Design and Construction of Industrial Network for Intelligent Factory

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Abstract: The rapid development of intelligent manufacturing industry has also put forward higher requirements for industrial networks, especially the emergence of intelligent factories and intelligent processing tedious processes, requiring that the network be able to achieve seamless communication, real-time efficiency and high-speed redundancy. Siemens Industrial Ethernet is proposed in this context. Taking the actual industrial network as an example, this paper puts forward two effective and feasible network construction models by using Siemens advanced industrial network, and analyzes the advantages and disadvantages of these two models so that the designers can use them better.

1. Introduction

Made in China 2025 is a major strategic plan to comprehensively improve the quality and level of China's manufacturing industry. The transformation and upgrading of manufacturing industry is imperative.Intelligent manufacturing factories are generated under the big data of the internet of tings. It is the use of modern technology to achieve factory office, management and production automation, to strengthen and standardize enterprise management, reduce work errors, to solve the purpose of various vulnerabilities, strengthen external contacts, broaden the international market to provide a direction of construction significance.

At present, domestic manufacturing enterprises are still facing many difficulties and challenges in intelligence, informatization, difitalization and automation. Communication network can connect field equipment, controller,human-machine interface(HMI) and enterprise management system, and it is also an important basis for orderly, safe and sTable operation of production. In addition, industrial information security technology is also indispensable. The industrial information security technology can protect the controller and engineer station in the production network from illegal invasion.

Based on this, this paper aims to study the design and architecture of the actual intelligent industrial network, to solve the problem of effective data transmission, information interaction and use in existing smart factories, and to improve the information use security.

2. Design of factory layout

According to the project design requirements, to complete the network planning and design in the following smart factory. As Fig. 1 shows,
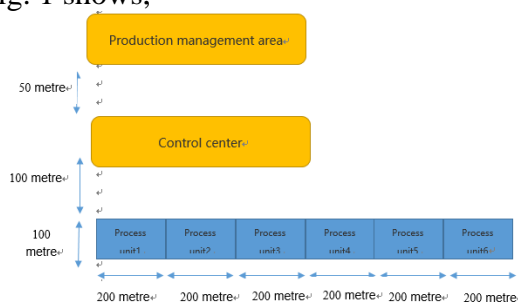

Fig. 1 factory layout

Plant area can be seen from the layout of the factory that the network consists of three levels: the equipment field bus layer, the control center layer, and the production management area.

It is the mainstream design of the three-tier architecture in the current industrial design. Among them, it can be seen from the analysis that the equipment field bus layer is distributed in a straight line. The process unit covers an area of 200 * 100 square meters, a total of 6 process units, the control center is 100 meters from the scene, and the control center is 50 meters from the production management area. According to equipment requirements, carry out engineering layout design.
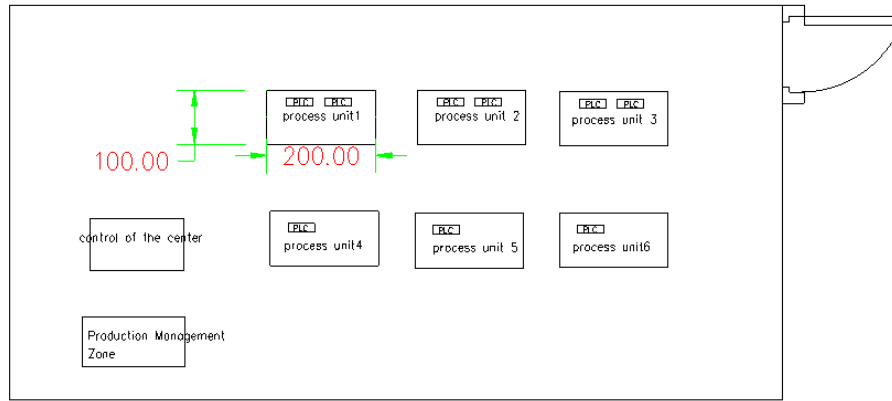

Fig. 2 layout design

Process units 1-3 contain two PLCs and can achieve real-time data transmission. We divide the process units 1-3 into groups and arrange the process units 4-5 in a row to improve the utilization rate of the plant area. The control center can be distributed horizontally or vertically, and the production management area is close to the control center.

3. Network Topology Design

Network topology refers to the geometric arrangement of communication lines and stations in the network. It includes star network ring network and bus network. Bus network architecture is the most common one in enterprise architecture. All stations in the network share a data path. Bus network installation is simple and convenient. Cables that need to be laid are the shortest and the cost is low. A site failure generally does not affect the whole network, but the failure of the medium will lead to network paralysis. With Siemens switch, optical fiber conductor or twisted pair connection can be realized, and data terminal can be connected by twisted pair.

In order to meet the needs of users to build a high-speed stable, safe, reliable and easy-to-manage wireless access network, according to the requirements of intelligent factory network and the characteristics of Siemens network technology. two network solutions are designed.

3.1 AP +3 Tier network architecture scheme

The network is still built in a hierarchical structure. In the bottom field layer, two sub-networks are established through SCALANCE X208. Process Unit 1, Process Unit 2 and Process Unit 3 are in one sub-network, and Process Unit 4, Process Unit 5 and Process Unit 6 are in one sub-network. Subnet field level and control layer are wired through SCALANCE X2 series switches. SCALANCE X2 and the second control layer are connected at high speed by twisted pair No. 5. When the connection length exceeds 100 meters, the relay is used for conversion. As Fig. 3 shows.

The control center layer receives high-speed data. It needs to provide high-density GE interface, collect the flow of the underlying switch, and connect it to the upper level of production management through wireless interface. The control layer achieves high-speed, High-Compatibility and network protocols and network devices that can solve unexpected problems such as information errors in time. Mainly to achieve real-time data information interaction, data analysis, high-speed data calculation, but also to prevent data loss, data packet loss, poor transmission and other emergencies.

