

Introduction to Digital Engineering & DoDI 5000.97 Overview

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Modeling & Simulation (DEM&S)
OUSD(R&E)
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October 2024





Executive Branch of the United States of America



Leaders

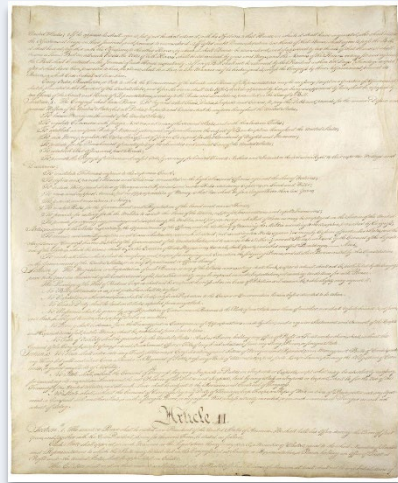


Joe Biden
President



Kamala Harris
Vice President

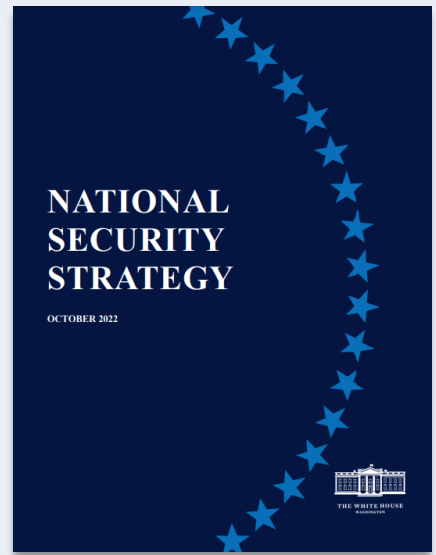
Authority From The Constitution



<https://www.archives.gov/founding-docs/constitution-transcript>

“The President shall be **Commander in Chief** of the Army and Navy of the United States, and of the Militia of the several States, when called into the actual Service of the United States,” –Article II, Sec. 2

Priorities



The war in Ukraine highlights the criticality of a vibrant Defense Industrial Base for the United States and its allies and partners. It must not only be capable of rapidly manufacturing proven capabilities needed to defend against adversary aggression, but also **empowered to innovate and creatively design solutions** as battlefield conditions evolve.



Department of Defense



Leaders

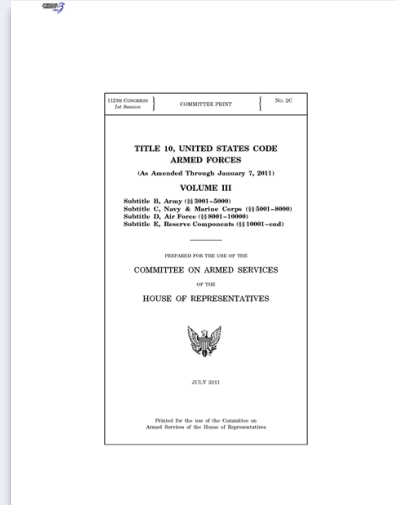


Lloyd J. Austin III
Secretary of Defense



Dr. Kathleen H. Hicks
Deputy Secretary of Defense

Authority From Title 10: U.S. Code



<https://uscode.house.gov/browse/prelim@title10&edition=prelim>

“(a)(1) There is a Secretary of Defense, who is the **head of the Department of Defense**, appointed from civilian life by the President, by and with the advice and consent of the Senate.”

Priorities



To succeed....the Department will **reduce institutional barriers**,....that inhibit...**interoperability**, intelligence and **information sharing**,...We will work across the U.S. government to **upgrade technology**....facilitate **information exchange for mutual benefit**.



Office of the Under Secretary Of Defense for Research and Engineering OUSD(R&E)

Leaders

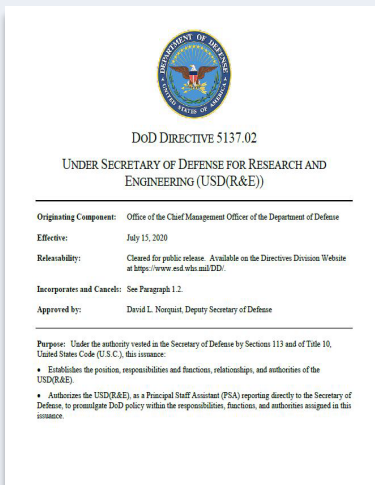


Heidi Shyu
DoD Chief Technology
Officer, OUSD(R&E)



Dr. David A. Honey
Deputy OUSD(R&E)

Authority From DODD 5137.02



<https://www.esd.whs.mil/DD/>

Purpose: Under the authority vested in the Secretary of Defense by Sections 113 and of Title 10, United States Code (U.S.C.), this issuance:

- Establishes the position....of the USD(R&E).
- **Authorizes** the USD(R&E),....reporting directly to....promulgate **DoD policy** within the responsibilities, functions, and **authorities assigned**.....

Priorities



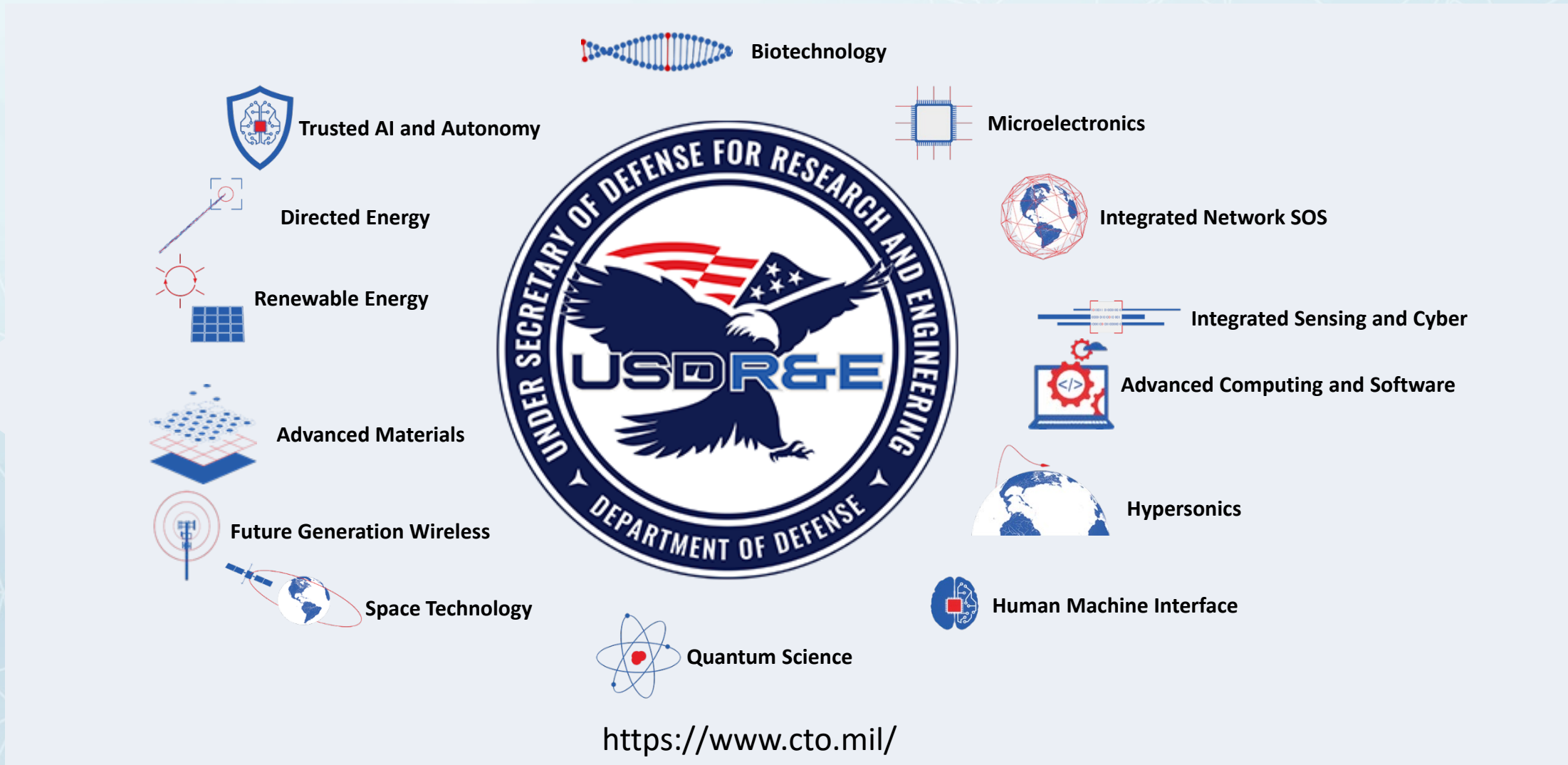
“We will continue to modernize our **digital infrastructure**”

