"Enabling Army Readiness and Modernization Priorities"
"Build Once and Reuse Often"

Headquarters U.S. Army, Center for Army Analysis, Army Modeling and Simulation Office
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MS.ARMY.MIL
ARMY MODELING AND SIMULATION OFFICE

United States Army Modeling & Simulation Office
AMSO

U.S.ARMY

Correlated Digital Representation Across System Lifecycle

Dr. Chuck Sanders
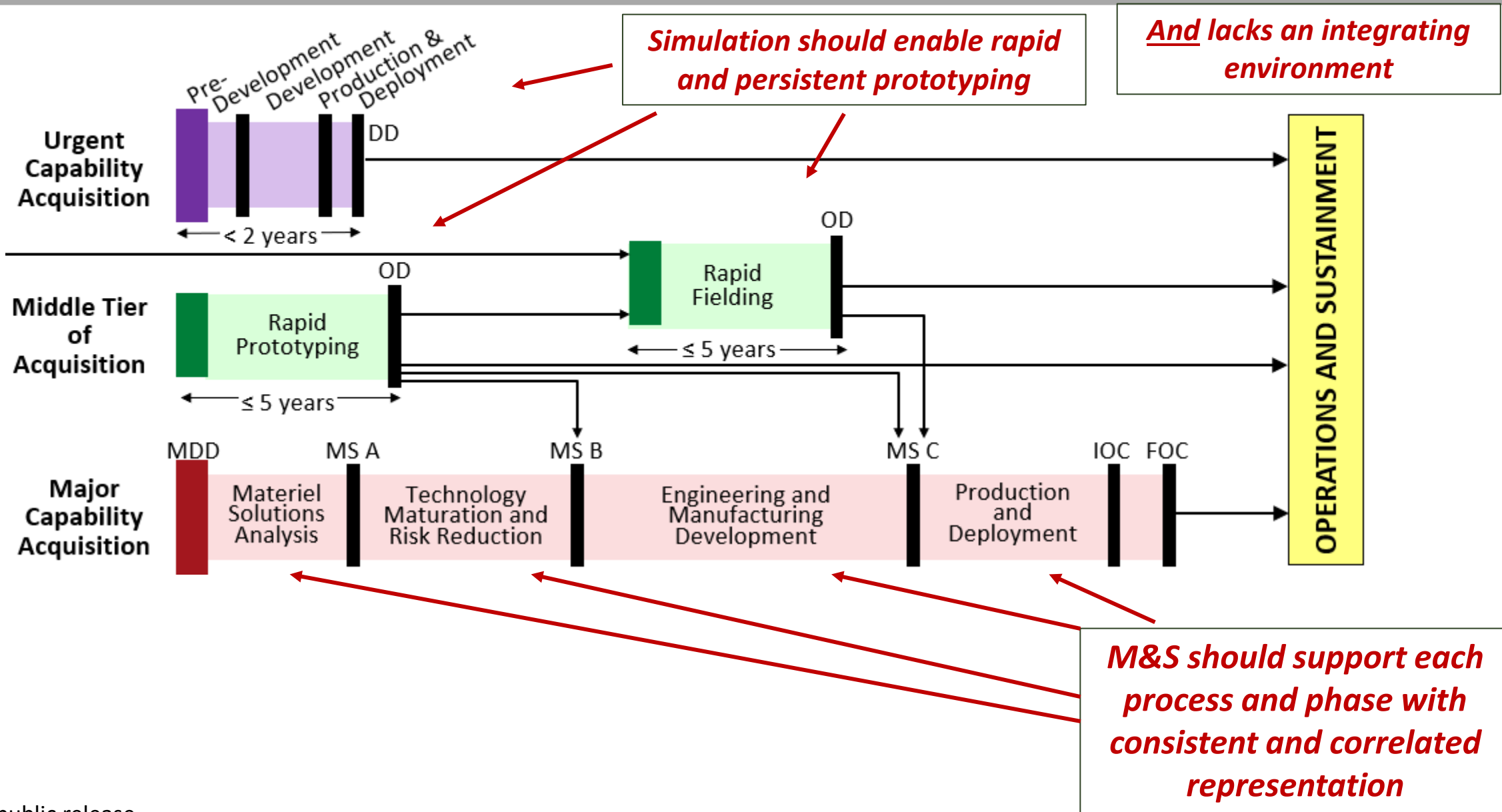~ Army Modeling and Simulation Office ~

Purpose

- To facilitate the collection, curation, and sharing of digital representation created across a system lifecycle.

