MALAYSIA PRODUCTIVITY CORPORATION

National Smart Manufacturing Standard Guidelines

(Version 2020)

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- *As the main orientation of Malaysia* industry4wrd *Strategy,* Smart *manufacturing is the critical measure to implement "Smart Manufacturing Strategy", the development trend for Malaysia manufacturing industry to keep the same pace with the world and the core to realize transformation and upgrading. With strong comprehensiveness,* Smart *manufacturing stands for the conformity and integrity of all kinds of manufacturing systems in a higher level. Standardization is an indispensable basis to promote the development of* Smart *manufacturing. As the existing standards regarding* Smart *manufacturing are unavailable, undeveloped or repeated, National Smart Manufacturing Standard System Guideline (Version 2020) (hereinafter referred to as "Guideline") is hereby jointly prepared by Malaysia Productivity Corporation (MPC)*

And based on the strategic deployment of Malaysia industry4wrd *Strategy, in order to guide the Smart manufacturing standardization at present and in future.*

I. General Requirements

(i) Guiding ideology

Efforts should be made to fully exert the fundamental and guiding role of standard in promoting the development of Smart manufacturing and resolve the imperfection and low-level repetition of standard system. The overall planning and macro guidance should be strengthened, the harmonious development of standards prepared by the government and the market should be established and the supporting new standard system should be coordinated by strengthening standard implementation and supervision and multi-industrial and multi-field integrated innovation in order to establish the Smart manufacturing system that meets the actual situations of Malaysia and keep pace with the world. The Smart manufacturing system framework consisting of *5+5+10* type standards should be established from three aspects, namely basic generality, key technique and major industries. Dynamic and complete mechanism should be established and standard should be gradually formed to support the development of Smart manufacturing.

(ii) Basic principle

Overall planning and implementation of classified strategies. Standard resources should be overall planned, standard structure should be optimized and the relevant domestic Smart manufacturing standards should be sorted out; the complete Smart manufacturing standard system should be prepared in order to satisfy the development of Smart manufacturing. The application standard of key Smart manufacturing industries should be formed and the standard systems that are connected and well matched mutually should be established by focusing on the key industrial development field along with traditional industry and by combining the development level and features of the industry.

Cross-boundary integration and implementation of urgent demands. smart manufacturing refers to the integration of new-generation information technology and manufacturing technique as well as the integration and interconnection of manufacturing industry in different links. The multi-industrial and multi-field integrity innovation is needed for preparing smart manufacturing standard system. As for the key bottleneck problems promoting Smart manufacturing such as data integration and interconnection, the

fundamental standards such as data interface and communication protocol should be prepared in priority.

Starting from actual situation and opening cooperation. The preparation and industrialization of standards with proprietary intellectual property rights and the communication with the advanced manufacturing countries and international standardization organization should be strengthened and Malaysia standards proprietary intellectual property rights should be upgraded to international level in proper time by combining actual situations such as the poor foundation of Malaysia's smart manufacturing standard and imbalanced industrial development and considering the standard applicability fully. In addition, the international standard that is applicable to the development demand of Malaysia's manufacturing industry should be properly transformed into national standards and Smart manufacturing system with good compatibility and strong openness should be established.

(iii) Construction target

The smart manufacturing standard system should be established preliminarily in 2020.few key smart manufacturing standards should be prepared, basic general

standards such as reference model, terminology & definition,

identification analysis and evaluation index as well as key technical standards such as data format and communication protocol should be prepared on the principle of “establishing general ones and those in urgent need”, the intelligent manufacturing standards for key industries should be explored and prepared; breakthrough should be made in ten key fields of *Malaysia industry4wrd Strategy* in priority. The national standards for intelligent manufacturing should be upgraded to international standards; the application and international level of standards should be improved gradually.

A comparatively perfect Smart manufacturing standard system should be established in 2021. Above 500 Smart manufacturing standards should be prepared and revised to cover both general standards and key technical standards basically; the Smart manufacturing standards should be broadly used in enterprises and particularly in manufacturing field in order to enhance Malaysia’s Smart manufacturing level significantly. Meanwhile, the international competitiveness of Malaysia Smart manufacturing standards should be improved substantially.

II. Construction Idea

There are generally three steps constructing Smart manufacturing standard framework. Firstly, a 3D Smart manufacturing system framework consisting of lifecycle, system hierarchy and intelligent functions is constructed by extracting the general abstract features of all kinds of Smart manufacturing application systems studied in order to define the connotation and extension of Smart manufacturing standardization, recognize available and unavailable Smart manufacturing standards and understand the overlapping relations of existing standards; secondly, the plane consisting of lifecycle dimension and system hierarchy dimension of Smart manufacturing system framework is applied to the five-level intelligent function dimension from upper to lower on the basis of deeply analyzing the standard demand and by comprehensively considering the logistic relations of all dimensions of Smart manufacturing system in order to form five key technical standards such as intelligent equipment, intelligent factory, intelligent service, industrial software, big

data and industrial internet and thus form Smart manufacturing standard system architecture together with basic general standards and key industrial standards; thirdly, the Smart manufacturing standard system architecture should be decomposed to establish Smart manufacturing standard system framework and guide the construction of Smart manufacturing standard system and the approval of relevant standards.

(i) Fig. 1 Smart manufacturing system framework Smart manufacturing system framework is constructed

from three dimensions such as lifecycle, system hierarchy and intelligent functions, as shown in Fig. 1.

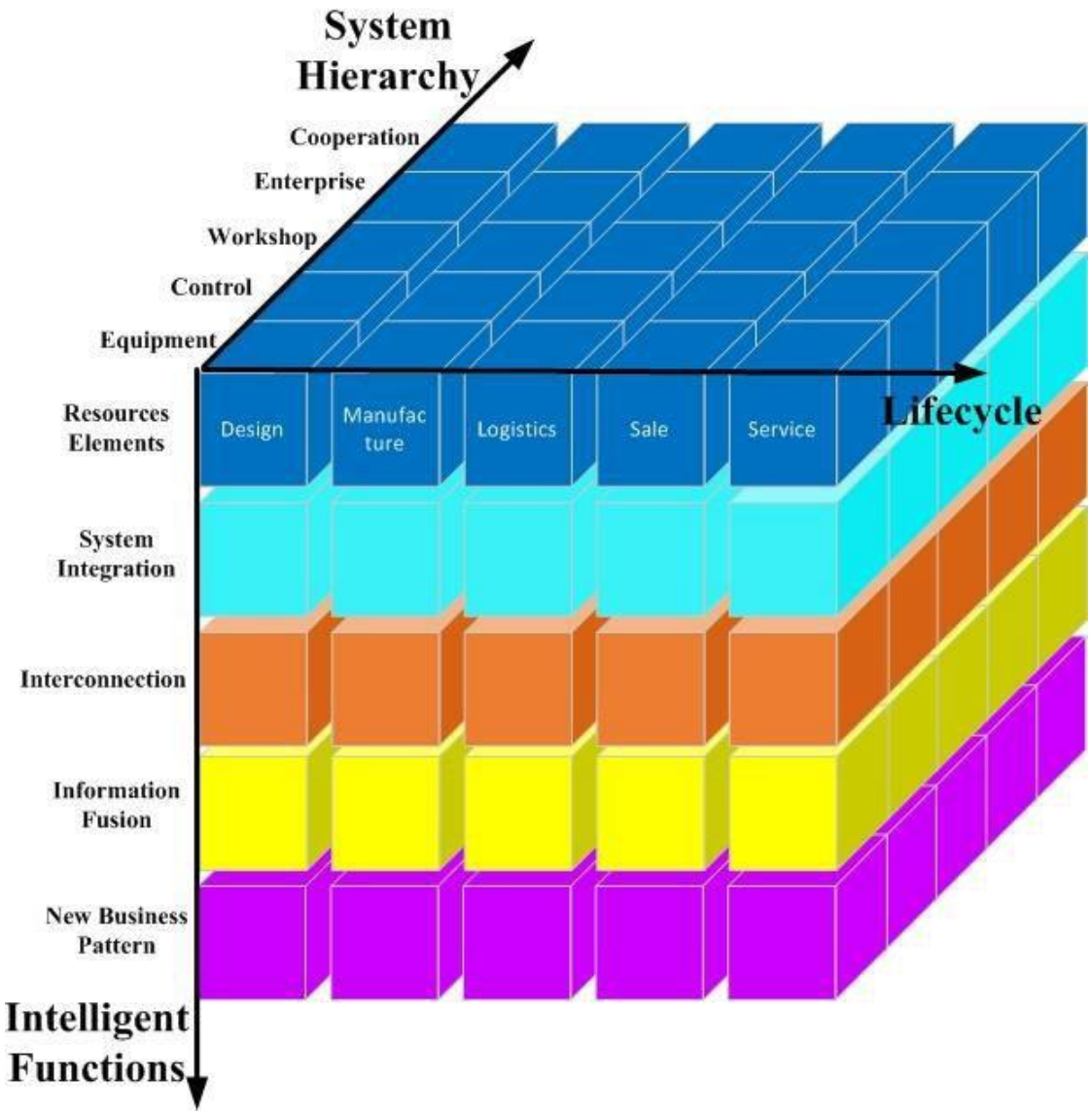

Fig. 1 Smart Manufacturing System Framework

1. Lifecycle

Lifecycle refers to the chain integration consisting of a series of mutually connected value creation activities such as design, production, logistics, sales and service. All activities in lifecycle are associated and influenced mutually. Lifecycle

differs in various industries.

