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DUNS #: 102082625
CAGE code: 4V266

# A DoD Centric Digital Engineering Lexicon

## 11 October 2024

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| Controlled by: | DESE Research, Inc. |
| CUI Category(ies): | None |
| Limited Dissemination Control: | |
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# Introduction

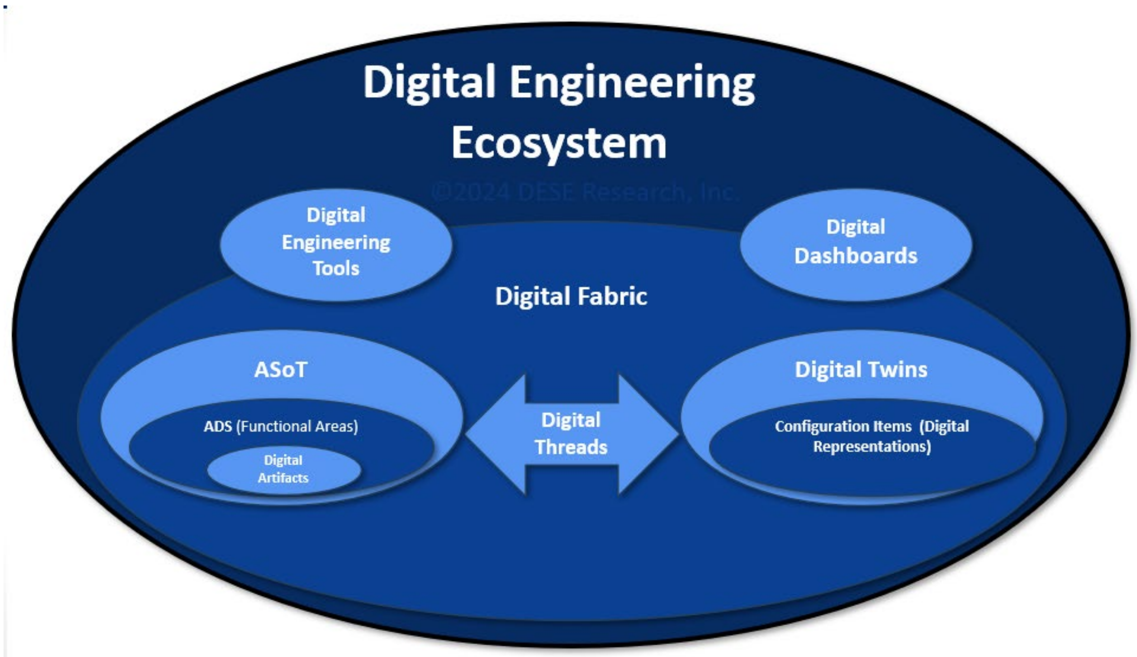
This white paper aims to define a comprehensive digital engineering lexicon, which includes terms that are integral to the digital engineering ecosystem and other relevant terms to support efforts on behalf of the U.S. Department of Defense (DoD). The objective is to provide clear and authoritative definitions to ensure consistent understanding and application across various stakeholders. It is our experience at DESE Research, Inc. that establishing a comprehensive lexicon prior to initiating any digital engineering systems design is crucial for success. Neglecting this step can lead to numerous issues that may cause significant delays or potential failures within a systems engineering program.

The primary references for the definitions in this lexicon are sourced from the following resources. Additional references are provided at the end of this document:

- DoDI 5000.97p, 21 December 2023, Heidi Shyu, Under Secretary of Defense for Research and Engineering [1].
- The Defense Acquisition University (DAU) Glossary [2]
- DESE Research Inc. staff. [3]

DoDI 5000.97p is the most authoritative source and takes precedence over all other references. If a term is not defined in DoDI 5000.97p, the definition is then deferred (by DoDI 5000.97) to the DAU Glossary, which is the next most authoritative source. Finally, any terms not covered by these two documents are defined by DESE Research, Inc. staff. These definitions are based on experience working in the DoD Digital Engineering arena. This hierarchy ensures that the most reliable and official definitions are prioritized to maintain consistency and accuracy within the digital engineering community.

