Impact of Digital Engineering Strategy Release

Philomena (Phil) Zimmerman

Director, Engineering Tools and Environments

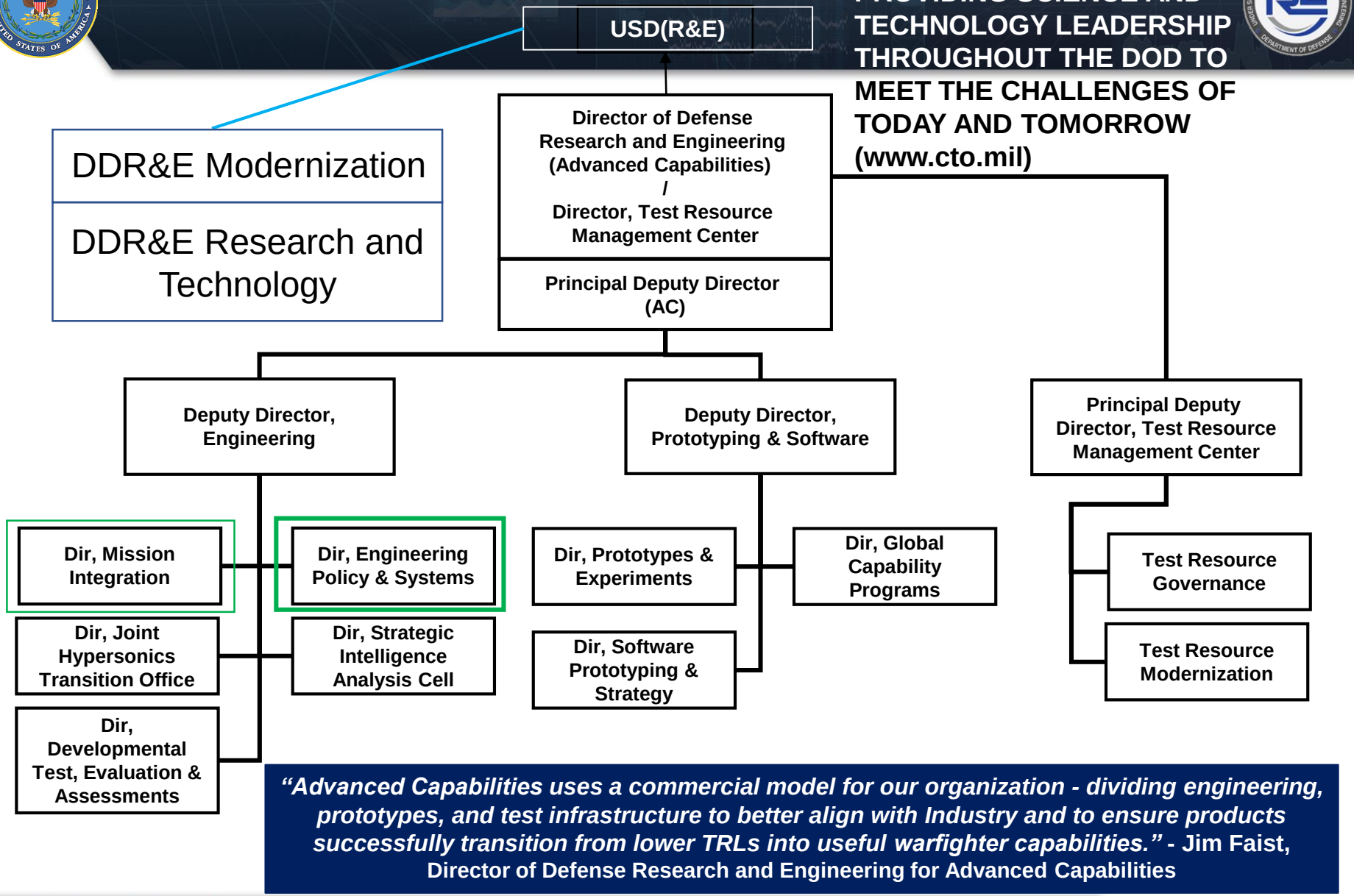
Office (OUSD Research & Engineering

(Advanced Capabilities)

Phoenix Integration

Sep 2021

PROVIDING SCIENCE AND TECHNOLOGY LEADERSHIP THROUGHOUT THE DOD TO MEET THE CHALLENGES OF TODAY AND TOMORROW (www.cto.mil)



"Advanced Capabilities uses a commercial model for our organization - dividing engineering, prototypes, and test infrastructure to better align with Industry and to ensure products successfully transition from lower TRLs into useful warfighter capabilities." **- Jim Faist, Director of Defense Research and Engineering for Advanced Capabilities**

OUSD(R&E)

The United States is in a great power competition with near-peer adversaries to develop and deploy emerging technologies such as artificial intelligence, hypersonic weapons, directed energy, and autonomous vehicles. Too often, the Department of Defense (DoD) conducts engineering activities using document-based processes and performs analyses in disparate environments, often resulting in rework, misalignment, cost overruns and delays.