2. System hierarchy

System hierarchy is composed of equipment level, control level, workshop level, enterprise level and cooperation level from the lower to the upper. In particular, the system hierarchy of Smart manufacturing represents the intelligence and internet protocol of equipment as well as network flattening. In particular:

(1) As the material technical basis for enterprise to deal with production activities, equipment level is composed of sensors, meters and instruments, bar code, radio frequency identification (RFID), machine, machinery and device;

(2) Control level consists of programmable logic controller (PLC), supervisory control and data acquisition (SCADA), distributive control system (DCS) and field bus control system (FCS);

(3) Workshop level is mainly about the production management of factory/workshop, including manufacturing execution system (MES);

(4) Enterprise level is focused on the operation management of enterprises, including enterprise resources planning (ERP), product lifecycle management (PLM), supply

chain management (SCM) and client relationship management (CRM);

(5) Cooperation level represents coordinated R & D, intelligent production, precise logistics and intelligent service realized by different enterprises of the industrial chain through internet sharing information.

3. Intelligent functions

Intelligent functions include five layers such as resources elements, system integration, interconnection, information fusion and new business pattern. Specifically,

(1) Resources elements include physical entities such as design & construction drawings, product technique documents, raw materials, manufacturing equipment, production workshop and factory along with energies such as power and gas. Personnel are also part of resources.

(2) System integration means integrating all kinds of manufacturing resources such as raw materials, parts, energy and equipment by information technique such as 2D code, radio frequency identification and software. It can realize the integration of intelligent equipment, intelligent production unit, intelligent production line, digital workshop, intelligent factory and even intelligent manufacturing system from small to large

scale.

(3) Interconnection means realizing mutual connection among machines, between machines and control systems and among enterprises in virtue of wireless and wire communication technique.

(4) Information fusion means realizing information collaborative sharing through system integration and communication under the premise of ensuring information safety using new generation of information technology such as cloud computing and big data.

(5) New business pattern means service manufacturing mode such as personal customization, remote operation & maintenance and industrial cloud.

The intelligent manufacturing system framework shows the whole process of intelligent manufacturing in a 3D manner. In the following, PLC, industrial robot and industrial internet are used as examples to fully interpret the position of key intelligent manufacturing field in system architecture and relevant standards through point, line and surface level in order to better annotate and understand system framework.

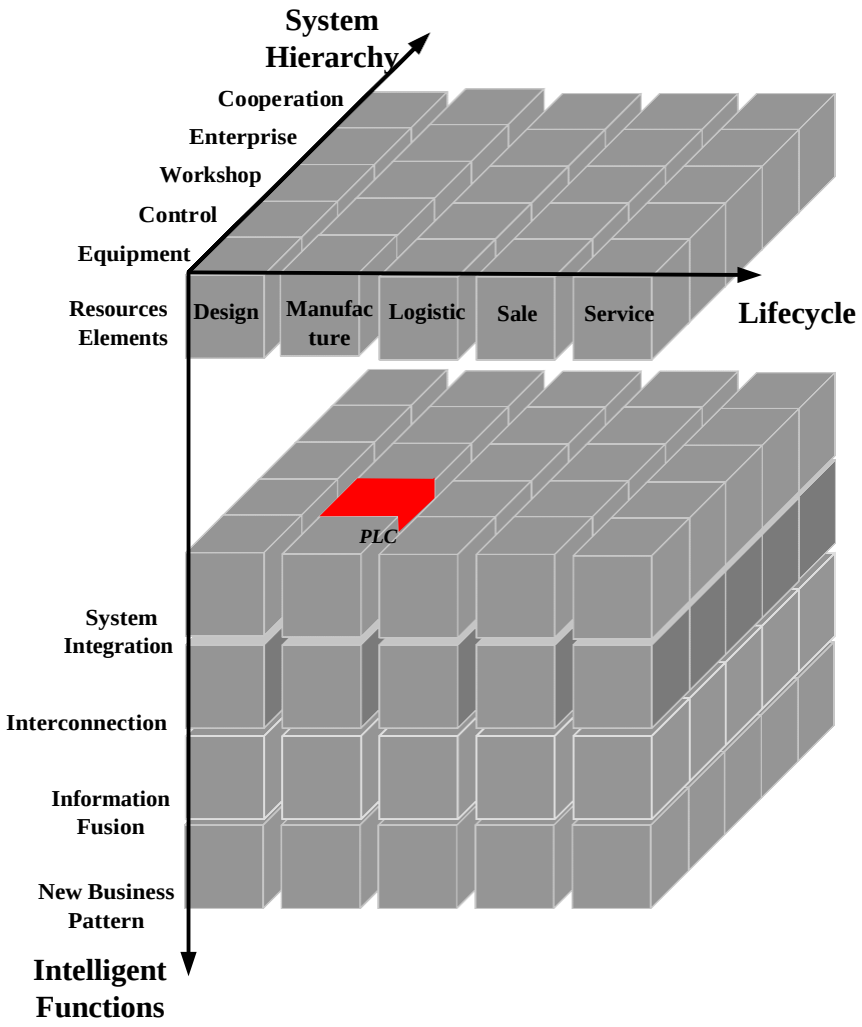

Fig. 2 Position of PLC in Intelligent Manufacturing System Framework

PLC is in the production segment in lifecycle dimension of intelligent manufacturing system architecture, control level of system hierarchy and system integration of intelligent functions, as shown in Fig. 2. The released standards of PLC mainly include:

- GB/T 15969.1 Programmable Controllers Part 1: General Information
- IEC/TR 61131-9 Programmable Controllers Part 9: Single-drop Digital Communication Interface for Small Sensors and Actuators (SCDI)

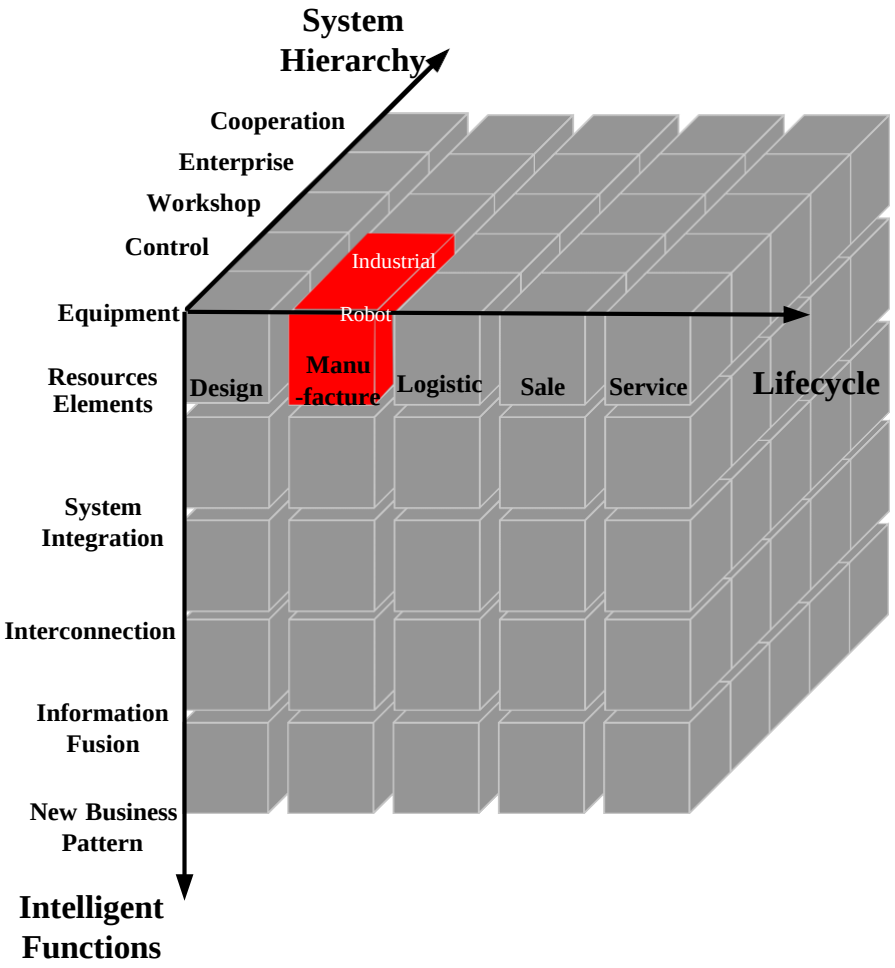

Fig. 3 Position of Intelligent Robot in Smart Manufacturing System Framework

Intelligent robot is in the production link in lifecycle

dimension of intelligent manufacturing system architecture,

equipment level and control level of system hierarchy and resources elements of intelligent functions, as shown in Fig. 3. Industrial robots standards released mainly include:

