

Making Service Lifecycle Management a Profitable, Competitive Advantage

Teamcenter SLM—an open solution spanning your extended enterprise



Global Leaders in PLM Consulting
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Key Takeaways

What you need to know

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Profitable operations and maintenance services of today's complex, smart, connected products require original equipment manufacturers (OEMs) and owner/operators (O/Os) to evolve and transform their lifecycle service management environments (i.e., processes and enabling solutions), as well as business models.

Successful enterprises turn service complexity and management into a competitive advantage while enabling new, profitable service-related business models.

Successful service lifecycle management (SLM) environments leverage a digital thread that provides end-to-end connectivity and feedback among design, production, and service, and maintains a comprehensive, actionable digital twin that contains the up-to-date configuration of the managed asset.

Siemens Digital Industries Software's (Siemens) SLM solution portfolio provides the technology, process enablement, and open flexibility to support OEMs, engineering, procurement & construction (EPC) firms, O/Os, and production line builders in transforming their service programs to create and enable new business models while delivering higher levels of customer satisfaction.

Siemens' SLM solution enables companies to create an effective collaborative and closed-loop feedback environment among product design, manufacturing, and service. Siemens' SLM solution also enables OEMs, EPCs, and production line builders to plan for service optimization as they design and produce their products, and O/Os to optimize their service time and activities.



Introduction

Industrial manufacturing companies need more effective service solutions

One of today's major business challenges is the increasing complexity of products, systems, and processes and how they are designed, produced, commissioned, operated, maintained, and decommissioned. These complex and unique products often must meet strict customer, regulatory, and serviceability requirements over extended periods of time—sometimes multiple decades. Optimizing the operations of these smart, connected assets is key to achieving operational efficiency and improving the profitability and success of a business. O/Os must effectively and efficiently operate and service their physical assets throughout long operational lives. They need the service of those assets to be proactive and cost effective, not reactive and/or at ever increasing expense. While companies in all Industries desire improved service capabilities, companies that have long-life, operation-critical capital assets are leading the way. These leaders are typically found in the following industrial sectors: Aerospace and Defense, Energy, Heavy Equipment, Industrial Equipment, and Infrastructure (e.g., power and water distribution systems, and rail networks).

To meet these challenges, service management is undergoing a rapid evolution. OEMs, EPCs, and manufacturing production line builders are no longer viewing service as a costly necessity, but an opportunity to create new business models that generate revenue, improve customer operational performance, and increase customer loyalty. OEMs, EPCs, and production line builders want to maximize the value of service to a business and become their customers' preferred service organization.

To improve service and create profitable "asset-as-a-service" business models, OEMs, O/Os, line builders, and a host of industrial companies are working to

implement SLM solutions and associated environments that will enable them to achieve better utilization of their assets throughout their entire operational life.

Key capabilities required for operating and servicing assets that have long lives include:

- Defining and managing the complete configuration of an asset as it evolves from concept through the end of its operational life.
- Reducing the cost of service, as well as the overall total cost of ownership.
- Enabling efficient spares and inventory management and optimization.
- Optimizing asset utilization—minimizing out of service time.

Effective SLM draws on information created and maintained in multiple sources, not just data from the managed asset. Integrating the diverse, distributed data that often exists within these complex business and IT environments requires creating and managing a digital thread that feeds a comprehensive digital twin drawing from the extended enterprise. Key roles of the digital thread are to establish closed-loop feedback from service to R&D and manufacturing and provide full lifecycle traceability of changes to the assets.

This eBook defines the need for a modern SLM solution, the characteristics of such a solution, and describes Siemens' strategy, program, technologies, solutions, and relationships to address the demanding service needs of OEMs, EPCs, O/Os, and product line builders.

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Goals of a Successful SLM Solution

Goals and functions of a modern SLM solution

As previously described, SLM is becoming more important to both creators of managed long-life capital assets and the owners and users of those assets.

Major goals of SLM are to reduce:

- Commissioning time—get assets into productive operations quickly and efficiently.
- Unplanned downtime—establish a predictive maintenance practice and improve service turnaround times.
- Rework when service is required—drive a model of first-time fix using the right tools, knowing the right configuration, and providing access to the right up-to-date configured service information.
- Cost—effectively manage ongoing upgrades and ensure accurate spare parts inventory always exists.

