Overarching Plan for Enabling Adoption of Modern Engineering Tools

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1   Introduction

A July 2023 Government Accountability Office (GAO) report[1] stated that "The iterative and fast-paced nature of Agile relies on the use of modern engineering tools to help identify needs, develop capabilities, and understand outcomes." Recommendation 3 of the report stated,

> *The Secretary of Defense should ensure that the Under Secretary of Defense for Research and Engineering [USD(R&E)], with the input of the military departments, establishes an overarching plan—which identifies associated resources—to enable the adoption of modern engineering tools, across all programs. This should include (1) mission engineering, (2) systems engineering, and (3) software engineering.*

The DoD position and initial response, dated June 2023, to the GAO Draft Report 23-105867, was a "PARTIALLY CONCUR" that stated:

> *The Department agrees that there is need of modern engineering tools across all programs including mission engineering, systems engineering, and software engineering. However, the Department does not agree a single overarching plan will address the issue nor can it provide a single source of resources needed to implement. The realization of engineering tool modernization is in the scope of each Service. The overarching plan will be developed in conjunction with the Services and R&E will actively support implementation efforts through working groups and relevant guidance and policy development.*

The purpose of this document is to establish a federated overarching plan to enable the adoption of modern engineering tools across all product life cycle phases of all programs, including Military Services and Defense Agencies.

The DoD understands the value of using modern engineering tools to reduce the design, development, and test timelines needed to field warfighting capability, perhaps by years. Modern engineering tools enhance efficiency and collaboration and support rapid development of DoD weapon systems. The application of digital engineering[2] principles and modern engineering tools for mission, systems, and software engineering can be used at various levels of complexity to evaluate performance, effectiveness, and utility. This includes implementing early and frequent mission engineering to assess technologies and systems-of-systems within operational environments to inform the necessary systems to support our warfighters. Models and data generated during early mission engineering feed acquisition decisions and requirements for

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[1] GAO-23-105867, "Defense Software Acquisitions: Changes to Requirements, Oversight, and Tools Needed for Weapon Programs." Washington, D.C.: Government Accountability Office (GAO), July 2023. https://www.gao.gov/assets/gao-23-105867.pdf

[2] *DoD Instruction 5000.97, Digital Engineering*. Office of the Under Secretary of Defense for Research and Engineering, December 2023. https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/500097p.PDF

software and systems engineering efforts. Subsequent sharing of data and models, with continuous user engagement and feedback, promotes Agile principles, iterative development, and collaboration between and across multidisciplinary teams contributing to the development, test, delivery, and sustainment of defense systems.

Tools do not negate the need for sound engineering processes and the supporting artifacts that enable data-driven decisions. Each Military Service and Defense Agency aligns its adoption of modern tools to the 2019 DoD Digital Modernization Strategy,[3] for which the 2018 DoD Digital Engineering Strategy[4] is the foundation.

Digital engineering is a means of using and integrating digital models and the underlying data to support the development, test and evaluation, and sustainment of a system. The DoD Digital Engineering Strategy describes how the application of digital engineering, and the associated tools, can modernize how the DoD designs, develops, tests, delivers, operates, and sustains systems. The DoD agrees that there is a need for modernization and accessibility of engineering tools, but it is in the scope of each Military Service and Defense Agency to execute digital engineering at their level.

Engineering processes that were historically paper based are evolving to a digital footprint that depends on modeling, simulation, and tools to accelerate the acquisition process. To make faster, higher-quality decisions in weapon system design, development, testing, fielding, and sustainment, the DoD is using engineering tools that provide computation, visualization, and collaboration throughout the system life cycle. Many of the tools, technologies, practices, and processes continue to evolve and mature, which requires the Military Services and Defense Agencies to align resources (e.g., such as networks, security, licensing, data and tool migration, etc.) associated with tool modernization.

Each engineering discipline approaches tool modernization in a similar manner, although the tools that support the activities may differ. In addition, each Military Service may approach the adoption of modern engineering tools in varying ways.

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[3] *Department of Defense Digital Modernization Strategy*. Office of the Deputy Secretary of Defense. July 2019. https://media.defense.gov/2019/Jul/12/2002156622/-1/-1/1/DOD-DIGITAL-MODERNIZATIONSTRATEGY-2019.PDF

[4] *Department of Defense Digital Engineering Strategy*. Office of the Deputy Assistant Secretary of Defense for Systems Engineering, Office of the Under Secretary of Defense for Research and Engineering, June 2018. https://www.cto.mil/sea/pg | Digital Engineering.

