IoT Lighting Solution for Industry 4.0

VERSION: CH MINISYS 2.0

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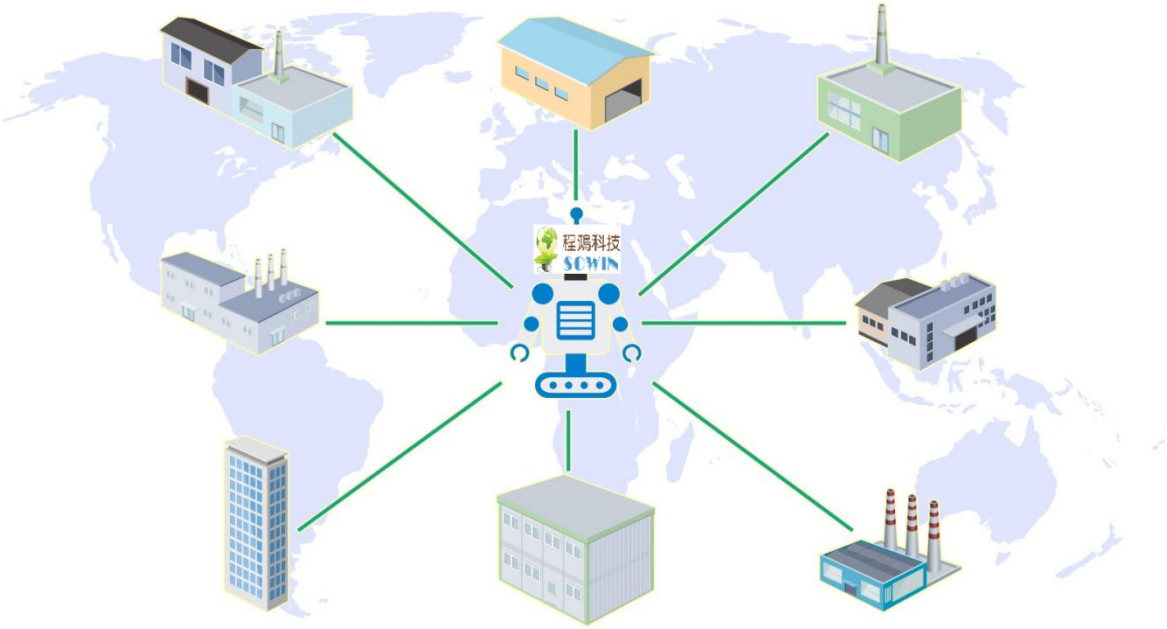
REVIEW: Morrison MO