- Desired outcome: Integrated simulations and systems engineering technical capabilities
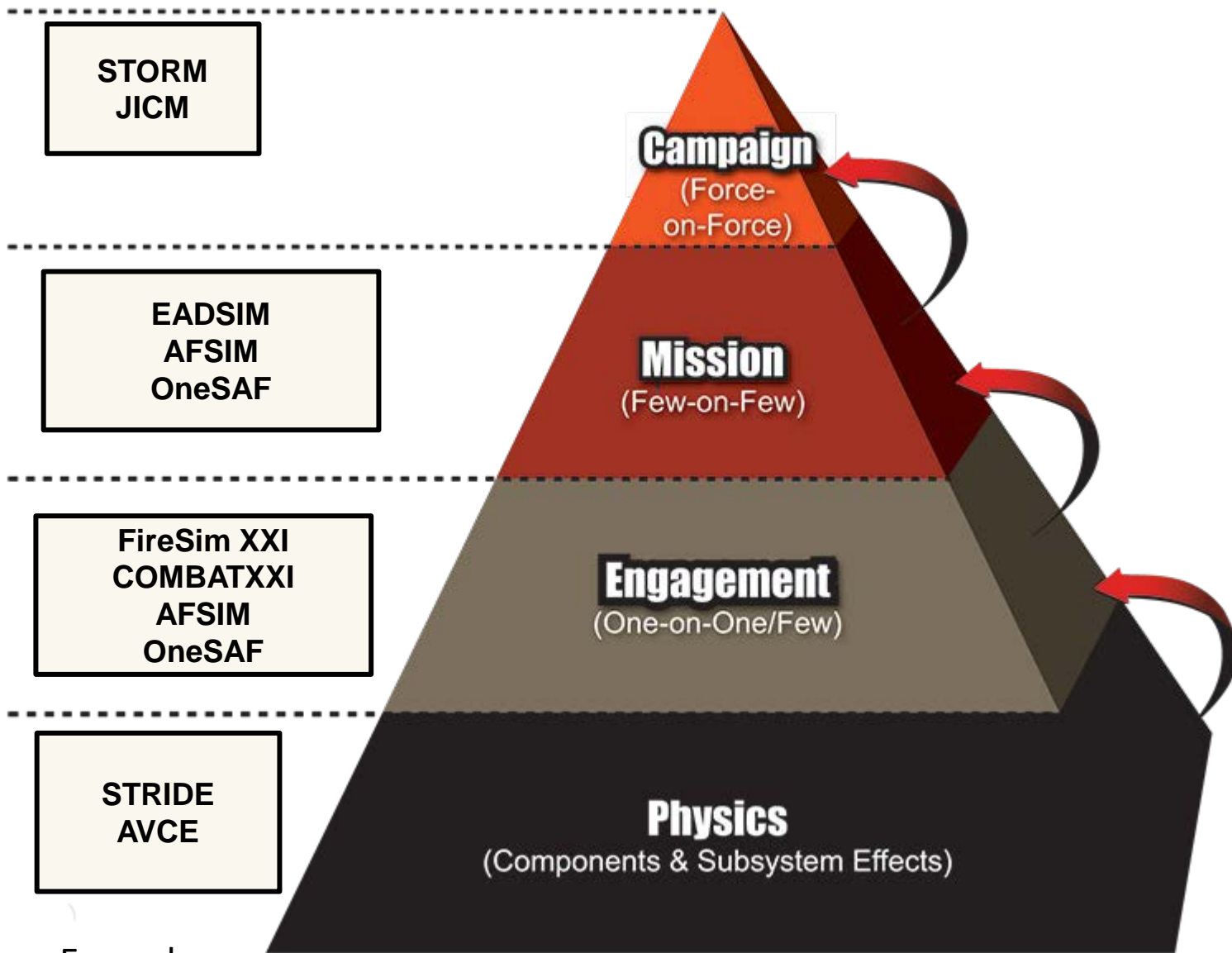
- Build once, use often
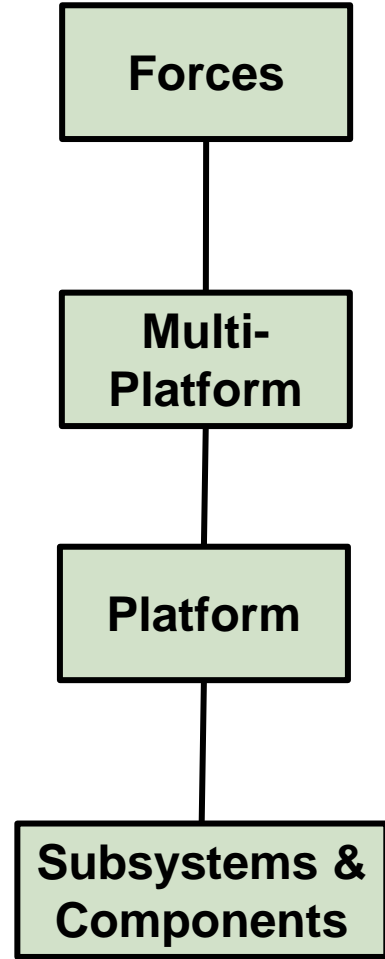
Use of Simulations Across Acquisition Framework

Simulation should enable rapid and persistent prototyping

And lacks an integrating environment

Pre-Development
Development
Production & Deployment

Urgent Capability Acquisition

DD

< 2 years

Middle Tier of Acquisition

OD

Rapid Prototyping

≤ 5 years

OD

Rapid Fielding

≤ 5 years

OPERATIONS AND SUSTAINMENT

Major Capability Acquisition

MDD

MS A

MS B

MS C

IOC FOC

Materiel Solutions Analysis

Technology Maturation and Risk Reduction

Engineering and Manufacturing Development

Production and Deployment

M&S should support each process and phase with consistent and correlated representation

DOD MODELING PYRAMID

STORM
JICM

EADSIM
AFSIM
OneSAF

FireSim XXI
COMBATXXI
AFSIM
OneSAF

STRIDE
AVCE

Examples

Campaign
(Force-on-Force)

Mission
(Few-on-Few)

Engagement
(One-on-One/Few)

Physics
(Components & Subsystem Effects)

Forces

Multi-Platform

Platform

Subsystems & Components

Modeling Fidelity Correlation Maintained

Model Types

Attrition

Engagement

Performance

Behavior

Cost

Trade Space

Logistics

Supply Chain

Engineering

4

❖Technology and threat change is outpacing Defense Acquisition <u>and</u> simulation development processes

❖Some Specifics:

- Current simulations do not support agility

- Current simulations do not adequately represent the emerging multi-domain operating environment and are difficult and costly to modify

- Continue to struggle with interoperability

- Inconsistent representation of systems, threats and operating environment across communities

- Stovepipes inhibit data and model sharing and reuse

- **What is Digital Engineering?**
  - Combines model-based techniques, digital practices, and computing infrastructure
  - Enables delivery of high pay off solutions to the warfighter at the speed of relevance

- **Reforms Business Practices**
  - Digital enterprise connects people, processes, data, and capabilities
  - Improves technical, contract, and business practices through an authoritative source of truth and digital artifacts
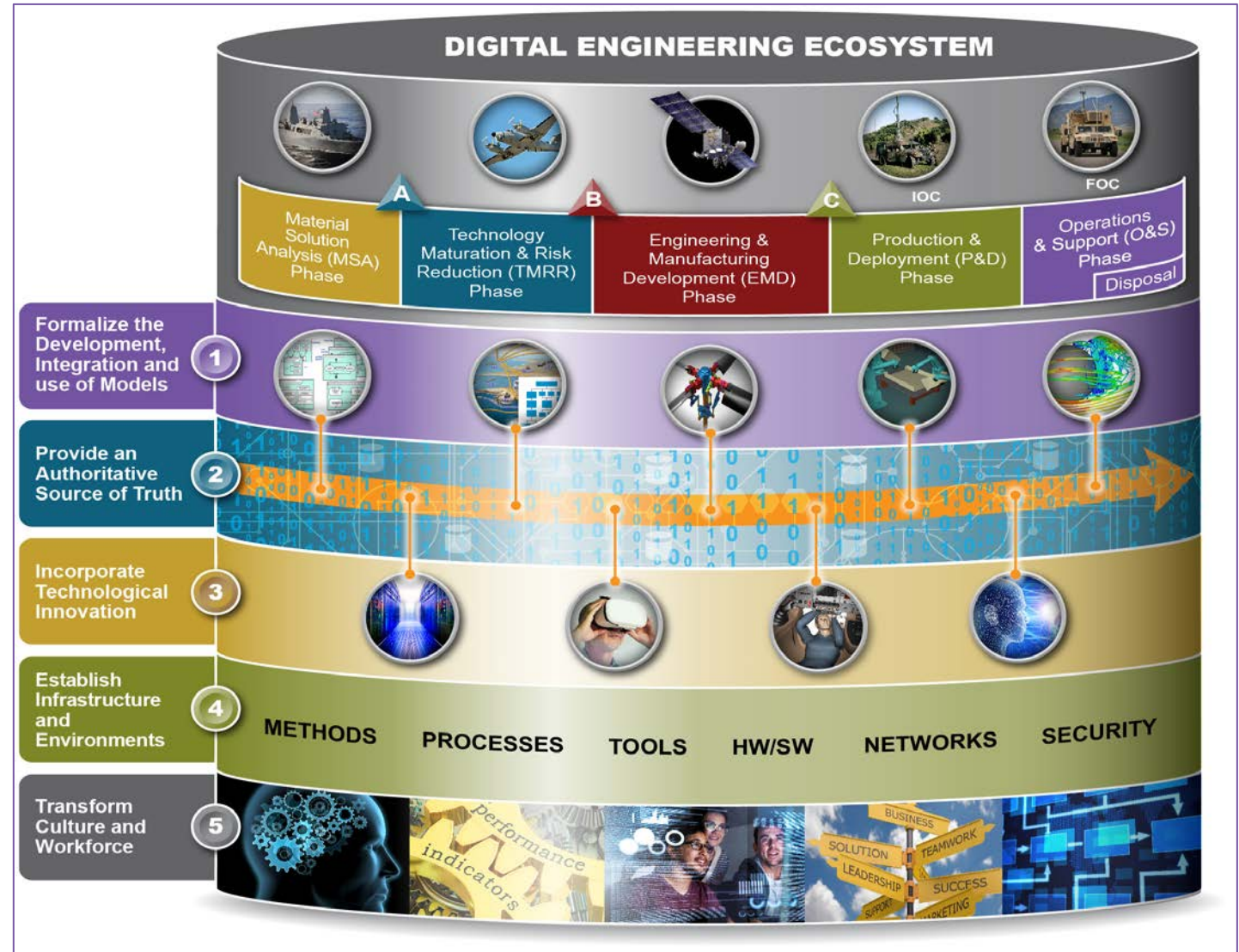
Modernizes how we design, operate, and sustain capabilities to outpace our adversaries