2 Overarching Plan

The overarching plan consists of two phases: Initial Phase and Incremental Phase.

2.1 Initial Phase

OUSD(R&E) will continue to engage with the Military Services and Defense Agencies regarding their respective plans for digital transformation or modernization relating to the use and adoption of modern engineering tools and any resources they identify that may enable their adoption.

This engagement across multiple communities is facilitated by numerous existing meetings, forums, and collaboration opportunities. OUSD(R&E) will aggregate information from these engagements to:

- View the current state of digital tool modernization plans across the Department.
- Share the Military Service-provided inputs and any insights gained with programs across the Department.
- Determine how OUSD(R&E) can support implementation efforts through working groups and relevant guidance and policy development.
- Help Military Services and Defense Agencies identify resources that may support the goals of their respective Military Service or Agency toward adopting modern engineering tools.
- Ensure coordination across OSD where appropriate, while keeping the plan at a high level, with summits addressing further details.

2.2 Incremental Phase

OUSD(R&E) will reevaluate the Initial Phase and release an updated plan every 2 years. In this federated approach, the intent is to see how the Military Services and Defense Agencies are working their plans within and across their respective organizations and how OUSD(R&E) is supporting the Military Service and Defense Agency efforts. This biennial reevaluation may take the form of viewing and discussing objectives defined by each Military Service or Defense Agency or by a central committee or group.

2.3 Summits

Of the resources to consider (budget, personnel, training, infrastructure, etc.), the budget is perhaps the most regimented and time constrained. Thus, the timing of the summits may follow budgetary cycles for OSD and the Military Services and Defense Agencies, as suggested in Table 1.

**Table 1. Timing of Incremental Updates to Department and Military Service Plans to
Enable Adoption of Modern Tools**

	Annual Cycle Each Fiscal Year			
	1QFY	2QFY	3QFY	4QFY
DoD		Semi-Annual Summit	Semi-Annual Summit	
Military Services and Defense Agencies	Finalize Budget for Tools (FY+1)			Military Services and Defense Agencies Draft Budget for Tools (FY+2)

The purpose of the summits is to align and synchronize activities between OUSD(R&E) and the Military Services and Defense Agencies in the pursuit of a federated approach to enabling adoption of modern engineering tools. The various terms of reference, such as what a modern engineering tool is or is not, can be refined at the summits for forthcoming efforts.

The summits are different from the other existing forums and meetings in that the summits are where OUSD(R&E) and the Military Services and Defense Agencies will gather to discuss updates regarding their respective organization's adoption of modern engineering tools. As inputs, summit participants will look at current Military Service modernization efforts, resources leveraged, and resources still needed for the efforts. As outputs, they will note accomplishments, determine objective measures to revisit during plan reviews, and determine steps forward.

The summits are scheduled to allow information to be coordinated in time for the budgeting cycle. DoD will continue the summits until it determines the Military Services and Defense Agencies have achieved sufficient adoption of modern tools or until the summits are assimilated into other activities of digital, mission, systems, and software engineering.

3 Military Service Approaches to Modern Engineering Tools

Although the Department acknowledges we still have work to do, the Military Services and Defense Agencies have made strides to improve their abilities in this area. The Military Services are planning and deploying digital transformation and digital tool modernization efforts. The following are general descriptions regarding various Military Service-specific approaches. They are key to this document's reporting on a plan to enable the adoption of modern engineering tools across programs in the DoD.

3.1 Department of the Army

The Department of the Army (DA) is promoting the adoption of digital engineering processes through upskilling the workforce on digital tools and techniques, fostering the development and reuse of collaborative digital engineering environments, and encouraging the use of interoperable

tools and data. The DA is also looking to leverage its software factories as one way to enable modernization. The software factory approach exposes Soldiers and civilians to technology industry best practices, including using modern cloud technology, Agile methodologies, and development, security, and operations (DevSecOps) to enable digital transformation.

The DA is exploring enterprise licensing and using cloud environments for tool use and sharing data. As an example, the Army Capability-based Architecture Development and Integration Environment (ArCADIE) is the Army's authoritative source for architecture data and supports the community of practice requirement. ArCADIE provides a robust collaborative and common enterprise environment for architecture-related efforts in support of critical institutional processes.

