

A wireframe illustration of a four-engine jet airplane, viewed from a low angle, set against a background of a blue and purple gradient with a network of white lines and dots. The airplane is rendered in a light blue wireframe style, showing its fuselage, wings, tail, and engines. Below the airplane, there are several small icons: a cloud with an upward arrow, a microchip, and a circular arrow.

SIEMENS

Ingenuity for life

Siemens Digital Industries Software

The growing importance of the digital thread across the A&D product lifecycle and associated systems

Executive summary

Today's aerospace and defense companies are at the forefront of two historic trends: unprecedented innovation and increased complexity. To take advantage of these trends and compete successfully, aerospace and defense companies must embrace the digital enterprise (digital twin and digital thread) in order to be more productive, innovate faster, and achieve program execution excellence to ensure programs deliver on technical requirements, cost and schedule.

Introduction

Digitalization is permanently changing the way industries across the globe conduct business. The aerospace and defense (A&D) industry is no exception. In fact A&D is innovating and combining technical innovations in ways never seen before to transform commercial aircraft, space travel and defense. And it's this digital revolution that has spurred the emergence of companies involved in electric aircraft, electric vertical take-off and landing (eVTOL) aircraft, supersonic aircraft, next generation fighter jets and new space applications for tourism, satellites and space exploration.

The advantages of digitalization are quickly becoming the difference between companies that advance in a competitive marketplace and companies that fall behind. Digitalization is not just about creating or sharing data, it's about seamless data integration and analyzing the data in a virtual context for better and more predictive decision making. Digitalization in the A&D industry helps companies improve program performance –

whether it's faster time to market, cutting costs, or adding the latest capabilities. It's about unlocking innovation so teams can move faster. It's adding productivity enhancements in every phase of the product development lifecycle. And today more than ever, it's providing the tools for increased collaboration among remote teams and empowering individuals working off site.

Enabling the digital enterprise is the Siemens Xcelerator, a portfolio of software, services and an application development platform that empowers customers to rapidly meet changing business models with flexible and adaptable applications. Xcelerator not only encompasses the industry's most comprehensive digital twin, but brings together a series of connected digital threads for the interoperability of task automation and other activities throughout all phases of systems development.



Trends driving the need for more digitalization

The A&D industry finds itself at the forefront of one of the most transformative periods in history. This movement to a more digitalized enterprise is without precedent. It's important to understand the trends and challenges facilitating the need for more digitalization.

Demand for digitalization is driven by:

- **Pressure to reduce program costs and schedule**
OEMs and their suppliers are challenged to bring new products to market faster while meeting technical, cost and schedule objectives. To compound this scenario, a growing number of competitors are bidding on fewer programs which makes winning the next program even more important. Methods and practices used just a short time ago as means to share and collect information are no longer applicable today.
- **Increasing program complexity and integration**
Program complexity is one of the primary reasons most aerospace companies suffer delays and financial losses during the execution of major programs. Issues arise because aerospace systems are becoming more sophisticated and challenging. The end customer is demanding greater innovation and improved performance. As companies seek to improve the performance of their products, they rely on more integration, electrification and software to meet customer demands.
- **Increased electrification of products**
Today there is a concentrated effort toward the de-carbonization of commercial aircraft, a shift to become more carbon neutral. The emergence of electric propulsion is a direct result of many new green energy programs. But even more important, electrification has replaced the traditional mechanical, pneumatic and hydraulic systems and structures that have been in aircraft for decades changing the skills, tools and approaches needed today. Electrification will only increase over the years as it improves aircraft system reliability and maintainability.

- **Globalization**

The A&D industry stretches across all corners of the world. Global competition, global suppliers and a global workforce are now commonplace. The need to collaborate and communicate effectively within engineering teams and throughout the wider workforce is of the utmost importance. Globalization also means competition is more intense with the entry of smaller, more nimble start-ups who are able to bid and compete for major new programs.