CHENG HONG E-TECH.COMPANY LIMITED

1. About Us

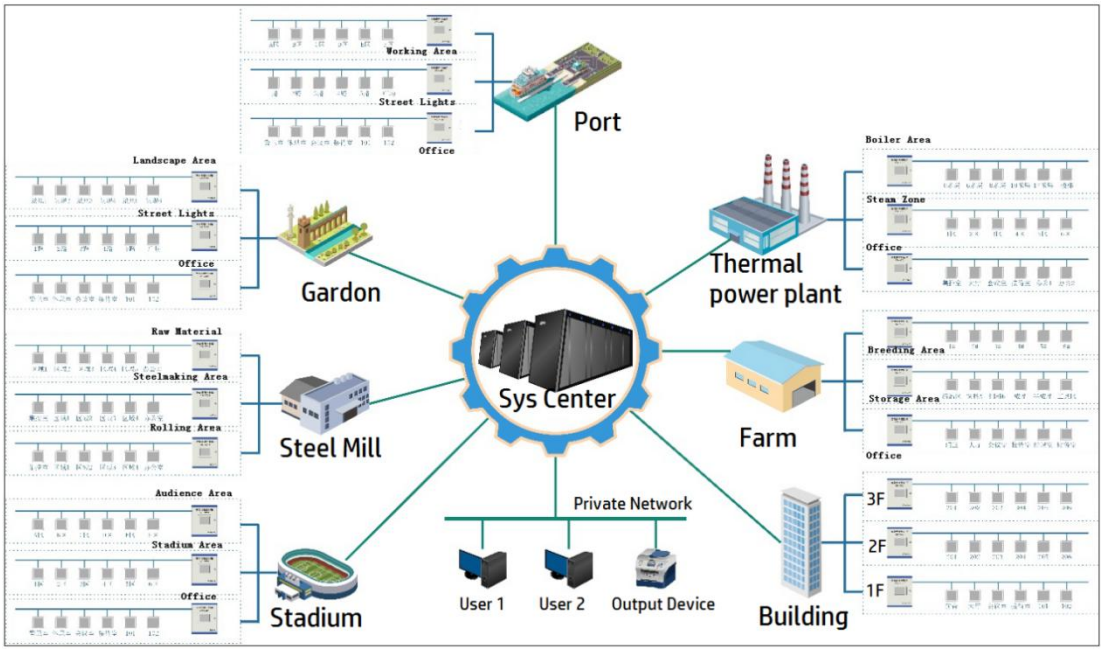
CHENG HONG E-TECH. CO LTD is a high-tech enterprise focusing on the research, development, production and sales of intelligent lighting control & management products. So far, it has had a large number of engineering cases in the lighting fields of smart city infrastructure, factory & warehouse, building, power plant and stations. Since the establishment of the company, based on the talent-oriented principle, relying on the core R&D team that has been engaged in the field of lighting industrial control for 16 years, it has achieved rapid and stable development, total over one hundred series of products and hundreds of derivative products, which have fully covered the industrial lighting field.

Today, when pseudo-intelligence lighting control systems are popular, we adheres to the concept of "non-sense intelligence, on-demand lighting" to make stable and reliable industrial products that users are interested and can solve practical problems to help the industry take off.



2 SYSTEM INTRODUCTION

The **Intelligent Industry Lighting Control System** for factories and warehouse is one of our four main product lines. The system is independently researched and developed by our company for office buildings, factories, power plants, petrochemicals, coking, mines, substations, airports, ports, railway stations, etc. . Through servers, workstations at all levels, on-site Touch-Screen-Control or mobile devices (mobile phones, tablets, etc.), manual temporary intervention or automatic operation or linkage mode to control the lighting equipment in these areas, also for Data collection and monitoring.



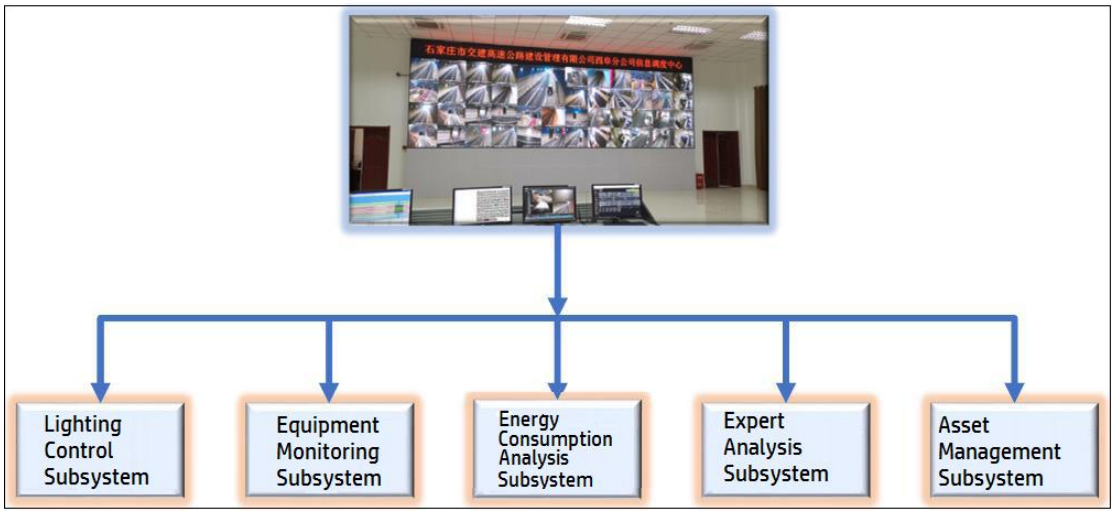
In the context of smart cities, the above-mentioned areas still use traditional lighting control solutions. Although the solutions are mature and widely used, there are many problems and shortcomings, such as the lifetime can not extend through management methods, attenuation of lamps can not be compensated, and reduce the number of lamp damage caused by the harsh environment; another example: the uneven illumination of the working surface happen when owners want to save power, which cannot meet the individual needs of users, and the rigid control methods and lighting scenes, relying on special personnel to participate in the control and inspection, and cannot Provide timely and reliable operating data to the manager, etc. In response to these problems, our company has launched this system, which integrates lighting equipment control, data acquisition, data processing, fault monitoring, remote control, linkage, multi-sensor acquisition, expert system and other functions into one-system, which truly helps users to achieve on-demand lighting and precise management.

