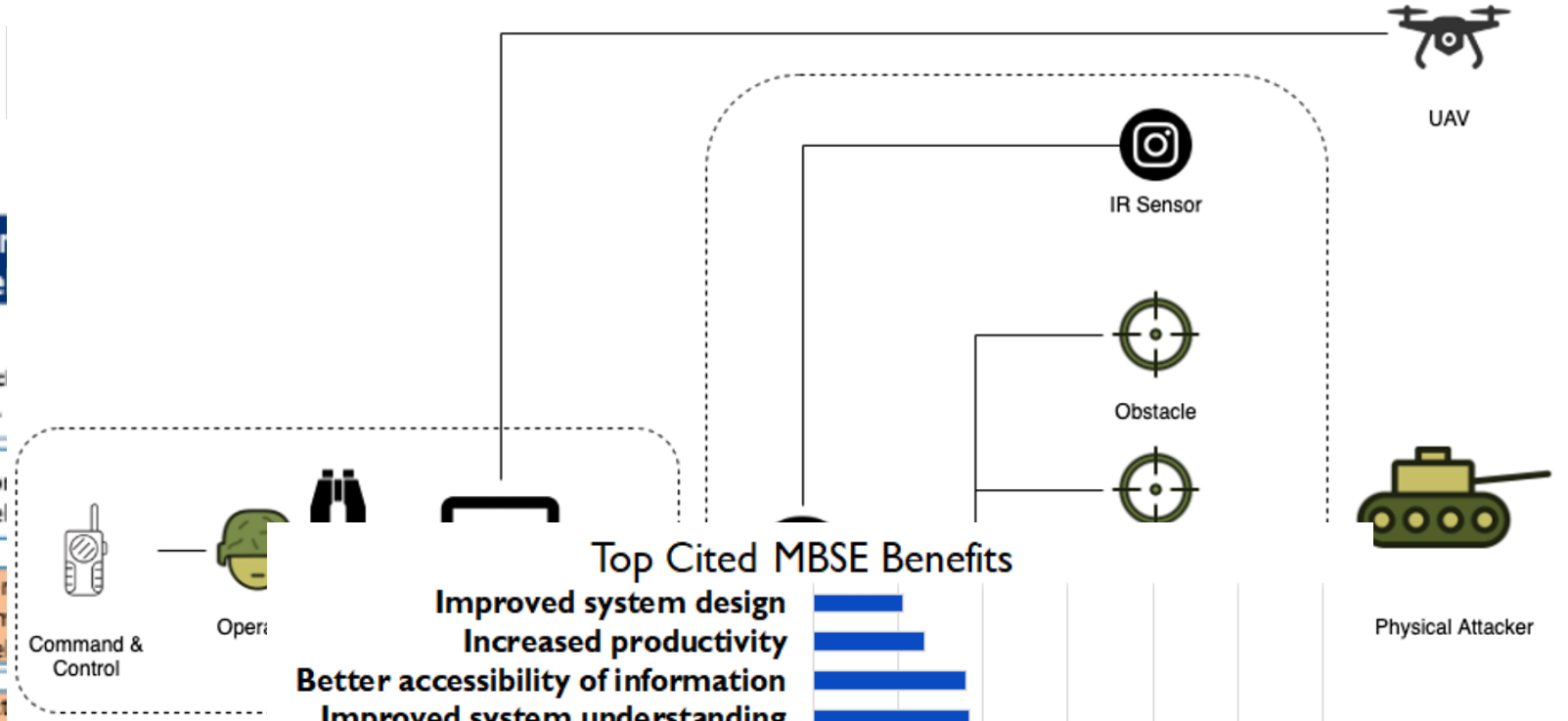


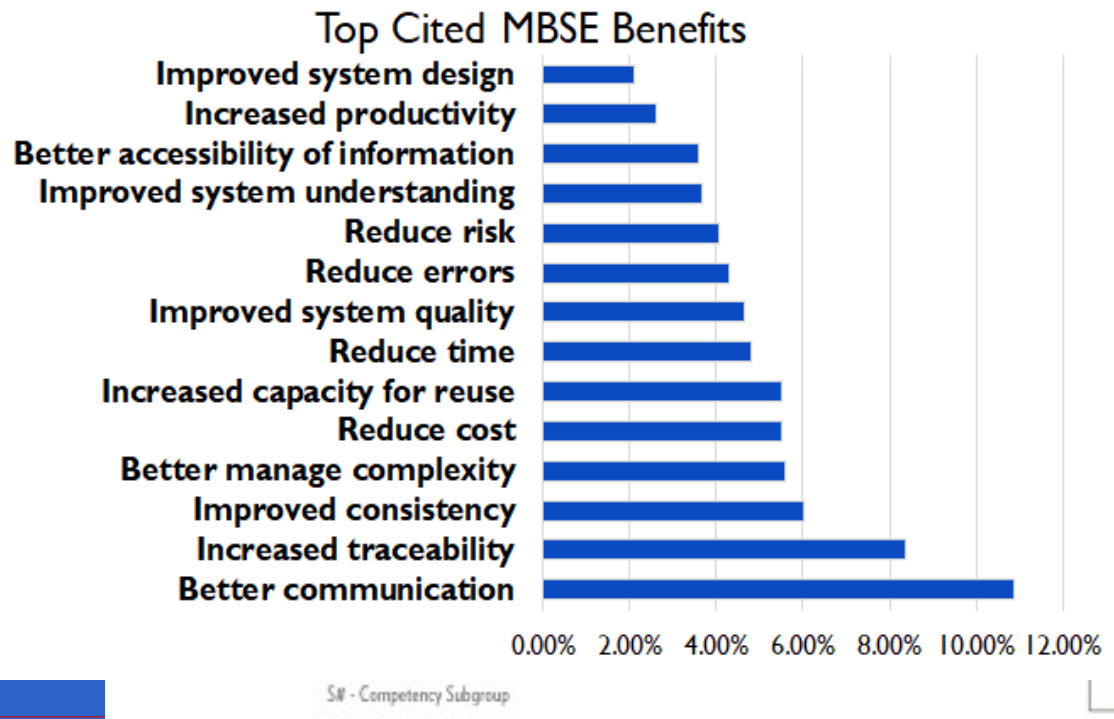
# SERC DE

## DIGITAL ENGINEERING COMPETENCY FRAMEWORK (DECF) VERSION 1.1

Using and Tailorin
Reference Mode




| | | |
|---|---|---|
| | C1 | Data Governance |
| | C2 | Data Management |
| **ULATION** | | |
| tion | C3 | Modeling |
| | C4 | Simulation |
| | C5 | Artificial Intelligence/Machine Learning |
| | C6 | Data Visualization |
| | C7 | Data Analytics |
| **G AND ANALYSIS** | | |
| | C8 | Digital Architecting |
| | C9 | Digital Requirements Modeling |
| | C10 | Digital Validation and Verification |
| | C11 | Model-Based Systems Engineering Processes |
| ement | C12 | Digital Model-Based Reviews |
| | C13 | Project and Program Management |
| | C14 | Organizational Development |
| | C15 | Digital Engineering Policy and Guidance |