- GB/T 19399-2003 Industrial Robots Graphical User Interfaces for Programing and Operation of Robots (GUI-R)
- GB/Z 20869-2007 Industrial Robot Intermediate Code for Robot (ICR)

Industrial robots standards under preparation mainly include:

- 20120878-T-604 Interface for Robot Simulation Development Environment
- 20112051-T-604 Communication Interface Specification of Open Robot Controller

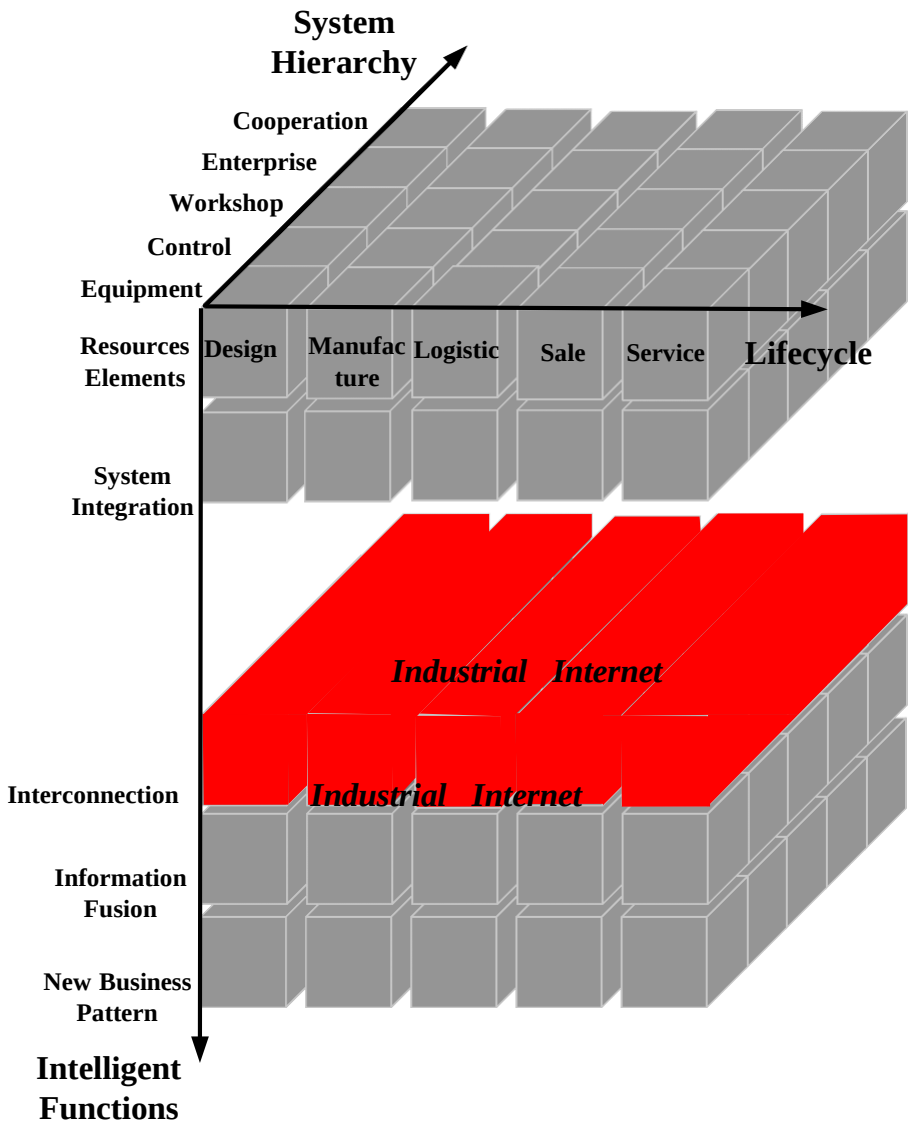

Fig. 4 Position of Industrial Internet in Smart Manufacturing System Framework

Industrial internet is in all links in lifecycle dimension of intelligent manufacturing system architecture, five levels, i.e., equipment, control, workshop, enterprise and cooperation of

system hierarchy and interconnection of intelligent functions. The released standards of Industrial internet mainly include:

- GB/T 20171-2006 EPA System Architecture and Communication Specification for Use in Industrial Control and Measurement Systems
- GB/T 26790.1-2011 Industrial Wireless Network WIA Specification Part 1: WIA System Architecture Communication Specification for Process Automation (WIA-PA)
- GB/T 25105-2014 Industrial Communication Networks -Fieldbus Specifications Type 10: PROFINET IO Specifications
- GB/T 19760-2008 CC-Link (Control & Communication Link) Specifications
- GB/T 31230-2014 Industrial Ethernet Fieldbus EtherCAT
- GB/T 19582-2008 Modbus Industrial Automation Network Specification
- GB/Z 26157-2010 Digital Data Communication for Measurement and Control - Fieldbus for Use in Industrial Control Systems - Type 2: Controlnet And Ethernet/Ip Specification
- GB/T 29910-2013 Industrial Communication Networks

-Fieldbus Specifications Type 20：HART Specification

- GB/T 27960-2011 Ethernet POWERLINK Communication Profile Specification

(ii) Structural diagram of intelligent manufacturing standard system

The structural diagram of Smart manufacturing standard system generally includes “A Basic Generality” “B Key Technique” and “C Key Industries”. In particular, “B Key technique” is composed of “BA Intelligent equipment”, “BB Intelligent factory”, “BC Intelligent service”, “BD Industrial software and big data” and “BE Industrial internet”. See Fig. 5 for the structural diagram of Smart manufacturing standard system.