3.System Composition

3.1 System Function Composition

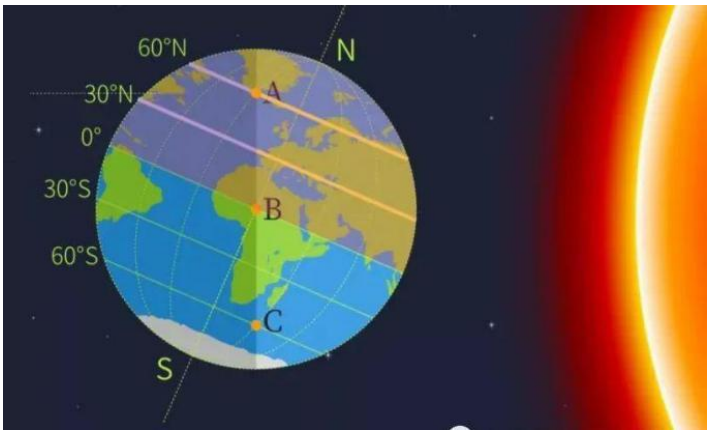
3.1.1 System Function Composition

The system consists of lighting control subsystem, equipment monitoring subsystem, energy consumption analysis subsystem, expert analysis subsystem and asset management subsystem.



3.1.2 Lighting Control Subsystem

3.1.2.1 Auto-Run: Control according to sunrise and sunset



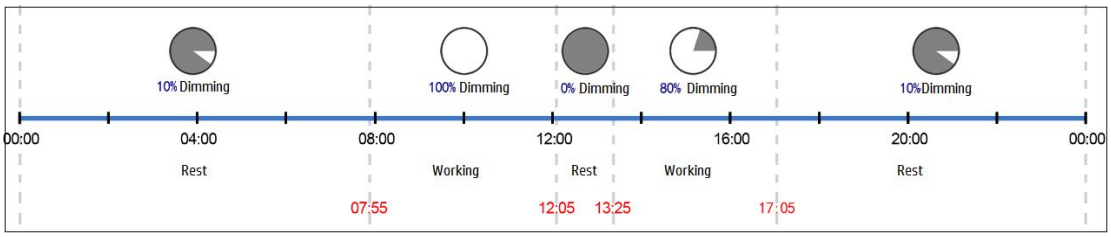
Through the astronomical clock calculation formula, as long as we know the latitude and longitude value and time of a certain place, we can accurately calculate the sunrise and sunset time of that place. According to this time, we can turn off the lights at sunrise and turn on the lights at sunrise;

Except for the equator, South Pole and North Pole, the sunrise and sunset times in other regions are different every day, making it possible to automatically and accurately adjust the time to turn on and turn off every day;

Due to the different altitude/obstacles, and transition thresholds requirement in each region, the sunrise and sunset offset time is introduced to fine-tune the calculated value.

This scheme is suitable for outdoor or semi-outdoor environments that require all-day lighting; such as: street lighting, square lighting, room lighting with sufficient daylight, etc.