| | C16 | Configuration Management |
| **E** | | |
| | C17 | Software Construction |
| | C18 | Software Engineering |
| **E ENVIRONMENT** | | |
| opment | C19 | Digital Environment Development |
| 7 Digital Enterprise Environment Management | C20 | Management |
| | C21 | Communications |
| | C22 | Planning |
| 8 Digital Enterprise Environment Operations and Support | C23 | Digital Environment Operations |
| | C24 | Digital Environment Support |
| 9 Digital Enterprise Environment Security | C25 | Digital Environment Security |

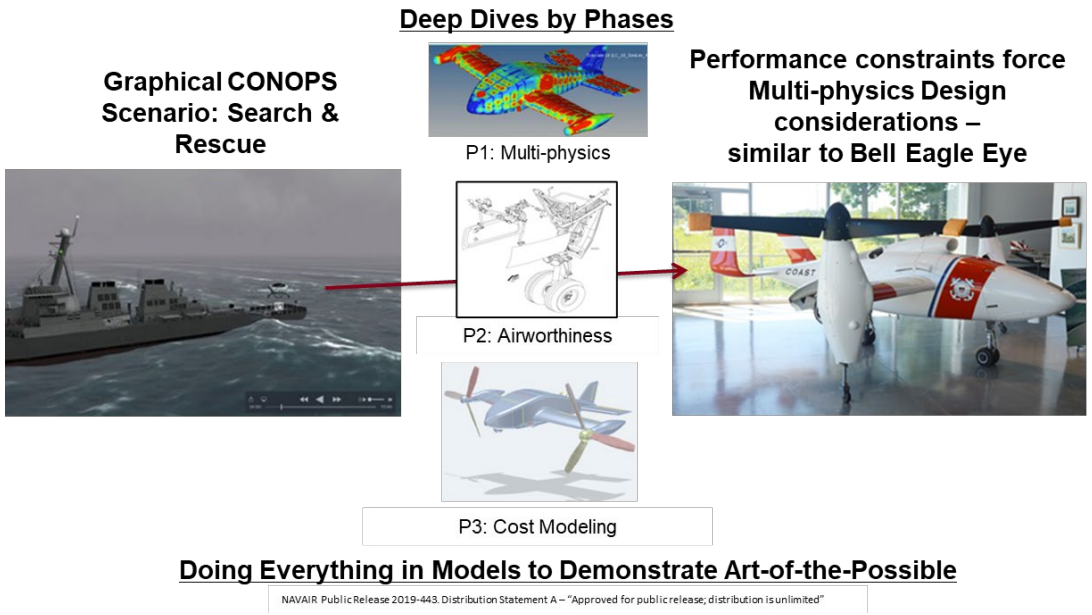
Silverfish

# Current Status

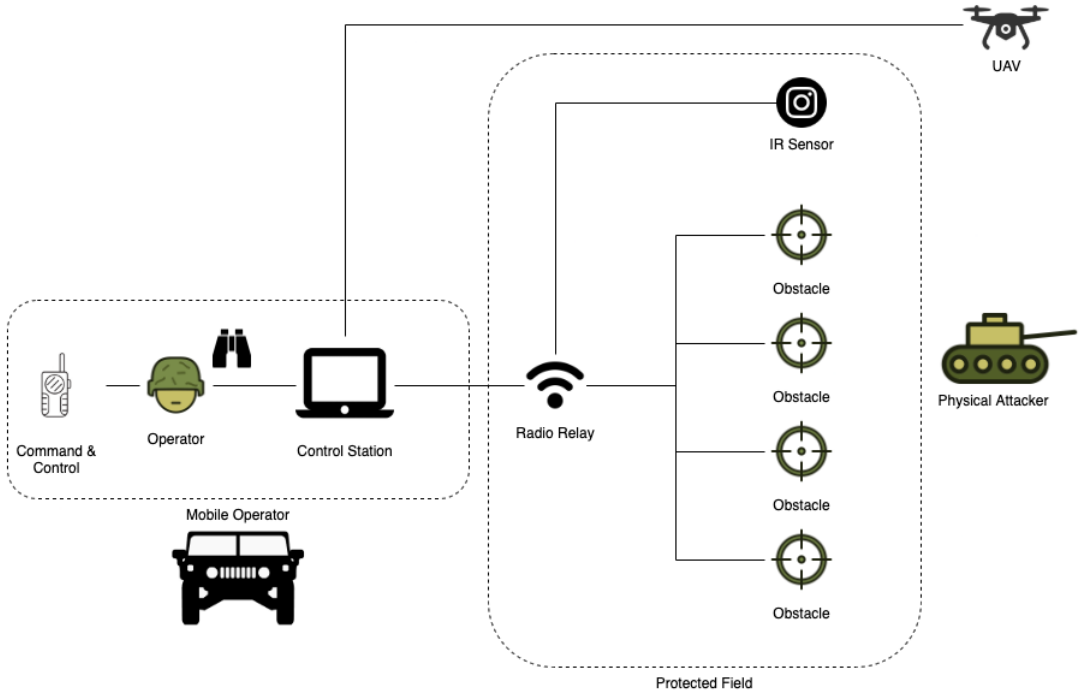
Mr. Paul Wach

# Charting Curriculum Around Two Systems of Interest

## Skyzer




## Silverfish



*What does "the" system model mean?

