Bentley
Advancing Infrastructure

Digital Twins: Why Every Utility Executive Should Care

DIGITAL TWINS: WHY EVERY UTILITY EXECUTIVE SHOULD CARE

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Multiple forces are in play that make it imperative to reduce and eliminate data silos and dark data and gain enterprise-wide insight into the electric power value chain that is rapidly transforming. To a large extent, the rapid adoption of distributed energy resources (DER) such as rooftop solar and energy storage systems means that a broad spectrum of stakeholders needs clear and data-rich insights across the value chain if those stakeholders are to make expeditious and informed decisions that ultimately impact the utility bottom line.

To become and remain the sort of data-driven organization that is central to supporting our rapidly changing electric economy, utilities must continue to advance digitally. Such advancement is not a "one and done" exercise. Instead, it is a continuous process that increasingly relies on collaboration and information sharing all across the organization.

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To better understand this imperative, consider one major utility in the southeastern United States. A series of mergers and acquisitions left it with a mish-mash of digital tools, none of which reflected accurately what was in the field and in service, and none of which could communicate effectively with any other system. As a result, professionals across the utility were challenged to perform their jobs that required them to access relevant data to make operational and capital investment decisions. Data that could have helped inform those decisions often resided in isolated, stand-alone IT systems and databases.

Similar challenges face utilities everywhere, including investor-owned entities, public power entities and independent power producers.

One increasingly valuable tool to address such data challenges is a digital twin, which is made technologically feasible as the realms of engineering technology (ET), information technology (IT), and operations technology (OT) merge and meld. The promise of a digital twin lies in its ability to enable utilities to fully exploit data and support nimble decision-making through analytics and operational insights that can bridge barriers that previously hampered information sharing. This has the added benefit of allowing existing tools to share and update information, eliminating the "rip and replace" syndrome of adopting new technologies to enhance productivity.

Defining Digital Twin

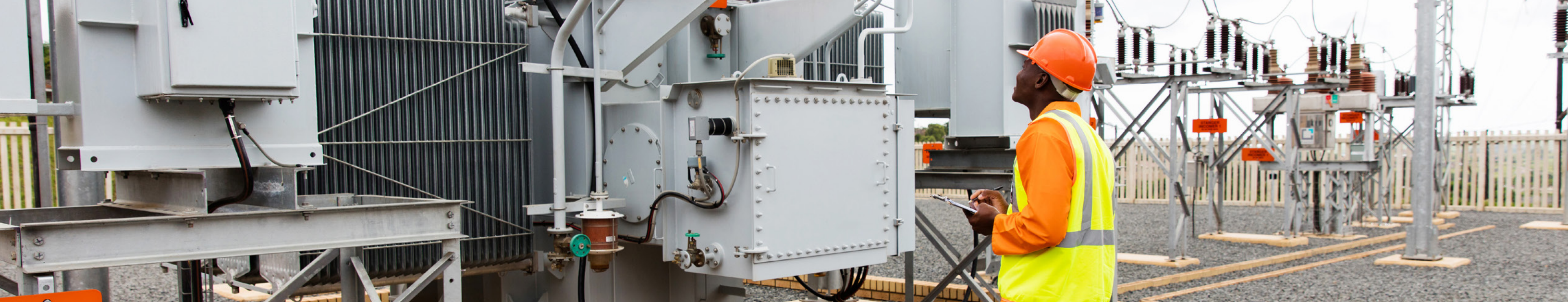
The concept of a digital twin refers to a digital representation of a physical asset, process or system, as well as the underlying information, that allows professionals to more fully understand and model that asset or system. Using a digital twin means that utilities can build an exact replica of their physical assets in the cloud and manage those assets from design and development through the end of their service lives. The digital twin enables utilities to gain efficiency in multiple ways, including taking advantage of cross functional skills with better collaboration, streamlined operations, improved safety and faster time to market.

One hallmark of a digital twin is an open or "federated" data environment that is strengthened by multiple information sources, including GIS data, engineering data and operations and maintenance data, continuous surveys, photogrammetry, LiDAR, and sensors.

When the digital twin is continuously updated and synchronized from sources such as these, it provides near real-time status updates, working conditions and operational challenges that are playing out in real time in the field.

Once deployed and with proper management, the digital twin is able to evolve over an asset's lifecycle, enabling users all across the organization to see crucial information about how the asset is currently performing or was performing at any given time. With that insight, users can readily model and assess how, for example, load profile changes and customer-installed generating assets will impact deployed assets.