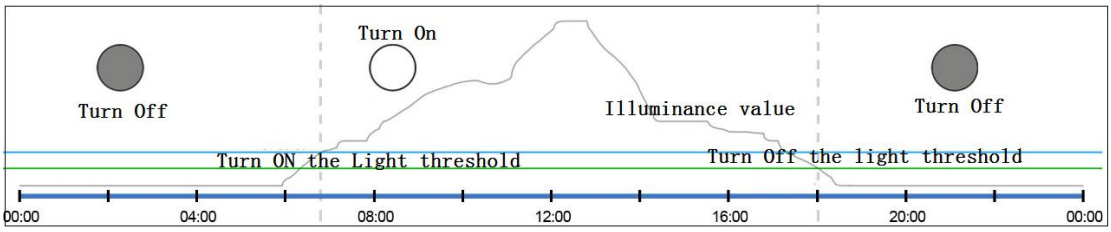
3.1.2.2 Auto-Run: Control by the Schedule



The **Timetable Control Scheme** is that the user sets the working hours of the day according to the Lighting Needs, and sets the illuminance value of the lamps during the working hours at the same time.

This scheme is suitable for environments with regular changes in illuminance; such as factory lighting, office lighting, etc.

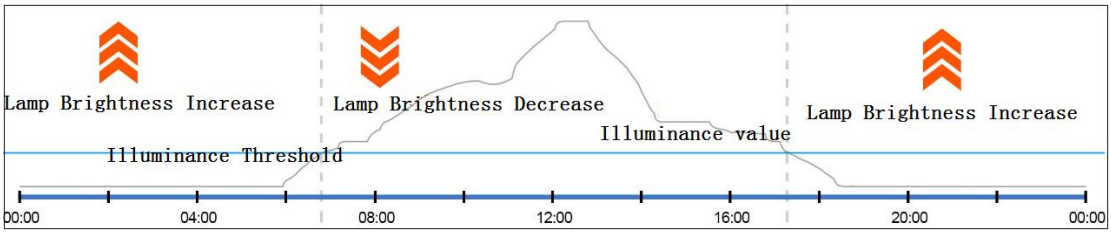
3.1.2.3 Intelligent Assistance - according to natural light control scheme



Collect the illuminance of natural light, when the collected illuminance value is greater than the light-on threshold, the system turns on the light; when the collected illuminance value is less than the light-off threshold, the system turns off the light.

This scheme is suitable for outdoor or semi-outdoor environments, rainy days or unusual weather conditions; such as: street lighting, square lighting, room lighting with sufficient daylight, etc.

3.1.2.4 Intelligent Assistance-according to the illuminance control scheme of the working surface.



Collect the illuminance of the working surface: when the collected illuminance value is greater than the illuminance threshold, the system decreased the lamp brightness until the collected illuminance value is close to the illuminance threshold; when the collected illuminance value is less than the illuminance threshold, the system increased lamp brightness until the collected illuminance value close to the illuminance threshold.

This scheme is suitable for semi-outdoor environments with high requirements for working surface illumination; such as assembly line lighting, office lighting, etc.

3.1.2.5 Intelligent assistance ~ System-level linkage control scheme

Linked with power monitoring, auxiliary control or fire alarm systems, in emergency or special circumstances, other systems directly operate the lamps in the corresponding area, and this system has open protocols and interfaces.