In 2018, the DoD released the Digital Engineering Strategy, reminding us that we have computational capability available that will not only transform the way we engineer our systems, but also transform the capabilities we can provide to our Warfighters. Each of the Services is moving out smartly on implementing the goals outlined in the 2018 Digital Engineering Strategy. Efforts such as the Digital Engineering as a Service (USAF), Navy and Marine Corps Digital Systems Engineering Transformation Strategy and the Army's Digital Engineering Vision, and subsequent actual implementations of digitally based engineering techniques improve communication, lower risk, optimize designs in the virtual world, and shorten acquisition timelines. Implementing the goals identified in the Digital Engineering Strategy is the only we can quickly and affordably address advanced persistent threats and innovate and modernize the Department at the speed of relevance.

Digital Engineering

An integrated digital approach that uses authoritative sources of systems' data and models as a continuum across disciplines to support life cycle activities from concept through disposal

1. Formalize the **development, integration and use of models** to inform enterprise and program decision making
2. Provide an enduring **authoritative source of truth**
3. Incorporate **technological innovation** to link digital models of the actual system with the physical system in the real world
4. Establish supporting **infrastructure and environments** to perform activities, collaborate, and communicate across stakeholders
5. Transform a **culture and workforce** that adopts and supports Digital Engineering across the lifecycle

Digital Engineering Implementation

Dr. Griffin

"This strategy describes the "what" necessary to foster the use of digital engineering practices. Those implementing the practices must develop the "how" – the implementation steps necessary to apply digital engineering in each enterprise."

Service Strategies and Plans

Outlines DoD's five strategic goals for Digital Engineering initiatives

Enterprises

U.S. ARMY

U.S. AIR FORCE

Collaborative Activities

- Digital Engineering Working Group / Community of Practice and Tiger Teams
- Systems Engineering Research Center
- INCOSE/NDIA Digital Engineering Information Exchange Working Group; Conferences, etc
- Engineering WF Task Force
- DoD Digital Engineering Body of Knowledge (DEBoK)
- Align Modeling and Simulation AND Digital Engineering
- Mod/Sim CoP/Tiger Teams
- Section 231

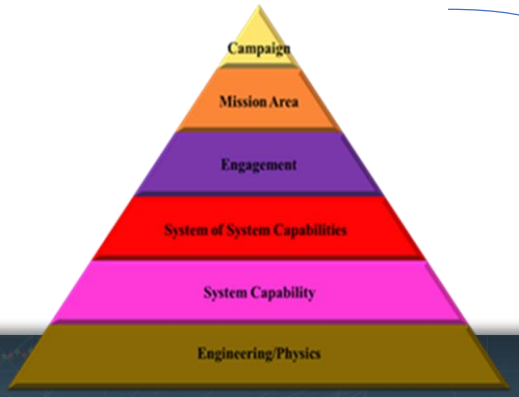
Implementing Digital Engineering Across the DoD

M&S

Digital Eng

- Defense Modeling and Simulation Coordination Office transitioned to Model and Simulation Enterprise as part of Engineering Tools and Environments
- Focus is on technical leadership and finding solution to problems for the enabling capabilities of models / simulations