Sophisticated analytical and decision-support tools can be built on top of the basic digital twin model. Those tools may include engineering calculations, process simulation, construction modeling and immersive simulation.



Organizing the Data

In order to be successful, data integrity and data quality are imperative as the digital twin is deployed. These factors must be managed through a robust set of governance rules. The most effective rules will typically embrace four fundamental principles.

- Data orchestration, which monitors the business value of data and also defines the exchange technology platform and mode of data exchange.
- Data oversight, which defines the role of compliance, audit policy, ethics, security, encryption and regulatory aspects such as protecting personal data. Robust data oversight equips the organization with guidelines and discipline on how, when and where digital twin data will be used.
- Data curation, which addresses issues related to data clarity, structure, quality and linkages. Curation involves creating semantic models by applying data classifications. Data curation is instrumental to the quality and rich contextualization of digital twin data to enable informed decision making.
- Data management, which addresses managing metadata by providing a comprehensive view of data life cycles, access control and revision control. This dimension addresses the need for ensuring that digital twin metadata is consistent and comprehensive. It also supports the ability to trace the lifecycle history of digital twin data.

Digital Twin Adoption in Other Sectors

Utilities are not alone in adopting digital twins. Every infrastructure segment is advancing digitally – on project sites, in smart buildings and manufacturing plants and in urban places.

A 2019 report from market research firm Gartner predicted that by 2022 more than two-thirds of companies that have already implemented IoT strategies will also deploy at least one digital twin. Three-quarters of respondents to a Gartner survey said they either were using digital twins or planned to do so in the next year. The firm credited this growth trajectory to the business value that digital twins offer, making them integral to enterprise IoT and digital strategies.

In late July, research firm ResearchandMarkets.com estimated the electrical digital twin market to be roughly $804 million in size and projected it could reach $1.6 billion by 2024, at combined annual growth rate of 15.4% during the forecast period.

Drivers in the Power Sector

To be sure, change is underway in grid investments as national economies and utilities move from a carbon-intensive model to a decentralized and decarbonized grid capable of meeting 21st century demands.
As this change advances, risk-averse utilities also must respond to the growing frequency and intensity of man-made and natural events—including wildfires and floods—that pose a threat to resilience and reliability requirements. What's more, infrastructure that was built to accommodate a 20th century business model is aging and in need of replacement. Add to these factors the stress on existing systems as customers increasingly become self-generators through distributed energy resources such as rooftop solar and home-based energy storage systems, and it's clear that utilities face an unprecedented array of complex investment decisions that involve multiple technology options each with a host of impacts on grid stability.

From a corporate standpoint, utilities must constantly optimize their CapEx and OpEx calculations. This can be even more challenging as the factors that go into these equations become more complex and uncertain. To continuously maximize CapEx/OpEx efficiencies, utilities must improve the quality of their decision-making both in terms of using relevant data and sharing it among departments and stakeholders.

Productivity also is affected by legacy work processes. Studies suggest that technical workers spend roughly one third of their working time finding documents and then communicating information about those documents. That percentage might be higher in organizations that focus on transmission and distribution networks, which manage assets—and documentation—that may be decades old.

One major West Coast utility relied on administrators to manually manage engineering drawings produced by multiple project participants. This manual process created a bottleneck that slowed project time cycles. By working to consolidate data and workflows to support the expected adoption of a digital twin, and also by allowing internal as well as external designers to have direct access to drawings and databases through a secure environment, the utility reduced project delivery times, made collaboration easier and reduced errors.

The DER Challenge

Productivity takes on a greater importance as DER increasingly challenges utilities to process and analyze interconnection requests. Utilities still depend on impact and hosting capacity analysis (HCA) to study multiple power flow scenarios. These detailed studies can be costly, require specialized engineers and are not always necessary for low-impact interconnection requests. The process for evaluating DER interconnections remains largely a manual and fragmented set of processes.

Grid modernization, resilience, reliability and DER considerations raise the stakes for better information and more holistic participation across generation, transmission and distribution planning departments, including business processes that ensure communication and consistency across planning groups. In addition, strategic integration relies on actionable data, a sound business process, robust and connected models and effective coordination between departments. With these elements in place, utilities can drive large operational efficiencies.

Establishing a Business Case

In 2018, Forbes laid out an argument for digital twin adoption, saying that, first, digital twins create a data-based model of assets or processes. They aid decision-makers across an organization to adopt advanced techniques to anticipate and prevent equipment failures as well as to find new ways to optimize performance.

