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Guidelines for the construction and implementation of industrial digital twin systems

工业数字孪生系统建设实施指南

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Foreword

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1.Scope This document provides guidance on the implementation path, scope, objectives, and hierarchical structure for building industrial digital twin systems, and outlines the implementation details. Information on the core elements involved in the process, such as technology, management, and results, as well as the specific requirements for each stage. This document applies to the planning, implementation, application, and improvement of industrial digital twin systems by industrial enterprises, and also to service providers, etc. Third-party organizations provide consulting, evaluation, construction, and implementation services for industrial digital twin systems.

4 General Principles

4.1 Implementation Path Based on the objectives of building and implementing the industrial digital twin system, the scope of implementation is determined, and implementation goals are defined at different levels. In the system's strategy... The process involves four phases. planning, implementation, application, and improvement. Activities are conducted focusing on elements such as technology, management, and effectiveness, and timely assessments of implementation readiness and system services are carried out. Service provider capabilities and application maturity assessments were conducted to identify existing bottlenecks and shortcomings, and the PDCA (Plan-Do-Check-Act) process was implemented. The evaluation-improvement cycle drives continuous system improvement and enhances the application of industrial digital twin systems, bringing benefits to the main implementers of the system. The sustainable and steadily increasing value is shown in Figure 1.

4.2 Scope of Implementation Based on the purpose of system construction and implementation, and in accordance with the system's functional requirements and application areas, the scope of implementation of the industrial digital twin system is as follows:

a) Device Domain. A device-level industrial digital twin system is applied to a single production device, mapping one or more functions on that device.

b) Production line domain. A production line-level industrial digital twin system is applied to a single production line, mapping one or more functions on that production line.

c) Workshop Domain. A workshop-level industrial digital twin system is applied to a single workshop, covering its main functions and mapping the workshop's... One or more business functions.

d) Factory Domain. A factory-level industrial digital twin system is applied to a single factory and can cover one or more major business units within the factory. Map one or more business functions of the factory.

e) Industry Chain Domain. Industry chain-level industrial digital twin systems are applied to a single industry chain, covering multiple factories along the chain and mapping... This includes one or more functions such as supply chain collaboration. Based on the functional requirements and scope of impact of the industrial digital twin system, the coverage and inclusion relationships between different implementation scopes are shown in Figure 2. As shown.

4.3 Implementation Objectives and Hierarchical Classification The implementation goal of an industrial digital twin system refers to the objective of the system construction and implementation entity, based on business needs and technical feasibility, within a specified implementation scope. Internally, it builds and deploys a digital system capable of dynamic mapping, real-time interaction, simulation optimization, and intelligent decision-making between physical entities and virtual models. The system establishes the expected results after implementation during the planning phase. After the industrial digital twin system is put into application, its effectiveness should be assessed to determine its maturity. An assessment is conducted, and the achievement of the industrial digital twin system's implementation goals is determined based on the assessment results. System application maturity is classified into five levels, with... The body is as follows:

a) Initial stage. Already possessing a certain level of digitalization and networking infrastructure, and just beginning or planning to implement information technology upgrades to equipment and infrastructure. The industrial digital twin system is under construction but has not yet been implemented, or the industrial digital twin system is under construction and implementation but has not yet been... It can truly play a role.

b) Basic Level. The starting point for the system construction and implementation entity to

realize the core value of the digital twin system. The necessary digital [system/technology] is already in place. The infrastructure, characterized by digitalization, networking, and intelligence, can effectively support the implementation and application of digital twin systems. The scope of system implementation has been completed. The digital twin system can monitor and collect data on the system's implementation scope in real time and support the geometric kinematics of the control logic. Simulation analysis, and the ability to visualize the results in an appropriate manner, can support the business operations within this scope of implementation.

c) Optimization Level. This is the advanced stage of implementing the digital twin system by the system construction and implementation entity. Building upon the basic level, applications are implemented. The digital twin system can effectively support business activities, and the model for the system implementation scope incorporates industry and domain knowledge. Mechanism and information models have been established, enabling the mapping between physical entities and digital twins in virtual space, and realizing the integration of virtual and real worlds. The synchronization capability enables the identification of operational status, conducts operational optimization and simulation prediction, and effectively supports the implementation of the system. The business of surrounding.

d) Intelligent Level. This refers to a high-level implementation of the digital twin system by the system construction and implementation entity. Building upon the optimization level, implementation... A comprehensive mechanism model has been established in the applied digital twin system, and the digital twin is deeply integrated with artificial intelligence, resulting in industrial digital twins. The system possesses intelligent analysis capabilities, enabling it to intelligently analyze and make decisions regarding pain points in the business, demonstrating exceptional performance. The system supports the implementation of business operations and enables enterprises to realize their core value.

e) Autonomous Level. The highest level of enterprise implementation of digital twin systems. Building upon the intelligent level, this involves implementing digital twin applications. The system can establish a complete feedback strategy system based on the system's intelligent analysis and decision-making capabilities to address specific business problems, in the absence of... It can operate autonomously with minimal or no external intervention, generating decision-making and control commands independently, and efficiently supporting system implementation. This expands the scope of business and significantly enhances the competitiveness of the system construction and implementation entities.

4.4 Implementation Elements The key elements for constructing and implementing an industrial digital twin system include technical elements, management elements, and performance elements. Technical and management elements... Different configurations and interactions will affect the effectiveness of industrial digital twin system construction and