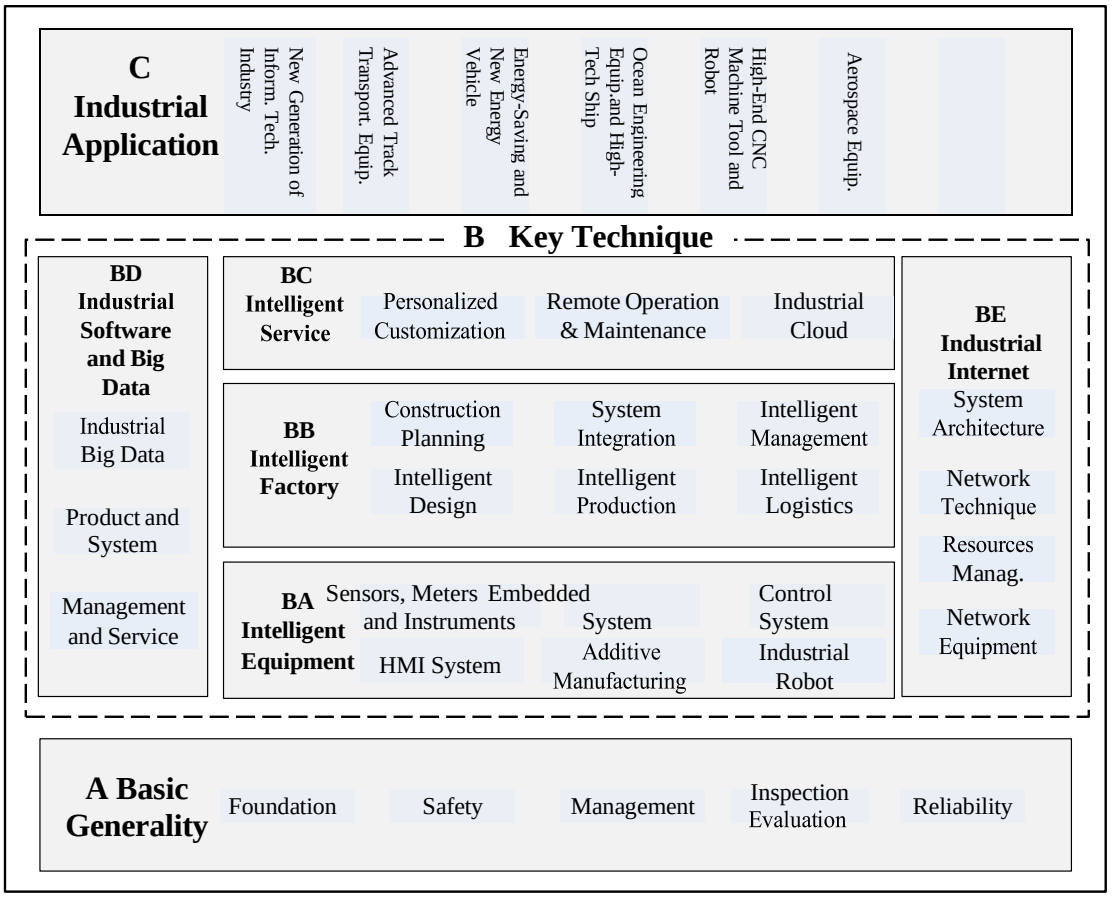

Fig. 5 Structural Diagram of Smart Manufacturing Standard System

Specifically, located at the bottom of structural diagram of Smart manufacturing standard system, A Basic generality standards are composed of five categories, i.e., foundation, safety, management, inspection evaluation and reliability. The basic generality standards studied support B Key technique standards and C Key industries standards, both of which are shown in the dotted line framework in the upper level of standard system structural diagram. Located in the bottom of B Key technique standards in the structural diagram of Smart

manufacturing standard system, BA Intelligent equipment standards are mostly closed to the actual production of intelligent manufacturing; BB Intelligent factory standards are on the top of BA intelligent equipment standards, which refer to the comprehensive integration of Smart manufacturing device, software and data and play a role in connecting the upper and lower levels in the structural diagram of Smart manufacturing standard system. Located at the top of B Key technique standards, BC Intelligent service standards involve the Smart manufacturing new mode and new industry standard; located at the left and right side of B Key technique standards of structural diagram of Smart manufacturing standard system, BD industrial software and big data standards and BE Industrial internet standards run through other 3 fields (BA, BB and BC) of B key technique standards, connect physical world and information world and promote the transformation of production manufacturing to service manufacturing. C Key industries standards are at the top of structural diagram of intelligent manufacturing standard system in order to handle the specific industrial demands. A Basic generality standards and B Key technique standards are defined and implemented to guide the Smart manufacturing of all industries.

(iii) Framework of Smart manufacturing standard system

According to the structural diagram of intelligent manufacturing standard system, the frame of Smart manufacturing standard system is composed of “A Basic Generality”, “B Key technique” and “C Key industries”, as shown in Fig. 6.

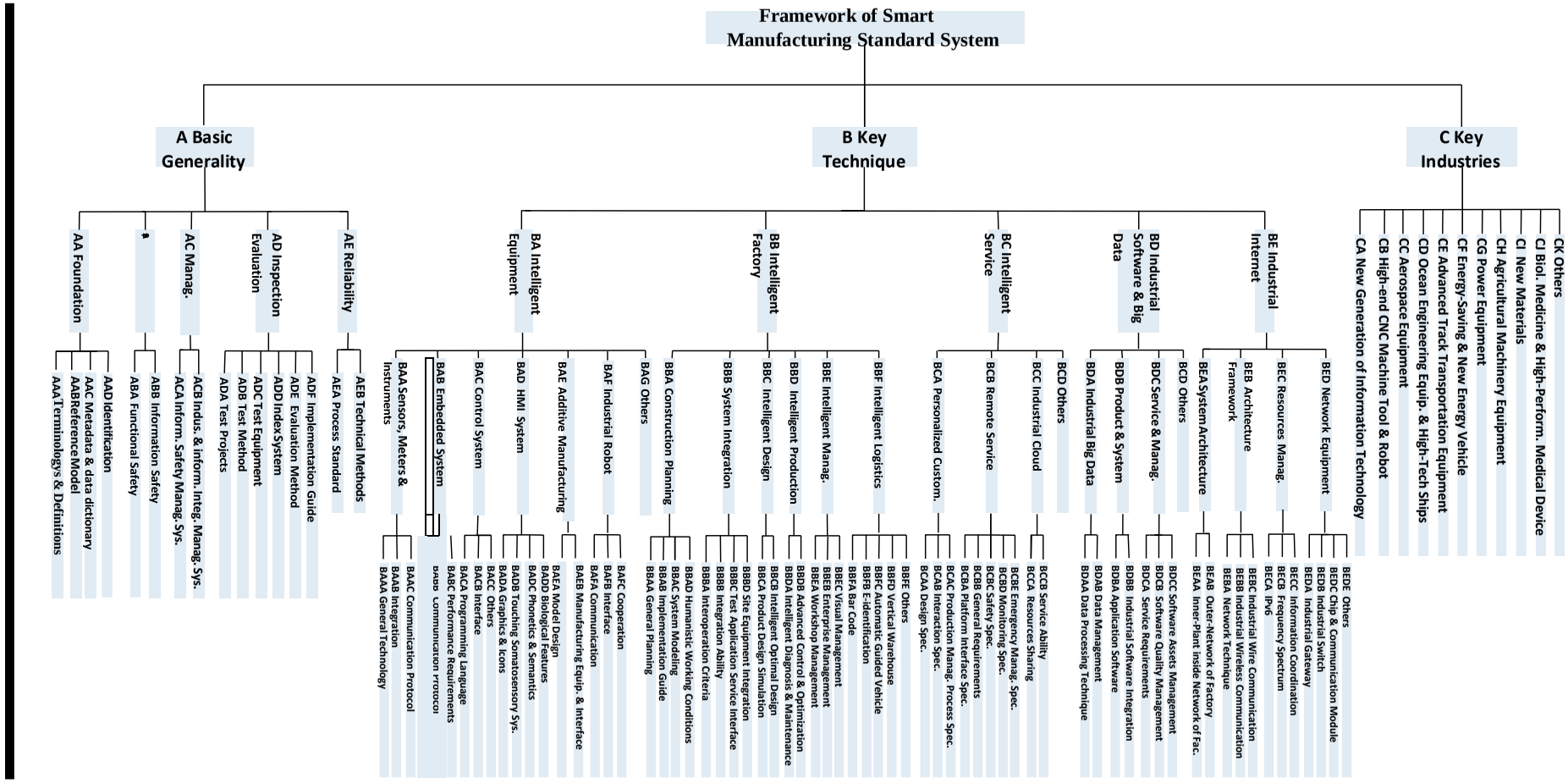

Fig. 6 Framework of Smart Manufacturing Standard System

III. Construction Contents

(i) Basic generality standards

The basic generality standards mainly consist of five parts such as foundation, safety, management, inspection evaluation and reliability, as shown in Fig. 7.

