Technical Analysis of the Station Equipment IOT Management System

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Abstract. Traditional BAS systems in subway stations have problems such as inflexible deployment, high implementation costs, weak edge computing capabilities, and low integration, which are not conducive to the realization of convenience and intelligence. In response to the problems of the traditional BAS system, Guangzhou Railway Institute designed and applied a brand-new station equipment IOT management system. This article first analyzes the overall technology of the new system. In addition, the article also shows the hardware and software and core applications of the new system. Finally, the article describes the characteristics and main benefits of the new system.

Keywords: Station IOT, BAS system, technical analysis, system application.

1. Introduction
In order to meet the operational requirements of rail transit, stations should be equipped with lighting equipment, ventilation and air conditioning equipment, water supply and drainage equipment, screen door systems, escalators and other mechanical and electrical equipment to ensure normal operation. At the same time, in order to meet the requirements of alarming, passenger evacuation, and disaster relief in emergency situations, rail transit stations must also set up fire alarm systems, water fire-fighting systems, gas fire-extinguishing systems, smoke prevention and exhaust systems, smoke prevention equipment and other mechanical and electrical equipment and systems. In order to realize the orderly linkage control and monitoring of these systems and equipment, a set of automatic control systems that can monitor the environment and equipment must be set up on the rail transit line \cite{1}.

Electrical and Mechanical Control System-EMCS (Building Automatic System-BAS) has attracted much attention because of its disaster prevention and energy-saving functions. Chapter 21 of "Code for Metro Design" (GB50157-2013) \cite{2} specifically regulates it, including system structure and control equipment, etc.

The subway BAS system is an automatic control system based on the theory of special subway environmental ventilation and air conditioning and disaster prevention treatment, which combines computer and network technology with the automatic control principle of electromechanical equipment. The system uses a distributed microcomputer monitoring system to conduct comprehensive operation management and control of mechanical and electrical equipment such as air conditioning, ventilation, water supply and drainage, lighting, elevators, escalators, and guide signs in
subway stations and section tunnels. In case of fire or train blockage, BAS system can enter the operation mode of disaster prevention promptly and quickly, automatically dispatch air supply and exhaust according to the fire point information sent by fire alarm system or the blocking point information sent by train automatic control system, conduct ventilation and exhaust smoke, guide evacuation of personnel, and greatly improve the intelligence and safety of Metro operation. The system is characterized by energy saving and comprehensively considers various factors affecting the load of the air conditioning and ventilation system such as trains, passenger flow, station equipment, ventilation, etc., and automatically adjusts the annual operation mode of the air conditioning and ventilation system according to the law of changes in the thermal environment of the subway. It can not only ensure the safe and reliable operation of the electromechanical system equipment of the subway station, create a safe, comfortable and efficient riding environment, but also reduce the operating energy consumption of the air conditioning and ventilation system and reduce the operating cost of the subway. [3-5]

However, the traditional BAS system is mainly based on wired communication, the layout is inflexible, and the implementation cost is high, which is not conducive to system expansion. The traditional BAS system is mainly based on a transparent transmission gateway, and the edge computing functions such as storage, calculation and analysis on the near device side are very weak, which is not conducive to the realization of the intelligence of the Internet of Things. The traditional BAS system is mainly based on local deployment of CS software, BS operating software under non-cloud computing, which is not conducive to the realization of distributed, decentralized, and convenient operation and maintenance. The traditional BAS system is mainly based on flat graphics and form interface, non-three-dimensional visualization, which is not conducive to the visualization, convenience, and easy training of the operation. The traditional BAS system does not have a high degree of system integration, and multiple management systems cannot be integrated for unified management, which is not conducive to management and conciseness and unity, and the data between multiple systems is not connected, and mining is insufficient. [6-8]

The Flat Device-Linked Management System (hereinafter referred to as "New System") based on wireless communication, edge computing, cloud platform and visualization technology can systematically iterate over the above traditional BAS problems, and implement the full life cycle management of the devices on this basis. The new system simplifies the training and pre-maintenance of maintenance personnel, reduces operating costs and improves operational results.

2. Overall technical analysis of the new system

Aiming at the problem that "traditional BAS systems are mainly based on wired communication, the deployment is inflexible, the implementation cost is high, and it is not conducive to system expansion".

Although the purchase cost of wired communication modules is low, the cost of construction and wiring is high, and expansion and transformation are not flexible. The wireless communication module involves a radio frequency circuit, so the cost is slightly higher to purchase, but there is no wiring cost, and expansion and transformation are not restricted.

Different from the high-speed and high-reliability process industry, wireless communication is applicable from the perspective of building electromechanics. Although there may be signal delays in wireless communication, the degree of error has nothing to do with whether it is wireless communication. The degree of communication error is guaranteed by the coding and inspection of the communication, and the relationship with the communication medium is very limited. The communication medium mainly determines the communication speed and communication distance, not the degree of error.

Wired and wireless are not relative conflicting concepts. A system should combine these two communication media as appropriate. Optical fiber can be used to form the communication backbone, and terminal communication can be realized through wireless.
Aiming at the problem that "traditional BAS systems are mainly based on transparent transmission gateways, and edge computing functions such as storage, computing, and analysis on the near device side are weak, which is not conducive to the realization of the intelligence of the Internet of Things."