It's not just commercial companies that are embracing digitalization. Equally important to the trends mentioned is how the United States Department of Defense (DoD) is addressing digitalization. The DoD refers to the digital transformation as digital engineering and in the document "[Digital Engineering Strategy](#)" released in June 2018, the DoD discusses the planning, development and transformation of an end-to-end digital enterprise across all departments. For the DoD, this is an opportunity to go faster and reduce the acquisition costs of new programs in order to stay competitive and dominant.

Digitalization in aerospace and defense

Siemens Digital Industries Software is helping customers across the aerospace and defense industries meet their rapidly changing needs through flexible and adaptable software and business solutions. We've been leveraging our expertise gained by applying our digital solutions, which includes our comprehensive digital twin, into some of the most innovative companies to assist in the design and manufacture of world-class products and processes.

The Siemens comprehensive digital twin

A digital twin is a virtual representation of a product or process in the correct context for users or teams to analyze, study and improve upon with very little risk or financial cost. In order to be useful, a digital twin must be tied to the latest authorized configuration. The Siemens comprehensive digital twin (figure 1) extends beyond the standard definition of a digital twin because it represents a digital twin of design, simulation and analysis and is part of an open ecosystem connecting tools from multiple vendors. The three configurations of the Siemens comprehensive twin include:

- The **digital twin of product** predicts physical appearances and other attributes such as performance characteristics before the actual product is built. More than just 3D CAD, the Siemens digital twin of product virtualizes machine learning, generative design and product lifecycle management to name a few examples.
- The **digital twin of production** allows for the optimization of the physical layout of production. This digital twin takes into account a variety of considerations for production capacity, virtual commissioning and utilization of resources for a more optimized throughput.
- The **digital performance twin** provides insight and optimization of in-service operations to include abilities to predict maintenance aspects and validate what was produced versus what was initially designed.

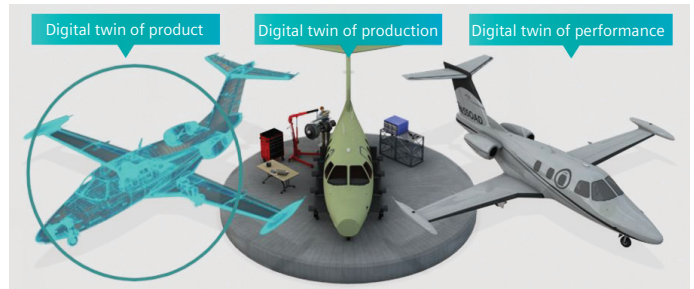


Figure 1: The value of the comprehensive digital twin is how closely the virtual world meets the physical world and how users can continuously optimize both product design and production activities.

The Siemens digital twin allows for the virtual testing or the “fly before you build” approach which enables users to confirm product performance and identify changes before the product is built. This approach reduces cost and schedule impacts, as well as limiting the risk to test programs. It also improves the effectiveness of a test program as users quickly understand where to focus testing to address areas of greatest concern.

To leverage the full potential of a digital twin, is to maximize its ability to think and understand the impact of changes from one connected twin to another, or from one connected system to the next within the product development ecosystem. This type of functionality requires a powerful, integrated and continuous exchange of digital information.

This is the role of the *digital thread*.

Digital thread

The Siemens digital thread brings a multiplying effect to our comprehensive digital twin by enabling numerous data processes across multiple systems. Merging the physical and digital worlds with a digital thread enables users to predict performance and optimize their product. Users are able to effectively deliver on their programs in a proven and secure manner.

One can think of the Siemens digital thread as a digital fabric that aligns with the most commonly used functional programs; engineering, program management, supply chain, production, and product support. This arrangement is not a serial processes within a single function, nor are these functions intended to operate

independently of one other. The exact opposite is true. With the digital thread task automation is achieved and functions are interconnected, integrated and linked so users can quickly access, share and manage program details across the entire product lifecycle – at any time, from any location.