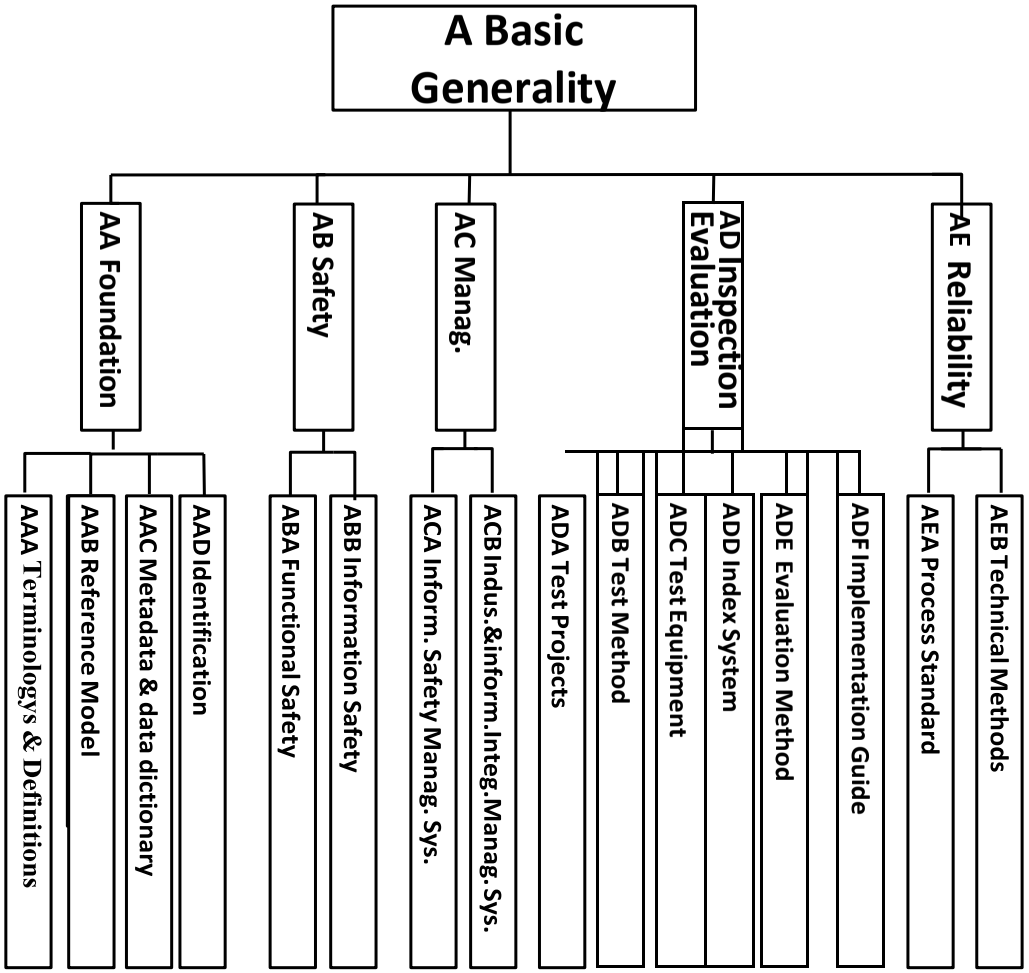

Fig. 7 Sub-system of Basic Generality Standard

1. Basic standards

Basic standards are composed of four parts, i.e., terminology and definitions, reference model, metadata, data dictionary and identification.

Terminology and definitions are used for unifying the relevant concepts related to Smart manufacturing and provide supports for the preparation of other parts of standards. Reference model standards are used for assisting all parties recognizing and understanding the objects and boundary of Smart manufacturing standardization as well as the hierarchy and internal contact of all parts. Metadata and data dictionary are used for specifying the naming rule, data format, data model, data elements and registration requirements of metadata in all such links as design, production and circulation of Smart manufacturing products, as well as the method to establish data dictionary and lay a solid foundation to the data integration, interaction and sharing of data in all Smart manufacturing links. Identification standards are used for the exclusive identification and analysis of all kinds of objects in Smart manufacturing, efforts shall also be made to establish Smart manufacturing identification system; such system shall be compatible to the manufacturing enterprises' existing

identification numbering system and can satisfy the

requirements of Smart manufacturing development such as equipment IP and intelligence.

2. Safety standards

Safety standards are mainly composed of functional safety and information safety.

Functional safety standards are used for ensuring that the safety functions of safety control system can be executed correctly when danger happens so as to avoid personal injury, environmental destruction and economic loss caused by equipment failure or system function invalidity. They consist of functional safety requirements as well as the implementation and management of functional safety. Information safety standards are used for ensuring that the information system will not be destroyed, changed or leaked by occasional or malicious cause while the system can be operated continuously, reliably and normally. They mainly include five parts, i.e., software safety, equipment information safety, network information safety, data safety and information safeguarding.

3. Management standards

Management standards mainly include information safety management system and industrialization and informationization integration management.

Information safety management system standards are used for preparing Smart manufacturing information safety management standards according to the features and demands of intelligent manufacturing of all industries and the key manufacturing links. They mainly include management standard and safety supervision. Industrialization and informationization integration management standards are used for guiding relevant enterprises to establish innovation management mechanism and maintain the constant competition advantages. The improvement of industrialization and informationization integration process management mechanism by standardization mainly includes requirements, foundation and terms, implementation guide, evaluation specification and audit guide.

4. Inspection evaluation standards

Inspection evaluation standards are mainly composed of test items, test method, test device, index system, evaluation method and implementation guide.

The test items standards are used for guiding the scientific order arrangement and effective management of Smart manufacturing device and system during the test process. Test method standards are used for preparing standards which cover the contents, way, steps, process and calculation analysis of test

for different kinds of Smart manufacturing devices and systems. Test device standards are used for ensuring the operation stability of test device and accuracy and reliability of test indexes during the process of Smart manufacturing device quality and system test. Index system standards are used for appraising the application fields, application enterprises and application projects of Smart manufacturing in order to promote enterprises to enhance their Smart manufacturing level constantly. Evaluation method standards are used for guiding Smart manufacturing enterprises to develop project evaluation and prepare Smart manufacturing evaluation index system. Implementation guide standards are used for guiding the specific work during the process of Smart manufacturing project evaluation.

5. Reliability standards

Reliability standards are mainly composed of process and technical method.

Process standards are mainly used for analyzing the reliability requirements of Smart manufacturing system, risk management and service life fees. They are mainly composed of reliability management of Smart manufacturing, fault prediction of Smart manufacturing equipment and

comprehensive guarantee of Smart manufacturing system. Technical method standards are used for guiding the reliability analysis evaluation of Smart manufacturing system as well as the reliability design and test verification of intelligent equipment.

(ii) Key technique standards

Key technique standards are mainly composed of intelligent equipment, intelligent factory, intelligent service, industrial software and big data and industrial internet.

1. Intelligent equipment standards

Intelligent equipment refer to the equipment or device provided with such additional functions as digital communication and configuration, optimization, diagnosis and maintenance, in addition to the basic functions. They are generally provided with such capacities as perception, analysis, reasoning, decision-making and control, which are deep integration of advanced manufacturing technique, information technique and intelligent technique. Intelligent equipment standards mainly consist of sensors, meters and instruments, embedded system, control system, human-machine interactive system, additive manufacturing and industrial robot, as shown in Fig. 8.

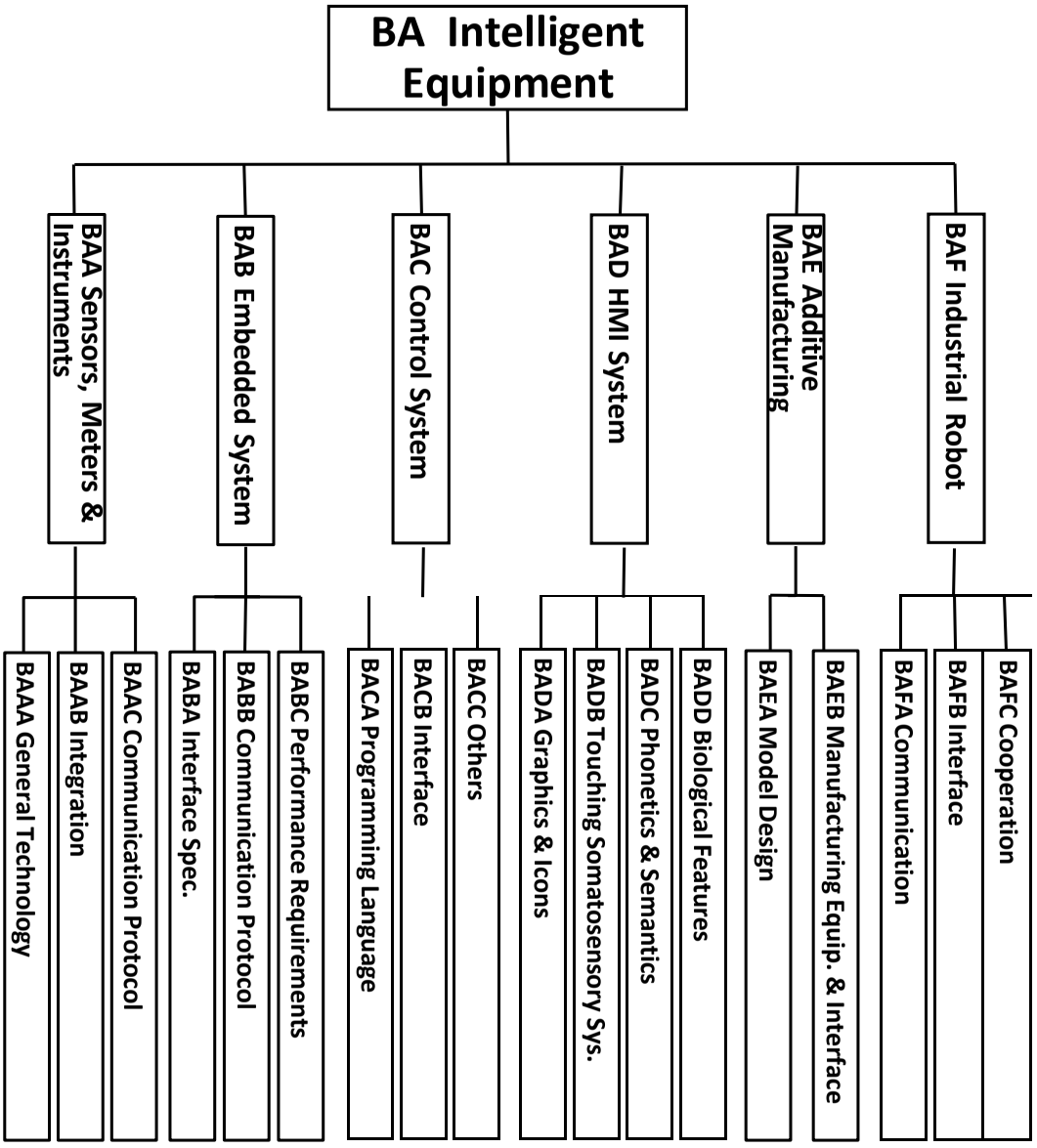

Fig. 8 Intelligent Equipment Standard Sub-system

(1) Sensors, meters and instruments standards

Sensors as well as meters and instruments standards are mainly composed of general technical standards such as data exchange, characteristics and classification, performance evaluation and intelligent requirements; integration standards

such as clock synchronization, interface, functional block, equipment integration and interoperability; communication protocol standards such fieldbus, industrial Ethernet, wireless industrial networks, safety communication, highly available communication and conformity.