The design of this layer uses wireless information access point to realize the interaction with production management. In recent years, wireless technology has become the core technology in the field of industrial control and the development direction of industrial automation. In the future, information will become more and more intelligent, and information access paths can be provided anytime, anywhere. The main advantages of wireless solutions are the simplicity and flexibility of mobile stations, which is also an important problem to be solved in intelligent work. SCALANCE W Industrial Ethernet equipment based on SIMENS is specially designed for industrial occasions. Its industrial design makes WLAN technology well integrated into the field control system. Its flexible and reliable characteristics provide a brand-new network solution for traditional industrial control.
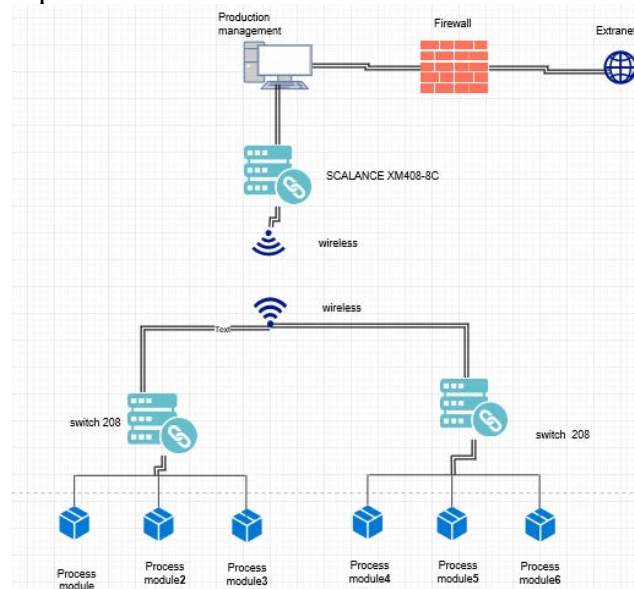

Fig.3Wireless Network Layout+ Three-tier network layout

SCALANCE W774 omnidirectional antenna wireless access point with wireless network card K-PLUG is selected to realize redundant WLAN, so that access point can transmit data on two channels and frequencies. Ensure high bandwidth and high reliability of connection; even if the node is temporarily interrupted due to occlusion interference 2 in one channel, the connection may remain valid through another channel.

Production management manages data transmission at all levels downwards, and communicates and interacts with external network information upwards. This layer uses SCALANCE XM408-8C to realize effective communication between control center and production management, and equips SCALANCE S615 information security module to improve the security of the whole intelligent industrial network.

SCALANCE XM408-8C Switch: 16 SFP interfaces with 10/100/1000 Mbit/s RJ45 and 4 SFP interfaces in the form of 100/1000 Mbit/s COMBO, 16 ports can be activated at the same time; 24 electrical or optical interfaces can be expanded; and three-layer switching functions can be extended through KEY PLUG card. DIN or S7 rail installation, supporting PROFINET IO diagnosis; integrated redundancy management functions. High-speed and reliable electrical or optical industrial Ethernet can be designed flexibly. They are very suiTable for the factory bus and terminal bus of SIMATIC PCS7 process control system with electrical or optical Gigabit Network technology.

SCALANCE S615 Information Security Module: It can provide protection function for equipment, automation unit and Ethernet network segment. Through SCALANCE S615, the production network can be effectively protected from internal and external threats, such as unauthorized access or unnecessary communication load. Furthermore, communication can be secured by encryption to prevent data interception and data tampering, such as remote access to devices via an insecure network Internet or WAN.
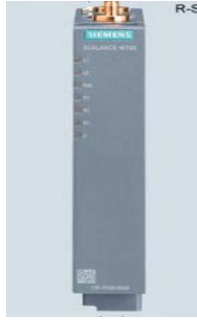
Fig.4 SCALANCE XM408-8C Switch

3.2 Switch + Routing Two-Layer Network Architecture Scheme

In this design, two switches SCALANCE X208 are used to establish two sub-networks in the field layer. The field layer and control layer network are realized by SCALANCE XM408-8C switching and routing equipment, while the production management layer is securely interconnected with the external network through SCALANCE S615 information security module. The network topology is shown in the following Fig.5.
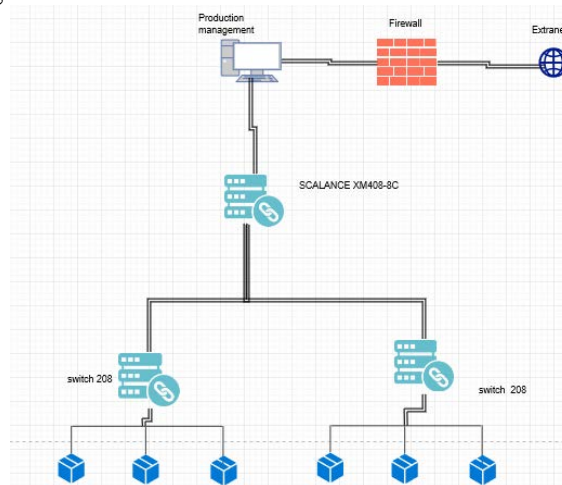

Fig.5 SCALANCE XM408-8C Switch

4. Summary

These two schemes have their own advantages and disadvantages. From the point of view of flexible use of performance, the first wireless network can improve the flexibility of network construction, improve the access and expansion of intelligent mobile and other networks in the later period. The second kind of network scheme design is simple and easy, and needs more network wiring design. For the long-term fixed intelligent factory, this scheme is also a good choice.

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