# List of models in the Skyzer MBSE Ecosystem

1. Skyzer Airworthiness Model
2. Skyzer Contractor SFR Compliance
3. Skyzer Contractor System Model
4. Skyzer Cost Model
5. Skyzer Launch & Recovery Model
6. Skyzer Launch & Recovery Model Document
7. Skyzer MBTD Model
8. Skyzer MBTD Model v2
9. Skyzer Mission Model
10. Skyzer Mission Model Document
11. Skyzer Mission Model RFI Document
12. Skyzer SOW
13. Skyzer Stakeholder
14. Skyzer System Estimation Model v2
15. Skyzer System Evaluation Model
16. Skyzer System Model
17. Skyzer System Model Document
18. Skyzer_rsp1_BR00_etc
19. Skyzer_rsp3_CM00_etc
20. Skyzer RFI Response Altair
21. Skyzer Profile Overview
22. Viewpoint Library
23. SAIC DE Profile
24. 516C TACC

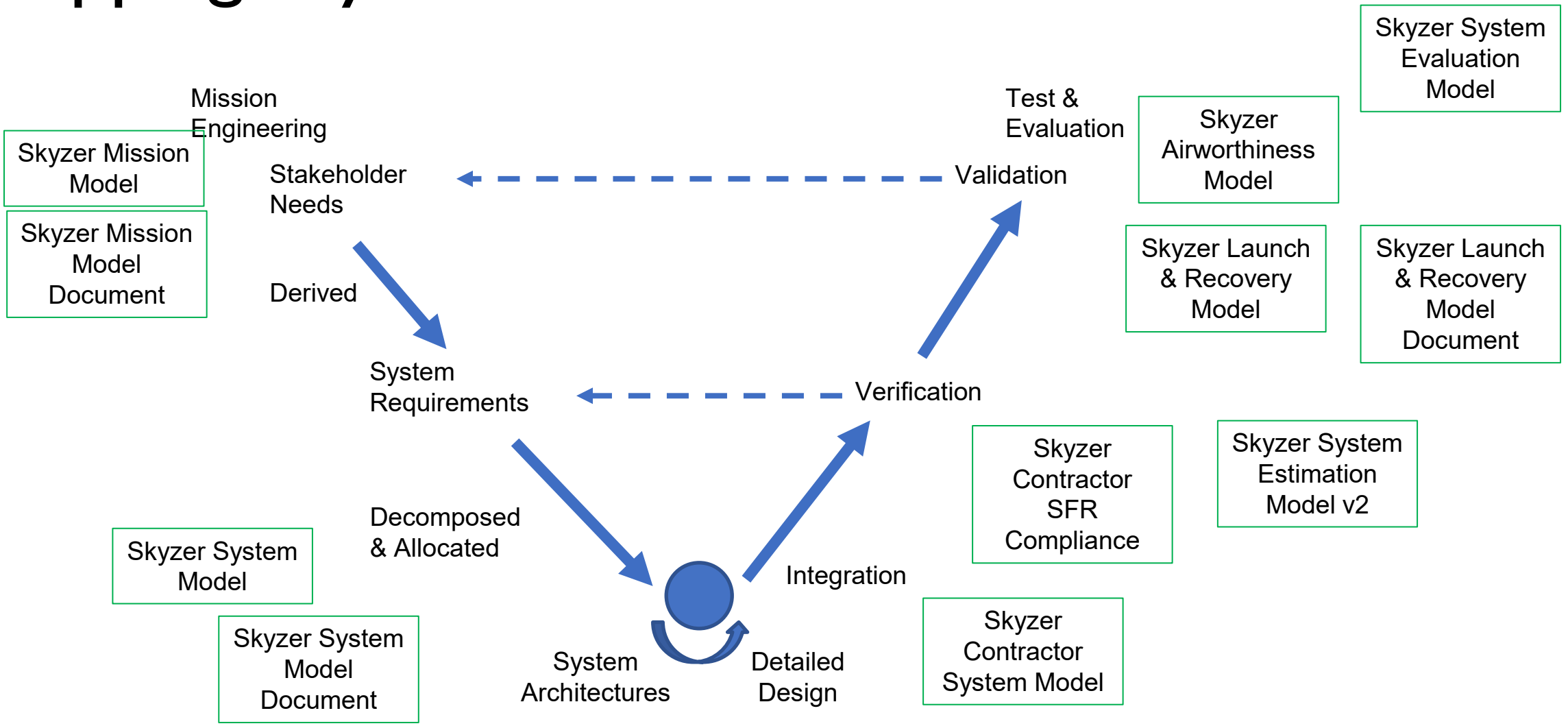
# Importance of Modeling Language and Extensions

- Unified Modeling Language
  - UML
  - Base language
  - ~Base metamodel
- Systems Modeling Language
  - SysML
- Skyzer Profile
  - Extension of SysML, which add for Skyzer

