How digital engineering models are changing IT development

A new era of digital twinning and model-based systems engineering is helping the Defense Department make smarter design decisions faster and with less risk.

By FedScoop Report

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Tom Rock,
Senior Program Director
GDIT

What if your defense agency could create "living" virtual models not only of your aircraft, weapons, communications and operating systems but also of the underlying IT and security systems that manage them?

Better yet, what if that meant no longer needing to migrate vast amounts of information into costly data warehouses but, instead, simply linking to real-time data sources about those systems — data known to be the authoritative sources of truth?

Finally, how might the ability to digitally simulate a wide range of alternative engineering solutions — in a matter of days, not months — impact your organization's ability to move faster, budget smarter, and deliver more effectively on its mission?

The world of digital engineering is hardly new. However, a sub-discipline known as model-based systems engineering is not only emerging as a fundamental approach to managing complex IT systems — but also helping organizations of all sizes accomplish those what-if scenarios, according to Tom Rock, senior program director at General Dynamics Information Technology.

Model-based systems engineering (MBSE) enables enterprises to escape the confines of document-centric engineering processes, which can introduce outdated and conflicting information. It replaces them with authoritative sources of truth about a system in development or operation. Moreover, by providing a single, standardized virtual modeling environment, engineers of various disciplines can simulate and assess the impact of different design changes.

With the rise of "digital twin" technology, which provides a high-fidelity virtual replica of existing systems, MBSE has contributed to dramatic advances in aerospace, heavy machinery, manufacturing and industrial facility design.

Leveraging MBSE helps engineers work more effectively; it also helps enterprises streamline the design and operating costs, reduce development risks, and integrate system-of-systems requirements more effectively as their systems evolve.

The MBSE imperative for IT

As enterprise IT systems continue to evolve from pre-engineered networks into dynamic ecosystems, the need for real-time, model-based systems engineering has become critical to understanding, managing and modernizing those systems, insists Rock, a former U.S. Air Force engineering and program manager who joined GDIT two and half years ago.

"Model-based systems engineering isn't just a discipline for engineers," he argues. "It also provides senior program leaders, chief financial and operations officials, and acquisition and risk management executives with a greater understanding of what's happening across their organization's systems and how various design and upgrade options might impact them."

It's no surprise then that MBSE — and the notion that the truth is resident in the model, not in the documents — became the mantra for engineering by the Office of the Deputy Assistant Secretary of Defense for Systems Engineering more than five years ago.

And it has become a driving factor in managing programs elsewhere at the Department of Defense, including at the U.S. Space Force. As Lisa Costa, the chief technology and innovation officer for the U.S. Space Force described it at last April's Space Symposium, "We are focused on [using] digital engineering and digital twins in the entire ecosystem — not just for acquisition, but …at how we embed digital engineering and digital twins into our training, our doctrine, our red teaming, our force design."

The adoption of MBSE for managing IT systems was a natural outgrowth to the way engineering has evolved over the past decade — and the importance of the most current and accurate design and operating data, according to Ed Farler, vice president within GDIT's chief technology office.

"Digital Engineering is an evolution of model-based systems engineering replacing the old visual representation model — which created some beautiful wall charts for everyone but were obsolete as soon as you started building the system. Digital engineering is about connecting all of the data in your environment to the model so that the model can be a living thing throughout the program's lifecycle," says Farler. "But it's also critical to create a framework that allows you to connect data in a bi-directional way — including data that's never been connected before, to provide a way to navigate the digital complexity of your environment for systems engineering activities," he explains.

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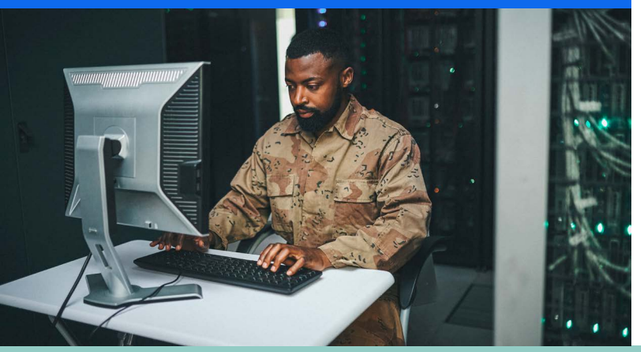
Leveraging Digital Engineering Environments

Digital engineering environments allow agencies to better manage their IT and related systems by enabling:

- **Model-Based Systems Engineering (MBSE)** – Using Object Management Group (OMG) open standards-based graphical representation of systems engineering practices instead of document-centric methods.
- **Simulation** – Using digital engineering models to simulate system solutions virtually to provide insights on analyzing alternatives.
- **Digital Engineering** – Connecting virtual digital models to current system data to provide real-time, real-world insights and answers to a wide range of questions.
- **Tool Independent Visualization** – Enabling visualization for all users, not just engineers, to make better-informed and rapid decisions.
- **Secure Automation** – Enabling virtual testing of code implementations of infrastructure, software-defined networking, modern DevSecOps, and cybersecurity.
- **Authoritative Sources of Truth (ASOT)** – Providing direct links to the original sources, reliable "sources of truth" that inform requirements, configuration, status, and performance.
- **Digital Twinning** – Providing automated digital construction of solutions, represented as models, digitally connected to the sources of truth, capable of serving as a model-based testbed for parametric analysis of alternatives and decision support.