Other important SLM goals include:

- Maintain asset availability and performance as part of asset-as-a service business model.
- Ensure traceability and auditability of service events.
- Create more effective service level agreements (SLAs) between manufacturer and operators.
- Increase service engineer and technician productivity.
- Effectively manage and leverage the explosion of diverse, distributed service information.
- Ensure ongoing quality and compliance throughout the service lifecycle.
- Provide feedback to product engineering to improve design for serviceability.

One of the key functions of a robust SLM solution is to enable a company to aggregate, contextualize, simulate, and analyze operational data captured from managed assets into actionable insight that can drive service planning by O/Os and identify possible asset design changes and upgrades by OEMs, EPCs, and production line builders. This feedback provides the information needed to enable engineers to design for serviceability and for manufacturing to produce the asset in a manner that better facilitates service. Another key function is the

ability to simulate the performance of a managed asset and its operational environment (e.g., what is called the performance use case of a comprehensive digital twin) so that various scenarios can be virtually anticipated and optimized prior to performing the physical work.

Finally, it should be noted that SLM encompasses three major areas:

- Service engineering—ensure compliance and quality while increasing efficiency, and iteratively improving the serviceability and design of the next version of the product.
- Service operations and execution—minimize downtime and lost productivity, improve service responsiveness, efficiency, and quality, while improving spares availability and reducing overall inventory costs.
- Asset performance management—track usage, wear, down time, execute performance analytics, and create and optimize predictive service activities, performance controls, and schedules.

Successful SLM environments must be architected to enable and increase connectivity among each of the three areas. Having full connectivity across these areas significantly reduces the time to make changes—to update or replace an asset or to repair non-performing or out-of-service assets.

As previously described, SLM is becoming more important to both creators of the managed long-life capital assets and the owners and users of those assets. Major goals of SLM are to answer question such as:

- What configuration is installed?
- What is being recorded and why?
- Where are the instructions to be used to correct this issue?
- Are the changes critical to performance and service?
- Was the required information captured correctly?
- Why do I see a different part installed?
- How do dependent assets impact each other?



Characteristics of a Successful SLM Solution

Modern solutions require modern architectures

No physical asset functions alone. It interacts with other assets, both sending and receiving data to other connected assets and systems. To work effectively, a successful SLM solution must support a heterogeneous, extended enterprise service value chain. This requires that SLM environments be able to adapt and grow as assets age and new assets and supporting solutions are added.

To achieve SLM goals, leading SLM solutions are adapting and applying product lifecycle management (PLM) concepts and techniques to the planning, design, production, and operation of long-life assets. In generic terms, a lifecycle management solution must manage complex asset information and their evolving structures, enabling associated workflows and collaboration to connect people and processes across functional silos along a complete digital thread. Such a solution must contain defined elements that facilitate the effective management of data across the asset's lifecycle, enabling bi-directional traceability, ensuring adherence to requirements, as well as enabling better decision making and operational use.

A successful SLM environment must be built on a flexible, adaptable, scalable architecture that enables an enterprise to easily adjust the SLM solution to meet its changing business needs. It

must also enable the creation of an open ecosystem of seamless, integrated connectivity to multiple sources of service data and processes, e.g., in-house and third-party service applications and solutions whether run on-premise, in the cloud, or at the edge. Such open ecosystem capability is required to enable implementation of a true lifecycle digital thread and a comprehensive, actionable digital twin.



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Each Asset has a Digital Twin

