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**Information technology - Big data - Industrial
application reference architecture**

信息技术 大数据 工业应用参考架构

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Information technology - Big data - Industrial application reference architecture

1 Scope

This standard gives a reference architecture for big data in the industrial field; specifies the basic functions of each component.

This standard applies to the development, management and application of industrial big data.

2 Normative references

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) are applicable to this standard.

GB/T 35295-2017 Information technology - Big data - Terminology

GB/T 35589-2017 Information technology - Big data - Technical reference model

3 Terms and definitions

The terms and definitions as defined in GB/T 35295-2017 as well as the following terms and definitions apply to this document.

3.1

Industrial big data

The application of big data theory and technology in the industrial field.

3.2

Industrial big data application reference architecture; IBDRA

A high-level conceptual model for open discussions on the inherent requirements, design structure and operation of industrial big data.

6.2 Data provider

6.2.1 Overview

The main function of the data provider is to collect the original data and provide it to the industrial big data application provider after preprocessing.

This component mainly includes two parts: data source and system. The data source generates the original data, which is collected, analyzed and classified by various information systems; then provided to the industrial big data application provider.

6.2.2 Data source

The main function is to provide raw data. Any entity and the activities of entities may be data sources, for example, various entities such as various personnel, industrial software, production equipment, products, the Internet of Things, the Internet, other software; meanwhile the various activities of corporate activities, personnel behaviors, equipment and equipment operations, environmental monitoring, Internet of Things, Internet operations may also produce data. Figure 1 lists the following three types of data sources in the form of examples:

a) Product: It is the core data source of industrial application data.

Taking the entire life cycle process of the product as the main line, covering the process of product market research, conceptual design, detailed design, process design, production preparation, product trial production, product finalization, product sales, operation and maintenance, product scrap, recycling in terms of time; spatially covering the enterprise, the enterprise and the end user in the supply chain, which are all generating product-related data. These data affect the data generated by many other data sources related to the product and support different industrial applications.

Product-related data has many manifestations, such as structured and unstructured data including product structure and configuration, part definition and design data, CAD three-dimensional model and two-dimensional drawing files, engineering analysis and verification data, manufacturing plans and specifications, CAD/CAM programming files, images files (photographs, modeling drawings, scanned drawings, etc.), product manuals, software products (programs, libraries, functions and other "parts"). The specific description form depends on the designer's design considerations.

b) Industrial IoT device: It is the new and fastest growing source of industrial big data.

automation. CAM generates and simulates and optimizes the instruction code data for CNC machining on the basis of the CAD model. The generated NC code can drive the operation of machine tool equipment, to manage, control and operate production device.

- c) CAE generally uses CAD systems to establish CAE geometric and physical models; complete the input of analysis data; mainly process, analyze and optimize the mechanical properties of complex projects and products. The result data generated by the system can generate vivid graphic output, to provide support for design activities.
- d) CAPP inputs the geometric information (shape, size, etc.) and process information (materials, heat treatment, batch size, etc.) of the processed parts into the computer, to generate process documents such as product and part process routes and process content.
- e) PLM is used to collect and categorized-manage product-related structured and unstructured document data; record the collaborative process data of related roles and links.
- f) MES is used to collect, manage and optimize manufacturing process data at the shop floor. MES collects various data information and status information from the product, industrial IoT device, production and operation during the entire time range from the start of receiving the order to the final product; interacts with the upper business planning layer and the lower process control layer.
- g) SCADA is used to collect and manage the operating parameters, control, measurement and various signal alarms of automation equipment; sends control commands to the equipment connected on the spot.
- h) DNC is used to collect, manage and control the input and output data of CNC machine tools. The data entities involved include four categories:
 - 1) Data entities related to manufacturing equipment hardware (such as machine tools, etc.);
 - 2) Data entities related to human-machine communication (such as communication protocol entities and serial communication entities);
 - 3) CNC data entities (such as NC program number, tool number, process number);
 - 4) Enter operation instructions or dispatch order entities.
- i) ERP revolves around the business process of the enterprise; is used to collect and manage the enterprise's material resources, human resources,

Data storage mainly adopts the technology of big data distributed cloud storage, to effectively store the preprocessed data in a distributed database with linear expansion of performance and capacity.

6.3.4 Analysis

Based on the needs of data scientists or the needs of vertical applications, use the data modeling, data processing algorithms, industry-specific algorithms, to achieve the technology of extracting knowledge from data.

