Design and Implement of a General Zone Controller for Intelligent Building Platform System

Long Shi¹, Yewei Zhang¹ and Jing Li¹

¹Beijing National Railway Research & Design Institute of Signal & Communication Group Co. Ltd, South Road of Automobile Museum, Beijing, China.
Email: shilong1117@163.com

Abstract. There are several problems of traditional building monitoring and management system, such as separation and isolation of sub-systems, lack of linkage control, low compatibility, difficulties in extending, etc. A design of intelligent building platform system architecture, which is compatible with existing building systems, has been put forward after the research of intelligent building technology. Combined with the requirements of modern intelligent building, a general zone controller with powerful processing capabilities, rich peripheral interface, multiple communication protocol and communication protocol has been designed and implemented. The zone controller can support the connection and linkage of various sub-systems, devices and sensors in different zone of the intelligent building. An intelligent conference management system of intelligent building system has been realized based on the zone controller.

1. Introduction

Intelligent building platform system is a kind of intelligent application service platform which deeply integrates traditional control technology, enterprise system integration technology and internet of things technology [1]. It collects large-scale information of various building equipment and personnel behavior and provides service-centered applications and professional knowledge based on big data analysis to meet the needs of building owners, business managers, employees, building property personnel and other groups of people[2]. It’s able to enhance the building environmental safety, improve the satisfaction of building users, increase the efficiency of building operation, reduce the operation cost and energy consumption, thus improving the building value and brand image in the whole life cycle[3].

Intelligent building platform system needs to establish network connections with large number of subsystems, equipment and sensors in buildings in order to provide various intelligent services. Therefore, a general zone controller should be deployed through dividing different function zone of the building[4]. In the existing technology, the traditional zone controller has relatively single
communication bus and interface. High compatibility of different zone characteristics, interface types and communication protocols can not be achieved, thus the types, number and application scenarios of accessible equipment are limited[5]. In this paper, a general zone controller is designed based on the platform system of intelligent building. The zone controller can access various subsystems, actuators and sensors in the building through abundant external interfaces. It integrates the mainstream communication protocols and various functional components in the industry, realizes the virtualization of the interface, and can be flexibly applied to equipment interconnection in various zone of intelligent building.

2. Design of Intelligent Building Platform System

As shown in figure 1, intelligent building platform system consists of three layer, including equipment layer, system access layer and platform layer.

![Figure 1. Structure of intelligent building platform system](image)

2.1. Equipment Layer

The intelligent building system divides equipment according to physical space zone instead of business function of subsystems, which is the principle of traditional building management systems. Each zone constitutes an intelligent control space (such as conference room, restaurant, laboratory, etc.). Intelligent control of whole equipment in the whole building is realized by arranging zone controllers combined with existing building monitoring and control subsystems. Equipment layer can be divided into three categories.
2.1.1. *Equipment connected and monitored by existing building subsystems.* BAS (corridor lighting, elevator equipment, public lighting, air conditioning, fresh air unit, etc.), FAS (fire detector, alarm controller, etc.) and CAS (Information Publishing Screen, Broadcasting Equipment, etc.).

2.1.2. *Equipment with no connection and monitoring.* Projectors, air conditioning terminals, environmental sensors, lighting equipment, audio video control system (cameras, microphones, screen), etc.

2.1.3. *Intelligent building zone controller.* The zone controller is installed to integrates the equipment within the zone, which have no connection and monitoring of existing system. A unified interface is used to collect all kinds of information in the platform layer.

2.2. *System Access Layer*
This layer contains the existing building subsystems, including BAS, FAS, CAS, SAS, etc. All kinds of monitoring subsystems adopt different interfaces to realize the monitoring of their equipment.

2.3. *Platform Layer*
This layer includes three parts: building information integrated control module, building intelligent application service module and building intelligent application service access terminal.

2.3.1. *Building information integrated control module.* It uses unified physical interface to access to zone controllers distributed in different building zone, collects and processes the multi-type source data of the equipment layer, publishes it to the intelligent application service module. It receives and processes the control information of the intelligent application service module, and sends data to the equipment layer.

2.3.2. *Building intelligent application service module.* It’s based on the data from building information integrated control module and combines with business needs to realize specific application function services, including conference intelligent management application, intelligent office area application, intelligent visitor application, intelligent guidance application, intelligent parking application, intelligent laboratory application, etc.

2.3.3. *Intelligent application service access terminal.* It includes three parts: mobile terminal, Web terminal and desktop application terminal. It provides access entrance different user groups in alternative ways.