The digital twin provides up-to-date performance and status of the asset

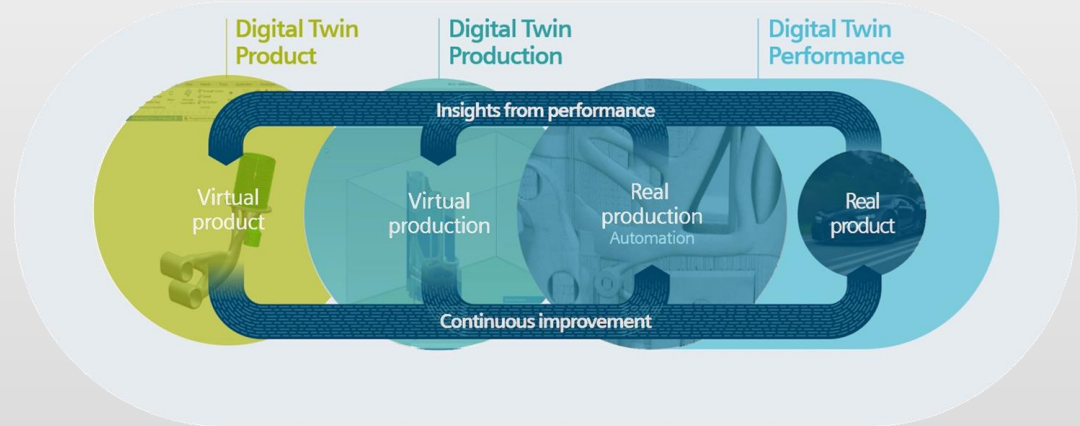
A comprehensive, actionable digital twin possesses the required accuracy and fidelity to predict physical behavior and even optimize the actual performance of the physical asset (i.e., the product and/or process) it represents. Implemented fully, the digital twin thus encompasses both the entire history and the current state of the physical asset it represents and can be used to accurately simulate past and future operational scenarios.

Quickly resolving operational and service problems requires accurate knowledge of an asset's complete configuration. To maintain the accuracy of the digital twin, the SLM solution must fully and accurately manage configurations throughout the assets' lifecycle (e.g., maintaining up-to-date, complete service and as-maintained BOMs). This includes providing the capabilities and tools to

capture data from distributed assets and perform appropriate analyses on that data. This enables a company to use asset performance data to proactively manage service activities and optimize spare parts inventory (spares, number, location) required, among other things.

Additionally, an effective, modern SLM environment must provide easy-to-use applications and be "personalized" or tailored to corporate, business unit, functional domains, and individuals (e.g., service technicians) to deliver consistent, contextually relevant, user experiences all while enforcing appropriate processes and standards. By creating this decision support environment, enabled by a closed-loop digital twin, organizations form the means of continuous performance optimization and increased utilization.

Integrated Domains of Closed Loop, Lifecycle Digital Twins
Courtesy of Siemens



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Designed to support the extended enterprise

Founded more than 170 years ago, Siemens AG has a long history of delivering products and services that enable their customers to succeed. Today, Siemens AG's vision is to enable, participate in, and orchestrate value chain ecosystems, and ultimately enable their customers to successfully undergo the digital transformation critical to future success (i.e., become a Digital Enterprise). They do so via industry specific approaches and solutions that enable open, interactive ecosystems with partners in the outside world to deliver seamless integration of data and processes across the extended enterprise value chain. Siemens Digital Industries Software (Siemens) a major group within Siemens AG, has been a leader in developing multi-domain solutions for many years with a commitment to both research and development tools, such as mechanical and electronic CAD, simulation and analysis, and manufacturing, including process planning, simulation, and execution. The use of Siemens solutions within the various Siemens AG manufacturing companies is extensive—comprising a major in-house customer, if you will. These operating units are often beta users of Siemens solutions and provide excellent examples of how that software delivers value and results to a complex commercial business.

One of Siemens' most important and enduring strategies has been "Leave No Customer Behind." Throughout the years, Siemens has focused on ensuring that their customers can move forward in technology and process enablement with minimum disruption and maximum leverage of their previous investments in Siemens' solutions. Siemens is building their solutions on a future-proof architecture designed to best support evolution while minimizing total cost of ownership. An example of Siemens' future-proof investment protection strategy is that Teamcenter X, a fully featured cloud-native implementation of Teamcenter, allows customers to migrate from on-premise Teamcenter to cloud-based Teamcenter X at any time, at any pace while maintaining their full Teamcenter capabilities.

Siemens has taken a very pragmatic approach to developing and delivering their suite of SLM solutions as a strategic part of their overall solution portfolio. They also recognize that no one solution provider can supply all the capabilities needed by every customer and have (1) established relationships with leading SLM technology and solution providers (e.g., IBM, SAP); and (2) provided extensive Siemens tools, e.g., Mendix and MindSphere, that enable quick and easy integration

with third-party and in-house developed applications. By doing so they provide a flexible, adaptable technology foundation upon which advanced SLM strategies can be based.



