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Tires Intelligent Manufacturing - Interconnection Network

Architecture - General Specification

轮胎智能制造 互联网络架构 通用规范

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Tires Intelligent Manufacturing - Interconnection Network Architecture - General Specification

1 Scope

This document specifies the terms and definitions, abbreviations, demands and connection framework, network architecture, network implementation and network security requirements of the interconnection network of tires intelligent manufacturing.

This document is applicable to the design, construction and upgrade of the interconnection network architecture for the tires intelligent manufacturing enterprises.

2 Normative References

The contents of the following documents constitute indispensable clauses of this document through the normative references in the text. In terms of references with a specified date, only versions with a specified date are applicable to this document. In terms of references without a specified date, the latest version (including all the modifications) is applicable to this document.

GB/T 22239-2019 Information Security Technology - Baseline for Classified Protection of Cybersecurity

GB 40050-2021 Critical Network Devices Security Common Requirements

3 Terms and Definitions

The following terms and definitions are applicable to this document.

3.1 network architecture

The overall design of the communication system, providing criteria for network hardware, software, protocols, access control and topology.

3.2 field level

The lowest-level part of the distributed control system, and also the most basic level.

NOTE: including production equipment, instruments and apparatus, etc.

3.3 workshop level

A unit with relatively independent functions in the production process.

NOTE: in the tire industry, it mainly refers to the rubber mixing workshop, semi-finished product

workshop, molding workshop, vulcanization workshop and inspection workshop, etc., which may vary from manufacturer to manufacturer according to actual conditions.

3.4 plant level

The entire factory of a tire enterprise.

NOTE: including design, production, logistics, management and other links.

3.5 network topology

The physical layout of various devices interconnected by transmission media, constituting a specific physical (i.e., real), or logical (i.e. virtual) arrangement mode between members of the network.

4 Abbreviations

The following abbreviations are applicable to this document.

AGV: Automated Guided Vehicle

API: Application Programming Interface

CC-Link: Control & Communication Link

CRM: Customer Relationship Management

DCS: Distributed Control System

ERP: Enterprise Resource Planning

FCS: Fieldbus Control System

HMI: Human Machine Interface

IPv4: Internet Protocol Version 4

IPv6: Internet Protocol Version 6

IT: Information Technology

K8s: Kubernetes

MES: Manufacturing Execution System

MODBUS RTU: Modbus Protocol Remote Terminal Unit

Modbus: Modbus Protocol

WMS: Warehouse Management System

5 Interconnection Network Demands and Connection Framework of Tire Factories

5.1 Overall Demands for Interconnection Network of Tire Factories

5.1.1 Basic demands for interconnection network of tire factories

The basic demands for the interconnection network of tire factories include:

- a) Network isolation and special network for special purposes;
- b) Cross-regional / cross-factory network collaboration;
- c) Data factory-wide secure storage;
- d) Adapt to production takt and with ultra-low latency (≤ 30 ms);
- e) Data protocol conversion in the device-side edge computing / network control layer;
- f) Simultaneous access to the intranet and the public network;
- g) Wired and wireless connections, data collaborative sharing.

5.1.2 Design principles of network architecture

The design principles of network architecture include:

- a) Reliability;
- b) Scalability;
- c) Security;
- d) Layered architecture.

5.1.3 Demands for six types of interconnections

The entities of the six types of interconnection relations involve all aspects of the entire process from automation control to product production, use, and management, etc., including:

- a) Intelligent equipment and factory control system;
- b) Work-in-process products and intelligent equipment;
- c) Work-in-process products and factory cloud platform (and management software);

- 5---factory control system and factory cloud platform (and management software);
- 6---factory cloud platform (and management software) and users;
- 7---factory cloud platform (and management software) and collaboration platform;
- 8---intelligent products and factory.

Figure 1 -- Schematic Diagram of Interconnection of Industrial Internet

5.2 Connection Framework of Interconnection Network for Tires Intelligent Manufacturing

5.2.1 The overall connection framework shall be divided into three levels: edge access layer, aggregation layer and core layer.