Boeing MBE Diamond
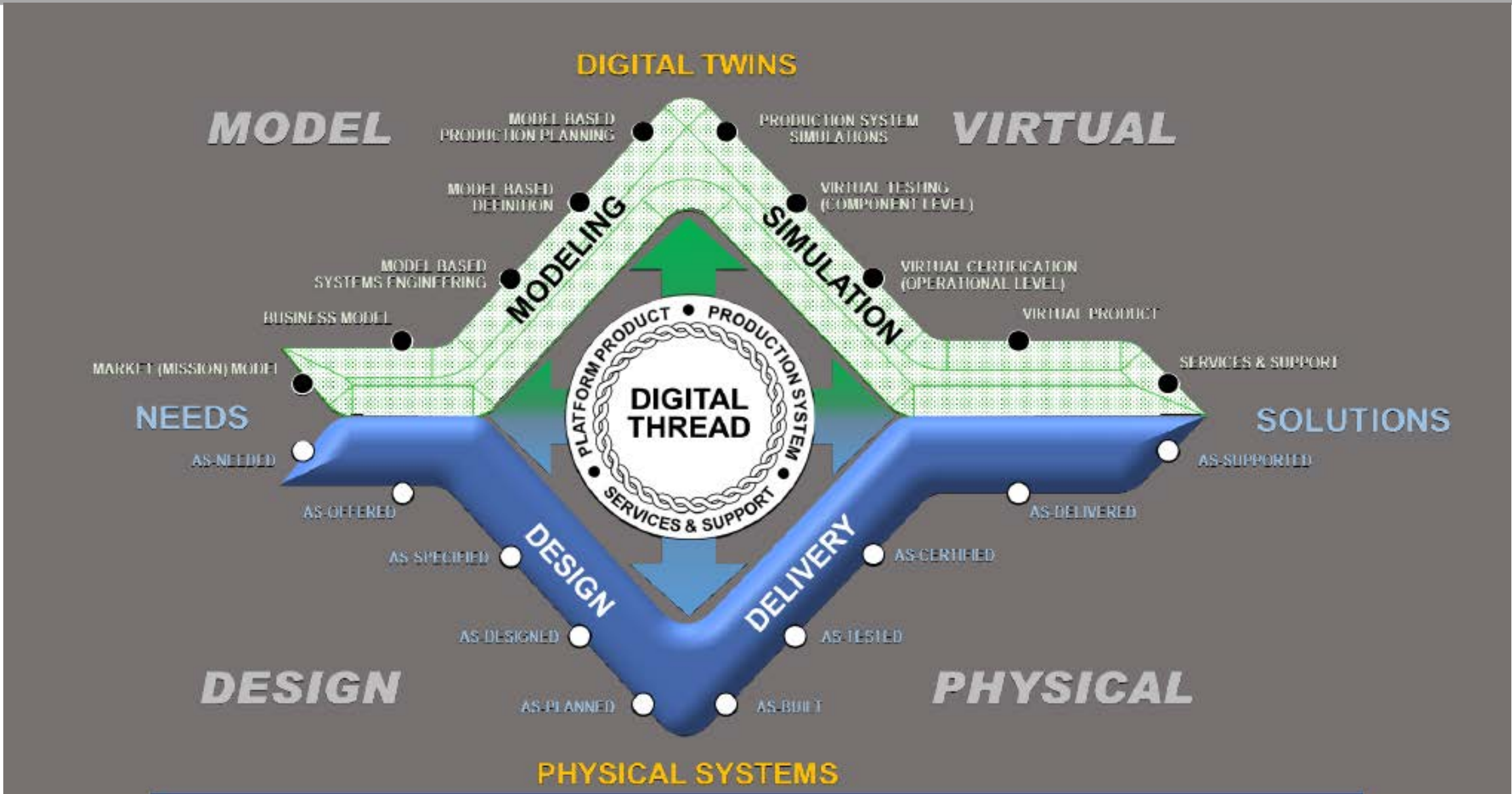
Some Army Implementations of MBSE/DE

- CCDC/AvMC – Building behavioral simulations in tandem with MBSE process

- CCDC/AC - Armament Virtual Collaboratory Environment (AVCE)

- CCDC/GVSC - Virtual Prototyping with soldier assessments

- PEO Aviation – Requirements modeling and need to link MBSE models with simulations