For example, establish the characteristic models for related processes that cannot establish the production optimization model based on traditional modeling methods; based on the production history data, real-time data, related production optimization simulation data based on orders, machines, processes, plans, etc., use clustering, classification, rule mining and other data mining methods and prediction mechanisms to establish multiple types of data-based industrial process optimization characteristic models.

6.3.5 Visualization

The processed, analyzed and calculated data is presented to the final data consumer through appropriate display technology, such as big data visualization technology, industrial 2D or 3D scene visualization technology, etc.

6.3.6 Access

Interact with visualization and analysis functions; respond to requests from data consumers and applications.

6.4 Big data computing architecture provider

6.4.1 Overview

According to 7.4.1 of GB/T 35589-2017, the main function of the big data architecture provider is to provide the resources and services used by industrial big data application providers when creating specific applications.

The big data computing architecture provider includes five activities: infrastructure, platform, processing architecture, information communication, resource management.

6.4.2 Infrastructure

Provide necessary resources for all other elements in the big data system. These resources are composed of a combination of some physical resources. These physical resources can control/support similar virtual resources. These

6.5 Data consumer

6.5.1 Overview

The main function of the data consumer is to access information on demand by calling the interface provided by the industrial big data application provider; process it to achieve a specific goal.

There are many types of data consumers, typical of which are intelligent design, intelligent production, networked collaborative manufacturing, intelligent service, personalized customization.

6.5.2 Intelligent design

With product data as the core, through the integrated association and analysis of output product models, knowledge bases (such as 2D and 3D drawings, product structure and process routes), user usage data, etc., to help designers achieve optimal product design and innovative design or automation design. The typical intelligent design includes automation design, digital simulation optimization.

Automation design realizes the intercommunication of CAX platform data (such as task process data, engineering application data, design knowledge) through the integration of multiple CAX computer-aided design tools and systems in the process of engineering design, simulation, trial production, testing. Combined with intelligent semantic analysis, realize the automatic execution of the design process; meanwhile realize the multi-disciplinary comprehensive design optimization on this basis.

Digital simulation optimization is used to comply with the relevance of design data; effectively conduct comprehensive evaluation and improvement of products in the design stage.

6.5.3 Intelligent production

Refers to the application of advanced industrial technologies such as human-machine intelligent interaction, industrial robots, simulation optimization of manufacturing processes, digital control, condition monitoring in manufacturing. It mainly includes typical scenarios such as comprehensive optimization of production efficiency and production failure prediction, etc.

Comprehensive optimization of production efficiency uses monitoring, data mining and analysis of key indicators of related production lines, device, equipment in the production process, to achieve production line upgrades, product quality optimization, equipment fault diagnosis and maintenance, intelligent scheduling, intelligent production, etc. thereby comprehensively

According to 7.6 of GB/T 35589-2017, this component mainly includes the following four functions:

- a) Network security: Through network security technology, ensure the normal operation of data processing, storage security and maintenance;
- b) Host security: Ensure the normal operation of nodes by means of security reinforcement of the operating system of the nodes in the cluster;
- c) Application security: It has security measures such as identity authentication and identification, user and authority management, database reinforcement, user password management, audit control, etc.; implements security policies for legitimate users to reasonably access resources;
- d) Data security: Ensure the security of user data from cluster disaster recovery, backup, data integrity, data storage by role, data access control, etc.

At the same time, it shall provide a reasonable disaster recovery architecture, to improve disaster recovery capabilities, thereby realizing real-time remote disaster recovery of data, cross-data center data backup.

Privacy protection is mainly to conduct effective data mining under the premise of not exposing sensitive user information; according to the different content to be protected, it can be divided into location privacy protection, identifier anonymity protection, connection relationship anonymity protection, etc.

6.7 Management

According to 7.7 of GB/T 35589-2017, the main functions of this component cover the following aspects:

- a) Provide a large-scale cluster unified operation and maintenance management system, which can conduct centralized operation and maintenance and unified management of data centers, basic hardware, platform software and application software; realize installation and deployment, parameter configuration, monitoring, alarms, user management, permission management, auditing, service management, health check, problem positioning, upgrade and repair, etc.;
- b) It has the ability of automate operation and maintenance; through the unified management of the resources of multiple data centers, the resources needed for the business can be reasonably allocated and dispatched, so as to achieve automatic on-demand allocation. At the same time, it provides the ability to centralize the operation and maintenance of

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