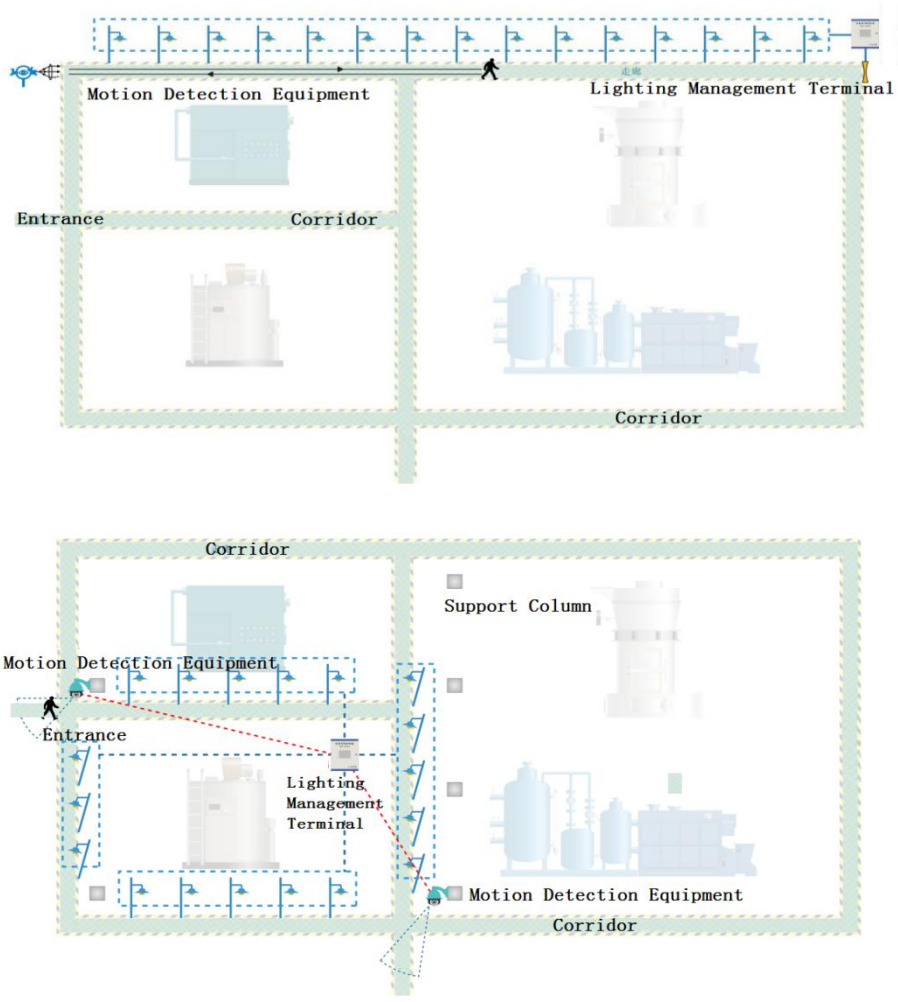
3.1.2.6 Intelligent assistance ~ Equipment-level Linkage Control Scheme

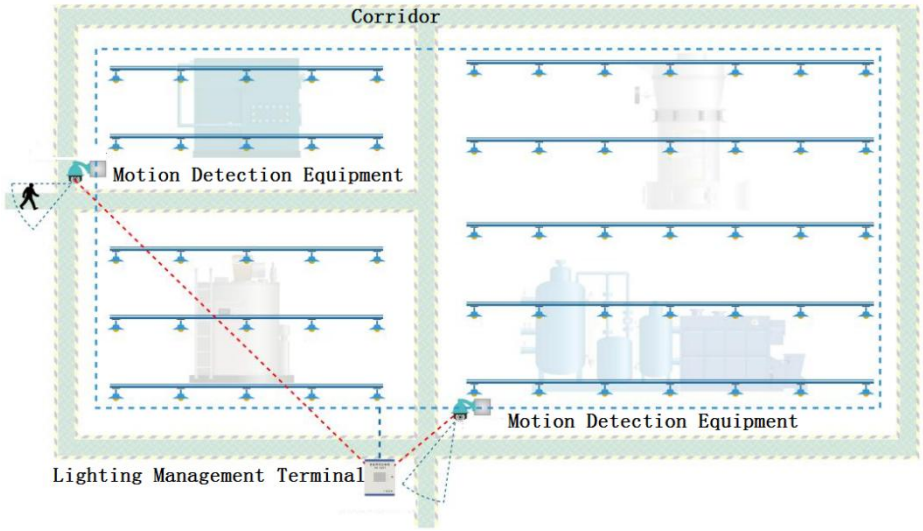
The lamps can be directly linked with cameras, rolling shutters, fire-fighting equipment and other equipment without going through superior management equipment or systems. For example, when the camera is moving, the corresponding position lamp directly compensates the light.