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Comprehensive, flexible, open

The foundation for Siemens' SLM offering is Xcelerator,* a comprehensive, integrated portfolio of software solutions and services supported by a robust application development and integration platform. This platform provides a foundation for collaborative design, manufacturing, and service, and acts as a catalyst to any industrial enterprise's digital transformation. Xcelerator provides solutions to:

- Collaborate in the design, manufacture, and operation of products and processes across discrete and process industries.
- Create and manage the required information models that support the digital twin.
- Create and manage open ecosystems and partner networks that seamlessly span all of a value chain's participants.
- Connect smart devices and systems across engineering, production, operational, and IT system environments.

All elements of the Xcelerator portfolio support and enable the creation of a complete, extended enterprise digital thread including open integration with non-Siemens delivered solutions. This enables the definition and management of a comprehensive digital twin, including the asset performance use case of the digital twin as described earlier. This portfolio is designed to reduce the barriers to innovation and ultimately enable manufacturing companies to become digital enterprises by leveraging today's, as well as tomorrow's anticipated transformational technologies and initiatives. Xcelerator's technologies support: generative engineering, additive manufacturing, Industry 4.0, and autonomous mobility. Xcelerator solutions have been developed to be adaptable to each company's needs and are able to be personalized down to the individual user.

A key capability of the Xcelerator portfolio is its multi-domain support for complex products and systems. Within the portfolio are applications and solutions that address all aspects of an asset or product, including mechanical,

electrical/electronic, software, and technical documentation. These domains are integrated so that data created in one domain is available in the others as appropriate and all the data is linked and managed by Teamcenter. This is a critical and core capability to enable the efficient and cost-effective service of today's complex, connected physical assets.



* <https://sw.siemens.com/portfolio>



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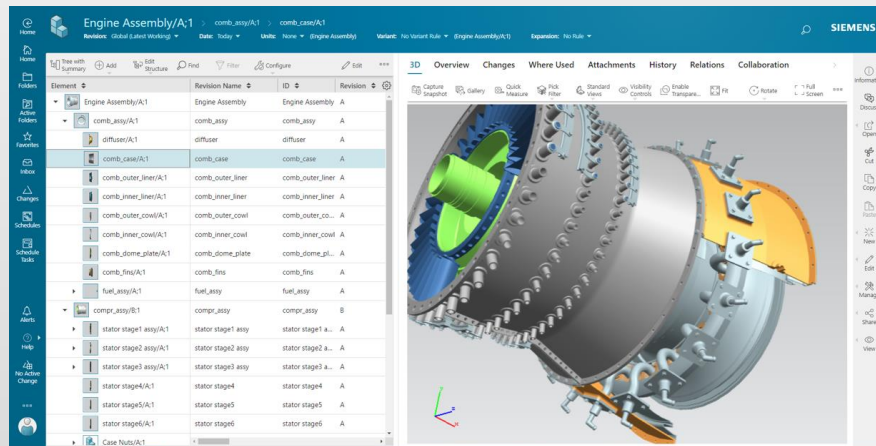
Teamcenter provides the SLM platform

Siemens has applied several components of their Xcelerator portfolio to support SLM. Foremost among these are Teamcenter, Mendix, and MindSphere. Teamcenter SLM has been tailored to support all aspects of SLM beginning with a strong base in service engineering. It is a functional module of the comprehensive Teamcenter suite built on the core capabilities of Teamcenter (i.e., product data management, security, reporting, process management, etc.).

Teamcenter SLM provides a strong PLM enterprise data and process management backbone that delivers the right information to both up- and down-stream systems and processes, and provides a common, logical source of information for all SLM related tasks and users including creating and maintaining service plans, full multi-domain asset (as-maintained) configurations, asset status and service history, and other related data. Additionally, Teamcenter SLM enables workers at all levels to find and re-use

product data and knowledge from engineering and manufacturing to improve service planning and execution. It is a key part of the digital thread that provides feedback to engineering to improve product designs for serviceability and reliability.