Second, digital twins provide detailed information about large collections of key assets in an industrial landscape. The intelligence helps inform decision-making when it comes to allocating scarce investment dollars.

Third, and no less important, digital twins expand a culture of data-based decision-making, thus supporting a host of corporate initiatives aimed at continuously improving performance. Indeed, one utility veteran said

that corporate culture is “immensely” important in determining both the pace and success of embracing digital technology.

Digital Twin Enabling Framework

Although infrastructure asset owners increasingly recognize the potential for digital twins in many use cases, including applied analytics, artificial intelligence (AI) and machine learning (ML), one challenge is that infrastructure projects rely on cooperation and collaboration across multiple disciplines. In the past teams have worked independently and in relative isolation. The result often ended up being thousands of asynchronous decisions and changes that presented multiple opportunities for errors.

By contrast, digital twins and associated workflows are enabled by an open and connected data environment. Project participants can share the benefits of an open, integrated and connected framework that enables collaboration, improves decision making and delivers both better project outcomes and better asset performance .

Decision Support

Utilities can support upcoming projects and ongoing operations by having a better understanding of existing system conditions. They also can improve operations by maximizing the value of field and site visits, helping to lower the costs associated with asset inspection through continuous digital surveying. Perhaps most importantly, the teams can define repeatable and efficient workflows that will continue to improve asset inspection and maintenance.

Creating a digital twin with the fidelity needed to be useful for project delivery or asset operations requires mirroring the physical reality of the site’s or asset’s existing conditions. This is referred to as the digital context. It requires aligning virtual engineering data—the digital components—to make that data available for analytics. It also requires synchronizing that data to reflect the continuous change that is intrinsic to every project.

Enhanced Collaboration

Collaborative digital workflows are characterized by data that is captured or created for one purpose and then accessed and used by other applications for other purposes. Such collaboration saves time, minimizes rework and improves data quality over the asset lifecycle.

A connected or federated data environment brings together GIS, CAD, BIM models, and operational data into a nearly real-time digital twin that encompasses both existing and proposed infrastructure information. Electric utilities can enhance their network design and operations with this nearly real-time digital twin. Doing so enables sharing data across operational silos, encourages stronger collaboration, and establishes a single, continuously updated data source to all applications and workflows.

Designing with reliability moves the focus from a pure design-centric viewpoint to one that considers the entire asset lifecycle; in other words, creating a complete picture of the asset over its life, regardless of whether it is a transmission asset or a generating turbine.

In this type of application, designers and planners utilize a digital twin that mirrors their operations and offers planning information. That information would be readily accessible and served through a common data environment. Rather than maintain a traditional “document-centric” approach, the design process would become more asset-centric, enabling planners and designers to see crucial information of how an asset is performing and compare that operational insight with other systems, simulate how a replacement asset would operate and predict where system failures may occur.

Then, once the asset was commissioned, asset information sharing from the project delivery team to the operations/maintenance team would become seamless, and the underlying asset information model would continue to provide accurate, timely and relevant information.

Construction Support

The notion of 4D construction improves collaboration, finds issues early eliminates waste and increases project value. Visual and data-rich environment engages all team members in a transparent process to optimize construction projects of all types, from tendering through construction, commissioning and handover. It includes progress monitoring, change reporting and project management functions.

Digital twins also can assume vital roles in assessing and managing risks in infrastructure projects, and key to infrastructure asset planning, design, construction and operations. Creating and curating subsurface digital twins involves modeling the underground environment (geology, hydrology, chemistry, and engineering properties, and the underground infrastructure), as well as utility networks, structures, and tunnels and then analyzing and simulating the subsurface behavior.

With this, a 3D representation of the subsurface coupled with models to analyze and simulate behavior becomes a valuable tool in all asset lifecycle phases. The subsurface digital twin enables technicians to navigate, find, view and query asset information. It can be used in engineering, maintenance, or GIS workflows to provide precise real-world digital context to design, construction and operations initiatives.

Optimizing Asset Performance

A “performance digital twin” enables owner-operators to extend the life of assets, optimize operational performance and maintain system reliability.

For example, substation owners can improve their design and operations with a near-real-time digital twin that includes data sharing across operational silos, enables efficient collaboration and provides a single source for all applications and workflows. This application considers how utility asset owners can address the challenges associated with aging equipment by creating a “performance digital twin.”