“harness the analytic power of **modeling and simulation**”





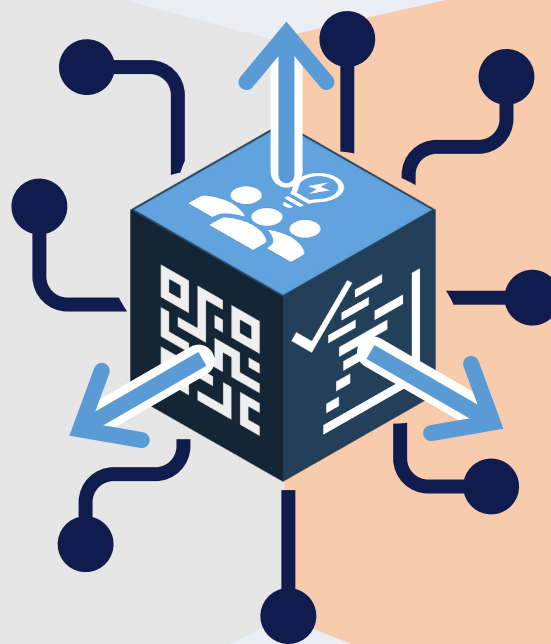
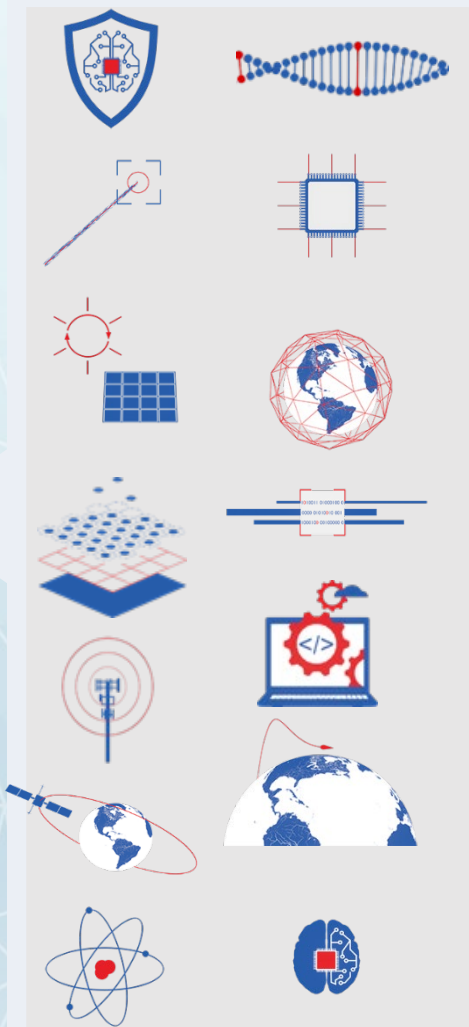
OUSD(R&E) - Critical Technologies



<https://www.cto.mil/>



OUSD(R&E) – Role of Engineering



ENGINEERING



Operational Warfighting Capability



Executive Directorate for Systems Engineering & Architecture

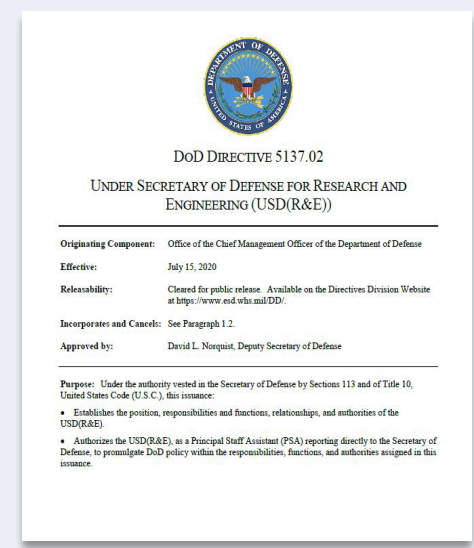


Leader



Thomas W. Simms
Executive Director, SE&A

Authority From DODD 5137.02



<https://www.esd.whs.mil/DD/>

Section 2, Paragraph q:
“...with key stakeholders, **develops** governing **policy** and **advances** **practices** and **workforce competency**...”

Priorities

Mission Statement

Engineering Foundations’ mission**develop and drive** the use of **innovative** and **modern engineering principles and techniques**....within the DoD....This team **provides policy, guidance, standards, and best practice** resources facilitates **communities of practice**; and **develops the workforce**....

Engineering Applications’ mission is....to **inform risk-based decisions** and **develop**....architectures to **reduce integration risks** for mission-enabling systems. This team provides **engineering assessments and architectures**.



Directorate for Digital Engineering, Modeling & Simulation



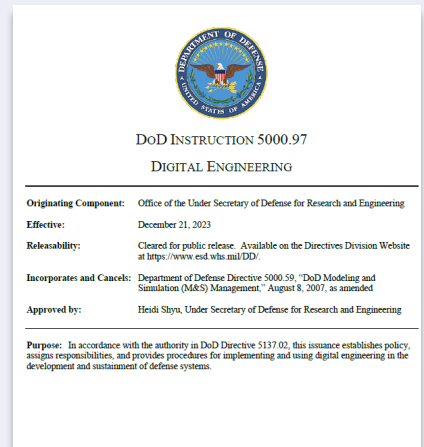
Leader



Daniel Hetteema
Director

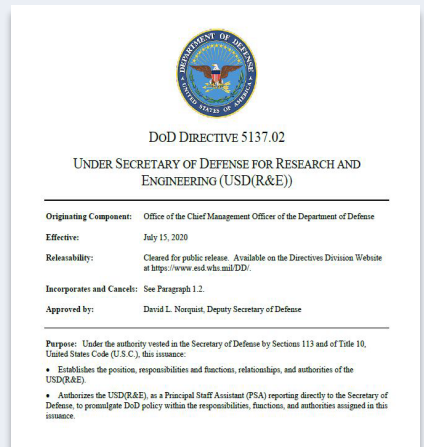
Authority From

DODI 5000.97



Section 2, Paragraph 1:
“Establishes governing policy, advances practices, and develops workforce skills for digital engineering.”