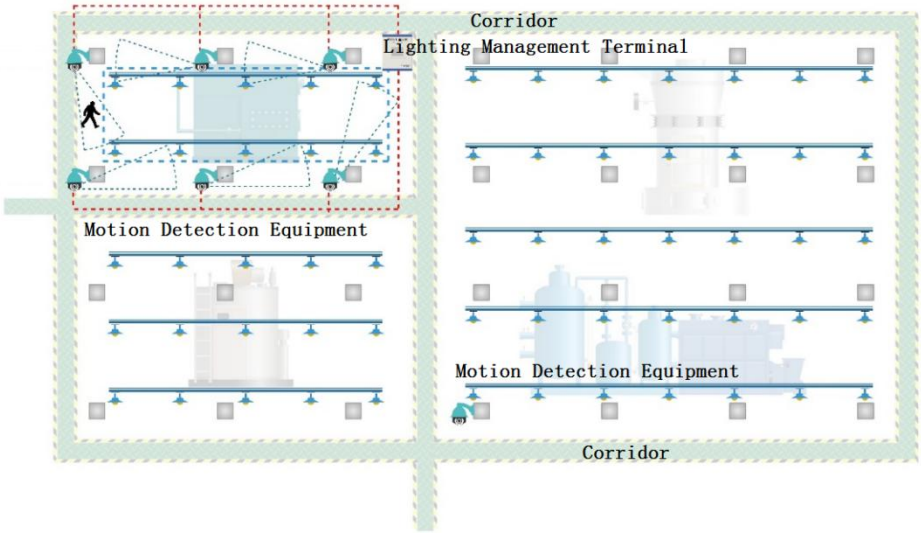
3.1.2.7 Intelligent Assistance ~ Inspection control scheme

Most factories are automated and do not require personnel to stay in the work place. These areas only need to ensure safe illuminance at ordinary times. During inspections, the brightness of lighting fixtures can be improved.

Generally, in the inspection mode, the luminous intensity only needs to be 50%-80% at the maximum.







During the inspection process, the staff can be equipped with handheld devices to realize where the lights are on where the person walks.

3.1.2.8 Intelligent Assistance ~Maintenance Control Plan

When the equipment is overhauled or emergency incidents are handled, the corresponding area is controlled through the overhaul panel switch. Generally, the lamp will be controlled to 100% brightness, and the automatic state can be restored locally or remotely after processing.

The inspection panel switch is generally installed in the original lamp switch position.

3.1.2.9 Intelligent assistance-Existence Control Scheme

Using cameras, infrared sensors or gates and other equipment to determine whether there are people in the area, so as to control the illumination of the lamps in the area; that is, there are people in the area, the lamps are the brightest, when there are no people in the area, the lamps will perform a safe illumination state.

3.1.2.10 Safety Assistance-Emergency Plan

When the server or system backbone communication network is abnormal or damaged, the on-site lamps and the local management center equipment and multiple sensors are linked, the lamps will run according to the set program without any impact;

Local management center equipment, lamps automatically switch to maximum brightness;

When there is a fire, accident, etc., the system can be linked with other emergency systems or equipment, automatically adjust according to the plan;

In situations where linkage is not possible, emergency operations can be performed remotely or locally through the man-machine interface. The local interface includes: buttons on the device or industrial touch screen, handheld devices, and overhaul panel switches.