Our primary set of terms within the lexicon is directly related to the Digital Engineering Ecosystem concept. These primary terms are presented first and are included in the following diagram. In this diagram, encapsulation of an element by another indicates a subordinate relationship of the first element by the second element. Arrows indicate the flow of information between elements across the encapsulating element. The secondary terms, while directly related to Digital Engineering, are not specifically tied to the ecosystem. These secondary terms are presented due to their common use across programs based on our experience.




**The Digital Engineering Ecosystem**

Each term is presented below in alphabetical order and referenced as appropriate. One final note prior to the definition of the lexicon terms; This document is frequently updated with the latest revision date indicated above the introduction.

# Digital Engineering Ecosystem Terms

## Authoritative Data [3]

Data supplied by a credible source, validated by the functional/program data officer as authoritative and recorded in a master data catalog.

## Authoritative Data Source (ADS) [2]

A recognized or official data source with a designated mission statement, source, or product to publish reliable and accurate data for subsequent use by customers. An authoritative data source may be the functional combination of multiple separate data sources.

## Authoritative Source of Truth [1]

The reference point for models and data across the system life cycle. The authoritative source of truth provides traceability as the system evolves, capturing historical knowledge and connecting configuration-controlled versions of models and data.

## Digital Artifact [1]

A product or output, in computer (i.e., digital) format, created within or generated from the digital engineering ecosystem. Digital artifacts provide data for alternative views to visualize, communicate, and deliver data, information, and knowledge to stakeholders.

## Digital Dashboard [3]

A user interface that visually represents key performance indicators, metrics, and data from multiple sources, enabling users to monitor, analyze, and manage systems in an intuitive and efficient manner.

## Configuration Item (System Configurations) [2]

An aggregation of hardware, software, or both that is designated for configuration management (CM) and treated as a single entity in the CM process.

## Digital Engineering Ecosystem (or Environment) [2]

The interconnected infrastructure, environment, and methodology (process, methods, and tools) used to store, access, analyze, and visualize evolving systems' data and models to address the needs of the stakeholders.

## Digital Engineering Tools [3]

Digital Engineering Tools are software applications other than traditional Digital Dashboards that support the creation, management, analysis, and visualization of digital artifacts. They help engineers design, test, and validate systems in a virtual environment, improving efficiency and collaboration.

## Digital Fabric [3]

A collection of closely related Digital Threads and Authoritative Data Sources that connect the different parts of the system lifecycle together. The integration of all Digital Threads and Digital Twins into a single environment enables Digital Engineering and seamless collaboration between functional areas.

## Digital Thread [1]

An extensible and configurable analytical framework that seamlessly expedites the controlled interplay of technical data, software, information, and knowledge in the digital engineering ecosystem, based on the established requirements, architectures, formats, and rules for building digital models. It is used to inform decision makers throughout a system’s life cycle by providing the capability to access, integrate, and transform data into actionable information.

### Digital Twin [1]

A computerized representation (integrated set of models) that serves as the real-time digital counterpart of a physical object or process. A digital twin is a virtual representation of a product, system, or process that uses the best available models, sensor information, data collected from the physical system, and input data to mirror and predict system activities and performance over the life of its corresponding physical twin and inform system design changes over time. There can be multiple digital twins of a system, but all digital twins should be based on authoritative sources of information and have clearly defined uses and scopes. Digital twins may vary in fidelity, based on the use case.

## Other Relevant Terms

### Authoritative Data [3]

Programmatic or technical data that has been certified to a particular level of trustworthiness. This certification is typically bounded by a process, which is the responsibility of a Subject Matter Expert (SME), board, or a group of experts with experience relevant to the certified data. Their expertise is instrumental in ensuring the trustworthiness of the data. It is important to note that different gradations within the category of "authoritative" need to be defined. These gradations define the criticality of decisions based on which sets of data are based on the associated level of trust. When combined with non-authoritative data, data taken from an authoritative source is no longer authoritative.

### Configuration Management [2]

A discipline applying technical and administrative direction and surveillance to: (1) identify and document the functional and physical characteristics of a configuration item, (2) control changes to those characteristics, and (3) record and report changes to processing and implementation status.