- PEO Missiles and Space – developing an integrated approach

"Model Based" Acquisition Toolbox
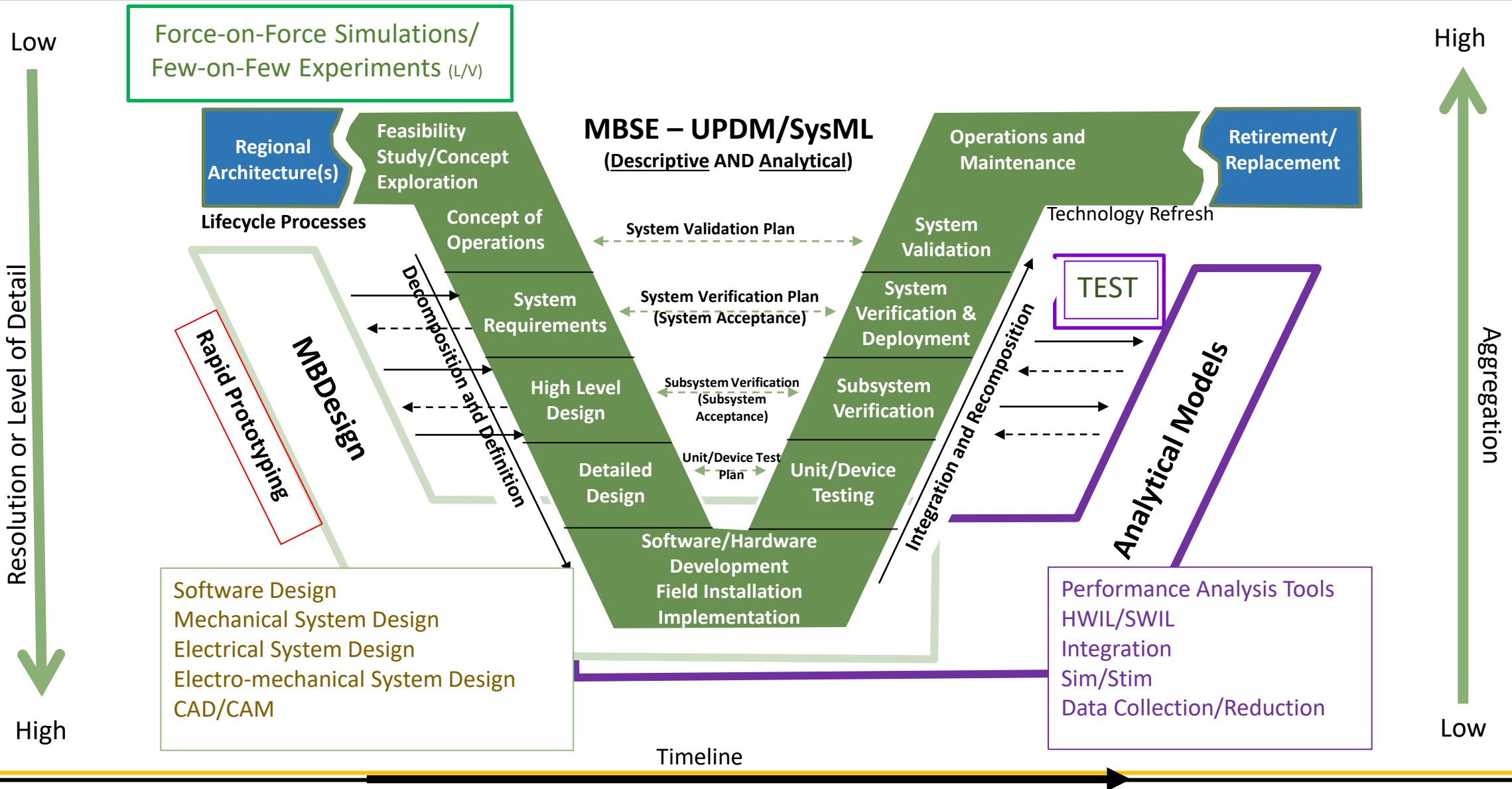
A Hierarchy of M&S Tools for Various Uses

RESOLUTION

Increasing Aggregation

Comparative Results

Increasing Resolution

Actual Performance
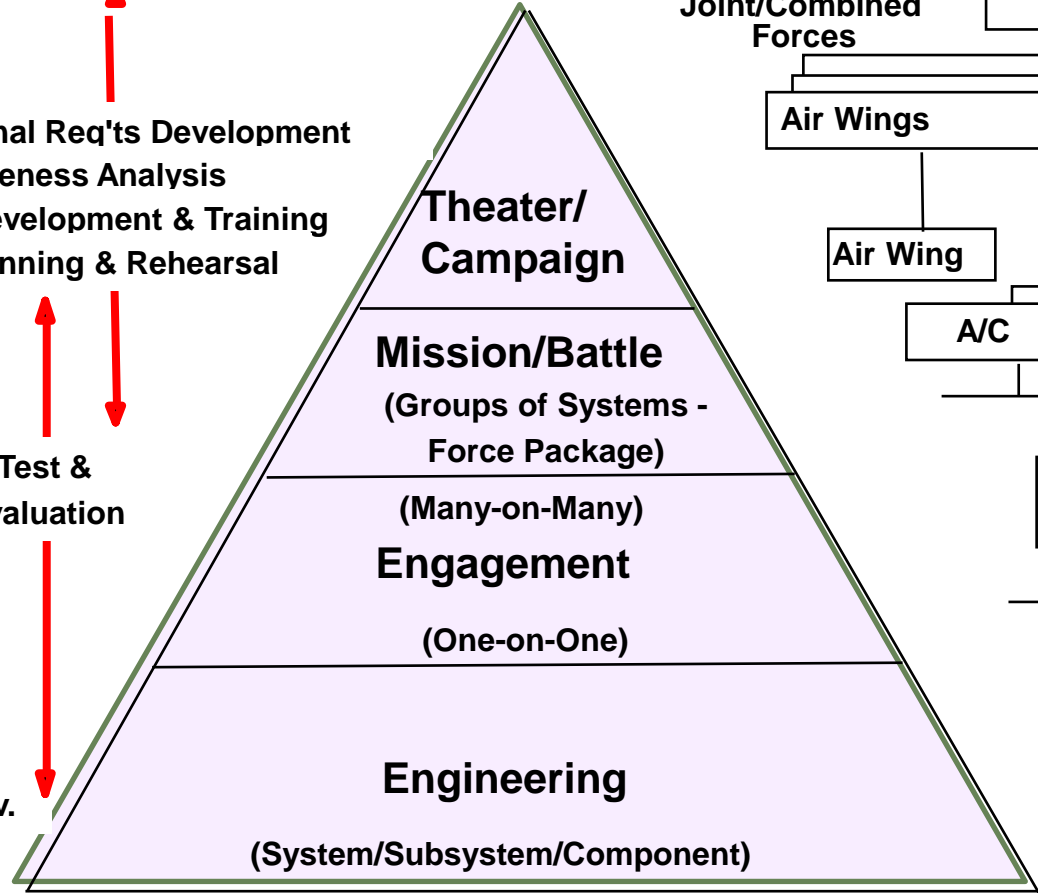
FUNCTIONS SUPPORTED

Operational Req'ts Development
Effectiveness Analysis
Tactics Development & Training
Mission Planning & Rehearsal

Test & Evaluation

Design
Manufacturing
Cost
Support
Development
Tech Req'ts Dev.