3.2 Department of the Navy

The DoD Digital Engineering Strategy of June 2018 guides the planning, development, and implementation of digital transformation across the Military Departments. It offered five strategic goals to bring about digital engineering practice. The Department of the Navy (DON) responded in June 2020 with the Digital Systems Engineering Transformation (D/SET) Strategy[5], setting the vision, objectives, processes, and actions to implement digital engineering in the U.S. Navy and Marine Corps. The objectives of the D/SET Strategy are:

1. Formalize the development, integration, and use of models.
2. Provide an enduring authoritative knowledge source.
3. Incorporate technological innovation to improve the engineering practice.
4. Establish the supporting infrastructure and environments for the digital engineering practice.
5. Transform the culture and workforce to adopt and support digital engineering across the life cycle.

The DON is modernizing the infrastructure and engineering tools in various functional areas. The DON Information Superiority Vision (ISV) includes information management, digital modernization, and the technology tools. The ISV elevated core strategic priorities across the DON. The ISV includes efforts to adopt enterprise services, implement zero trust, optimize the DON information environment, and improve cyber readiness.

The DSET Strategy objective 4, "Establish the supporting infrastructure and environments for digital engineering practice," is central. The DON Chief Engineer and Navy Modeling and Simulation Office (NMSO) prioritized several tool modernization initiatives, including the Naval Integrated Modeling Environment (IME) and Software Modernization initiatives.

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[5] *Digital Systems Engineering Transformation (DSET) Strategy. Acquisition Executive of the Navy.* June 2020. https://nps.edu/documents/112507827/0/2020+Dist+A+DON+Digital+Sys+Eng+Transformation+Strategy+2+Jun+2020.pdf/

The Naval IME is the Enterprise Information Technology (IT) service for systems modeling. IME is enabling the use of modeling and simulation (M&S) and model-based systems engineering (MBSE). This environment reaches more than 6,000 users with an anticipated 30 percent year-over-year growth. The Naval IME is transitioning hosting to leverage the DoD high-performance computing (HPC) infrastructure to improve performance and redundancy, and increase the enterprise ecosystem of interoperable engineering tools and data. This transition will provide:

- Integrated digital environments and artifacts.
- Access to high-performance computing.
- Elasticity to commercial cloud when needed.
- Ability to integrate with M&S capabilities.

The DON software modernization approach focuses on six areas: workforce, enterprise architecture, software factories, acquisition, authorization, and continuous feedback.[6] The DON software enterprise ecosystem initiatives are a critical element of Navy modernization.

3.3   Department of the Air Force

The Department of the Air Force (DAF), through the Air Force Materiel Command, is implementing the Digital Material Management (DMM) Initiative, which is instituting a "digital first" culture in which new programs will be required to start digitally, and programs in development or sustainment will adopt digital practices where benefit can be gained. Programs will start with models and data rather than with documents and various repositories. Initiatives include identifying and facilitating access to critical tools, modernizing the IT infrastructure to allow access to those tools, mechanisms to secure the data, and a training program to facilitate digital training.

In light of Air Force Materiel Command's DMM Initiative, the Assistant Secretary of the Air Force for Acquisition and the Assistant Secretary for Space Acquisition and Integration published a joint Digital Building Code providing guidance to assist the program executive officers and program managers in determining and implementing digital engineering and management, Agile software, and open systems architecture.

The DAF has also developed Launch Pad, a cloud-based enterprise tool environment with mission engineering, systems engineering, and software engineering tools for use by DAF organizations. This new capability is rapidly attracting users across the DAF engineering community.

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[6] *Strategic Intent for Naval Software Modernization.* Joint Memorandum Assistant Secretary of the Navy (Research, Development, & Acquisition) and Department of Navy Chief Information Officer, August 2021. https://www.doncio.navy.mil/ContentView.aspx?ID=16701

The DAF also has an approach to software modernization via digital transformation. The approach provides an analysis of digital engineering and software tool capability manufacturers that deliver high mission impact with broad reach into the DAF weapon system enterprise. The plan looks at some of the most effective software tools according to type such as analysis, architecture, MBSE, and visualization. Another DAF approach will consider authority to operate (ATO); Infrastructure-as-a-Service (IaaS), which will seek to provide servers on networks for support; Data-as-a-Service (DaaS), which will seek to provide access to data sources; and Platform-as-a-Service (PaaS), which will seek to provide a knowledge base along with various software tools.