A key function of Teamcenter SLM is that it enables the communication and coordination of operational activities for greater compliance, faster service, and lower costs. One of Teamcenter's strengths is its ability to fully manage small to very large, complex asset configurations (including product and platform variants), incorporating mechanical, electrical/electronic, software, and documentation components, and make that information available as needed to any service-related user or activity. As stated earlier, complete, up-to-date configuration status is key to successful, right first-time service.



Teamcenter SLM Service Manager
Courtesy of Siemens



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Mendix and MindSphere deliver connectivity and integration across the value chain

Mendix enables developers, business analysts, and power users to rapidly create and deploy company-unique, personalized, multi-experience composite applications across their extended enterprise ecosystem. Such a platform allows more participants to make fast, accurate decisions about product development, manufacturing, and service. Siemens uses the Mendix platform to expose the various components of Teamcenter SLM and other parts of their Xcelerator solution portfolio as resources and microservices to: (1) integrate solutions and develop applications within Teamcenter SLM and the Xcelerator portfolio; and (2) connect Siemens' solutions to third-party extended enterprise solutions. Adaptors exist for most enterprise software solutions and the entire Xcelerator portfolio has been designed so all its functional services can be consumed by Mendix constructed applications. Siemens' customers can also use Mendix and its Data Hub capability to expand Siemens-based solutions, deliver Data-as-a-Service (DaaS) applications, develop in-house business-unique solutions, and connect to data sources across extended value chains. Finally, Mendix enables

Siemens and its customers to create comprehensive, integrated service environments.

MindSphere is Siemens' IoT-as-a-Service solution that supports connected, smart devices, as well as factory floor machine connectivity. It leverages Siemens AG's deep experience in factory automation to provide connectivity to data and analytics services needed to close the loop back to stakeholders throughout the lifecycle. MindSphere Analyze and Predict provides solutions that enable manufacturers to use integrated data sets and modern data analysis to derive deep, predictive insights about asset health and performance. It supports edge-through-cloud data management and incorporates predictive learning. It, with Mendix, also enables companies to create closed-loop feedback among service, production, and development. Finally, MindSphere provides Cloud- and Edge-based asset connectivity that enable asset performance analysis, to make rapid, informed operational and service decisions, and enable autonomous action to be taken directly.

Applications

Powerful industry solutions with advanced analytics



Develop robust industrial IoT solutions faster with global scalability

MindSphere

Edge Management

Edge Device Management, Edge App Management, and Edge App Store

Connectivity

Connect products, plants, systems, machines and enterprise applications



Edge Apps

Siemens, partner (OEM), and 3rd-party Edge Apps

Edge Devices

Multiple enabled devices hosting the Industrial Edge platform

Courtesy of Siemens



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Enabling all elements of SLM

Siemens' SLM strategy is to include a mix of solution offerings that allow their customers to best leverage their service technology and solution investments. While the core Siemens SLM solution is built on its Xcelerator portfolio, Siemens acknowledges that an extended enterprise SLM solution must work in a heterogeneous environment. Therefore, the solution suite is not just Siemens-focused. It is open to support in-house and third-party solutions. As evidence of this, Siemens has established relationships with other service solution leaders including IBM and SAP to offer their customers maximum choice when enabling a comprehensive SLM environment. Siemens SLM program supports all aspects of SLM, including:

- Service Engineering includes serviceability, technical publications, planning, forecasting, reliability, and configuration management. Teamcenter SLM provides these capabilities as part of the overall SLM solution. It is integrated with service operations solutions to provide accurate configuration information and get updated service history activities.
- Service Operations includes scheduling, dispatching, creating and managing work orders, defining SLAs, billing, and technician management. Siemens has partnered with IBM to offer IBM Maximo Enterprise Asset Management a global-leading service operations solution. They have also established relationships and integrations with other service operations solutions, e.g., SAP Intelligent Asset Management.
- Asset Performance Management (APM) is delivered by Siemens Opcenter suite for production performance management and MindSphere for connectivity, data acquisition, analytics, and reporting. As with Service Operations, companies can integrate the Siemens SLM solution with other APM solutions provided by third-parties, e.g., IBM and SAP.

As stated earlier, Mendix can be used to create business-specific applications as well as integrate with other SLM applications (Siemens provided, in-house, and third party) as part of the enterprise's overall SLM environment.