MODELS & SIMULATIONS

Theater/ Campaign

Mission/Battle
(Groups of Systems - Force Package)

(Many-on-Many)

Engagement

(One-on-One)

Engineering

(System/Subsystem/Component)

FORCE OR SYSTEM LEVEL

Joint/Combined Forces

Corps

Air Wings

Battle Groups

Air Wing

A/C   EW

Aircraft System

Air Vehicle

Fire Control

Radar

The Hierarchical Aggregation of Models reduces Fidelity significantly

Example

➤ Map MBSE system definition into an executable simulation structure

➤ Define algorithms for each simulation event

➤ Derive a common simulation data set for the system

Simulation

MBSE

Common Executable Simulation Framework

Platform Conceptual Model

Vulnerability

Algorithm/tool

Armor & Geometry

Speed & Acceleration

Algorithm/tool

Prop

Detection Range

Algorithm/tool

Sensor

Combat Vehicle Model

Platform variables

Track/Wheel

C2/AI

Wpn

Algorithm/tool

Algorithm/tool

Algorithm/tool

Based on testing and experimentation

Maneuverability

Tactical Agility

Pk

Platform Performance Data

Platform Model for Constructive Sim

Common Executable Simulation Framework

Platform Performance Data

Simulation

Approved for public release

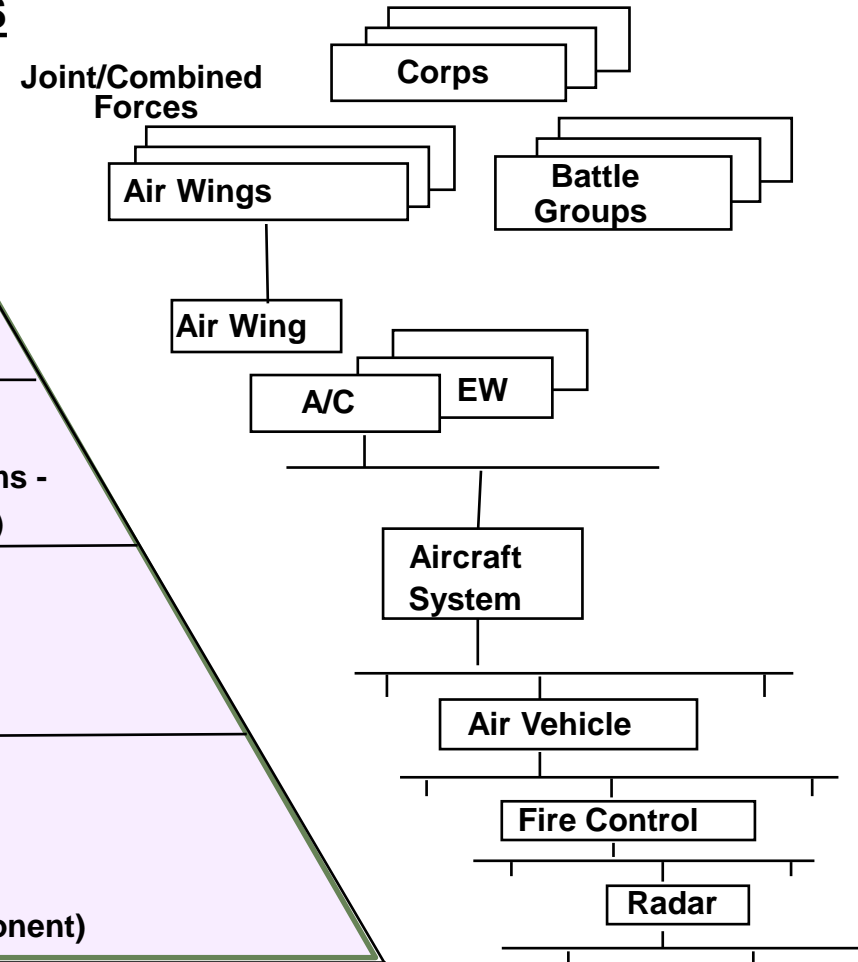# Need Consistent System Representation Across Levels
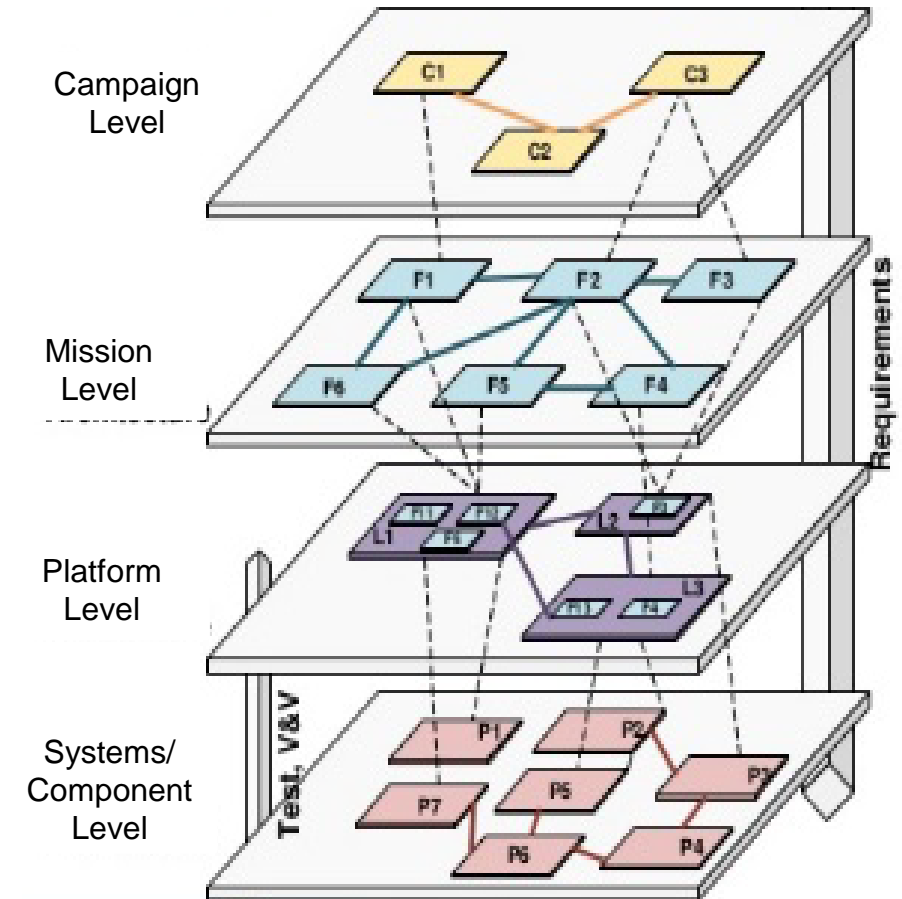
MODELS & SIMULATIONS
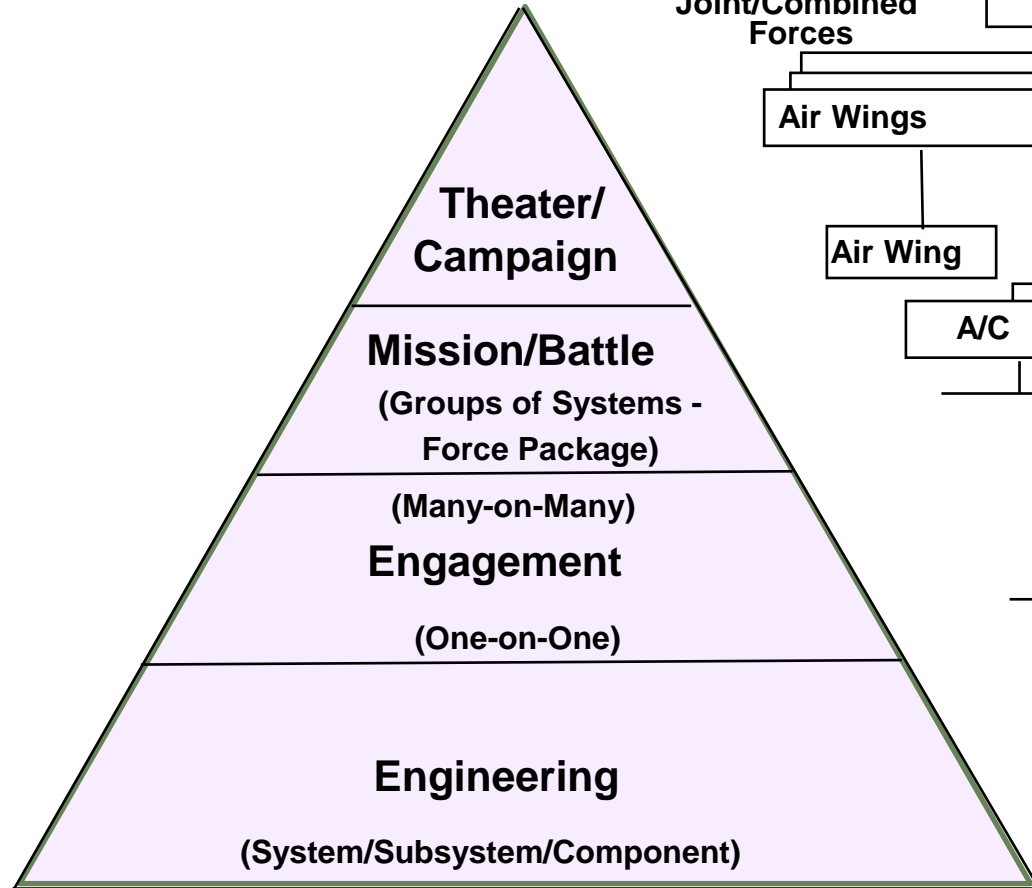
FORCE OR SYSTEM LEVEL