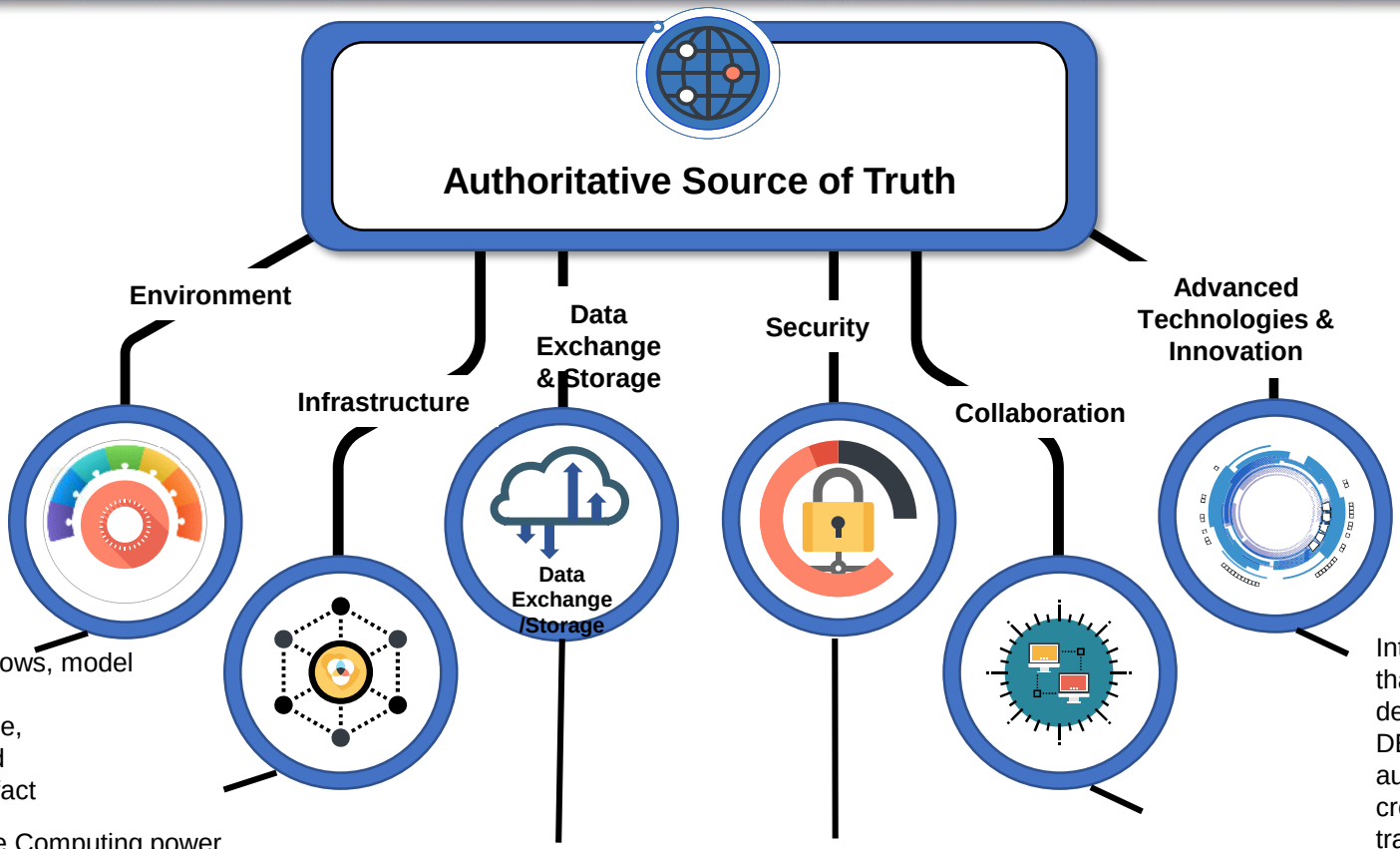
Model: A physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process; i.e. "a representation of reality"



All usable in digital engineering; what do you need to do?....

"The goals (of the Digital Engineering Strategy) promote the **use** of digital representations and components and the **use** of digital artifacts as a technical means of communication across a diverse set of stakeholders."
"Advancements in computing, modeling, data management, and analytical capabilities offer great opportunities for the engineering practice. **Applying** these tools and methods, we are shifting toward a dynamic digital engineering ecosystem."

Digital Ecosystem Requirements Key Attributes



Integrated workflows, model centric activities, automation, reuse, sustainment, and autonomous artifact generation

Hardware Computing power, Software tool suite and IT topologies of networks with flexible connectivity, extensibility and seamless Interoperability

Curated shared model and data environment with high speed throughput to broker, exchange and store data