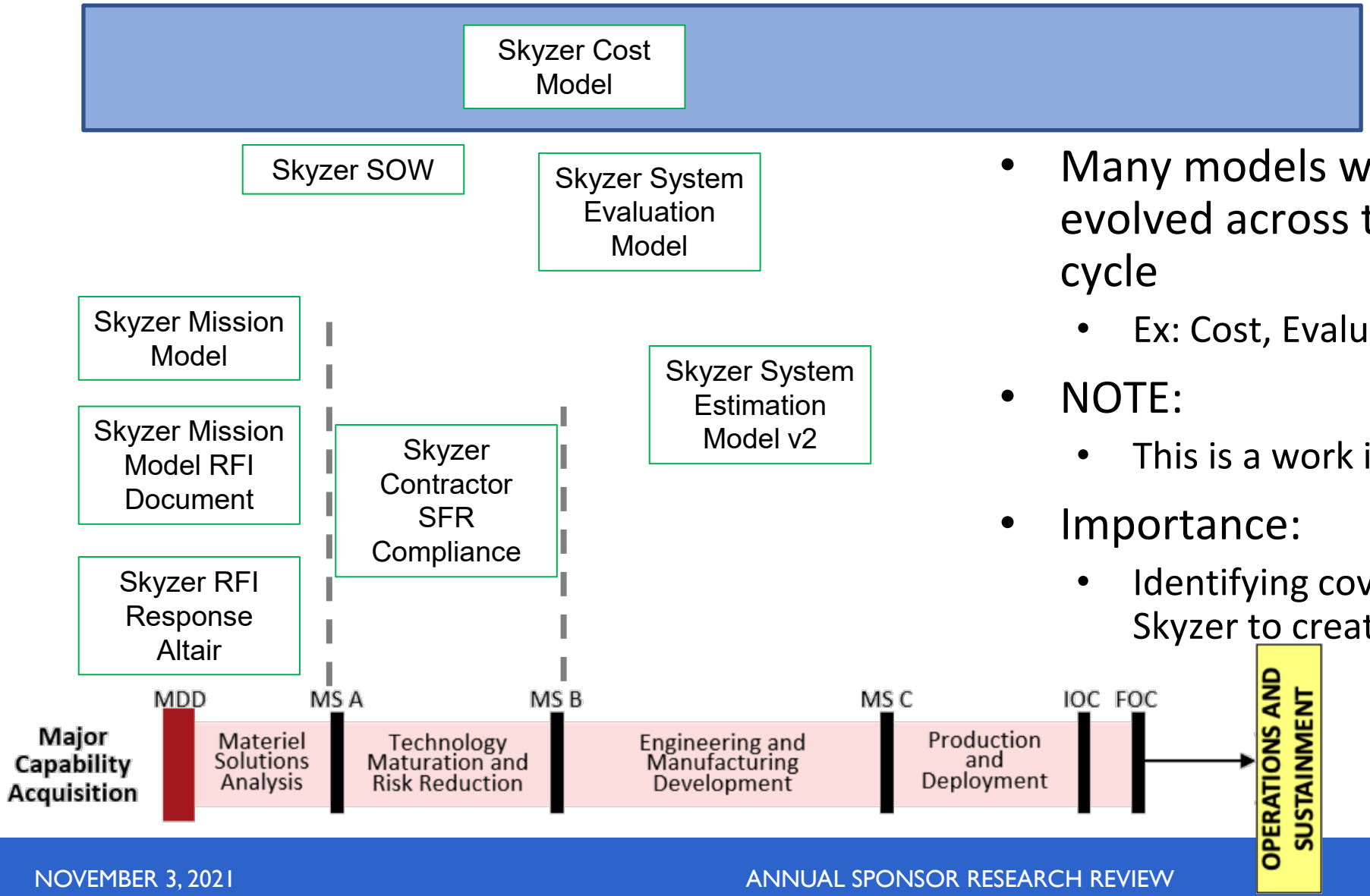
- In practice, other cases may include:
  - Unified Architecture Framework (UAF)
  - Business Process Modeling Notation (BPMN)
  - Standards
    - Ex: 516C-TACC-Airworthiness
  - May see unique extension of SysML to specific project, organization, etc.