3. *Design of Zone Controller*
Zone controller consists of application layer, Operating system layer, embedded software platform layer and hardware interface layer, as shown in Figure 2.
3.1. Hardware Interface Layer

Hardware interface layer uses AM3352 processor with the working frequency of 800MHz based on ARM A8 architecture. Hardware resources include 512MByte DDR3 SDRAM, 256MByte NAND Flash, 2 gigabit Ethernet communication interfaces, 8 UART communication interfaces (4 isolated RS485, 2 isolated RS232, 2 TTL output), 8 isolated GPIO interfaces, 1 SPI interface, 2 IIC interfaces, 2 isolated CAN interfaces, 8 ADC interfaces, 1 SD Card interface, etc. A zigbee module and WIFI module are integrated on board to support wireless communication function.

3.2. Operating System Layer

Operating system layer is a program that manages and controls hardware and software resources. It can run tailored Linux or real-time operating system by using OS adapter module in embedded software platform layer.

3.3. Embedded Software Platform Layer

Embedded software platform layer provides a general control platform for external information system and upper-layer application. It supports for a variety of protocol conversion, physical interface mapping, rich common function libraries, a large number of common components, data configuration, operating system adaptation, a variety of APIs and distributed components. Data acquisition, storage, sharing, exchange and other services can be provided. Both local applications and external control systems can call platform layer resources. At the same time, platform layer realizes virtualization by mapping controlled objects. Application software can control virtual objects through unified API interface to control actual physical objects.

3.4. Application Layer

Application layer provides applications running locally, which can collect and upload equipment status, parse platform instructions, control equipment, store data, converse protocol, process intelligent
scenario logic, read configuration file and manage communication interface. It can also be controlled by external commands through platform layer and realize the simplification of external application and reuse of software modules.

4. Implementation of Intelligent Conference Management System Scheme Based on Zone Controller

Intelligent conference management system is one of the important application subsystems of intelligent building platform system. It's mainly responsible for conference room resource maintenance, reservation, inquiry, message push and dynamic display, intelligent control of equipment and linkage of application scenarios. In order to achieve the above functions, a zone controller is deployed in each conference room, which connects the intelligent building platform through ethernet and the control equipment and sensors in the conference room through various communication buses. The structure of an intelligent conference room is shown in the Figure 3.

The zone controller connects all the equipment in the conference room through various communication interfaces, and connects the intelligent building platform server through ethernet. In addition, when the network connection is interrupted, the local processing logic is activated and the WiFi hotspot is available. Authorized users can establish a connection with the regional controller through mobile APP to control equipment in the conference room.

The list of equipment is shown as Table 1.

![Figure 3. Structure of an intelligent conference room.](image)

Table 1. Equipment list of an intelligent conference room

| Equipment                  | Interface       | Power Supply |
|----------------------------|-----------------|--------------|
| AMX                        | RS232           | 220VAC       |
| Projector                  | RS232&GPIO      | 220VAC       |
| Access control             | GPIO            | 12VDC        |
| Publishing screen          | ETHERNET        | 220VAC       |
| Conditioning control       | RS485           | 220VAC       |
| Lighting control           | RS485           | 220VAC       |
| Curtain control            | RS485           | 220VAC       |
After the successful reservation of conference rooms, intelligent building platform will send conference information, authorized user list, equipment type and quantity list, scenario mode list to the zone controller. According to the platform instructions, the zone controller initializes equipment connection, display relevant information including conference title, content, time and personnel on the publishing screen, open equipment control rights to authorized users. Users can control a variety of equipment (AMX, projector, access control, air conditioning, lighting, projection curtain, curtain and fresh air system, etc.), obtain environmental data (carbon dioxide content, PM2.5 content, temperature, humidity and illumination, etc.), select scenario modes (conference mode, lighting mode, leaving mode and adaptive mode, etc.) through mobile APP.

5. Summary

This paper designs and implements a general zone controller which supports the intelligent building platform system, and applies it to the intelligent transformation of conference room, realizing the application of intelligent conference management. The zone controller integrates rich hardware communication interfaces, runs LINUX operating system based on ARM architecture, and provides functions of interface acquisition, communication protocol, intelligent algorithm and data processing in embedded software platform layer. It can be flexibly applied to different zone of buildings according to different parameters configuration, providing powerful software and hardware platform for building informatization, automation and intellectualization.

6. References

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