(2) Embedded system standards

The embedded system standards of Smart manufacturing standard system mainly consist of interface specification, communication protocol and performance requirements of embedded system.

(3) Control system standards

The control system standards of Smart manufacturing standard system mainly include programming languages such as PLC, DCS and FCS, and also interface.

(4) Human-machine interactive system standard

The human-machine interactive system standard of Smart manufacturing standard system mainly include graphic and icon standards such as human-machine interactive graphics and icons in industrial control field, functional attributes and registry management; touching somatosensory standards such as somatosensory description language, gesture

order and functional attribute; phonetic and semantic standards

such as voice command, semantic comprehension and semantic database; biometric features recognition standards such as biometric features recognition technical interface and biometric features recognition data exchange.

(5) Additive Manufacturing Standards

Additive manufacturing standards mainly include model design standards such as design specification, document format, data quality assurance, documents storage and data processing as well as additive manufacturing equipment and interface standard.

(6) Industrial robot standards

Industrial robot standards (including mobile robot) mainly include communication standards such as data format, communication protocol, communication interface and control semantics; interface standards such as interface between industrial robot programming and operation graphics user, interface between programming system and robot control; collaboration standards such as the collaborative operation between robot and human during the manufacturing process, collaborative operation of robots and collaborative operation between robot and production line.

2. Smart factory standards

With respect to connecting all production operation processes of the factory, Smart factory realize fast information exchange, transmission, storage, processing and seamless intelligent integration of all links ranging from production design and sales to equipment control and enterprise resources management. Intelligent factory standards mainly consist of six parts, i.e., construction planning of Smart factory, system integration, intelligent design, intelligent production, intelligent management and intelligent logistics, as shown in Fig. 9.

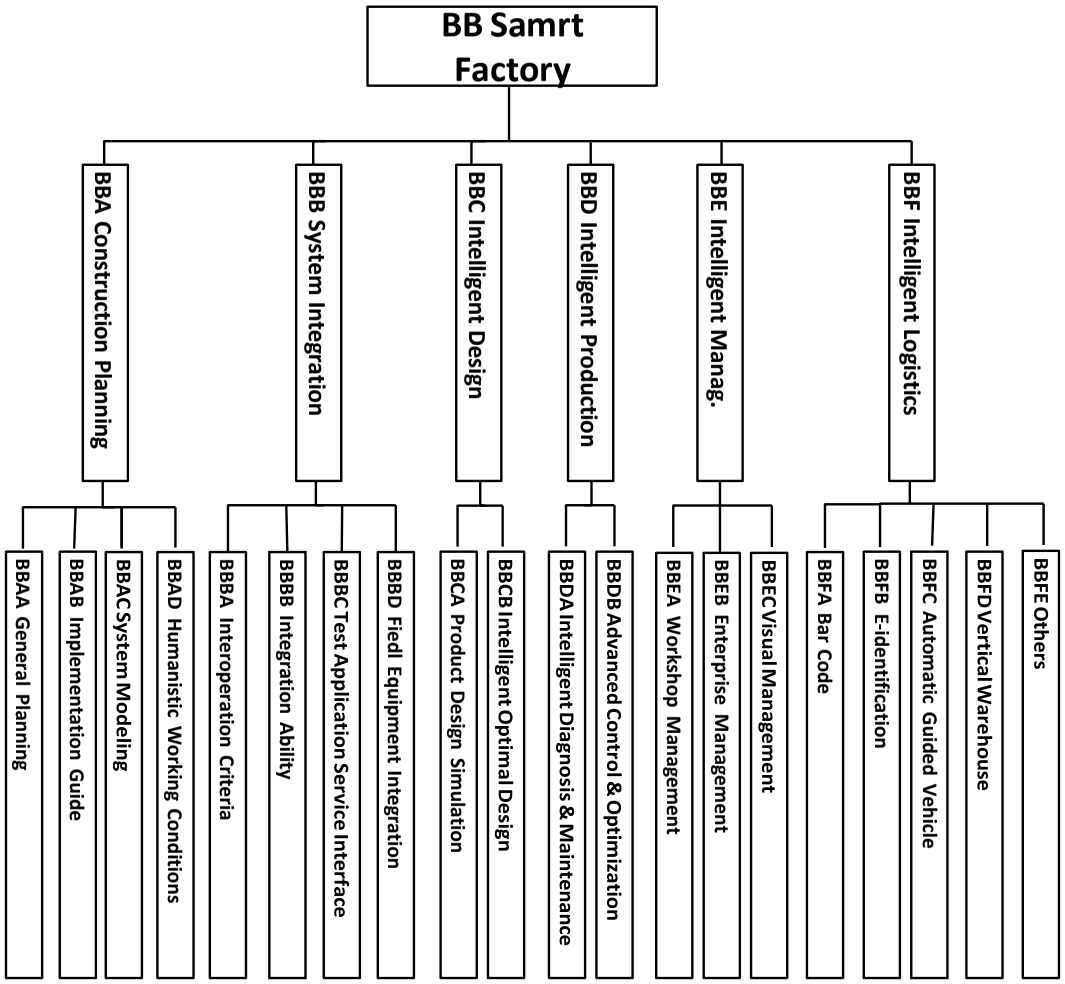

Fig. 9 Smart Factory Standard Sub-system

(1) Construction planning standards

Construction planning standards mainly include general planning standards such as basic functions of a factory, design requirements and design model standards; implementation guide standards required for reaching the planning design of Smart factory such as simulation analysis, collaborative design and construction implementation standard; system modeling standard such as intelligent factory-based technological process

and arrangement model, production process model and organization model; design standard that provides employees with humanistic working conditions.

(2) System integration standards

System integration standards mainly include interoperability criteria such as descriptions on defining Smart manufacturing software interoperability and matching of manufacturing unit; standards and specifications on the integration ability such as integration functional module descriptions and integration ability evaluation; test application service standards such as interface service and protocol for describing the capacity of Smart manufacturing software, relevant template specification, interface for visit/search capacity and process definition matched based on the requirements; field equipment integration standards such as OPC UA, EDDL, FDT and FDI.

(3) Intelligent design standards

Intelligent design standards mainly include product design simulation standards such as product digital definition, product digital model machine, design simulation, process simulation and digital test, as well as intelligent optimization design

standards such as optimizing product simulation results, describing optimization model and optimization method.

(4) Intelligent production standards

Intelligent production standards mainly consist of two parts, i.e., standards regarding the diagnosis and maintenance of production process control system and standards regarding the advanced control and optimization of production process system. The former ones include the general requirements for defining the diagnosis, capacity evaluation and maintenance of intelligent production system while the latter ones include the integration structure, functional module and information interaction mode of control and optimization software for production manufacturing system.

(5) Intelligent management standards

Intelligent management standards mainly include the workshop management standards such as manufacturing message specification and MES application; enterprise management standards such as enterprise operation decision-making management, plan management, production management, technique management, quality management, personnel management, finance management, equipment management and logistics management; visual management

standards such as the visualization of standard products information, equipment information, inventory information, production status and energy supervision.

(6) Intelligent logistics standards

Intelligent logistics standards mainly include the standards used for recognizing the bar code and e-identification of raw materials, components and parts, equipment and product information, for the equipment inside factory such as automatic guided vehicle as well as the intelligent logistics equipment standard used inside the factory and the vertical warehouse of workshop.

3. Intelligent service standards

With respect to new business and new mode, intelligent service provides all kinds of specification and reliable service through using enterprise's internal and external resources comprehensively. Intelligent service standards mainly include three parts, i.e., personalization manufacturing, remote operation & maintenance and industrial cloud, as shown in Fig. 10.