*Many models will be exist and evolve across the SE-Vee

# Mapping Skyzer to the SE-Vee

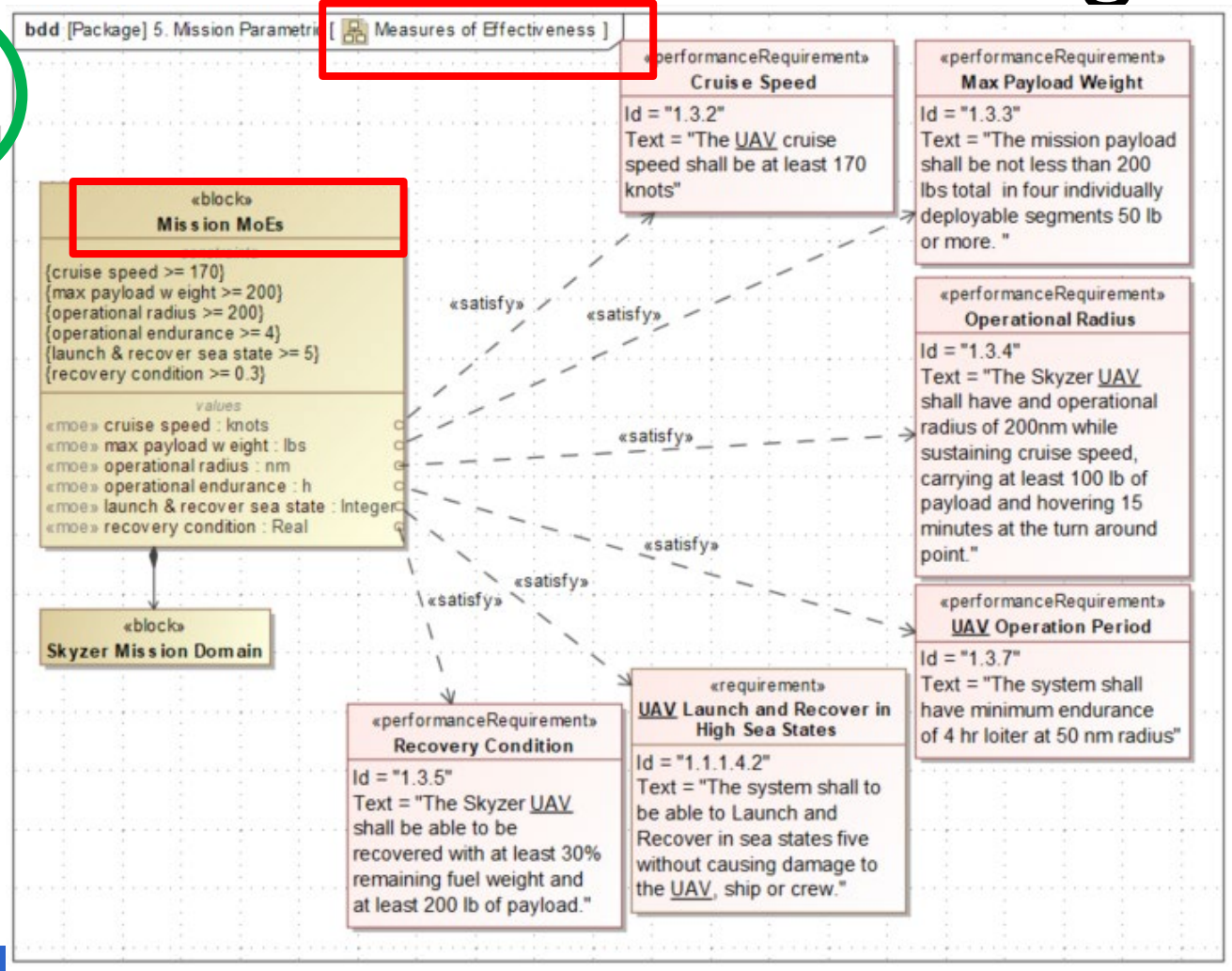


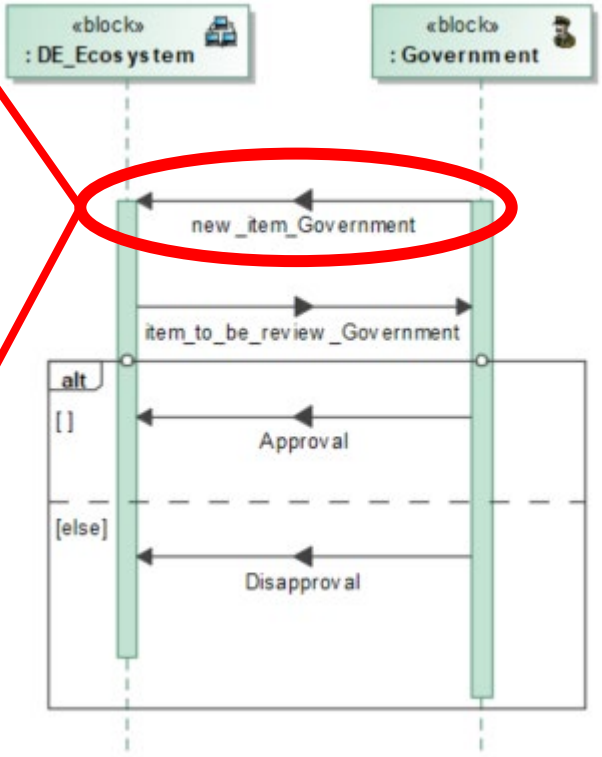
# Mapping Skyzer to the Acquisition Life Cycle




- Many models will be used or evolved across the acquisition life cycle
  - Ex: Cost, Evaluation, Estimation, SOW
- NOTE:
  - This is a work in progress
- Importance:
  - Identifying coverage/gaps in the use of Skyzer to create lesson plans