CORRELATED SYSTEMS DATA/MODELS

SysML Models Provide Reusable, Single Source, System Knowledge Capture

The vision is to build a system representation that allows multiple system stakeholders to extract their artifacts for their own intended use
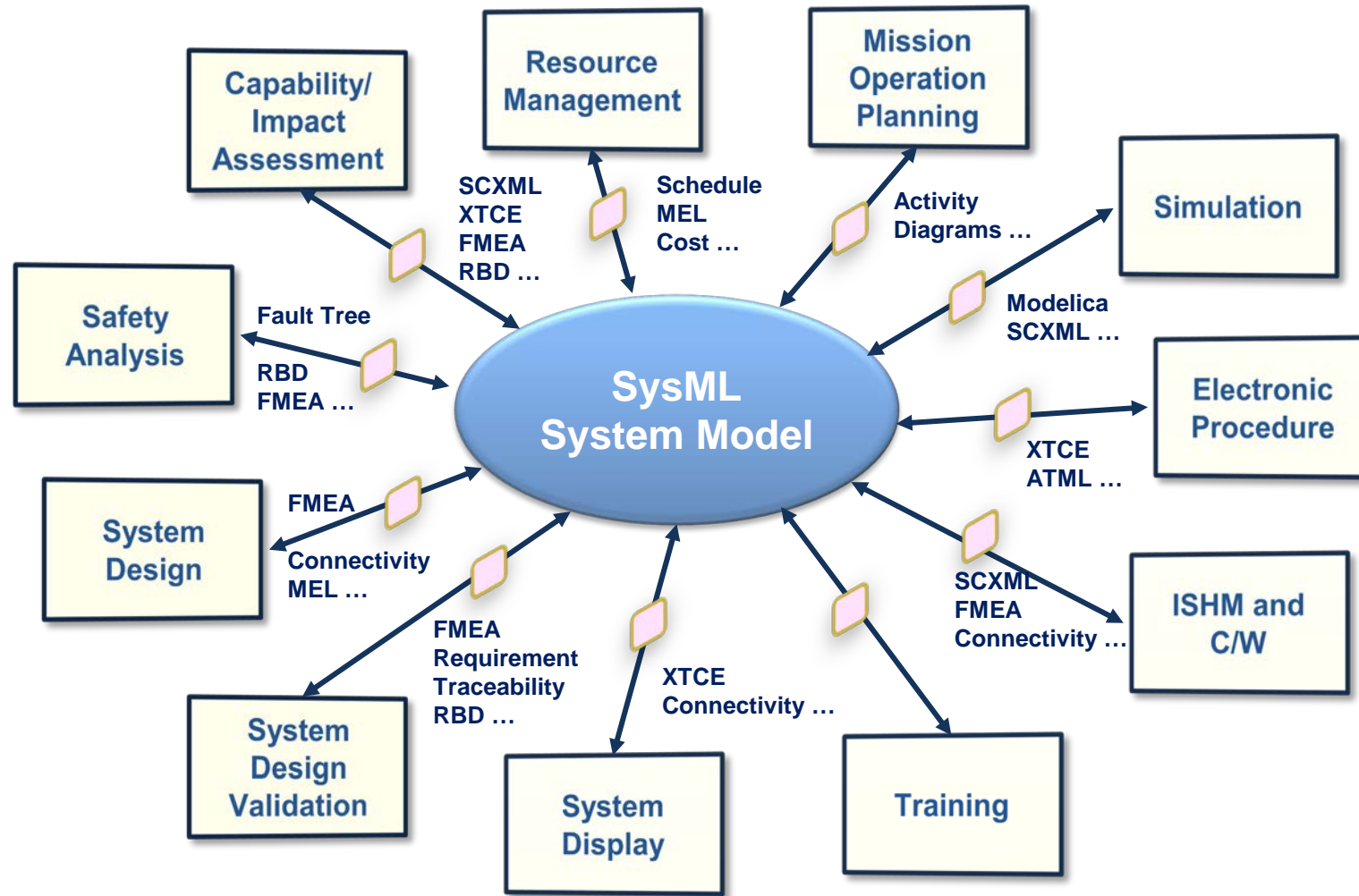
Model Once and Use Many Times

- Designed on system of systems concept

➢ Facilitate capture and reuse of data and models generated during system design and development

➢ Facilitate continuous interoperability

➢ Enable persistent prototyping

➢ Enable more effective warfighter involvement

- Built on a common modeling framework

- Shared with industry partners

Advanced Framework for Simulation, Integration, and Modelling (AFSIM)

AFSIM Application

AFSIM Framework

AFSIM Infrastructure

| Simulation Management | Time Management | Event Management | Terrain Management | Utilities | Distributed Simulation Interfaces |

AFSIM Components

| Platforms | Movers | Sensors | Weapons | Processors | Communication | Track Management |

- Movers: Core, A/A Missiles, SAMs
- Sensors: Core
- Weapons: Core
- Processors: Core, RIPR
- Communication: Core, Link 16
- Track Management: Core, MTT

Core AFSIM Models | Restricted Models | Additional Models

Approved for public release

Mission Architecture

Conceptual modeling of concepts, approaches, and systems of systems that enables details of the process flow, timing, interactions, data, capabilities, and performance to be examined in relation to the other processes, entities, and systems that contribute to achieving the mission objective