DODD 5137.02



Section 2, Paragraph q:
“...with key stakeholders, **develops governing policy and advances practices and workforce competency...**”

Priorities

Mission Statement

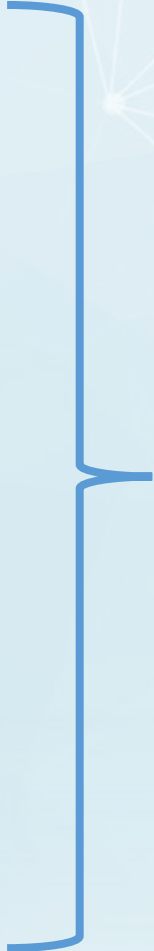
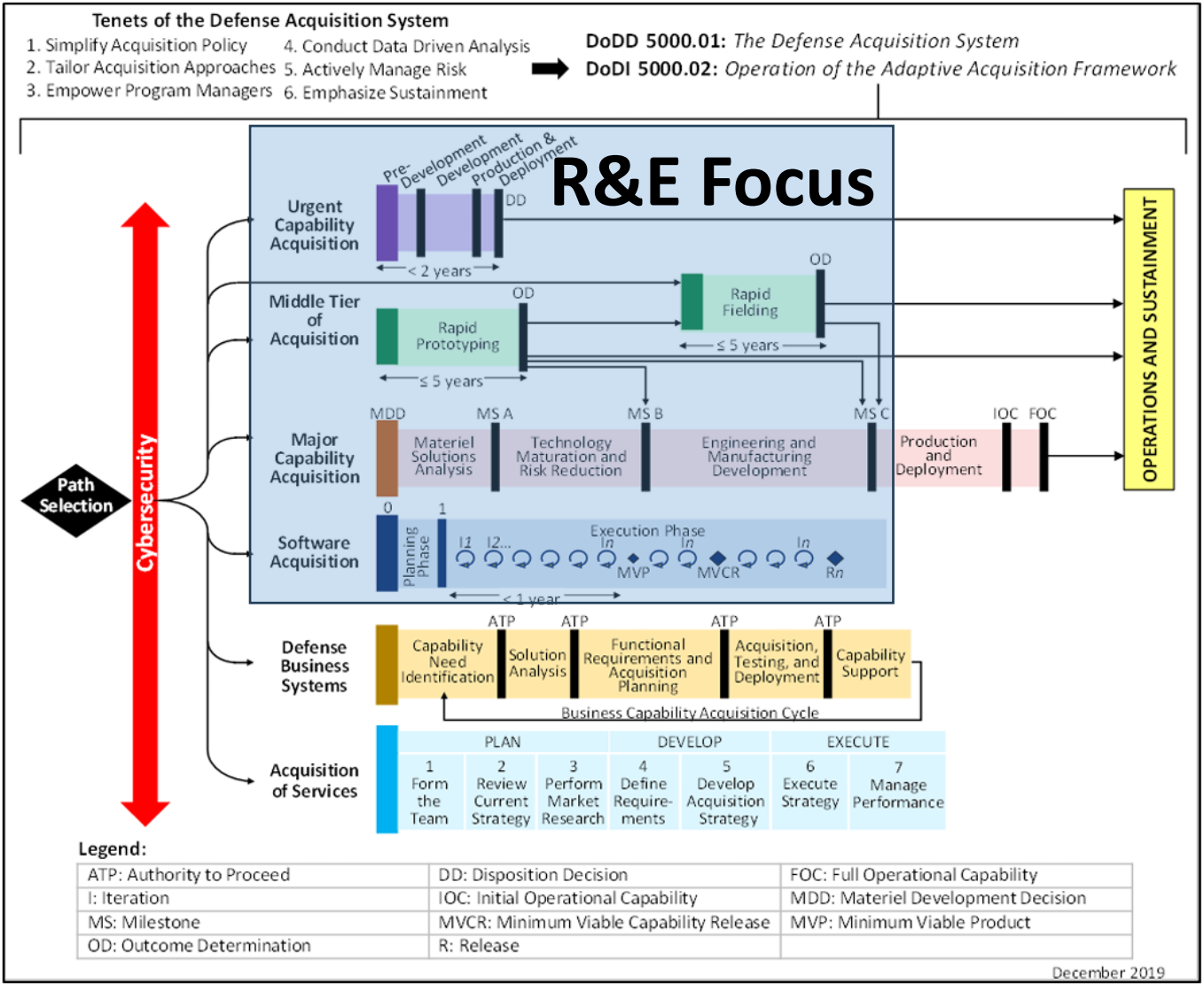
Practitioners are the backbone of the department; we strive to ensure they have the data, tools, and time needed to achieve the mission of the DoD.

DEM&S focus on delivering products that address pain points, growing the community of digital practitioners, strengthen the capabilities of workforce, and building a resilient industrial base through standards.



R&E's Focus Area Across the Acquisition Framework

DoDI 5000.02 OPERATION OF THE ADAPTIVE ACQUISITION FRAMEWORK



The value of digital twins can be experienced across all phases



DODI 5000.97 Digital Engineering

Purpose: The Department of Defense is transforming its engineering practices to incorporate digital technology and innovations into an integrated, digital, model-based approach. This instruction establishes policy, assigns responsibilities, and provides procedures for implementing and using digital engineering in the development and sustainment of systems.

This policy directs:

- Programs started after the date of the policy will incorporate digital engineering during development unless the program's decision authority provides an exception.
- Programs started before the date of the policy should incorporate digital engineering, to the maximum extent possible, when it is practical, beneficial, and affordable.
- Digital engineering should be addressed in the Acquisition Strategy and in the Systems Engineering Plan.
- Digital engineering methodologies, technologies, and practices support a comprehensive engineering program for defense systems.



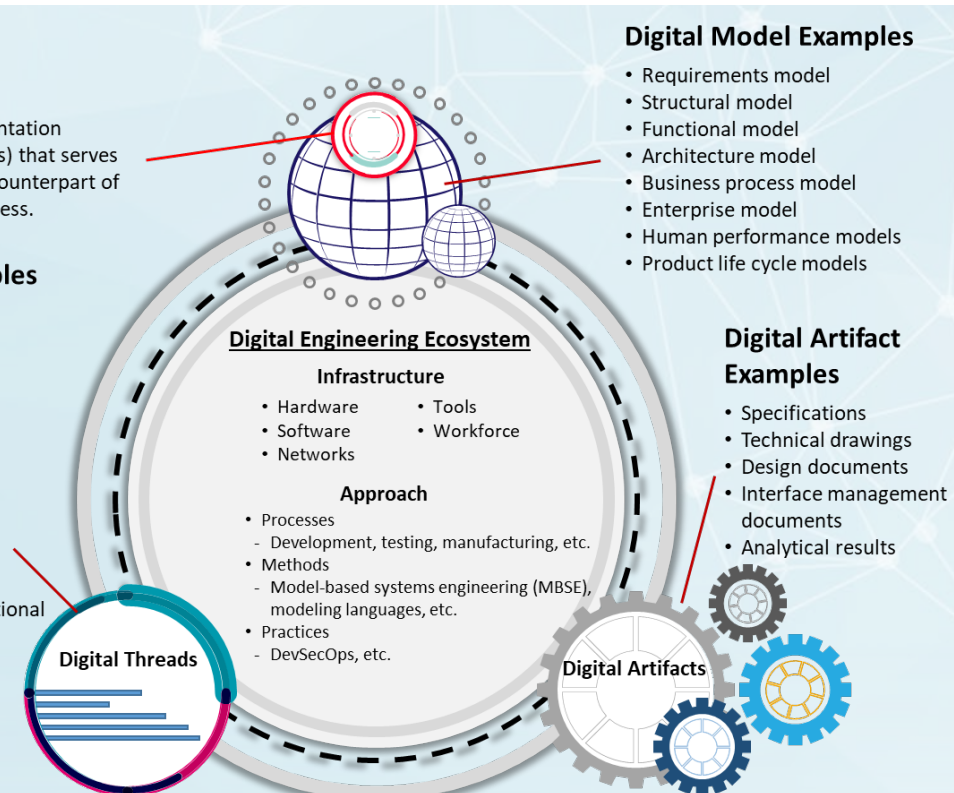
Digital Twin

A computerized representation (integrated set of models) that serves as the real-time digital counterpart of a physical object or process.