# Developing Digital Workflows: Modeling Artifacts to Digital Signoff

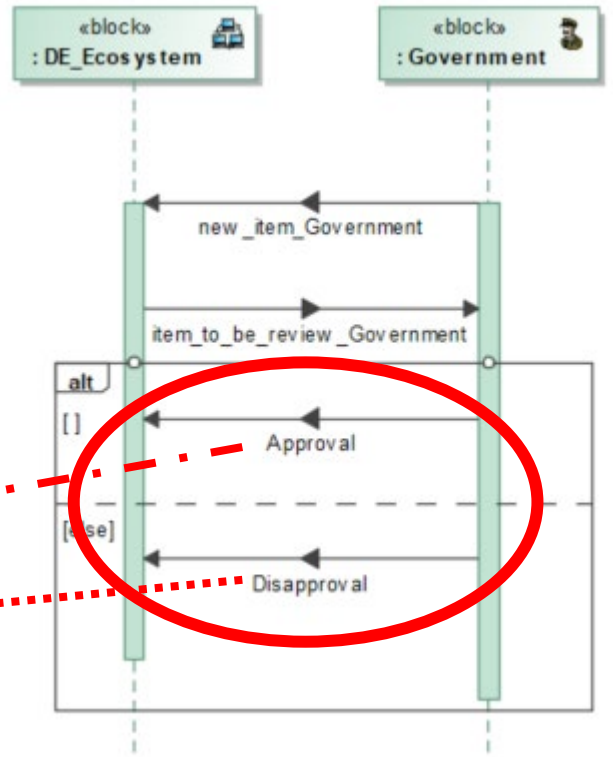


# Developing Digital Workflows: Modeling Artifacts to Digital Signoff

Table 138. Stakeholder Need Signoff

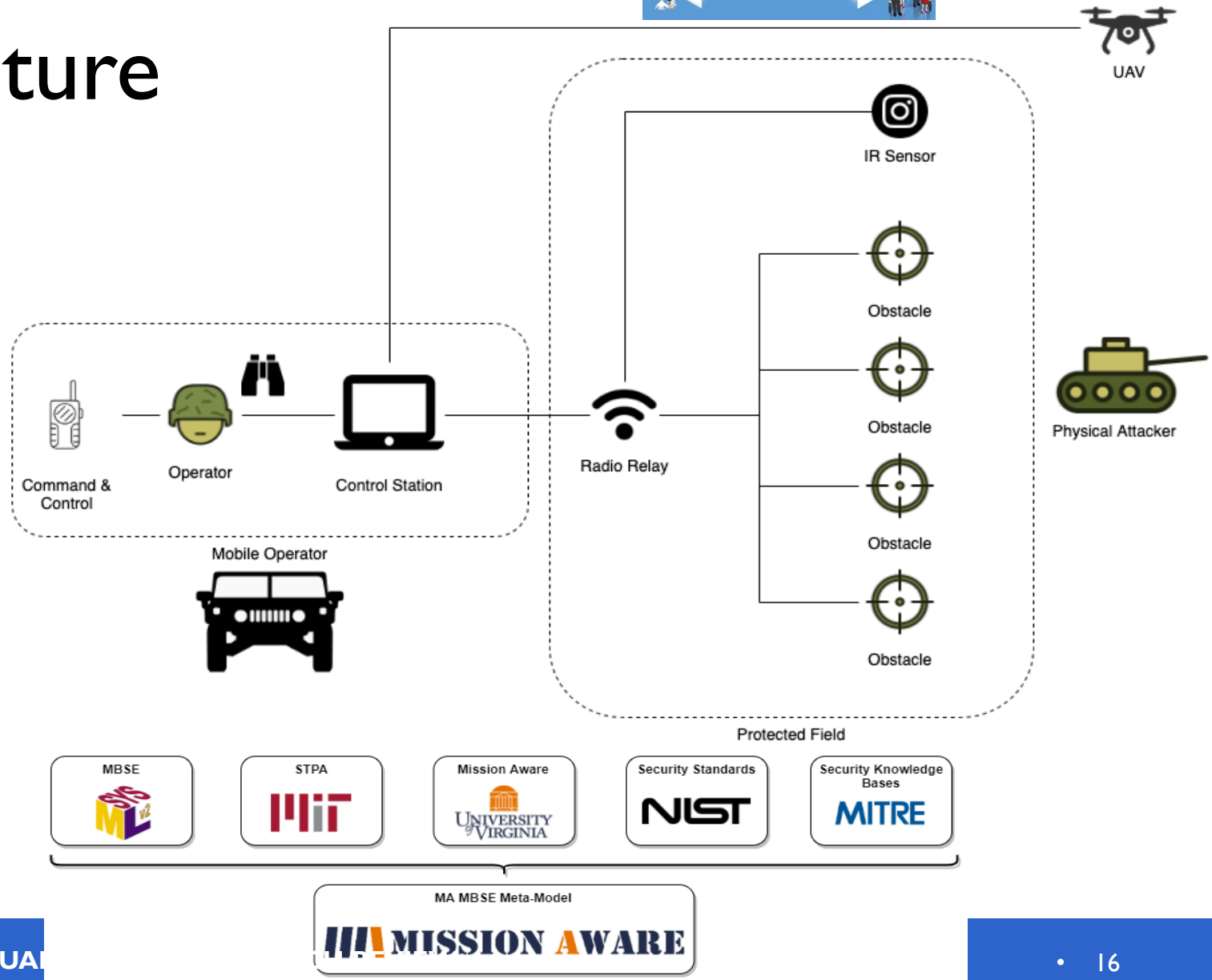
| Approved Elements | Approval Status | Approved By (SME) | Approved By (Chief-Engineer) | Completeness | Comment |
|---|---|---|---|---|---|
| Data Collection | undefined | - | - | 0 | - |
| Operational Level Stakeholder Needs | undefined | - | - | 0 | - |
| System and Operational Context | undefined | - | - | 0 | - |
| Causal Analysis | undefined | - | - | 0 | - |
| Operational Requirements | undefined | - | - | 0 | - |
| Operational Use Cases | undefined | - | - | 0 | - |
| To-be Domain Architecture | undefined | - | - | 0 | - |
| Measures of Effectiveness | undefined | - | - | 0 | - |



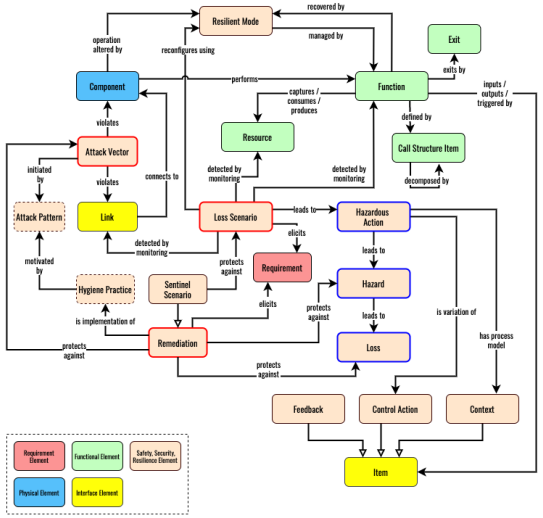
# Cyber Resilience Credential Silverfish Architecture


## Silverfish description

- Prohibited Area:
  - ~100 acres ≈ .16 sq. miles
- Obstacle Deployment:
  - ~50
  - Aligned to Compass Coordinates (Operator Observation Point)
- Cell Grid:
  - ≈ 300 ft. x 300 ft.
  - 6 Munitions per Cell (Ready/fired state)
- Vehicle Traversal:
  - Max Speed = 10 mph ≈ 15 ft/sec
  - 20 seconds/grid
  - 2.3 min/protected area