The Space Force has drafted a Digital Services Ecosystem (DSE) Strategic Requirements Document (SRD) to pursue Space Force-specific needs across data federation, governance, security, technology, and user interface. Space Force's goal is to create an ecosystem with common services used by capability development, operations, and business process activities across all classification domains. Space Force is also looking to consolidate program-unique, cloud-based environments to support an enterprise approach with DAF. Space Force has created a preliminary government reference architecture for an enterprise Digital Engineering Ecosystem. The ecosystem offers modern tools for a broad user base across the entire capability development life cycle from Concept through Acquisitions, Test to Sustainment.

3.4 Defense Agencies

The Department's digital transformation efforts includes the Defense Agencies as well as the Military Services. The Missile Defense Agency created a Transformation Task Force (MDA/TF) with the mission of identifying and streamlining efforts to accelerate delivery of capabilities to the warfighter and support systems throughout their life cycle. Several programs have already begun the modernization, and two key interceptor development programs are "born digital."

MDA/TF will adapt Agency systems engineering and software engineering processes and adopt mission engineering practices to leverage the value of modern engineering and data-sharing tools across all programs. The initiative is intended to realize greater insight and empower well-informed decisions to innovate software development, stressing the need for the tools to comply with data-sharing standards and allowing the tools to contribute to and pull from common sources of truth. MDA will combine the modern engineering tools with other data sharing and analysis tools across all programs and functional areas to manage project and acquisition efforts to realize greater insight and empower well-informed decisions.

4 OUSD(R&E) Support to Modernization of Tools

OUSD(R&E) supports implementation efforts through working groups and relevant guidance and policy development. In addition, OUSD(R&E) develops, procures, and leverages digital tools for execution and implementation.

4.1 Forums and Working Groups

To support DoD programs and the implementation of the Military Services' modernization efforts, OUSD(R&E) participates in, and provides, forums and working groups for knowledge sharing and collaboration with the Military Services and Defense Agencies regarding future digital ecosystems and tools.

The OUSD(R&E) Principal Deputy Executive Director for Systems Engineering and Architecture (SE&A) hosts a Chief Engineers Council with the Chief Engineers of the Services and other DoD Components. The SE&A Digital Engineering, Modeling & Simulation directorate hosts recurring forums for future digital ecosystems and tools that support mission engineering, systems engineering, test and evaluation, and software engineering. The SE&A Systems Engineering and Software Engineering directorates also conduct forums with the warfighter stakeholders. The OUSD(R&E) Deputy Assistant Secretary of Defense (DASD) for Mission Integration oversees a Mission Engineering Practitioners Forum with regularly scheduled working groups that include participants from the Military Services.

These engagements provide situational awareness of current issues, trends, and tools relevant to the DoD. The groups raise awareness and address the challenges and advantages of rapidly iterative environments inherent in DevSecOps and other Agile practices. The forums and working groups foster discussions on the adoption and use of relevant digital engineering tools pertaining to mission engineering, systems engineering, test and evaluation, and software engineering. Members share best practices, lessons learned, and success stories to inform other Military Service and Defense Agency representatives about approaches to modernize their engineering tool ecosystem.

Ongoing meetings, forums, and collaboration opportunities among the Military Services, Defense Agencies, and OUSD(R&E) include: software factories, Communities of Practice, working groups, senior steering groups, workshops, tiger teams, task forces, meetings with Chief Digital and Artificial Intelligence Office and Chief Information Officer, data summits, National Defense Industrial Association events, digital talent management forums, and various other Military Service-specific meetings.

4.2   Policy and Guidance

OUSD(R&E) maintains policy[7] associated with digital engineering[8] and modern digital tools, including incorporating the use of digital artifacts and developing digital threads to support acquisition decisions.

OUSD(R&E) is involved in many guidance efforts including those for the DoD Software Science and Technology (S&T) Strategy and a corresponding implementation plan, the DoD Software Modernization Strategy and implementation plan, the Systems Engineering Guidebook, the Mission Engineering Guide, and an update to DoD Software Engineering for Continuous Delivery of Warfighting Capability.[9] Other efforts include evaluation of tools such as the Digital Engineering Tool Evaluation Criteria Template (DETECT),[10] as well as supporting acquisition of systems engineering digital artifacts through the use of common tools that enable collaboration, sharing, and coordination to develop a methodology to support tool selection for the Military Services and Defense Agencies.