Mission Engineering Guide
Nov 2020
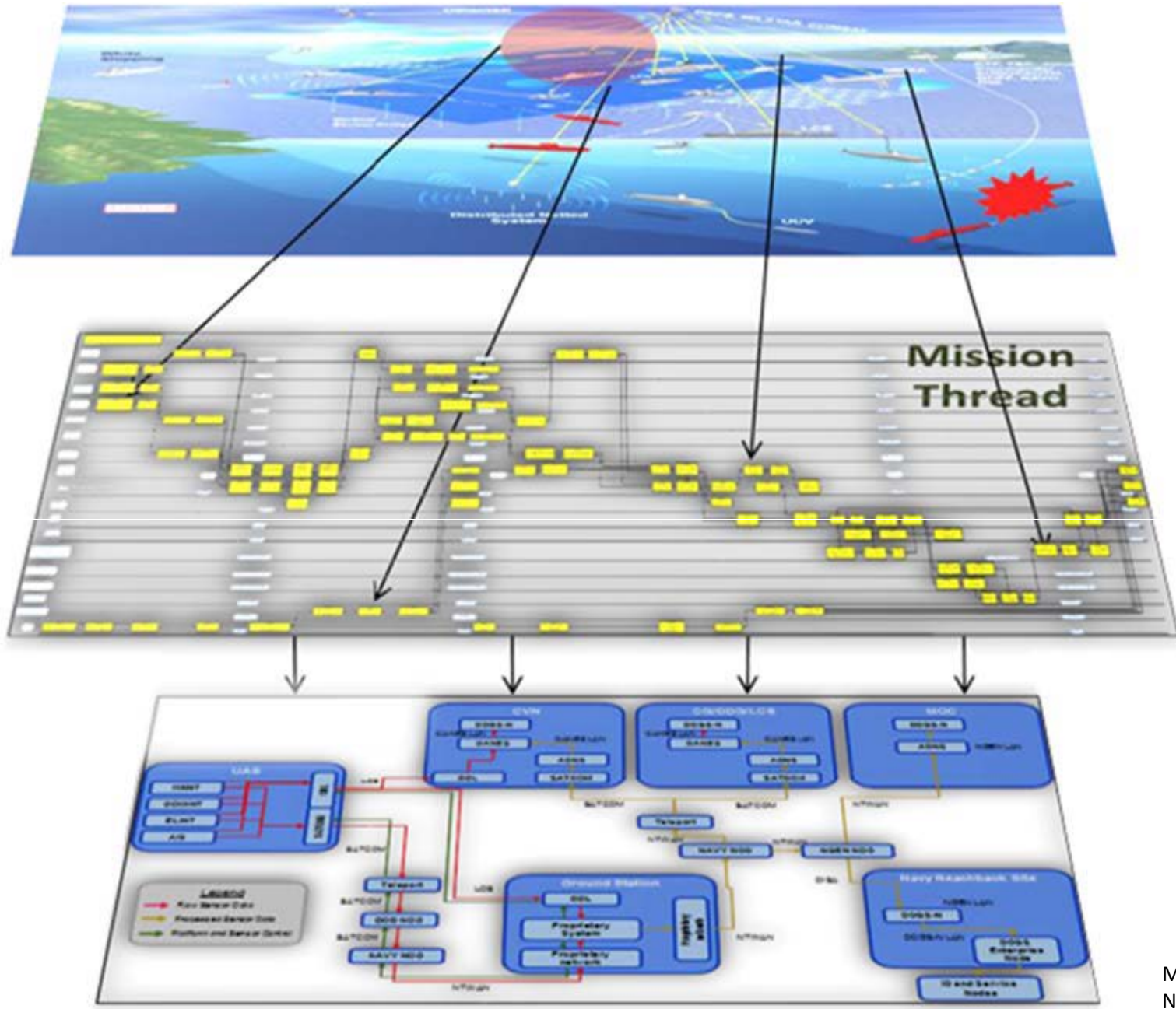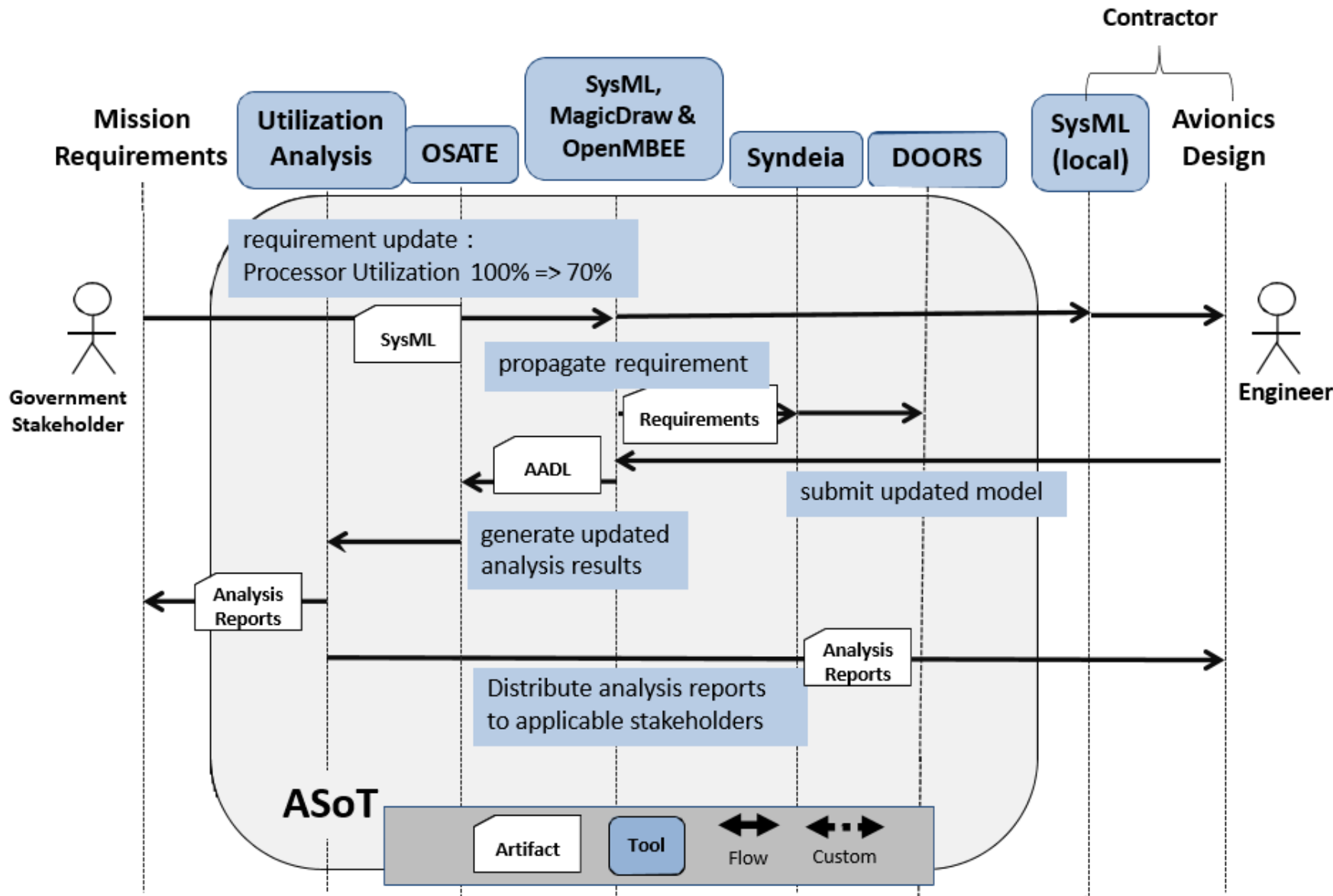
- Govt can share mission level modeling of desired system requirements
- Enable efficient sharing of industry design test results
- Industry control of IP for Govt access to system modeling