Digital Thread Examples

- Requirements analysis
- Architecture development
- Design and cost trades
- Design evaluations and optimizations
- System, subsystem, and component definition and integration
- Cost estimations
- Training aids and devices Development
- Developmental and operational tests
- Product support

--- Data ---



Digital engineering transforms DoD systems engineering practice.



Aligning Digital Engineering & Digital Twins

OSD Digital Engineering (DE) Tenets

- 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 improve the engineering practice
- 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 Twin Tenets

- 1 Digital Twins are **virtual assets**, informed by data, that provide the basis for informed decision making
- 2 **Digital Twins** are artifacts enabling an enduring **authoritative source of truth**
- 3 Digital Twins incorporate **technological innovation** (e.g. sensors fusion, AI, data analytics, etc...) to improve decision making
- 4 Digital Twins require **infrastructure and environments** to seamlessly interconnect assets
- 5 Use of Digital Twins requires **culture and workforce** transformation around info sharing, data access / ownership, etc...

Graphic from AIAA & AIA Digital Twin: Definition & Value



Measuring Congressional Demand

“digital twin” search on congress.gov

Limit Your Search ☰

Uncheck all

- Legislation
- Committee Reports
- Committee Meetings
- Committee Publications
- Congressional Record

Congress ☰

Check all

- 118 (2023-2024) [42]
- 117 (2021-2022) [85]
- 116 (2019-2020) [30]
- 115 (2017-2018) [4]
- 114 (2015-2016) [1]
- 113 (2013-2014) [2]

[Show less ^](#)

	Requested	Given
F-35 C2D2	1,124,207	1,874,207
Cooperative Avionics Test Bed (CATB) Aircraft		[200,000]
F-35 System Digital-Twin Models		[350,000]
Mission Software Integration Laboratory (MSIL)		[300,000]
Program carryover		[-100,000]

Excerpt from House’s FY25 NDAA

\$350k of “new” money

Key inflection year



Measuring Success in FY23 Justification Books

DoD FY23 Defense Wide RDT&E Justification Book

Air Force FY23 RDT&E Justification Book

Navy FY23 RDT&E Justification Book

UNCLASSIFIED		
Exhibit R-2A, RDT&E Project Justification: PB 2023 Office of the Secretary Of Defense		
Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603338D8Z / Defense Modernization and Prototyping	Project (Number/Name) 721 / ECTE
B. Accomplishments/Planned Programs (\$ in Millions)		
Building on the initial series of flights and swims, further development and integration will be completed to optimize system performance, and to integrate a representative payload. In late FY 2022, prototype development will complete, transitioning to the U.S. Navy for a FY 2023 operational demonstration to validate system performance in an operationally relevant environment.		
FY 2022 to FY 2023 Increase/Decrease Statement: Development of the FSG UUV prototype completes in FY 2022 prior to transitioning to the U.S. Navy for further development and integration.		
Title: Echelon		
Description: This project will develop a common digital twin technical framework capable of supporting a wide variety of military RF systems. Echelon will support virtual testing of digital twin prototypes, enabling the Department of Defense to evaluate the effectiveness of prototype systems or subsystems in realistic environments and against red threats early in development. The developed high-fidelity multi-physics framework/testbed will enable Service research and acquisition programs to mature digital twin prototypes prior to purchasing extensive hardware enabling programs to shorten the development lifecycle of current system upgrades and next generation systems. This effort includes the hardware and software implementation of the first instantiation of the Echelon technical framework. During FY 2021, the Echelon project completed use case definitions, requirements derivation, and assessed/identified available tools to be leveraged for the digital twin framework baseline. In addition, the Echelon project established an initial model based systems engineering (MBSE) model for the project. This MBSE model will evolve as the digital twin framework is further developed in FY 2022 and FY 2023.		
FY 2022 Plans: Building on the initial MBSE Echelon model, FY 2022 activities will focus on developing and delivering the first release of the Echelon framework and testbed. This first release will enable project transition partners to begin building their respective Echelon compliant digital twins. In FY 2022, initial work will begin to validate the framework and testbed.		
FY 2023 Plans: FY 2023 tasks will complete the validation of the initial Echelon framework and testbed. Building on the first release of the Echelon framework, FY 2023 activities will focus on further development and validation of the framework's extensibility to support multi-function digital twins. Additional activities include mission engineering interfaces integration with the digital twin and testbed. FY 2023 will conclude with a multi-service demonstration of a digital twin within the Echelon testbed.		
FY 2022 to FY 2023 Increase/Decrease Statement: Funds support the demonstration of a digital twin in the Echelon framework to validate the prototype's capability to provide a virtual integrated, multi-function, net-centric environment. The majority of hardware and software development, integration, and		
UNCLASSIFIED		
PE 0603338D8Z: Defense Modernization and Prototyping Office of the Secretary Of Defense	Page 19 of 29	R-1 Line #46

Title: Guidance Technologies	0.000	28.196	28.841
Description: Develop guidance technologies to improve the precision, controlled lethality, and flexibility of conventional munitions. Specific technical areas include precision navigation and terminal seekers.			
FY 2022 Plans: Continue integration of hardware-in-the-loop, software-in-the-loop, and other modeling and simulation technologies for the demonstration of open architecture, high-speed, networked, collaborative and autonomous, and modular munition concepts. Continue the design and development of seeker sub-system prototypes for platform self-defense. Continue development of advanced, high-resolution infrared scene projectors, distributed simulation concepts, software-defined radio frequency test chamber, scene generation, mission, engagement, campaign level simulations, and panoramic infrared dome technologies. Continue to develop technologies for precision navigation of weapons in Global Positioning System-denied scenarios. Continue to mature and integrate advanced carriage and release concepts and sub-systems. Continue providing multi-security level, cross-domain distributed modeling and simulation support for munition research using distributed connectivity between Eglin Air Force Base facilities and other geographic locations. Continue integrating lethality models into guidance and control simulations to enhance weapon integrated performance. Continue development of sensor test technologies to enable verification of autonomous munition concepts. Continue integrating higher fidelity constructive analysis tools with engagement and mission level modeling and simulation. Initiate miniature munition technology integration for ground launch demonstration.			
FY 2023 Plans: Continue integration of hardware-in-the-loop, software-in-the-loop, and other modeling and simulation technologies for the demonstration of open architecture, high-speed, networked, collaborative and autonomous, and modular munition concepts. Continue the design, development, and evaluation of seeker sub-system prototypes for platform self-defense. Continue			

Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		Date: April 2022	
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603601F / Conventional Weapons Technology	Project (Number/Name) 63670A / Weapon Technology Development	
B. Accomplishments/Planned Programs (\$ in Millions)			
development of advanced, high-resolution infrared scene projectors, distributed simulation concepts, software-defined radio frequency test chamber, scene generation, mission, engagement, campaign level simulations, and panoramic infrared dome technologies. Continue to develop technologies for precision navigation of weapons in Global Positioning System-denied scenarios. Continue to mature and integrate advanced carriage and release concepts and sub-systems. Continue improving multi-security level, cross-domain distributed modeling and simulation for munition research using distributed connectivity between Eglin Air Force Base facilities and other geographic locations. Continue integrating higher-fidelity lethality models into guidance and control simulations to enhance weapon integrated performance. Complete development of sensor test technologies to enable verification of autonomous munition concepts. Continue integrating higher fidelity constructive analysis tools with engagement and mission level modeling and simulation. Continue miniature munition technology integration for ground launch demonstration. Initiate design and development of a weapons digital ecosystem that enables digital engineering and the use of high-fidelity digital twinning across the weapons lifecycle.			
FY 2022 to FY 2023 Increase/Decrease Statement: FY 2023 increased compared to FY 2022 by \$0.645 million. Justification for increase is described in the plans above.			

UNCLASSIFIED			
Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force			
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B. Accomplishments/Planned Programs (\$ in Millions)			
	FY 2021	FY 2022	FY 2023
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B. Accomplishments/Planned Programs (\$ in Millions)		
	FY 2021	FY 2022
FY 2021 Accomplishments: Developed autonomous command and control of ship power and energy systems, leveraging digital twin technology that protects the ship's power and energy grid. In addition, designed and built a digital twin testbed for physical experimentation with power and energy controls technologies.		
FY 2022 Plans: Continue efforts to develop autonomous command and control of ship power and energy systems, leveraging digital twin technology that protects the ship's power and energy grid. In addition, designed and built a digital twin testbed for physical experimentation with power and energy controls technologies.		

	10.136	10.500
UNCLASSIFIED		
Exhibit R-2A, RDT&E Project Justification: PB 2023 Air Force		
Appropriation/Budget Activity 3600 / 3	R-1 Program Element (Number/Name) PE 0603601F / Conventional Weapons Technology	Project (Number/Name) 63670A / Weapon Technology Development
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Challenges Digital Twin Adoption at the DoD

- “Color of Money” – RDT&E vs O&M and the surrounding organization structures
 - 5-10 yr cost savings likely isn’t a priority to the PM
 - Congressional budget process is *complicated*
- Need clarity of DT’s “maturity” in alignment to acquisition process
 - Think more TRL less CMMI
- No standard approach to address the cybersecurity concerns
 - Align to DoD’s vision of Zero Trust Architectures
- DoD isn’t yet a “data first” organization
 - We acquire complex systems; the designers, operators, upgraders, are all different companies, sometimes at the same time

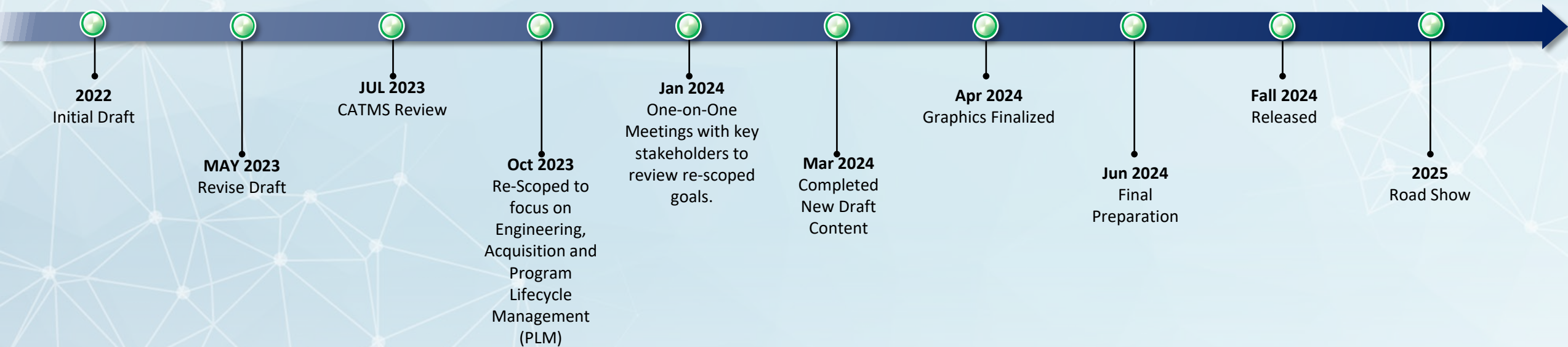


Development of Modeling & Simulation for Engineering Strategy



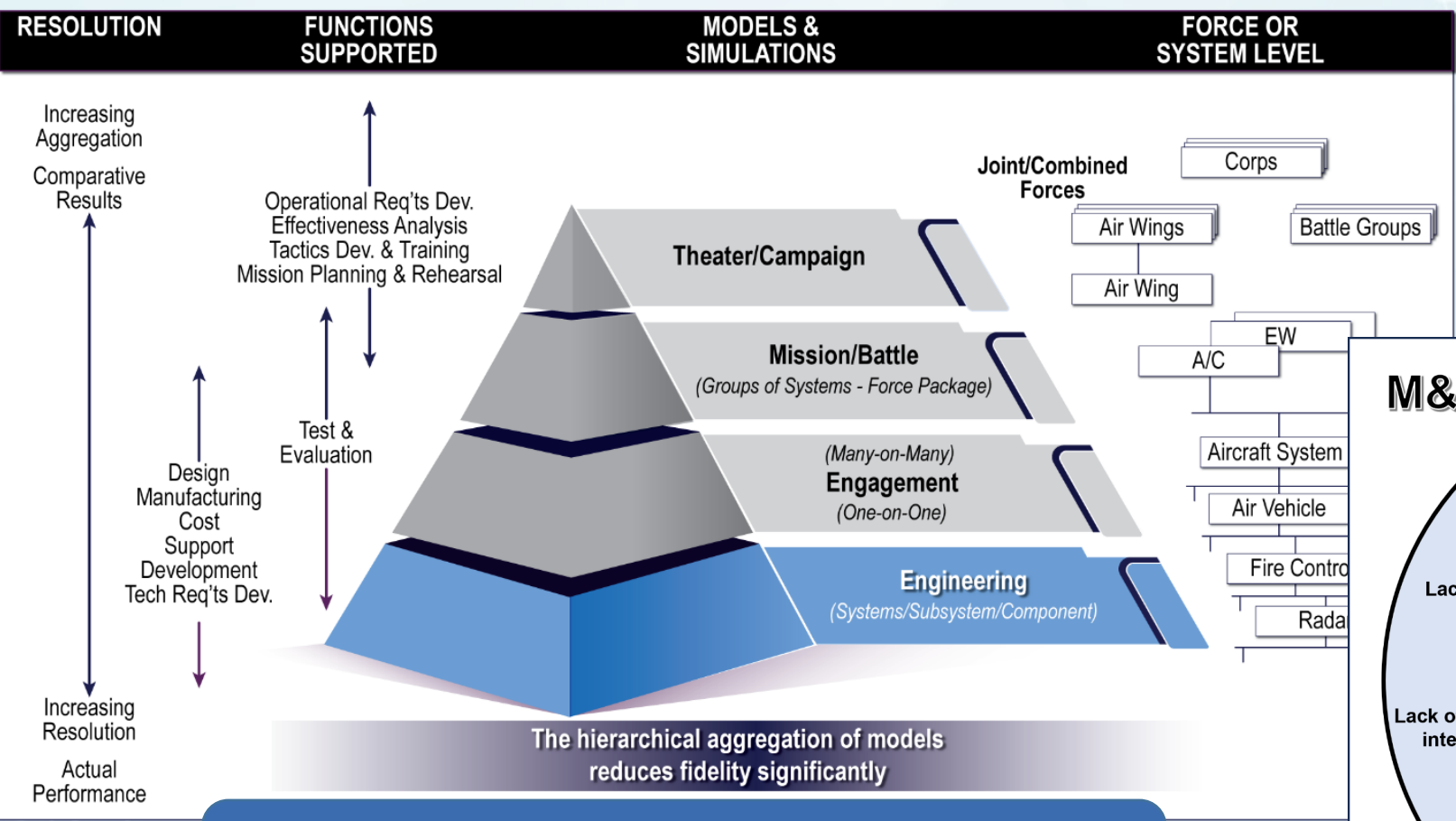
Primary Goals:

- Goal 1 Develop a joint, enterprise-level common technical framework and infrastructure, supporting modeling and simulation.
- Goal 2 Promote trust within the M&S community through authoritative sources of data.
- Goal 3 Leverage the professional development system supporting modeling and simulation.
- Goal 4 Cultivate integration of enterprise-level management within the DoD and the larger M&S community.
- Goal 5 Adapt policies, processes, and infrastructure enabling rapid (agile) assessment and procurement of emerging technologies and tools.

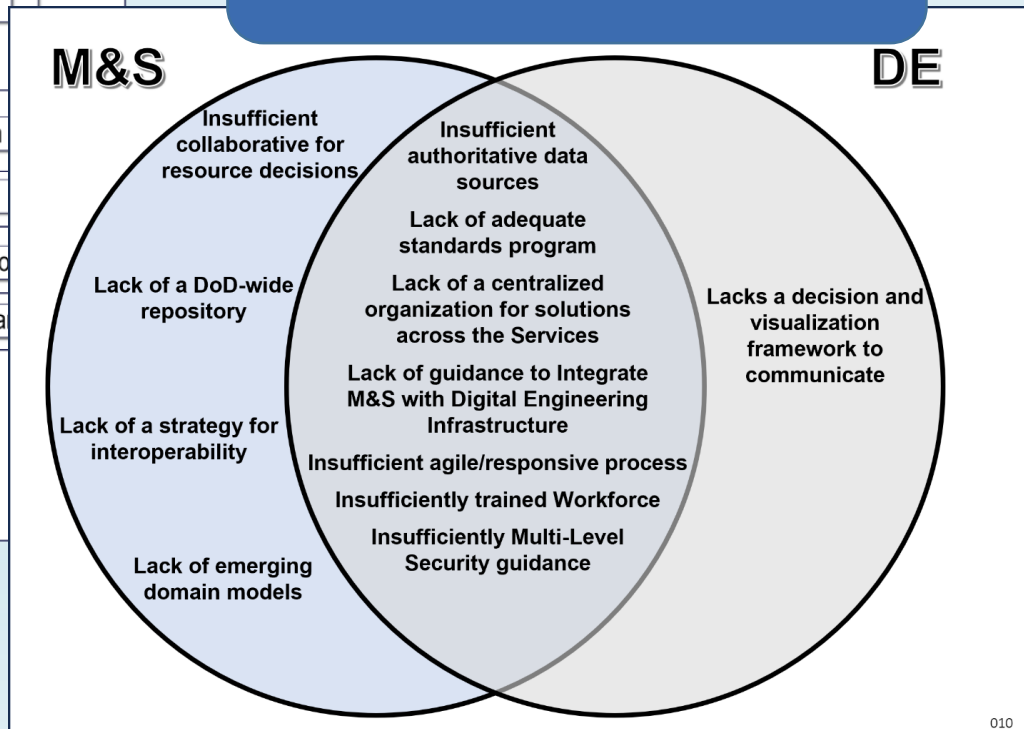




Modeling & Simulation Strategy for Engineering



Importance of address overlapping pain points.



Focus is on the engineering level and the interactions across levels

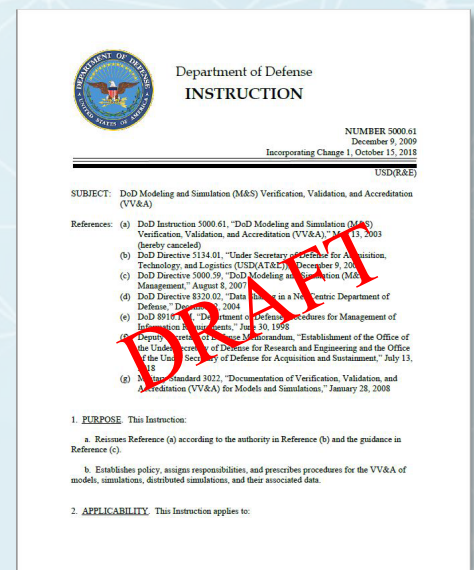
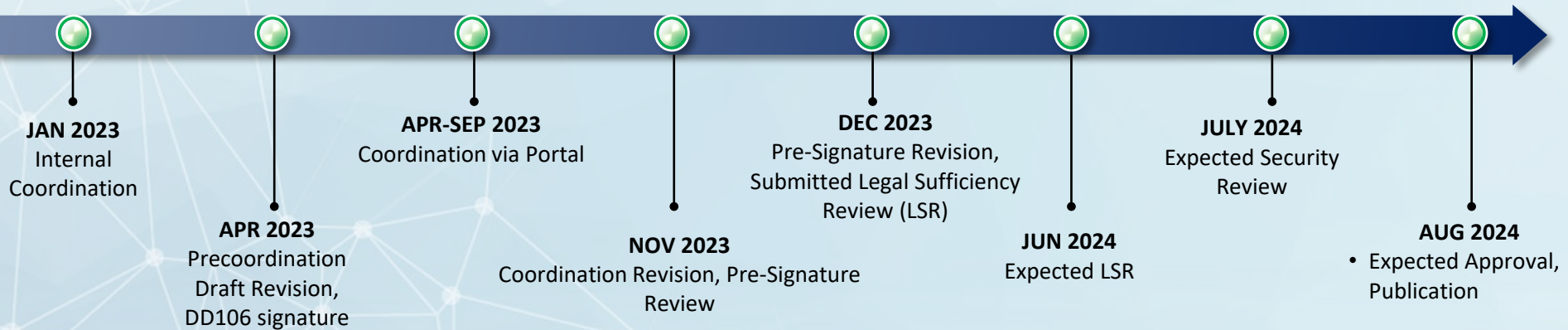


DODI 5000.61 DoD Modeling and Simulation (M&S) Verification, Validation & Accreditation (VV&A)

Establishes DoD policy for VV&A of M&S

- Requires VV&A of models, simulations and data used to support DoD processes, products and decisions
- Directs VV&A results be documented and made accessible
- Assigns Components and PAS* Officials as final validation authority for representations in their areas of responsibility