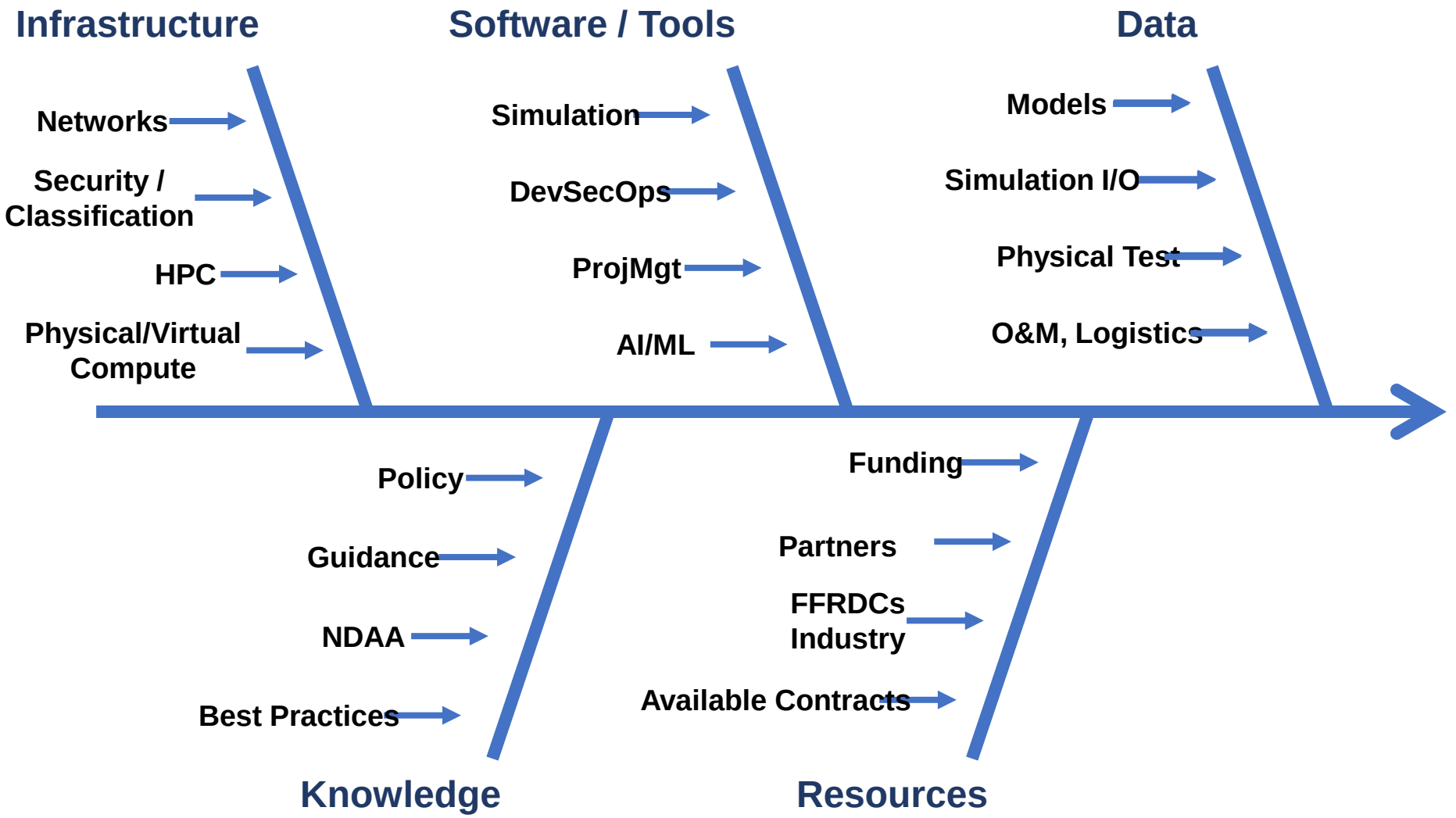
Access to secure DoD infrastructure at appropriate classifications

Collaboration across users, stakeholders, organizations, engineering disciplines, and lifecycle phases