This twin can be based on reality models to improve operational performance of substations within the context of a connected data environment. Immersive visualization brings together non-graphical data from asset registries, risk databases and specifications. The underlying structure applies analytics, artificial intelligence and machine learning in simulations and decision support.

Managing DER

In an era of distributed energy resources, utilities increasingly leverage analytical tools for rapid and data-informed decision-making. The increasing demand for DER interconnections poses numerous challenges for utilities. DER threatens the traditional consumer business model. Under such pressure, siloed departments impede the sort of workflows that are required to ensure reliability. What's more, the sheer volume of DER interconnections can be overwhelming.

Utilities need a way to integrate the DER interconnection process with planning and design workflows to arrive at a "stage, merge and validation" process that can manage the digital twin of the entire power system and keep it up to date. Adopting such an approach would result in only a relative handful of application requests—for example, those that fail the initial screening and supplemental screening--that would need to be reviewed by planners.

Analytical tools can empower utilities to better manage the rapid growth of DER. The rapid adoption of DER is changing the ways that utilities do business with customers, manage their electric distribution network and plan for infrastructure investments.

Utilities need a digital twin that enables owner-operators to more efficiently model the grid for decentralized energy without compromising safety and reliability. Some of the challenges that utilities encounter with DER integration are system complexity, changing regulatory requirements, variable customer demand and effective cost management. Digital twins can provide efficiencies in grid operations by streamlining DER interconnection applications with optimized workflows to better assess operational impacts, long-term strategic scenarios, and investment decisions.

Seen this way, a digital twin of the entire power system ensures data quality through integrated preprocessing that incorporates business rule validations, load flow validations, and short circuit validations of the network model information. Digital twins with robust data management guidelines also can streamline data cleansing and enable quality control workflows to be initiated by the automated validation handlers.

Workflow Optimization

What's more a digital twin can enable workflow optimization by streamlining approval processes through a process of requiring less direct involvement from high-value engineering resources and by expediting the interconnection request process when appropriate.

This means that the decision support process can be improved to allow decision teams to readily determine if further engineering analysis and studies are necessary for any given application or project.

Digital twins also can enhance operational efficiency and worker productivity by enabling non-engineers and managers to effectively manage DER interconnection applications while adhering to standardized regulatory requirements for DER permits. Doing so will improve workflows and reduce manual work.

A bottom-line, quantifiable benefit is improved quality and optimized cost, the result of fewer rework order and less opportunity for cost overruns. Future capital planning also may be better supported through improved forecasting and new feature planning capabilities.

Summary

For decades, electric utilities have collected data that ranges from power plant health to substation operating conditions. Once most of that data was collected it went unused and sometimes forgotten.

Multiple forces are in play that make it imperative to reduce and eliminate data silos and dark data and gain enterprise-wide insight into the electric power value chain that is rapidly transforming.

The rapid adoption of distributed energy resources in particular means that multiple stakeholders need clear and data-rich insights if those stakeholders are to make expeditious and informed decisions that impact the utility bottom line.

One tool to address emerging data challenges is a digital twin, which is made technologically feasible as engineering technology (ET), information technology (IT), and operations technology (OT) merge and meld.

Using a digital twin means that utilities can build an exact replica of their physical assets in the cloud and manage those assets from design and development through the end of their service lives. The digital twin enables utilities to gain efficiency in multiple ways, including taking advantage of cross functional skills with better collaboration, streamlined operations, improved safety and faster time to market.

About the Sponsor, Bentley Systems

Bentley Systems is the leading global provider of software solutions to engineers, architects, geospatial professionals, constructors, and owner-operators for the design, construction, and operations of infrastructure. Bentley's MicroStation-based engineering and BIM applications, and its digital twin cloud services, advance the project delivery (ProjectWise) and the asset performance (AssetWise) of transportation and other public works, utilities, industrial and resources plants, and commercial and institutional facilities.

Bentley provides electric utility solutions in an open, connected data environment to help drive grid modernization and digitization initiatives with intelligent and data-driven planning through performance across the enterprise and with EPCs – facilitating delivery on the promise of safe, reliable, and resilient power. Bentley solutions help drive efficient multidiscipline workflows across generation, transmission, and distribution design projects – improving productivity, fostering collaboration, and helping teams meet project deliveries to local and national standards. Additionally, Bentley solutions help to improve the life of assets with proactive strategies for long-term asset reliability and performance, to optimize grid performance with proactive digital workflows and DER integrations, and to minimize time and cost for equipment, component inspections, and maintenance with immersive digital operations.

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