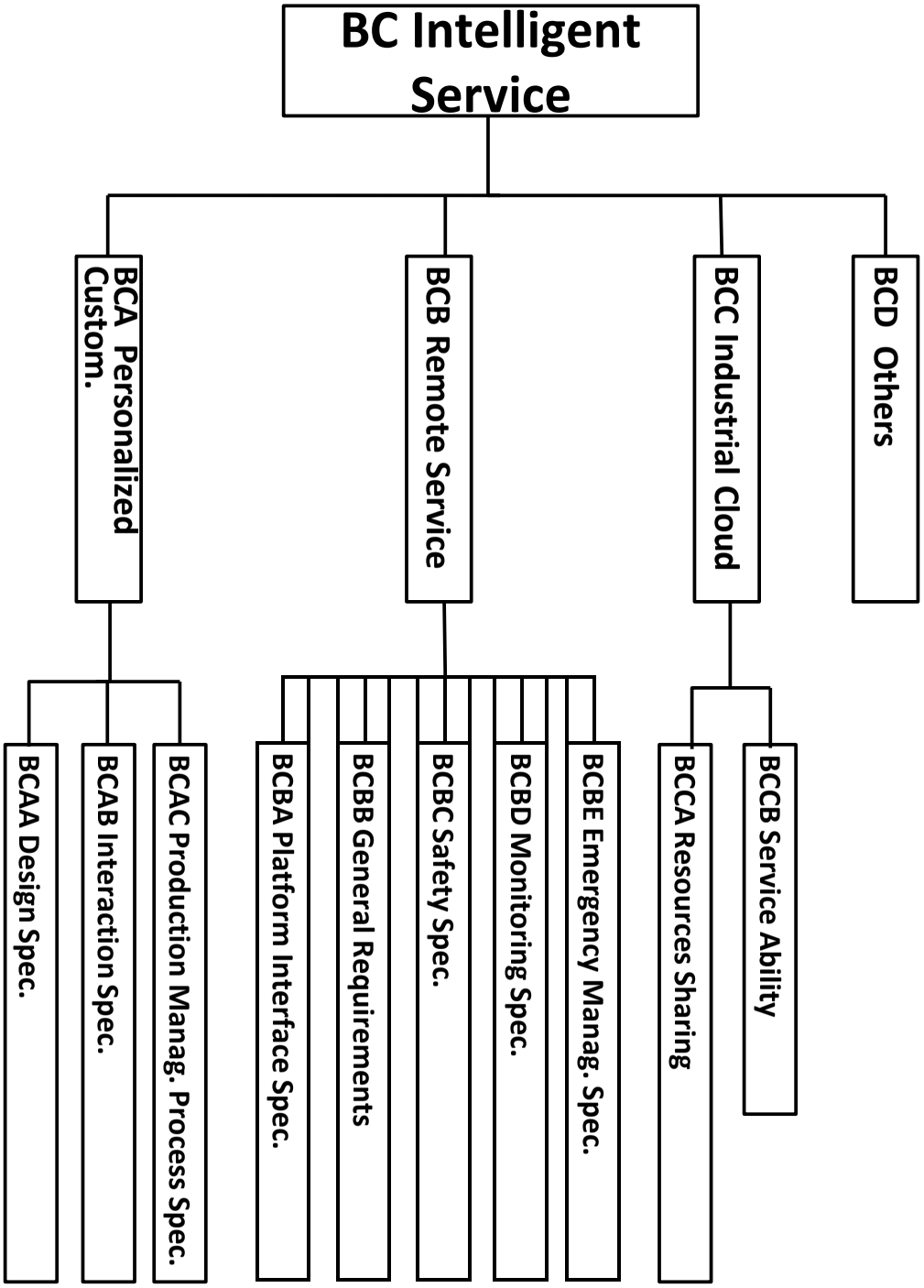

Fig. 10 Intelligent Service Standard Sub-system

(1) Personalized customization standards

Personalized customization standards mainly include personalized customization design specification satisfying the large-scale individual production, interaction specification and production management process specification.

(2) Remote operation & maintenance standards

Remote operation & maintenance standards mainly include platform interface specification, general requirements, safety specification, monitoring specification and emergency management specification.

(3) Industrial cloud standards

Industrial cloud standards mainly include resources sharing standards such as interface and protocol as well as service capacity standards.

4. Industrial software and big data standards

Industrial software and big data provide supports for connecting industrial software data chain and realizing the comprehensive application of industrial big data by focusing on the vertical and horizontal integration of enterprise information system. Industrial software and big data standards mainly include industrial big data, products and systems, and service and management, as shown in Fig. 11.

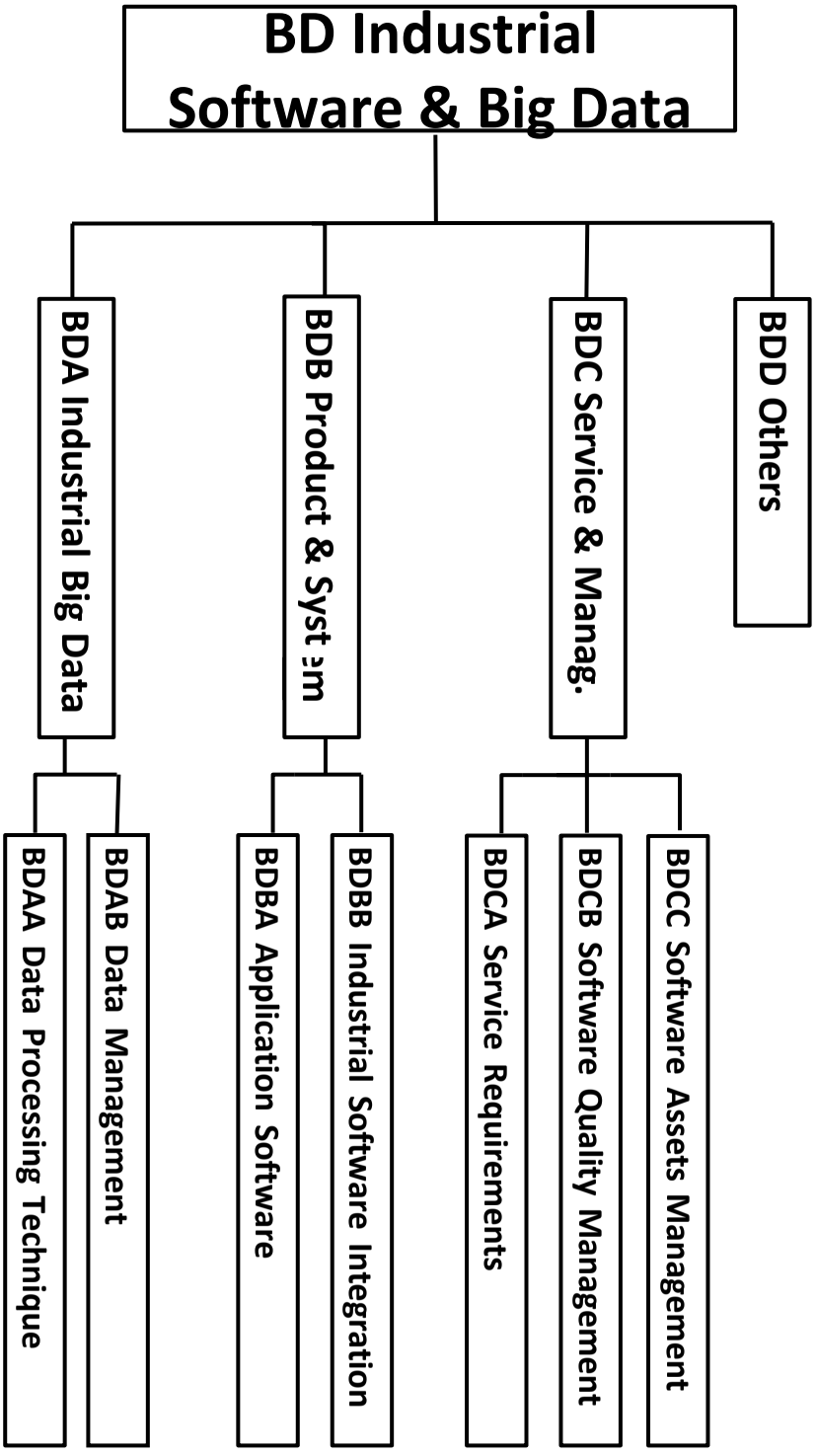

Fig. 11 Industrial Software and Big Data Standard Sub-system

(1) Industrial big data standards

Industrial big data standards mainly include data processing technical standards for the intelligence of production process, product, new-industry and new-mode intelligence, management and service intelligence, as well as data management standards such as data quality, capacity maturity, data assets management, data opening and sharing and transaction.