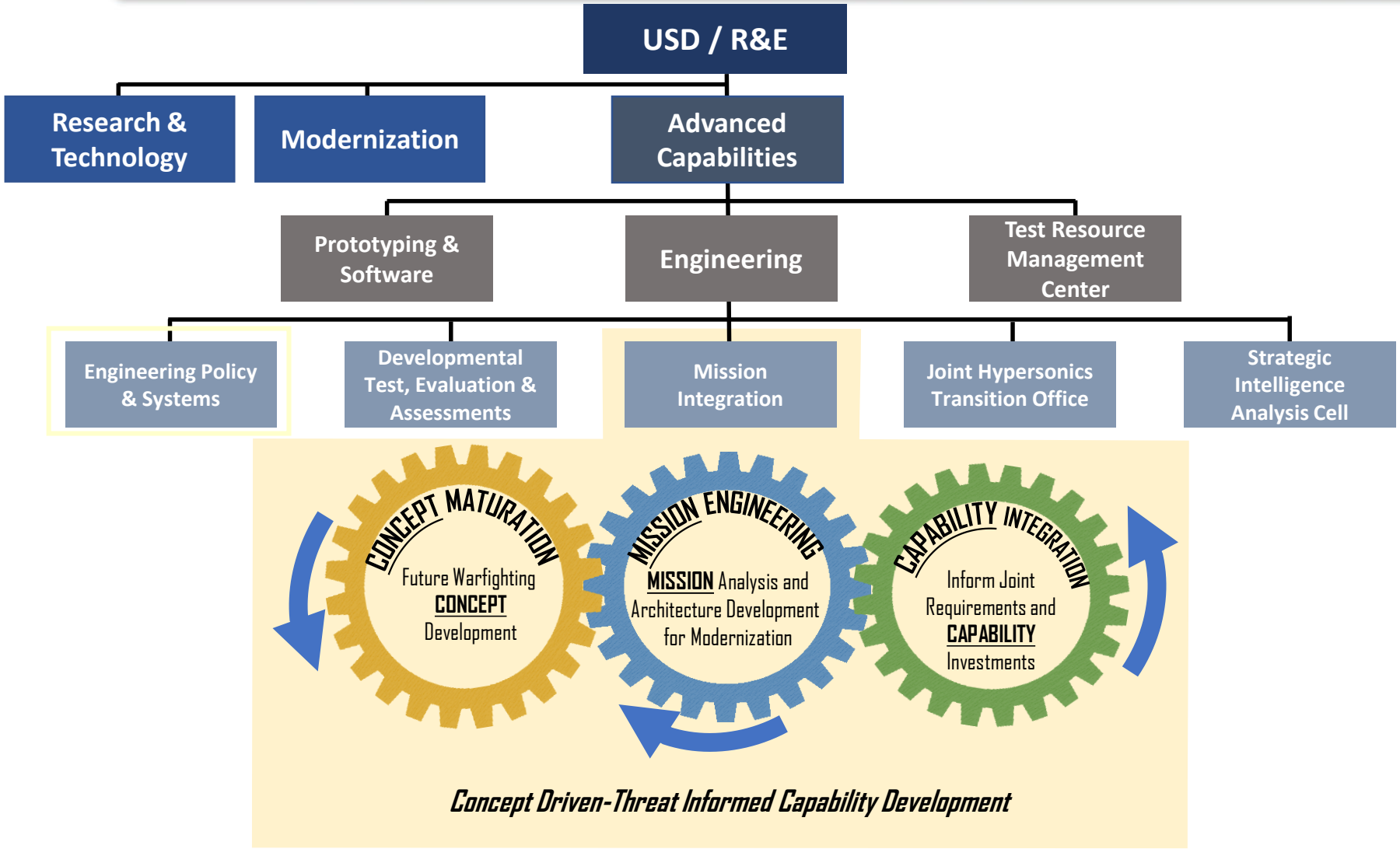
Intelligent applications that enable rigorous development, DEVOPs, prototyping, automated testing, and cross domain traceability

Driving Requirements: Tools, Cloud Migration, Concurrent Users, Classification & IT Support

Ecosystem Influencers



(U) Advanced Capabilities Organization



Mission Engineering Overview

Mission Engineering is the deliberate planning, analyzing, organizing, and integrating of current and emerging operational and system capabilities to achieve desired warfighting mission effects.

Mission Approaches To Be Explored

- Mission Setting
  - Threats/Intel
  - Scenario/Vignette
- Operational
  - Concepts of Ops./Emp.
  - Joint Warfighting Concept
- Current & Future Tech./ Capabilities

Mission Analytics

- Analyze Mission Engineering Threads
- Metrics
- Analyses
  - Gap, Sensitivity, Efficacy
- Transparency and Curation of Data
- Modeling & Simulation Tools

Mission-Focused Threat-Informed Outputs

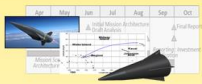
- Solution Architectures
- Mission Maturation Roadmaps
- Technology Investment Decisions
- Requirement Settings

Mission Engineering Objectives

- Mission-focused threat-informed analysis to evaluate capability solutions, advise on development of requirements and inform technology investment decisions
- Identify enhanced capabilities, technologies, system inter-dependencies, and architectures to close mission gaps
- Develop Government Reference Architectures to guide technology development, prototypes, experiments, and system-of-systems portfolio management to achieve reference missions
- Inform stakeholders on building the right things, not just building things right; align capability maturation relevant to the evolving threat and future warfighter needs