Siemens Digital Industries Software provides the technical foundation to support our comprehensive digital twin and digital thread. The Siemens Xcelerator includes Teamcenter, for example, which weaves a digital thread and creates a fabric of information connecting people with data and applications for real-time, real-world decision making.

A&D digital thread solutions

Commercial aerospace and defense companies are embracing new technologies in ways the industry has never seen before. Siemens' [program execution excellence](#), whether for a commercial or defense program, is based on the goal of improving technical performance, program cost, and program schedule – all while managing or mitigating risk.

To complement our digital twin and facilitate program excellence, Siemens offers seven A&D digital threads (figure 2) to serve as the digital foundation and solutions for the most commonly used processes in use today.

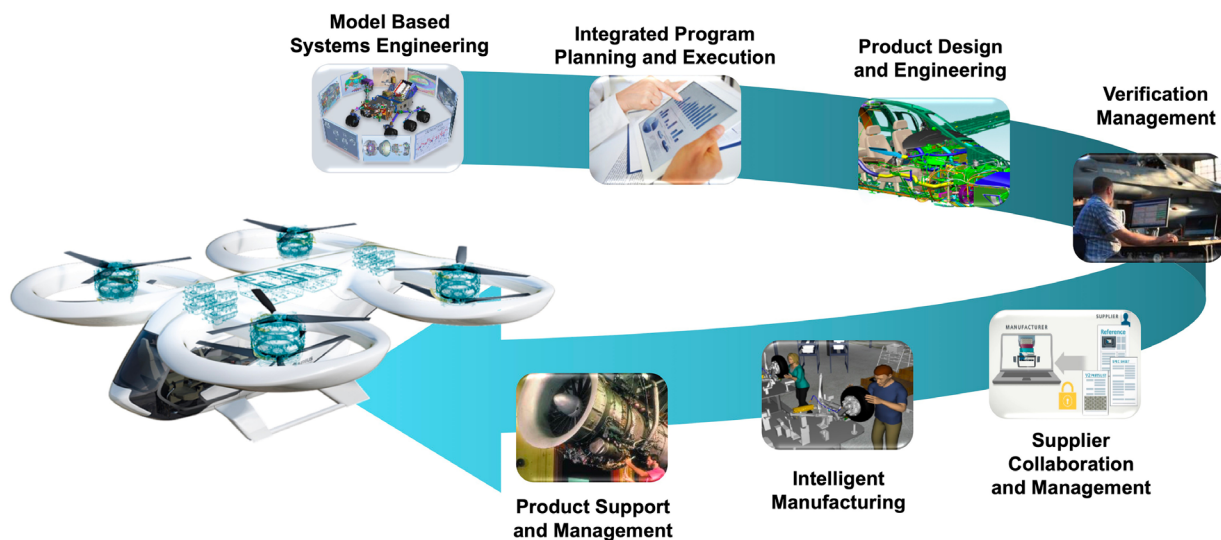


Figure 2: The seven A&D digital threads throughout the complete product lifecycle. Digital threads automate tasks and help users innovate faster and focus on areas where they can provide the most value.

The seven A&D digital threads:

Model Based Systems Engineering (MBSE)

The MBSE digital thread brings together core elements of the Siemens collaboration platform with elements from systems engineering, mechanical, electrical/electronics (E/E), software design, multi-domain modeling and simulation. MBSE helps eliminate the unforeseen consequences that appear at system integration and establishes faster and more repeated successes in the future.

Integrated Program Planning and Execution

This A&D digital thread provides a systems-based approach to project program planning by integrating cost, schedule, risk and technical requirements into a fully planned and budgeted program management solution. This thread provides an integrated view across all domains.

Product Design and Engineering

Siemens is in the unique position to represent the entire product – digitally – in the mechanical, E/E and software disciplines. Additionally, these disciplines are served with an integrated set of Siemens tools for CAD/CAM/CAE development. By utilizing this A&D digital thread users obtain breakthrough results faster using an evolutionary process leveraging existing or prior investments.