5   Resources

Allocating resources (budget, personnel, training, infrastructure) for tool adoption is challenging. Military Services and Defense Agencies are balancing competing priorities with limited resources. The complexity of modernizing digital tools goes beyond simply acquiring the tools. Complexities that affect the identification of associated resources include, but are not limited to, the following:

- Managing versions of tools and integrating their functionality.
- Ensuring they comply with security and interoperability standards.
- Managing relationships and agreements with tools vendors.
- Ensuring that tool capabilities provided by vendors meet the needs of DoD.
- Working with security and IT offices to get an approved ATO for the tool.
- Operating tools across multilevel security (i.e., unclassified, secret, top secret).
- License management, in which efficiency and reuse will conserve resources.
- Emerging processes that enable tools to support digital engineering.

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[7] *Systems Engineering and Architecture Library*. Office of the Under Secretary of Defense for Research and Engineering, Systems Engineering and Architecture. https://www.cto.mil/sea/pg/

[8] *DoD Instruction 5000.97, Digital Engineering*. Office of the Under Secretary of Defense for Research and Engineering, December 2023. https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/500097p.PDF

[9] *Systems Engineering and Architecture Library*. Office of the Under Secretary of Defense for Research and Engineering, Systems Engineering and Architecture. https://www.cto.mil/sea/pg/

[10] *Overview of Digital Engineering, Modeling & Simulation for DAU SE Modernization*, Office of the Under Secretary of Defense for Research and Engineering, Digital Engineering, Modeling & Simulation. https://www.dau.edu/sites/default/files/2024-04/DEM%26S%20Overview%20for%20DAU%20SEMod.pdf

- Data portability or data access.

- Data interoperability.

- Application programming interfaces (APIs).

- Workforce training and retention, which involve training and tool adoption and the cyber workforce.

- Managing updates required to maintain capabilities and security compliance.

- Access to high-performance computing.

Hosting the information collected from the Military Services and Defense Agencies in a repository or portal may provide a comprehensive enterprise view of the engineering tool modernization and adoption landscape.

Along with other considerations, licensing also contributes to the resource challenges. In planning their engineering tool license purchasing decisions, the Military Services and Defense Agencies could leverage the comprehensive enterprise view and seek to leverage enterprise software-ordering vehicles that have been negotiated with commercial vendors.

Each Military Service is complex in size and scope. The challenges and priorities they focus on will drive tool modernization for them. Each Service has its own budget to develop these solutions. Thus, the Department does not agree that it should provide a single source of resources to implement digital modernization overall, but it could supplement and resource collaborations and key lines of effort that would benefit tool modernization across the DoD.

OUSD(R&E) seeks to ensure cohesive approaches so that advances made in the individual departments may benefit the entire DoD.

6   Conclusion

No single plan will address the issue of enabling the adoption of modern engineering tools, nor can it provide a single source of resources needed to implement the effort. A federated plan recognizes that modernizing engineering tools is within the scope of each Military Service and Defense Agency, with OUSD(R&E) supporting efforts through working groups and by developing relevant guidance and policy.

The two-phase overarching plan described in this document seeks to illustrate the Department's efforts to meet this challenge, including summits that will be aligned to allow coordinated input to the budgeting cycle. The Department will continue the summits until it achieves sufficient adoption of modern tools or until the summits become assimilated into other activities of digital, mission, systems, and software engineering.

Acronyms

ArCADIE	Army Capability-based Architecture Development and Integration Environment
ATO	Authority to Operate
DA	Department of the Army
DaaS	Data-as-a-Service
DAF	Department of the Air Force
DevSecOps	Development, Security, and Operations
DMM	Digital Material Management (Air Force)
DoD	Department of Defense
DON	Department of the Navy
DSET	Digital Systems Engineering Transformation (Navy)
FY	Fiscal Year
GAO	Government Accountability Office
HPC	High-Performance Computing
IaaS	Infrastructure-as-a-Service
ISV	Information Superiority Vision (Navy)
M&S	Modeling and Simulation
MBSE	Model-Based Systems Engineering
NMSO	Navy Modeling and Simulation Office
OUSD(R&E)	Office of the Under Secretary of Defense for Research and Engineering
PaaS	Platform-as-a-Service
SE&A	Systems Engineering and Architecture
TTF	Transformation Task Force (Missile Defense Agency)
USD(R&E)	Under Secretary of Defense for Research and Engineering