STUDIES

Rapid Precision Strike



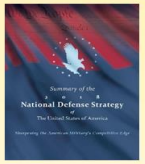
Time Sensitive Targeting

Directed Energy

ARCHITECTURE

JADC2

R&E AD Modernization

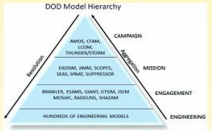


PROCESS & TOOLS

DoDI 5000.EN

Mission Engineering Guide

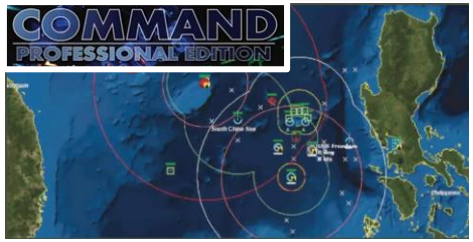
Digital Ecosystem



Simulation Tools

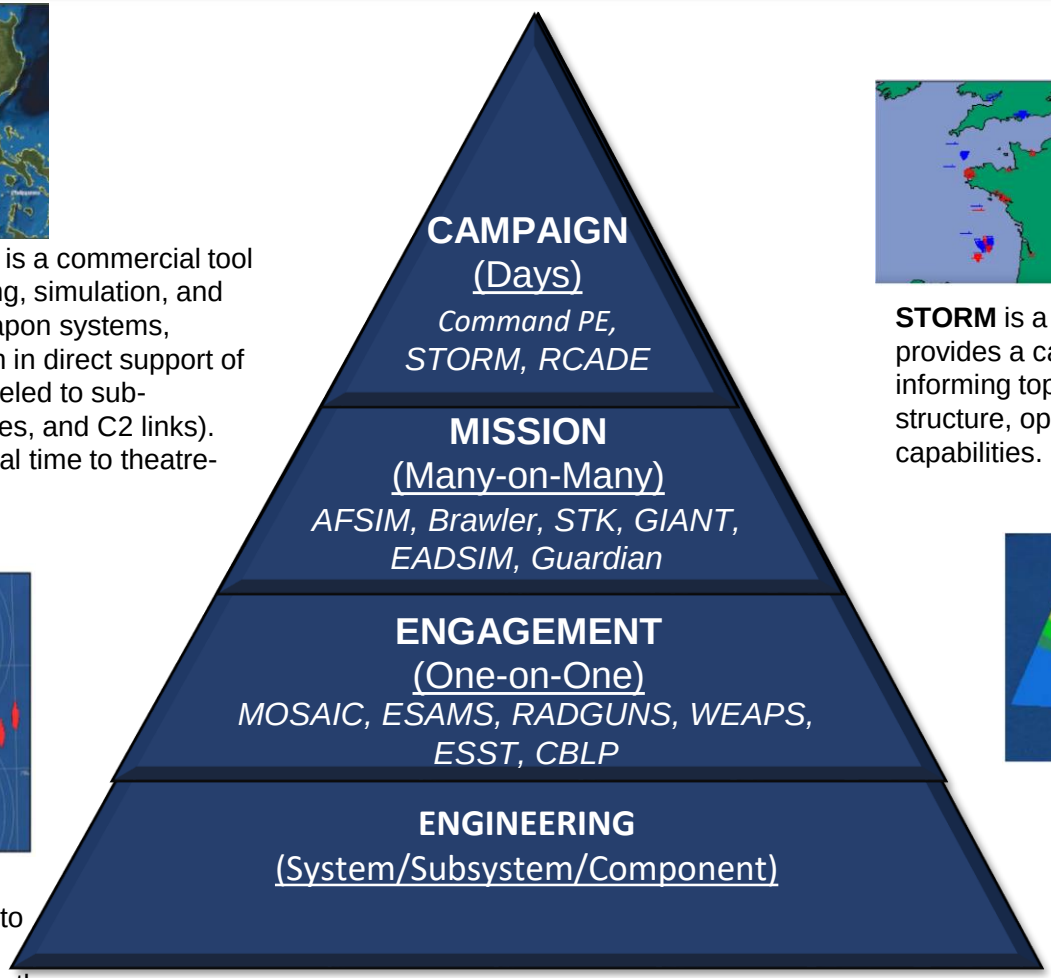
Mission Engineering analyzes Systems and Systems of Systems in a Operational Mission context

Mission Engineering Simulation Pyramid, e.g.



Command Professional Edition is a commercial tool that provides wargaming, modeling, simulation, and analysis of operational plans, weapon systems, logistics, and energy consumption in direct support of today's Warfighter. Units are modeled to sub-components (e.g., sensors, engines, and C2 links). Scaling from a simple 1-vs-1 in real time to theatre-level strategic engagements.

AFSIM is a government tool that covers domains from sub-surface to space and is used for a broad spectrum of simulations, to include the engineering, engagement, mission, and "campaign-lite'' level through the use of analytic wargaming and experimentation.



STORM is a government model that provides a campaign analysis tool to aid in informing top-level decision makers on force structure, operational concepts, and military capabilities.

GIANT provides a "many-versus-many" constructive and repeatable simulation to determine GPS and Inertial Navigation System (INS) performance along with weapon system operational effectiveness in an optional GPS interference or noise jamming environment.

Mission Engineering leverages variety of digital tools to produce quantitative results.