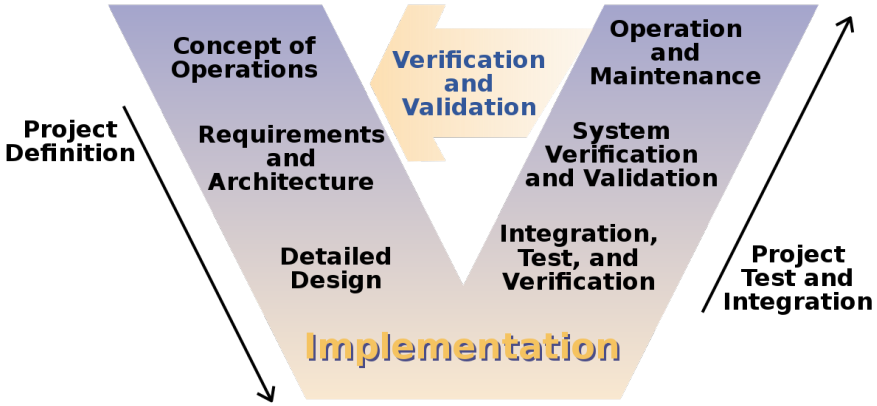


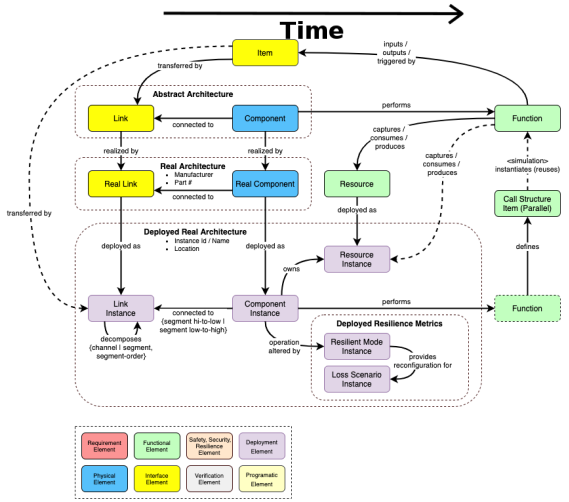

# Mapping Mission Assurance to the SE-Vee



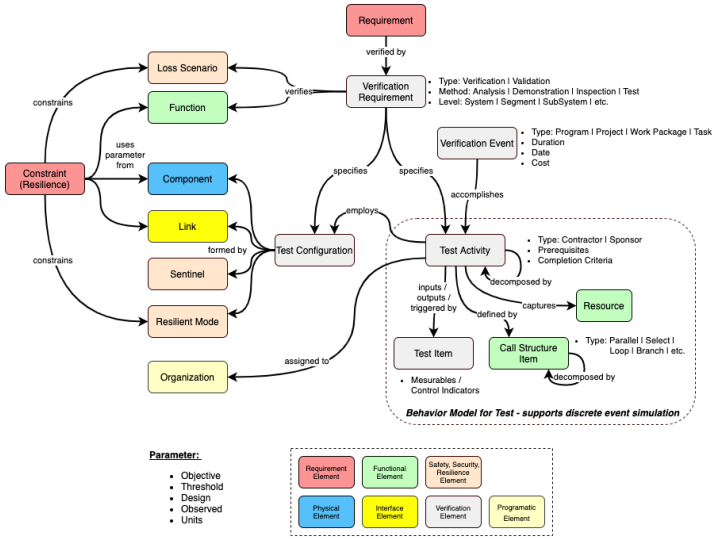

## Mission Aware Meta Model

- Meta-Models
  - MBSE Top Level
  - MBSE Essential / Detail View
  - Mission Aware Top Level
  - Mission Aware Detail View
    - STPA-Sec
    - CSA Elicited Requirements
  - Verification & Test
  - Deployment - Design Simulation