The new age of 'digital twin' technology

Farler has seen the power of such a framework take root within the U.S. Air Force, where GDIT has helped form a digital twin program that effectively allows stakeholders to take existing data from various systems and platforms and explore what-if scenarios. According to Farler, GDIT connects MBSE with data in the digital engineering environment (DEE) to focus on aspects of interest for stakeholders. DEE creates an environment with customizable workflows and dashboards where users can access the data they need when they need it. Because it is cloud-agnostic, scalable, and adaptable, DEE offers the flexibility of programmable infrastructure and the financial efficiency of an agile environment.

What distinguishes digital twins of today from the past is the ability to connect to a broader range of system data and artifacts — looking at a system of systems — to create various models. This ensures that authoritative data is discoverable by all program stakeholders, not just engineers.

"It allows me to build a model of your entire network automatically. I can bring in data from all the tools in your network. I can model changes to the network and push those back to those tools to simulate the impacts on the network and get the results back to my overall model. So it gives you that ability to model a larger enterprise. That's the beauty of this. I can have a model that integrates weapons systems working with IT systems. And really, digital engineering has become my common language and increases my ability to communicate and collaborate," says Farler.

GDIT's approach takes DEE further by providing a model-based-data-as-a-service (MBDaaS) approach, using open standards, point-and-click navigation and automated visualization capabilities that don't rely solely on engineering tools or specific hardware and software platforms.

"To do this, we model engineering and business operations and use 'digital threads' to connect that data. These digital threads support the creation of digital twins and simulation capabilities, helping users understand the logical consequences of mission scenarios and make data-driven decisions in response," Farler explains.

Farler describes it as a data-driven method that optimizes "what if" engineering cycles and critical decision-making. It allows teams to collaborate securely and make better decisions as they manage, create, and test digital prototypes before investing resources in live solutions at lower risk.

"By creating a digital twin of a system, with all the relevant data in the environment, I know how it's executing today. So now if I want to make changes or a new procurement, I can simulate many different options and figure out which one will deliver the best value in the best performance," Farler says. "That allows the enterprise and their engineers to move from a model-based design methodology to a 'model-driven' methodology."

Expanding use cases for MBSE

By allowing engineering and security teams to focus on real-time views rather than on documents and having forward and reverse information flow with your systems, digital engineering can dramatically reduce errors that crop up with humans-in-the-loop and improve performance in a variety of use cases, including:

- Continuous ATO – Offering end-to-end visibility of controls, solutions, current status, and risk — and a more reliable means to continually authorize the platform and secure your supply chain.
- Requirements Traceability – Providing greater visibility from the requirement to the solution, test, and operational status.
- Network Modernization – Letting your agency build models from your existing data, simulate analysis of alternatives virtually, and push software-defined network changes.
- Zero Trust Compliance – Using models to see the impacts of all policies on specific groups or end users.
- Digital Twinning – Connecting the data in the enterprise to the model, creating virtual replicas of systems within your system, simulating changes and supporting visualization.

Value in looking at systems differently

Beyond the obvious benefits of enhanced communications, increased efficiency, more predictable outcomes and greater flexibility, DEE and MBSE bring about a broader cultural benefit, argues GDIT's Tom Rock.

"When I can ask questions differently — when I can ask: 'What is the actual system doing' — and then model for different enterprise outcomes, like my cybersecurity, that resonates with every executive, not just the IT and engineering folks," he says.

"The other value of these digital environments is that they allow us to see how changes to one part of my system play out and impact other parts. As a result, I get a more comprehensive, more detailed, and more accurate solution because I know I have pulled all of the data at the same time."

That's being demonstrated to surprising effect at the U.S. Air Force, according to USAF Col. Jason Bartolomei, the system program manager for the Ground Based Strategic Deterrent (GBSD) program. Speaking at the same Space Symposium, Bartolomei described how digital twinning allowed his engineering team to "look at 1,000 booster designs. Our government team found many, many designs that were more affordable and better performing than the ones industry was showing us," he said.

That came as no surprise to GDIT, which serves as the integrator for the digital engineering environment of the GBSD program.

"The one thing that's different about our whole modeling approach," says Farler, "is our models are very much focused on what questions you want to answer. We're not building a data warehouse. We only query the data we need to answer specific questions… The result is faster, more secure and more reliable timely modeling."

[Learn more about how GDIT is helping federal defense agencies leverage model-based systems engineering]

This report was produced by FedScoop and underwritten by GDIT.

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