ME Digital Environment, Tools and Models

Mission Engineering Database

Attributes:

- Transparency of program performance data
- Collaborative mission efficacy analysis
- Curation of data — accuracy of analyses depends on pedigree of data

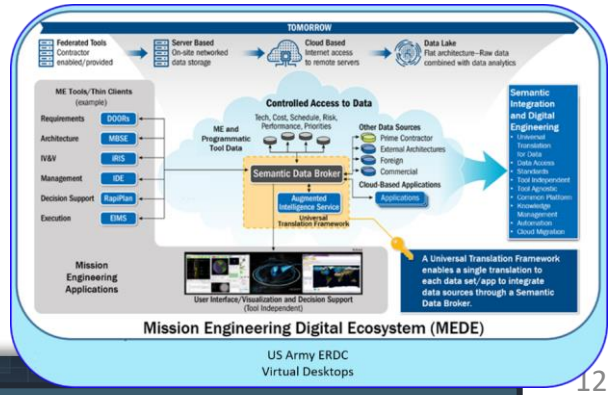
Raw data, scenario definitions, model files, documents, study scope, and analytical results

Data Management	Data Storage	Catalog
Consolidate raw data from the different studies	Standardize source document data for later use	Create and manage templates used on the studies
POC for studies to retrieve data that has already been used	Manage folders and storing process of data	Store input/ output/ results data from studies
		Create and manage categorizations to cross-link elements

Previous Analyses | **Technical Data** | **Architectures** | **Models**

Mission Engineering Digital Environment (MEDE) combines technologies, software, and a computer network infrastructure to support end-to-end mission engineering efforts.

- **Simulation tools**
- **Analytic tools**
- **Access by FFRDCs & government partners**
- **Collaborative**
- **Scalable**
- **Unclass & Secret**



ME requires shared knowledge and a digital ecosystem for effective collaboration.

Digital Ecosystem Pipeline

<u>Align</u>
Policy & Guidance
Digital Engineering
Requirements
Architectures
Roadmaps &
Assessments
DoD 5000 artifacts
Standardized data
formats
Cultural Shift

<u>Leverage Cloud
Infrastructure</u>
Shared Cloud Space
Software Development
Artificial Intelligence
Machine Learning
High Performance
Computing
Tool repository
Big Data Analytics
Visualization

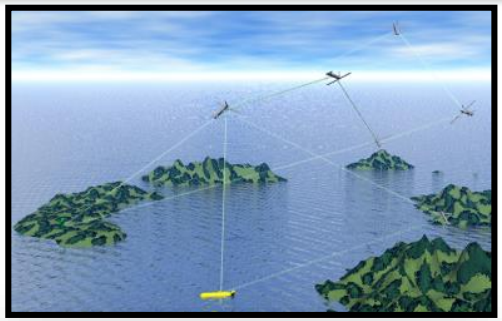
<u>Development & Testing</u>
Software Development
DEVSECOPS
Configuration Management
Design Reviews
Assess
Testing
DoD 5000 artifacts
Visualization

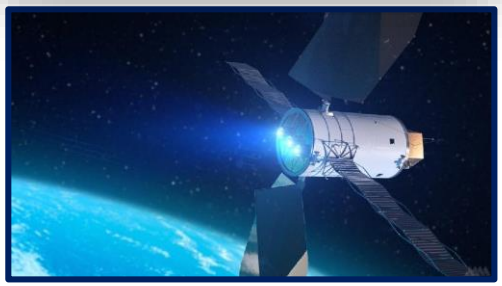
<u>Manage, Share & Curate
Data</u>
Data Accessibility
Data Discoverability
Knowledge Management
Visualization
Bodies of Knowledge
Automated Reports
Visualization

Improve the Pipeline to the Warfighter

In Closing…..

- **Digital Engineering remains “the what”, not “the how”**
- **Digital Engineering Strategy 5 goals remain an effective means to concentrate necessary activities to move system engineering practice into a digital execution**





Digital Engineering isn’t just for acquisition of systems; it’s as widely applicable as Systems Engineering is….

DoD Research and Engineering Enterprise

Creating the Technologies of the Future Fight

Point of Contact Digital Eng:

Ms. Phil Zimmerman

Dir, Engineering Tools and Env

OUSD (R&E), Advanced Capabilities, Engineering, Engineering, Policy and Systems

571 372 6695

Philomena.m.Zimmerman.civ@mail.mil

Point of Contact Mission Eng:

Mr. Marc Goldenberg

Chief Engineering, Mission Engineering

OUSD (R&E), Advanced Capabilities, Engineering, Mission Integration

703-692-6551

marc.j.goldenberg.civ@mail.mil

DoD Research and Engineering Enterprise

https://www.CTO.mil/

Twitter

@DoDCTO

US Army

The old saying is that ‘an army runs on its stomach.’ But that’s’ not quite the case anymore. With our feet firmly planted in the digital age, our Army doesn’t run on its stomach – it runs on data.