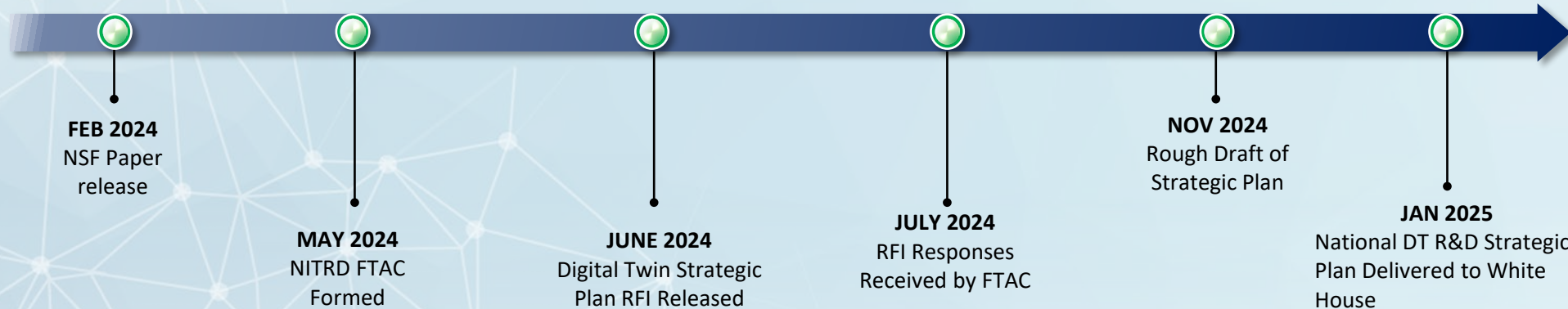
Establishes standards for documentation and accessibility of VV&A results





NITRD Digital Twin FTAC

- The National Academies of Science, Engineering, and Medicine (NASEM) released a report called “Foundational Research Gaps and Future Directions for Digital Twins”
 - Report contained numerous findings, conclusions, and recommendations on digital twin technology
- In response, the Networking and Information Technology Research and Development (NITRD) Program launched a Fast Track Action Committee (FTAC) on digital twin technology
 - Collaborate across industries on best practices, lessons learned for digital twin technology
 - Develop a National Digital Twin R&D Strategic Plan



NITRD

RFI
Request for Information (RFI) on the National Digital Twins R&D Strategic Plan

On behalf of Office of Science and Technology Policy (OSTP), the NITRD NCO seeks public input for the creation of a National Digital Twins R&D Strategic Plan.

Deadline: 11:59 p.m. July 28, 2024



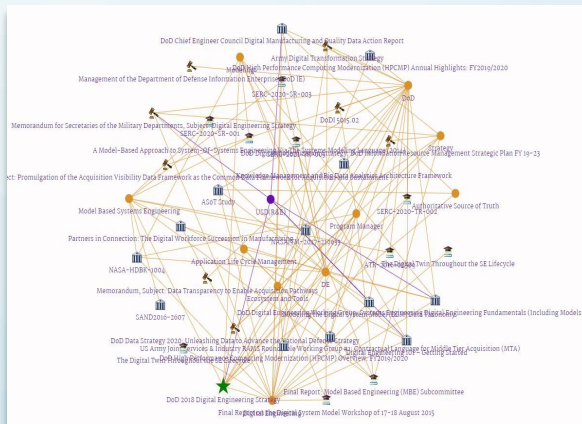
Digital Engineering Body of Knowledge

Continuous Capability Maturity Continuous Content Curation Continuous Outreach Activities



DEBoK

Digital Engineering Body of Knowledge



Community Calendar

Filter By: Title Search

Today Back Next May 2024 Month Week Day Agenda

Sun	Mon	Tue	Wed	Thu	Fri	Sat
28	29	30	01	02	03	04
	DICE Digital Engineering Conference 2024					
05	06	07	08	09	10	11
	2024 Department of the Air Force Model...		CIMdata PLM Road Map &...			
12	13	14	15	16	17	18

- DEC 2022** Full Operating Capability
- FEB 2023** Conduct DEM&S CoP
- MAR 2023**
 - Complete DTIC Content Migration
 - Conduct Governance Board
- APR 2023** Continue business practice development
- MAY 2023** DEBoK Jam
- JUN 2023** Initiate RMF process
- NOV 2023** IITSEC
- MAR 2024** CUI Baseline
- DEC 2024** SIPR Baseline
- JUN 2025** Classified Capability

- DEM&S Knowledgebase
- Hosts authoritative resources
- Geared toward accelerating capability development
- Collaborative community

<https://de-bok.org/>





Upcoming DEM&S Community of Practice in 2024

Sharing Digital Engineering, Modeling & Simulation Concepts and Best Practices

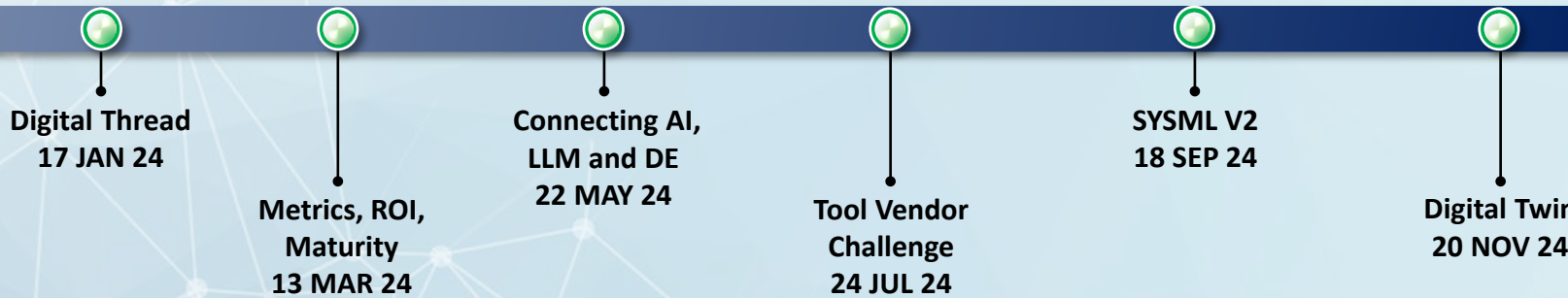
- Involvement from the DoD, Federal Government, Industry and Academia.