5.2.2 Edge access layer, that is, through wired and wireless modes, connects the production factors, such as personnel, machines, materials, environment and systems related to the Internet system in the tire factory, supports the forwarding of different data formats for business development, and realizes end-to-end data transmission. To achieve intercommunication and interoperability between data and information elements, the protocols that should be adopted include but are not limited to OPC UA, MODBUS RTU, MQTT, WebAPI, TCP, UDP and CC-Link, etc.

5.2.3 Aggregation layer: it is advisable to use SDN and VxLAN technologies to design the factory aggregation layer network. The network can be abstracted into a physical bearer network and an application-oriented Overlay network, as shown in Figure 2.

M---Wireless Network in the Factory;

N---Mixing Equipment;

O---Cutting Equipment;

P---Molding Equipment;

Q---Testing Equipment;

R---Sensor.

Figure 3 -- Overall Connection Framework among Various Entities in the Interconnection Network for Tires Intelligent Manufacturing

6 Interconnection Network Architecture for Tires Intelligent Manufacturing

6.1 Interconnection Network Structural Division of Tire Factory

The interconnection network structure of tire factory should be divided into two levels: IT network and OT network. The network level is divided into field level, workshop level and factory level in accordance with the actual management level of the tire factory. The two-layer three-level network structure of the tire factory is shown in Figure 4.

equipment commands, data polling and collection, the delay shall not exceed 30 ms.

- b) Support flexible IT/OT networking. Realize the separation of control plane and forwarding plane, coordinate network resource scheduling through SDN controller and manufacturing control and support flexible manufacturing and automatic production organization.
- c) Support remote factory networking, preferably use MPLS special line technology or SD-Wan technology, and with the capability of accessing remote factory for networking.
- d) Support IPv4 and IPv6, IT network and OT network, support IP protocol, and support direct interconnection between IT and OT nodes.
- e) Support full-node visualized management, and provide functions, such as alarm management, performance management, report management, and audit management, etc..
- f) It is advisable to support new technologies and new solution connections, such as TSN, 5G, WIA for industrial automation, and the sixth-generation wireless network (Wi-Fi 6) and other new technology connection modes.

7 Implementation of Interconnection Network for Tires Intelligent Manufacturing

7.1 Implementation Framework

The goal of interconnection network construction is to build a new infrastructure that is interconnected with all production factors and the entire system, as shown in Figure 7.

- e) Data servers / cloud data centers for data aggregation and analysis of tire intelligent manufacturing factories;
- f) Special line equipment for remote networking access.

7.4.2 Deployment requirements

The basic requirements for the network construction of tire intelligent manufacturing factories are high reliability and large bandwidth. The key is to achieve agile network management, data collaboration and a full-coverage network system. The specific construction requirements shall include:

- a) SDN technology shall be deployed using a flattening network architecture (for example, large Layer 2 network technology, etc.) to achieve flexible and simplified network management;
- b) Wireless networks, such as 4G/5G, NB-IoT, and wireless LAN shall be utilized to achieve comprehensive network coverage;
- c) Containerization technology (such as Docker containers, K8s, etc.) should be used to support containerized deployment of tire factory platform application and management system, and to achieve real-time, efficient collection, analysis and interaction of data within the factory.

7.5 Data Communication System Implementation

The goal of data communication system deployment is to build a bottom-up, full-process, full-business data communication system.

Intelligent manufacturing factories should support production equipment, monitoring and acquisition equipment, dedicated remote terminal units and data servers, etc. that support international or domestic standardized data protocols, such as OPC UA, MODBUS RTU and MQTT; and deploy data middleware and application systems that support tire factory-specific data structure models to achieve cross-factory / cross-regional and cross-system information interoperability.

8 Security of Interconnection Network for Tires Intelligent Manufacturing

8.1 Equipment Security Protection Requirements

The equipment security protection requirements for the interconnection network for tires intelligent manufacturing shall comply with the requirements of 6.1 and 7.1 in GB/T 22239-2019.

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