### Digital Engineering [2]

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

### Digital Model [1]

A digital (i.e., in an electronic form, able to be read and manipulated by computer) representation of an object, phenomenon, process, or system. The representation can include form, attributes, and functions and may be depicted visually or described via mathematical or logical expressions.

## Digital Surrogate [3]

A Digital Surrogate is a term used to describe using simulation models within Digital Twins as a temporary stand-in for the Physical Counterpart. This approach is employed while the appropriate hardware is still being developed or when comprehensive data describing a specific physical system characteristic is unavailable. The Digital Surrogate enables the emulation of interfaces and data flows necessary for system development, providing flexibility and allowing for experimentation. It ensures that the virtual representation remains useful and accurate even without complete physical data, facilitating continuous progress in the development and optimization of the system. It can be replaced once appropriate hardware is available or swapped with the Physical Counterpart hardware when needed.

## Digital Transformation [3]

Adopting digital technology fundamentally changes how an organization runs and generates value. A process shift from leveraging documents to leveraging models and data.

## Model-Based Systems Engineering (MBSE) [1]

The formalized application of modeling to support system requirements, design, analysis, verification, and validation activities beginning in the conceptual design phase and continuing throughout development and later system life-cycle phases.

## Program Operating Model (POM) [3]

The Program Operating Model (POM) is the framework that defines how a program will function to achieve its objectives. It outlines the structure, processes, resources, governance, and technologies needed to manage and execute a program effectively. It ensures alignment between strategic goals and the day-to-day operations of a complex system's lifecycle.

## Physical Counterpart [3,4]

The Physical Counterpart of a Digital Twin refers to the actual physical system, subsystem, or component being monitored and optimized. It has various sensors and data acquisition systems to capture real-time measurements and operational data continuously. This data is used for real-time monitoring, control, development of virtual models, and verification and validation of these models. The Physical Counterpart represents the tangible entity whose performance and condition are mirrored and optimized through its Digital Twin.

## System of Reference (SoRef) [3]

A System of Reference is an authoritative system that guarantees that consumers can obtain reliable data to support transactions and analysis. Such an authoritative system would instill confidence in the data's quality for transactions and analysis, even if the information did not originate in the system of reference. Contrary to an Authoritative Data Source, this information does not originate within the System of Reference. A typical System of Reference uses data from a true Authoritative Data Source.

### Virtual Counterpart [3,4]

The Virtual Counterpart of a Digital Twin is the digital representation of the physical system, including all its components and interactions. It leverages advanced tools and techniques such as modeling, simulation, AI/ML integration, and visualization to simulate, analyze, and optimize the physical system. The Virtual Counterpart is continuously updated with real-time data from the Physical Counterpart, ensuring it remains an accurate and dynamic representation. It supports predictive analysis, scenario testing, and decision-making processes to enhance the performance and reliability of the physical system.

## Summary

This lexicon provides essential definitions to facilitate a shared understanding of key terms within the DoD digital engineering domain. By clearly defining these terms, stakeholders can communicate more effectively and leverage these concepts to drive innovation and efficiency within the digital engineering ecosystem. Stakeholders using these definitions will be compliant with DoDI 5000.97p.

## References

[1] "DoD Instruction 5000.97 Digital Engineering", Heidi Shyu, Under Secretary of Defense for Research and Development, Office of the Under Secretary of Defense, December 21, 2023.

[2] DAU Glossary, The Defense Acquisition University, Online glossary at DAU Glossary | www.dau.edu

[3] DESE Research, Inc. Staff, our highly qualified team members that are currently involved in developing the latest, state-of-the-art, Digital Engineering technologies. www.dese.com

[4] "Foundational Research Gaps and Future Directions for Digital Twins (2024)", National Academies of Science, Engineering, and Medicine, ISBN 978-0-309-70042-9 | DOI 10.17226/26894.

For more information on how DESE Research, Inc. can support your digital engineering needs, please contact us at www.dese.com or contact the author at Paul.Leopard@dese.com