Approved for public release

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System Conceptual Model

Enterprise Conceptual Model Overview

package Enterprise [CM_EntSoSOverview]

Bruce McNaughton
Version 0.2
21-May-2019
Enterprise Conceptual
ModelOverview

This conceptual model has been created using system concepts from the System and System-of-Interest Conceptual Models.

This model is In the style of Figure 2 System-of-Interest Structure Page 12, ISO 15288:2015 Systems and Software Engineering - System Life Cycle Processes

System-of-Interest

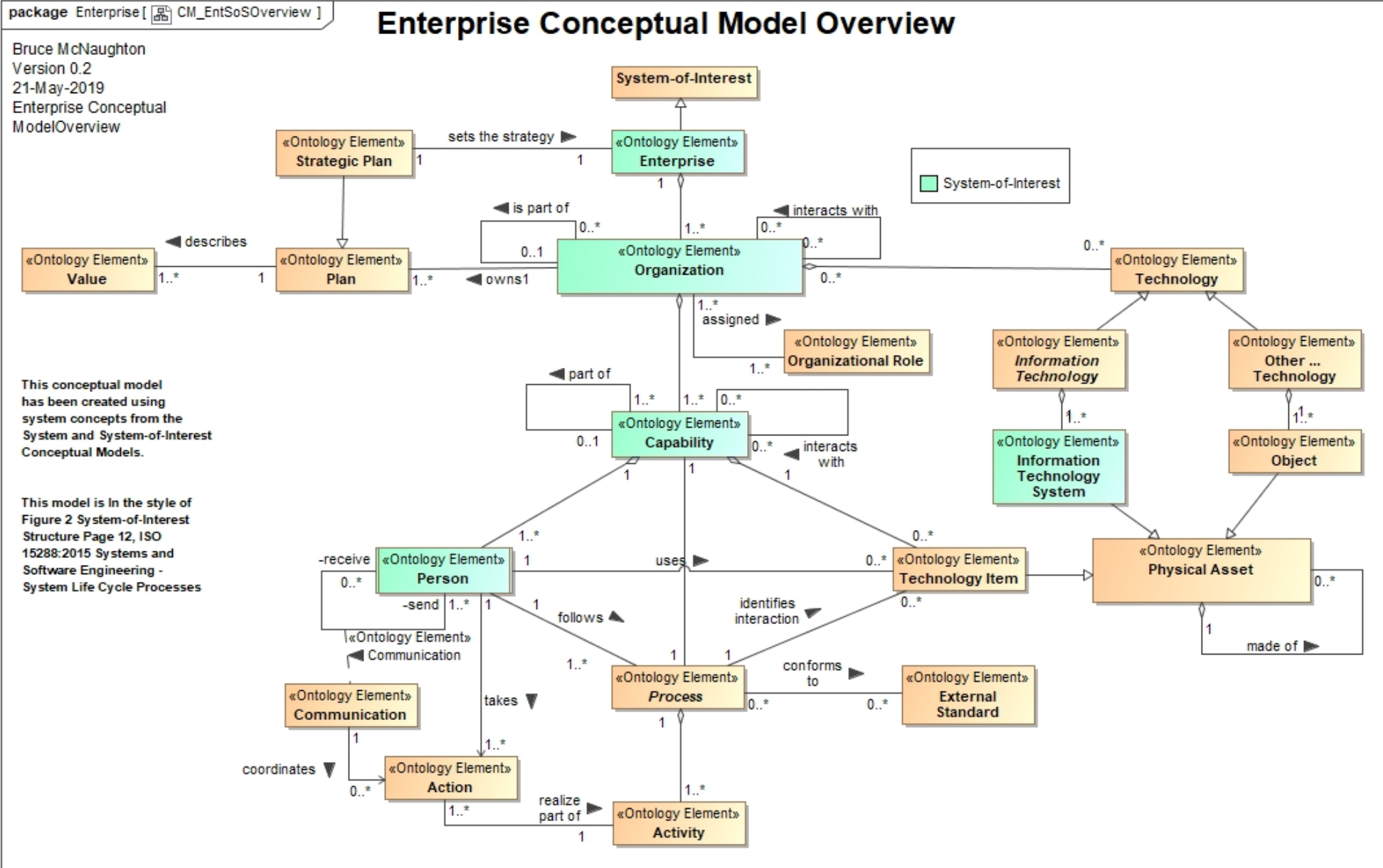«Ontology Element» **Strategic Plan** — sets the strategy ▶ — «Ontology Element» **Enterprise**

«Ontology Element» **Value** ◀ describes — «Ontology Element» **Plan** ◀ owns1 — «Ontology Element» **Organization**

◀ is part of

◀ interacts with

◀ assigned — «Ontology Element» **Organizational Role**

«Ontology Element» **Technology**

«Ontology Element» *Information Technology*

«Ontology Element» **Other ... Technology**

«Ontology Element» **Information Technology System**

«Ontology Element» **Object**

◀ part of — «Ontology Element» **Capability**

interacts with

«Ontology Element» **Person** — uses ▶ — «Ontology Element» **Technology Item** — «Ontology Element» **Physical Asset**

-receive / -send

«Ontology Element» Communication

follows ▲

identifies interaction ▶

made of ▶

«Ontology Element» **Communication** — coordinates ▼

takes ▼

«Ontology Element» **Process** — conforms to — «Ontology Element» **External Standard**

«Ontology Element» **Action** — realize part of — «Ontology Element» **Activity**

System-of-Interest (legend)

Approved for publ

20

- Modular

- Enables Composable Simulations for a variety of uses

- Varied time management

- Works with models built in other frameworks (through APIs)

- Facilitates rapid introduction of new models/data

- Correlated data repository-management service

- Can be run from the cloud

- What systems data is required for each level of representation?

- Who should collect, curate, and share systems data?

- Should the systems data/modeling be organized in a standard way?

- Who should pay for and/or build the infrastructure?

- How should the infrastructure be set up? Centralized or distributed?

- What is the role of industry? How use the infrastructure to better enable rapid development/delivery of capabilities?

- What should be the process for V&V of systems data/modeling?