Verification Management

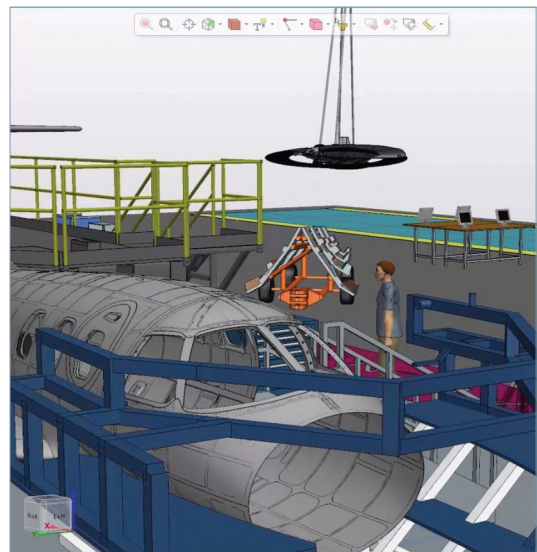
The verification management A&D digital thread enables traceability for rapid certification through synchronizing requirements from design, analysis and test of virtual and physical assets. This digital industry solution instills a corporate wide standardization and the re-use of proven procedures. Not only does the thread address these concerns, but it also brings an unprecedented level of automation to a time-intensive process.

Supplier Collaboration and Management

This A&D digital thread manages data interactions, supplier source selection along with quality and deliverables for suppliers using a model-based process to help move away from document-based processes. Through this thread, along with various Siemens tools, users can coordinate processes and manage information, both internal and external, across all stages of the product lifecycle in a way that protects the data rights of all parties involved.

Intelligent Manufacturing

The intelligent manufacturing digital thread achieves a fully integrated factory. Seamlessly moving from engineering designs to manufacturing planning, users can quickly optimize the factory layout and virtually evaluate flexible automation. Through virtual commissioning, this thread brings simulation and real-time feedback to large scale production lines and manufacturing plants. When connected to the other Siemens digital threads, users are able to create virtual aerospace and defense factories with unprecedented levels of automation, and utilize insights from the IIoT to optimize production processes.



Product Support and Management

A digital thread that enables manufacturers, owners and service organizations to support complex products within a model-based service management environment. Because this phase comprises the highest portion of an asset's total cost of ownership, it's critical for fielded products to be supported by a configuration-driven environment that provides physical, service-oriented product definitions and maintenance information.

Conclusion

Digitalization today affects every A&D business or organization disrupting current leaders and creating new opportunities for the swift and innovative. While these opportunities are exciting, they present numerous challenges. The technology required to initiate new programs increases the level of complexity and integration along with the regulatory requirements necessary for success. We are also aware of the cultural or institutional challenges that accompany transformational change.

Siemens Digital Industries Software has carefully aligned itself to help customers meet the current and evolving conditions associated with the adoption of the digital enterprise. The Xcelerator portfolio is the mechanism and means to achieve this goal. It provides OEMs and their partners with the foundation to build and scale to a fully advanced digital enterprise that encompasses the comprehensive digital twin and corresponding digital thread solutions.

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About Siemens Digital Industries Software

Siemens Digital Industries Software is driving transformation to enable a digital enterprise where engineering, manufacturing and electronics design meet tomorrow. Xcelerator, the comprehensive and integrated portfolio of software and services from Siemens Digital Industries Software, helps companies of all sizes create and leverage a comprehensive digital twin that provides organizations with new insights, opportunities and levels of automation to drive innovation. For more information on Siemens Digital Industries Software products and services, visit [siemens.com/software](https://www.siemens.com/software) or follow us on [LinkedIn](#), [Twitter](#), [Facebook](#) and [Instagram](#). Siemens Digital Industries Software – Where today meets tomorrow.

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