The strength of Siemens' SLM strategy is that building on the Xcelerator portfolio of technologies and solutions enables a company to create a complete extended enterprise digital thread and an actionable, comprehensive digital twin. Teamcenter maintains an up-to-date, accurate physical asset configuration (as-maintained) with robust data traceability for configuration changes and service activities. Siemens' pragmatic approach to not trying to "go it alone" allows customers to leverage previous SLM investments and have a choice in applications and technology. In other words, a customer is not locked into a Siemens only solution.



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Achieving SLM benefits using Teamcenter SLM

OneSubsea Processing, a Schlumberger company, is a manufacturer of industry-leading technologies, systems, and alliances for increasing subsea production and recovery. The company has 5,000 employees in 23 countries. They manufacture and service complex equipment with lifespans of 20+ years under tough conditions. Needless to say, that even a short downtime could potentially cause millions of dollars of loss due to a non-functioning oil or gas drilling field. It could sometimes be impossible to service their asset in the field, being at the bottom of the ocean.

OneSubsea has to plan for service as they design and manufacture. After the asset is in production, they always need to have clear and accurate visibility of its configuration in order to prevent problems from happening and to handle any problems in the most efficient way. Many times, this has to be done remotely or through redundancy of parts. Information that is essential includes:

- Which serial or lot parts are assembled in the asset?
- If there was a service event, what was done?
- What could go wrong?
- What tools will be required to fix the asset in a minimal time?

Further, any action done has to comply with strict regulations, so they need to be able to provide compliance proof at any time and as durable as possible during the production life.

Given the nature of their challenges, OneSubsea realized that by starting their PLM journey with SLM, they would be able to see an immediate increase in value to their business. One of their key requirements was to be able to plan their service throughout the design and manufacturing processes. With such visibility, they could fulfil this requirement and deliver value to both design and service engineering. In case of an un-planned problem, they can respond immediately knowing exactly how their subsea asset is configured and what serial parts it contains. They are also able to achieve 100% proof for regulations compliance. They have implemented ERP and expanded their PLM usage with their physical asset configuration as their master data.

The primary benefits OneSubsea achieved from implementing Teamcenter SLM include:

- Aftermarket efficiency and effectiveness.
- Saving engineering time.
- Early involvement from manufacturing.
- Having one source of information.
- Reduced risk and cost.
- Ensure compliance.
- Work smarter.



Courtesy of OneSubsea



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Siemens has a comprehensive, open SLM solution program

Today's complex physical assets must be operated efficiently and meet strict customer, regulatory, and serviceability requirements, often over many decades of useful life. Optimizing the use of smart, connected assets is key to achieving operational efficiency and improving the profitability and success of many businesses. OEMs and production line builders need to design for serviceability and provide SLM solutions so that O/Os can effectively and efficiently operate and service their key assets. O/Os need asset service to be proactive, not reactive, cost effective, and enabled across a heterogeneous, extended enterprise environment.

Siemens Digital Industries Software's SLM solution, built on the Xcelerator portfolio, is a comprehensive, integrated suite of software and services augmented by key relationships with third-party service application providers. Teamcenter provides a comprehensive enterprise backbone that manages a complete digital thread of service-related information and enables a comprehensive performance digital twin. Key is Teamcenter's ability to manage large, complex, multi-variant configurations that encompass all the mechanical, electrical/electronic, software, and documentation components of any serviceable asset. MindSphere provides the ability to connect assets and their operational status with other assets and systems and provides the analytics needed to gain insight into service issues and create proactive service plans. Finally, Mendix enables customers to create and connect business-unique applications, data sources, and processes needed to optimize service and asset

availability across an open service ecosystem that incorporates both Siemens, in-house, and third-party solutions.

CIMdata believes that Siemens' pragmatic approach to delivering open SLM solutions provides the breadth and depth that enterprises need to create comprehensive, actionable digital twins and manage the complete service lifecycle across a heterogeneous set of extended enterprise solutions and needs while protecting their service-related investments. Companies looking to optimize and expand their service capabilities should include Siemens's SLM portfolio in their evaluation of solutions for implementing a flexible, adaptable, open SLM environment.



Courtesy of Siemens

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