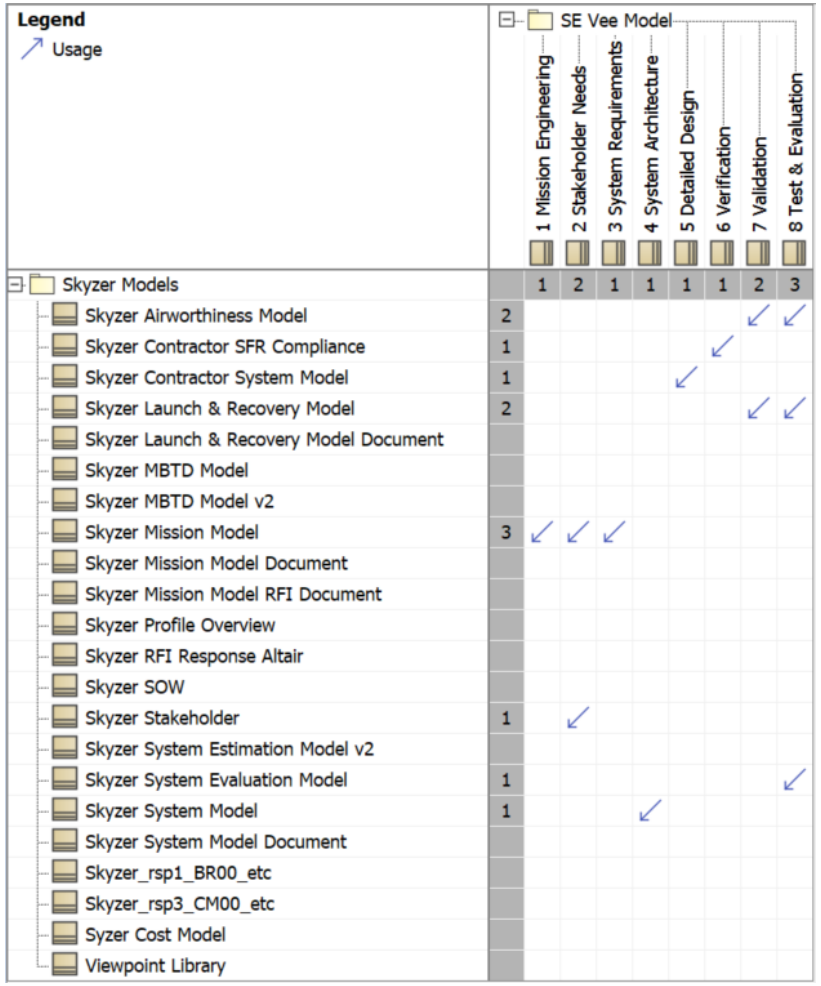

## Design Simulation Meta-Model




## Validation & Test Meta-Model

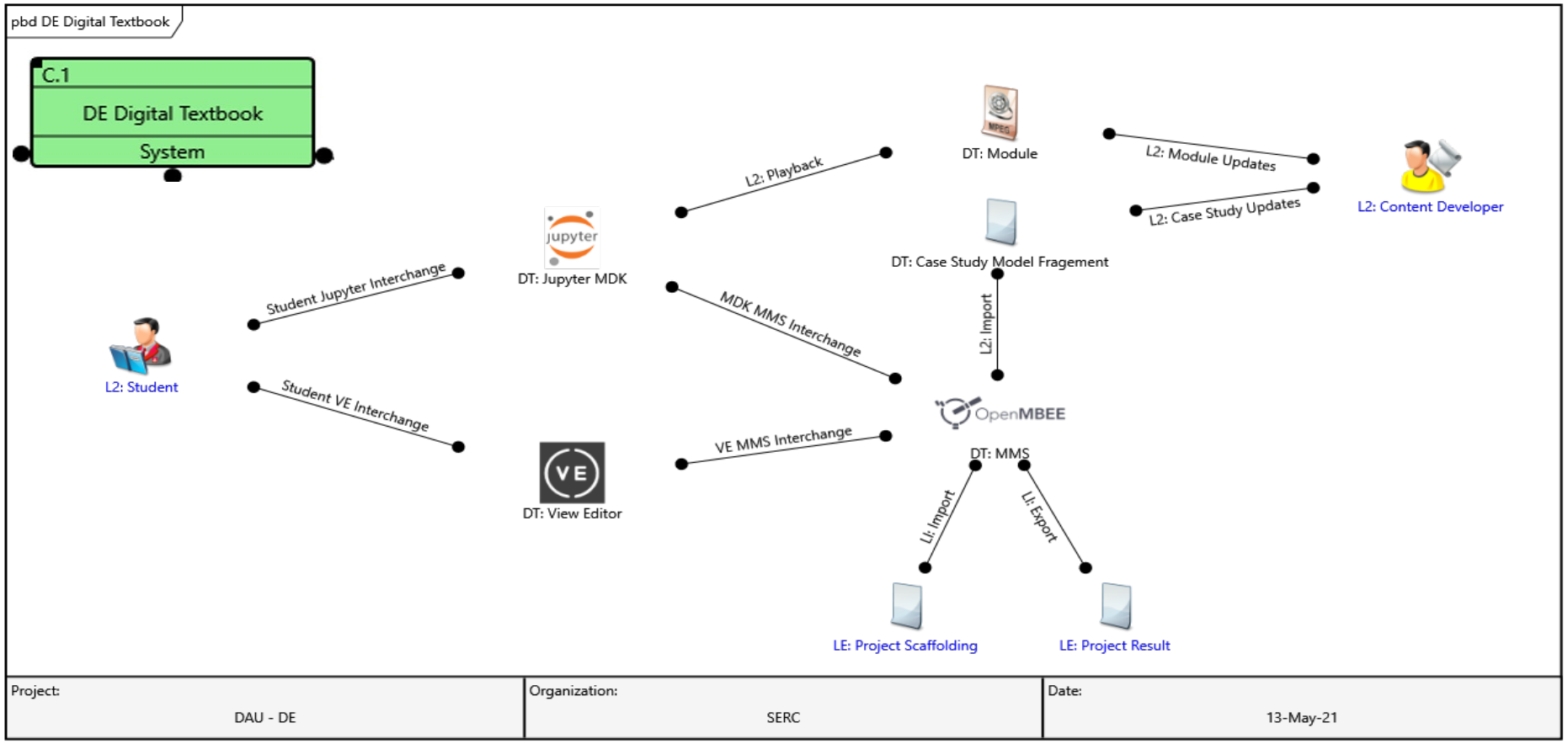
- Silverfish Case Study System Models
  - Mission / System Requirements Model
  - Use Case Model
  - Architecture Model
  - Behavior / Control Structure Model
  - Operational Risk Assessment Model (STPA)
  - Resilient Modes Model
  - Cyber Vulnerability Assessment Model
  - Verification & Test Model

# Tracking Relationships Between Models & Relevant Curriculum

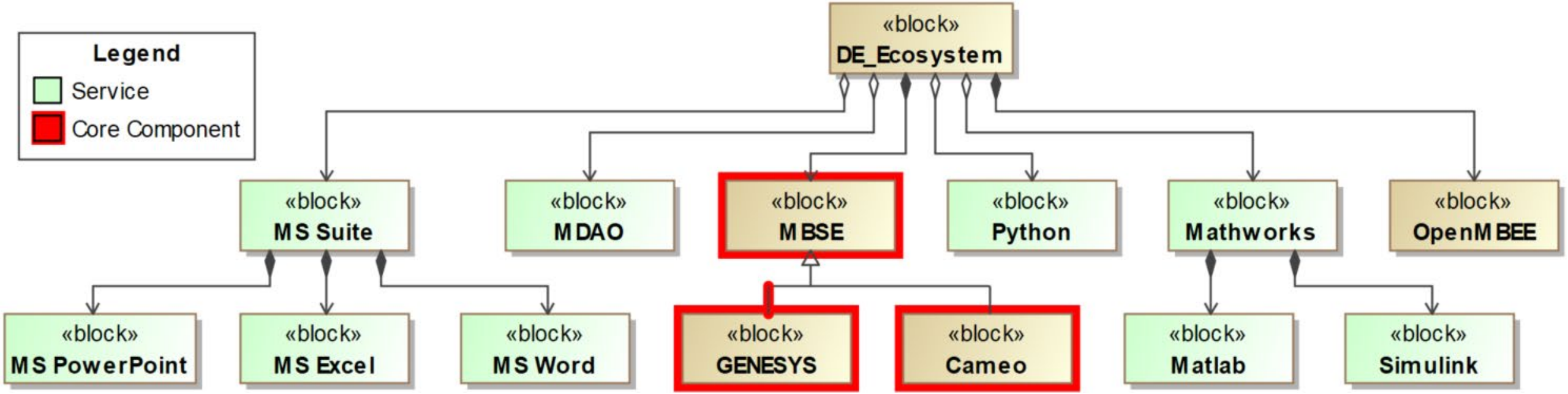



- To the left is a dependency structure matrix
- Can be read as: "Area [X] of the SE-Vee uses model [Y] from the Skyzer Ecosystem"
- NOTE: This is a work in progress
- **Importance:**
  - **Identifying coverage/gaps** in the use of Skyzer **to create lesson plans**
- Using the same approach to:
  - Map Skyzer to the acquisition Life Cycle
  - Map Skyzer models to Skyzer models
  - Map Skyzer to career fields (e.g., T&E)
  - Map Skyzer to DE credentials

# Looking to the Future: Notional DE Digital Textbook



# Lesson Learning Example: What is the Minimum DE Ecosystem?




- Open diamond is a reference relationship to a service system
  - Think On-Star in vehicle
  - If the car is wrecked, On-Star still exists
- Closed diamond is a composition relationship
  - If the car is wrecked, the component is also destroyed

- If the MBSE component is removed, then…
  - the DE Ecosystem may not exist?
  - Or…the DE Ecosystem exists with less coherence!

# WRT-1043 Team





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