The Army is turning to “**digital-twin” technology** to resolve challenges and boost efficiencies for its enduring fleet of Black Hawk helicopters. “The intent of the **UH-60L program** is to demonstrate the application of this technology in fleet sustainment operations to increase timelines and operational readiness, reduce the cost of documentation, and increase sustainment affordability

Future Vertical Lift (FVL) Architecture Framework (FAF) represents a baseline of digital content aligning **MBSE processes, concepts, tools and guidance** across the FVL Family of Systems. FAF is a MOSA and MBSE enabler to address system architecture development and implementation, and the Government’s vision for an authoritative single source of truth.

US Navy

The DON embraces Digital Engineering as a means to maximize agility, interoperability, reusability, and scalability across the Navy. The Navy and Marine Corps Digital Systems Engineering Transformation Strategy, released in June 2020, specifies activities to enhance our engineering acquisition practices. Our strategy …. transforms how we support acquisition and informs designers, developers, managers, and technical authority stakeholders with continuous access to authoritative data. Our strategy shifts the practice of systems engineering from traditional document-centric activities to digital-centric activities. It also supports common application across the Navy and Marine Corps, as well as provision and access to digital models and data applied in a Model-based Systems Engineering approach in order to improve the understanding, quality, consistency and timely delivery of warfighter capability across all domains, and across all stages of the program lifecycle. …. We continue to expand our efforts, working with our industry partners to provide a standard of practice that delivers affordable, lethal capabilities to the warfighter at the speed of relevance. Our plans include connecting the IME to the Department of Navy High Performance Computing Network. This will provide potential for "digital threads" of information to be conveyed and used for physic-based models, architectural models, digital testing, digital twins, and data analytics supporting decision-making across the life cycle of programs from inception to development, production, and sustainment.

US Air Force

…. digital engineering starts with model-based systems engineering. And we've been implementing this for decades now. But what's really new is today's instantiation, along with modern data analytics and computing capabilities, creates a transformational opportunity. So as the Air Force and space force fully embrace digital engineering, we're seeing benefits, such as we're able to model 1000s of different design concepts early on in acquisition, before a program even starts. And then billions of design trades can be assessed. And if you pair this with artificial intelligence, we have an opportunity for a more optimized system design….We can also do prototyping and developmental testing of systems virtually. Much cheaper than testing the real hardware, and much more quickly. And all of this provides an opportunity for earlier and more frequent analysis, and informs formal hardware evaluations that can reduce surprise in operational test that cause rework today, late in [an] acquisition program lifecycle….. our strategy is absolutely to work along with industry. Industry – our defense industry, and certainly our commercial industrial base has been incorporating these technologies and these opportunities. And so our strategy to focus our transformation on program Pathfinders have been a terrific way to make this real for our workforce. And to be able to learn from the benefits that industry is incorporating. **-—Kristen Baldwin, U.S. Air Force, Deputy Assistant Secretary for Science, Technology and Engineering.**

Source: https://federalnewsnetwork.com/air-force/2021/03/air-force-seeks-new-opportunities-to-apply-the-computer-to-prototype-model-of-design/

Missile Defense Agency

MDA Ground Missile's Digital Engineering Plan is drafted and in review. This plan is aligned/traced to the Digital Engineering Strategy. It has significant leadership support, and has received approval on the authoritative data source certification process. Analysis has moved into the MDA Engineering Web Services that included ability to access simulations and high performance analysis, while meeting all cyber controls within MDA facilities. Other systems are now considering taking advantage of their partnership in the common integrated environment.

These and other successes are not without challenges……Time to establish and stabilize the integrated environment, role-based access controls, and establishing single sign on are time consuming steps, but necessary. Culture change and adoption, to include training, inconsistencies across multiple programs causes inefficiencies and duplicative efforts…….

Kerry Lunney, INCOSE

Organisations that truly carrying out digital engineering have an environment to develop incremental deliveries, building on a product approach, starting from a MVP delivery. There is much interaction with the customer and user experience is important and feedback regularly given. Likewise models, simulation, digital twins, etc are prevalent. This lends itself to more software intensive projects which by definition are already on the digital path. You need a digital mindset with continuous integration and failure is OK as long as you learn from it. The market accepts these products/solution.

This is much harder for Defence, Transport and Infrastructure work. In Defence you have to contend with interoperability issues, obsolescence (ie keeping a system going longer than ever envisaged), critical safety and security challenges, etc. Plus the culture overall doesn't lend itself to a digital approach. Think of the massive procurement and legal changes required. Likewise, who is going to be the first to share risk for agile deliveries?