Advantages of Participating

- Networking Opportunities
- Knowledge Exchange
- Exclusive Events
- Collaborative Projects
- Resources and Learning Materials

2023 Topics

- Model Interoperability
- Digital Ecosystems
- Contracting/Digital Artifacts
- Bodies of Knowledge
- Workforce Development



**Digital Engineering,
Modeling & Simulation
Community of Practice**

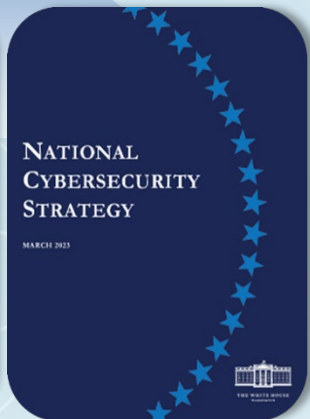
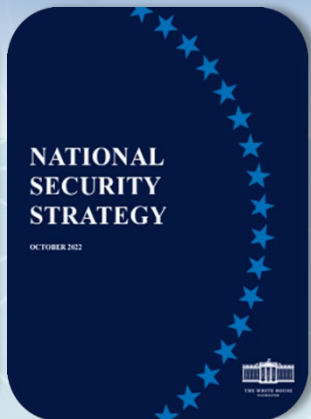
**500+ person
membership**



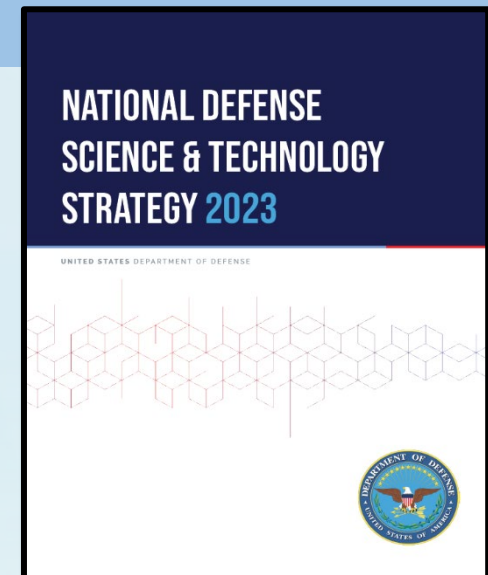
Standards Are Foundational to Digital Transformation



Aligned With

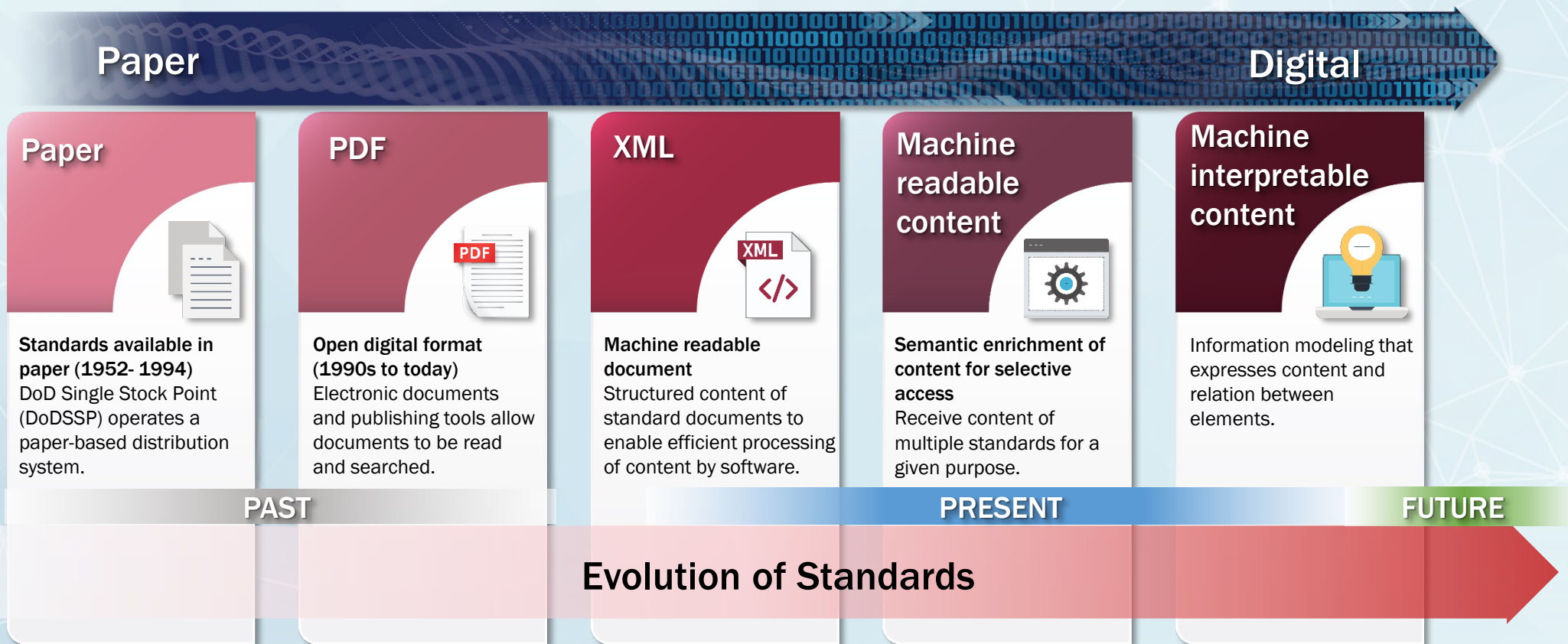


“Technology standards and protocols are core to our digital infrastructure, national security, and economic prosperity.”





Documents as Digital Data



*DoD implementation of [ISO - IEC/ISO SMART](#) Model



How DTC Can Address the Gap

- Highlight Value
 - **Do:** Show how DT can save “resources” and how new ideas are unlocked
 - **Don’t:** Oversell to senior leaders – be honest about the investments
- Educate the Community
 - **Do:** Identify characteristics of successful deployments
 - **Don’t:** Focus on definitions – can quickly turn your audience off
- Measure Maturity
 - **Do:** Invest in Uncertainty Quantification or other maturity model
 - **Don’t:** Make it “all or nothing” – everything in the DoD is a spectrum
- Standards
 - **Do:** Find commonality then standardize around that
 - **Don’t:** Create a new standard just to address the “lack of commonality”



Case Study: The Office of Strategic Services

Central Intelligence Agency

Today's CIA Careers Legacy Newsroom Library

CONTACT REPORT INFORMATION

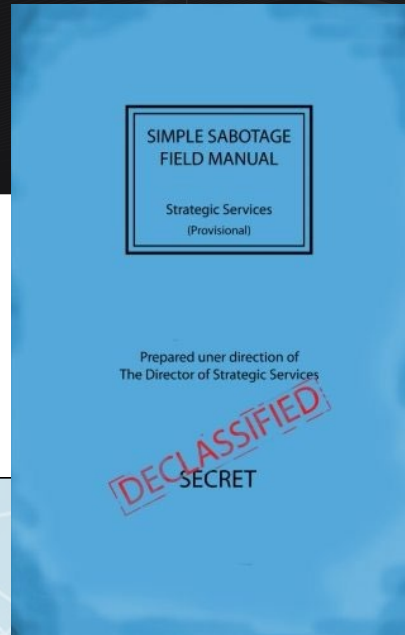
Search

Exhibits —

The Office of Strategic Services: America's First Intelligence Agency

About the OSS

Before World War II, the US Government left the business of collecting and disseminating intelligence to American foreign-policy experts and elements of the armed services. America's entry into the war following the intelligence failure of Pearl Harbor led to the establishment of the Office of Strategic Services (OSS) on 13 June 1942.



“(11) General Interference with Organizations and Production

(a) Organizations and Conferences

(1) Insist on doing everything through "channels." Never permit short-cuts to expedite decisions.

...

(3) When possible, refer all matters to committees, for "further study and consideration." Attempt to make the committees as large as possible - never less than five.

...

(8) Be worried about the propriety of any decision - raise the question of whether such action as is contemplated lies within the jurisdiction of the group or whether it might conflict with the policy of some higher echelon.”



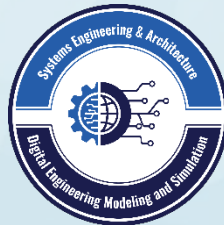
*Don't accept organizational sabotage in the use of models in a digital ecosystem.
Focus on driving value, moving forward, and celebrate the wins.*



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