With the development of computer technology and communication technology, the cost of calculators and communication devices has been reduced. At present, it has become possible to deploy a large number of calculators and high-speed communication components with complex computing capabilities on the near device side. Traditional BAS is mainly a pyramid-shaped signal acquisition system, not a distributed complex computing system, and it is impossible to realize the complex calculation and judgment of the equipment state in the near side. However, after deploying calculators and high-speed communication devices with complex computing capabilities on the near device side, whether it is local computing or side-cloud collaboration, real-time complex computing judgments on the status of the device can be realized. For the operation and maintenance management personnel, it is not simply to understand the current basic state of the equipment, but to understand the trend of the equipment in real time. It is no longer post-maintenance or over-maintenance, but planned pre-maintenance. Different from password recognition and sign-in management, facial biometric recognition and automatic positioning and trajectory management, it has revolutionized the management of operation and maintenance personnel themselves.

Aiming at the problem that "traditional BAS systems are mainly based on local deployment of C/S software, BS operating software under non-cloud computing is not conducive to the realization of distributed, decentralized, and convenient operation and maintenance".

Generally speaking, C/S software needs to install dedicated client software on the operating device, while B/S software only needs a browser to operate. Obviously, using B/S software, the system can be operated on any Internet operating device that can run a browser, such as a computer, a tablet, a mobile phone, and so on. Its operation behavior is a distributed, decentralized, and extremely convenient operation. For operation and maintenance management personnel, it means that working hours are more flexible, and fewer and more scattered operators can be used to complete corresponding operations at any time and any place. Cloud computing means faster deployment time, lower-cost system investment, lower-cost operating costs, and safer data management.

Aiming at the problem that "traditional BAS systems are mainly based on plane graphics and form interface, non-stereoscopic visualization, which is not conducive to the visualization, convenience, and easy training of the operation".

Form-based operations are not visual enough and require a certain amount of abstract thinking ability. Three-dimensional visual operation, intuitive image, what you see is what you get, and the requirement for abstract thinking ability is greatly reduced. Three-dimensional visualization and forms are not a conflicting relationship, but a complementary relationship. Three-dimensional visualization reduces the requirements for abstract thinking ability, guides operations, and forms instructions further guide standardized operations. The combination of the two can play a better role. For operation and maintenance management personnel, this means that they do not need to be trained for a long time to be competent in operation. Under the guidance of the three-dimensional visual interface and auxiliary forms, an untrained person can also complete most of the work.

Aiming at the problem of "the traditional BAS system has a low degree of system integration, and multiple management systems cannot be integrated for unified management, which is not conducive to management and conciseness and unity, and the data between multiple systems is not connected, and mining is insufficient".

The current BAS system consists of multiple independent subsystems, such as equipment condition monitoring systems, smart lighting systems, smart toilet systems, energy management systems, power distribution monitoring systems, electrical fire monitoring systems, and fire power monitoring systems. Except that the fire-related systems cannot be merged due to the requirements of laws and regulations, the other systems are essentially the monitoring of electrical equipment, the environment, and the behavior of people, and they are merged into one operating system. A unified data management and
analysis system means simpler work and more accurate data and status judgments for operation and maintenance managers.

3. Main products and core applications
The hardware product of the new system is shown in Figure 1, and the screenshot of the software interface is shown in Figure 2. Its core applications include equipment condition monitoring and full life cycle management systems, EPS and UPS management systems, fine energy management systems, smart lighting management systems, smart toilet management systems, power distribution monitoring systems, equipment and personnel smart operation and maintenance systems, etc. In addition, the electrical fire monitoring system and the fire power monitoring system should be set up independently due to the requirements of fire protection laws and regulations, but their data and operation and maintenance management systems can be merged into a unified large system on a higher level.

Figure 1. The physical map of the new system hardware products.

Figure 2. Screenshot of the new system software interface.
4. Conclusions
The new system has achieved good operational results in many aspects. It realizes the full life cycle management of equipment, turns after-the-fact maintenance and over-maintenance into trend maintenance, improves the planning of maintenance work, and effectively prevents downtime. Its more precise energy management has achieved better energy-saving effects. It simplifies the training of operation and maintenance personnel, reduces the number of operation and maintenance personnel, reduces the professionalism requirements of operation and maintenance personnel, and improves the quality of operation and maintenance. It has opened up multiple independent data systems, making it easier to apply and mine the value of data. It has faster, more real-time and more convenient operation. It improves the stability and security of the system and data, while reducing construction, operation and maintenance costs.

References
[1] Jiewen WU. Research and application of the rail traffic station equipment intelligent monitoring based on embedded technology [D]. Donghua University, 2008.
[2] GB50157-2013, Code for design of Metro [S]. Beijing: China Construction Industry Press, 2013.
[3] Qi hang. New technology of subway BAS system [J]. Science and technology innovation guide. 2015, 22: 106-107.
[4] Han Xuliang. Application of subway BAS system in environmental control [J]. Electronic technology and software engineering. 2014, 2: 105-105.
[5] Yang Qi. Research on Metro Integrated Automation System [J]. Urban rail transit research. 2010, 13 (006): 45-51.
[6] Ren Na. Adaptability analysis of urban rail transit BAS system and related suggestions [J]. Automation and instrumentation. 2017 (07): 211-212.
[7] Li Caoxian, Yu Qiping. Improvement of software design in BAS system application [J]. Journal of Fujian Institute of technology. 2003, 1 (004): 48-50.
[8] Peng Xianchen. Research on design and implementation of subway BAS system [D]. Lanzhou University of technology, 2013.