(2) Product and system standards

Product and system standards mainly include industrial software standards such as the functional definition of software product, tools, system and platform, business model, technical requirements and interface specification and industrial software integration standards such as enterprise resource plan, supply chain management, client relationship management, manufacturing execution system, product lifecycle management and process control system.

(3) Service and management standards

Service and management standards mainly include service process and service capacity for the development, integration, outsourcing and operation & maintenance of industrial software, and service requirements for industrial cloud service such as service catalogue, service level protocol, service quality and

service procurement; industrial software quality standard such as the measurement of industrial software quality and assets maintenance as well as the management standard of industrial software assets.

5. Industrial internet standards

Industrial internet is designed to constructing factory internal and external networks featured by high reliability, bandwidth, connecting number and low time delay; it tries to run through all layers inside the factory and full value chain beyond the factory by focusing on interconnection, low-cost computing, safe and reliable interoperation industrial information infrastructures in order to realize information tracking and management of the whole lifecycle, and satisfy factory's internal intelligence and network and external exchange. Industrial internet standards mainly include four parts, i.e., system architecture, network technique, resources allocation and network equipment, as shown in Fig. 12.

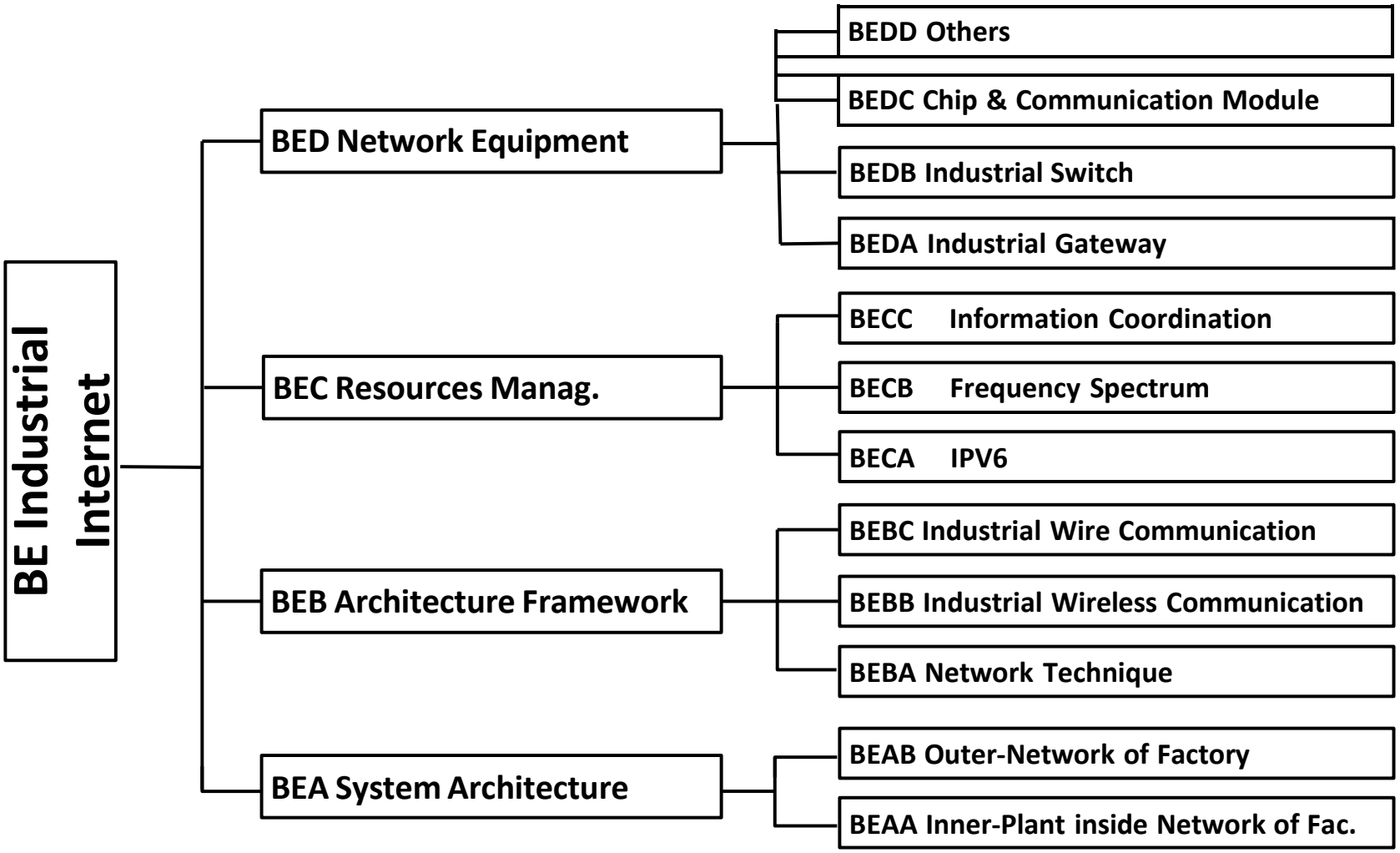
BE Industrial Internet
BED Network Equipment
BEDD Others
BEDC Chip & Communication Module
BEDB Industrial Switch
BEDA Industrial Gateway
BEC Resources Manag.
BECC Information Coordination
BECB Frequency Spectrum
BECA IPV6
BEB Architecture Framework
BEBC Industrial Wire Communication
BEBB Industrial Wireless Communication
BEBA Network Technique
BEA System Architecture
BEAB Outer-Network of Factory
BEAA Inner-Plant inside Network of Fac.

Fig. 12 Industrial Internet Standard Sub-system

(1) System architecture standards

System architecture standards mainly include factory's internal network standards such as network interconnection of different layers inside enterprise, interconnection and interoperation technique under the mode of design/supply chain/manufacturing/service/consumption collaboration; it also includes the industrial external network standards regarding the interconnection of enterprise, business and industry.

(2) Network technique standards

Network technique standards mainly include the standards regarding the low time delay and highly reliable connection between fault machines, between machine and control system and between upstream and downstream of enterprises and intelligently interactive network technique; industrial wireless network standard for the different demands of field equipment level, workshop monitoring level and factory management level; industrial wire communication standards for industrial field bus, industrial Ethernet and industrial cabling.

(3) Resources management standards

Resources management standards mainly include IPv6 standards applied in industrial internet and frequency spectrum

and information coordination standards of wireless frequency spectrum applied to industrial environment.

(4) Network equipment standards

Network equipment standards mainly include standards regarding industrial gateway such as network equipment, communication protocol and interface, industrial switch, chip and communication module.

Appendix 1: Terms and Abbreviations related to Intelligent Manufacturing

4G: (the 4th Generation mobile communication technology)

5G: (the 5th Generation mobile communication technology)

CAD: (Computer Aided Design)

CAM: (Computer Aided Manufacturing)

CRM: (Customer Relationship Management)

DCS: (Distributed Control System)

EDDL: (Electronic Device Description Language)

EPA: (Ethernet in Factory Automation)

ERP: (Enterprise Resource Planning)

FCS: (Fieldbus Control System)

FDI: (Field Device Integration)

FDT: (Field Device Tool)

IEC: (International Electrotechnical Committee)

IP: (Internet Protocol)

IPv6: (Internet Protocol Version 6)

ISO: (International Organization for Standardization)

LTE-M：(LTE-Machine to Machine)

MBD: (Model Based Definition)

MES: (Manufacturing Execution System)

OPC UA: (OPC Unified Architecture)

PLC: (Programmable Logic Controller)

PLM: (Product Lifecycle Management)

SCADA: (Supervisory Control and Data Acquisition)

SCM: (Supply Chain Management)

WIA: (Wireless Networks for Industrial Automation)

Appendix 1: Terms and Abbreviations related to Smart Manufacturing

4G: (the 4th Generation mobile communication technology)

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FCS: (Fieldbus Control System)

FDI: (Field Device Integration)

FDT: (Field Device Tool)

IEC: (International Electrotechnical Committee)

IP: (Internet Protocol)

IPv6: (Internet Protocol Version 6)

ISO: (International Organization for Standardization)

LTE-M：(LTE-Machine to Machine)

MBD: (Model Based Definition)

MES: (Manufacturing Execution System)

OPC UA: (OPC Unified Architecture)

PLC: (Programmable Logic Controller)

PLM: (Product Lifecycle Management)

SCADA: (Supervisory Control and Data Acquisition)

SCM: (Supply Chain Management)

WIA: (Wireless Networks for Industrial Automation)