3.1.2.11 Safety Assistance-Early Warning, Warning Program

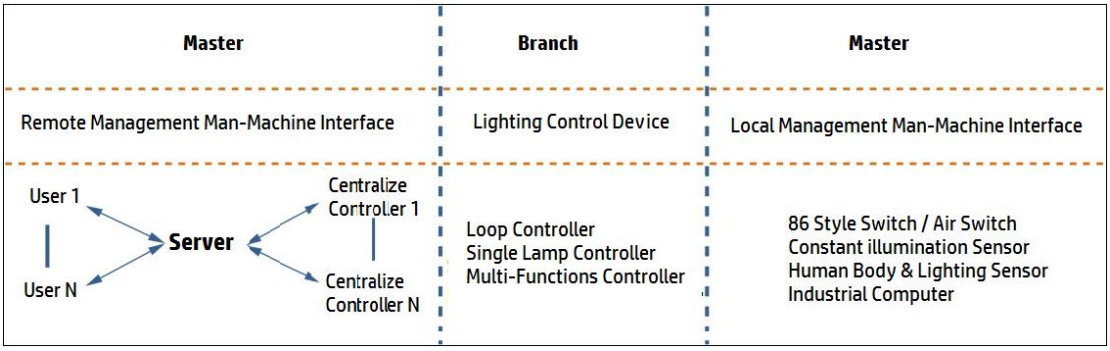
When harmful gas or dust exceeds the standard index, the system will immediately alarm and locate the alarm location or range through the human-machine interface; at the same time, some lamps in the corresponding area will give early warning and alarm according to the SOS frequency.

When the temperature of the lamp or the ambient temperature is too high, the system immediately alarms and locates the alarm position or range through the human-machine interface; at the same time, the lamps in the corresponding area are dimmed until the temperature drops or the dimming ratio is less than 10%.

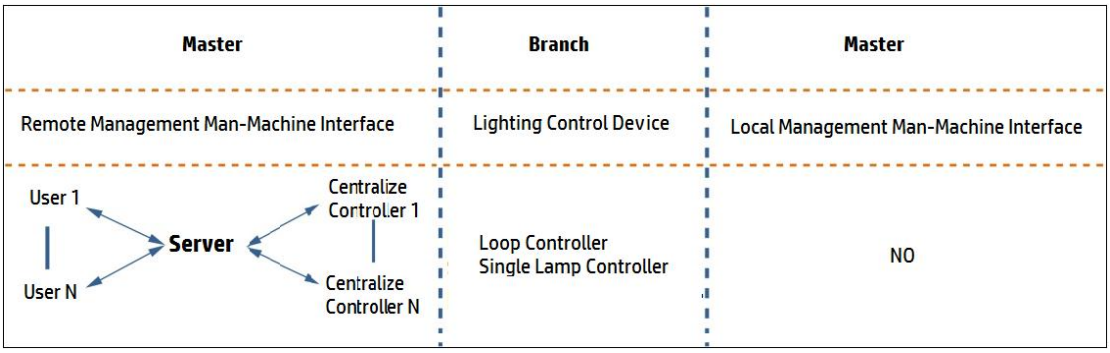
3.1.2.12 Intelligent Fusion Solution

The traditional lighting control system adopts the "Master-Branch" architecture, while our intelligent lighting control system adopts the latest mainstream architecture: the "Master-Branch-Master" architecture.

- Master-Branch-Master Architecture



- Master-Branch Architecture



Because of the Master- Branch- Master" architecture, the above scheme can be combined and fused to achieve more intelligent applications.

3.1.3 Equipment Monitoring Subsystem

3.1.3.1 System Level Monitoring

The system can count the light rate by region and time. When the light rate is lower than the set threshold, the system automatically alarm.

Area lamps are abnormally turned on or off, the system automatically alarm.

3.1.3.2 Loop-Level Monitoring

Monitor the power supply loop to realize grid health analysis and power grid quality analysis.

Monitor loop control equipment to realize loop state monitoring.

The electrical parameters of the communication bus of the loop are monitored to realize the health analysis of the communication bus.

3.1.3.3 Single Lamp-Level Monitoring

Monitor the lamps, realize the monitoring of lamp On/Off, Dimming status, to realization of the multiple faults, electrical parameters and electricity consumption collections.

3.1.4 Energy Consumption Analysis Subsystem

3.1.4.1 Power Acquisition Module.

The total power consumption of lighting fixtures can be collected and statistically analyzed, and the power consumption of the power supply circuit can be collected and statistically analyzed. It can be inquired by day, month, and year.

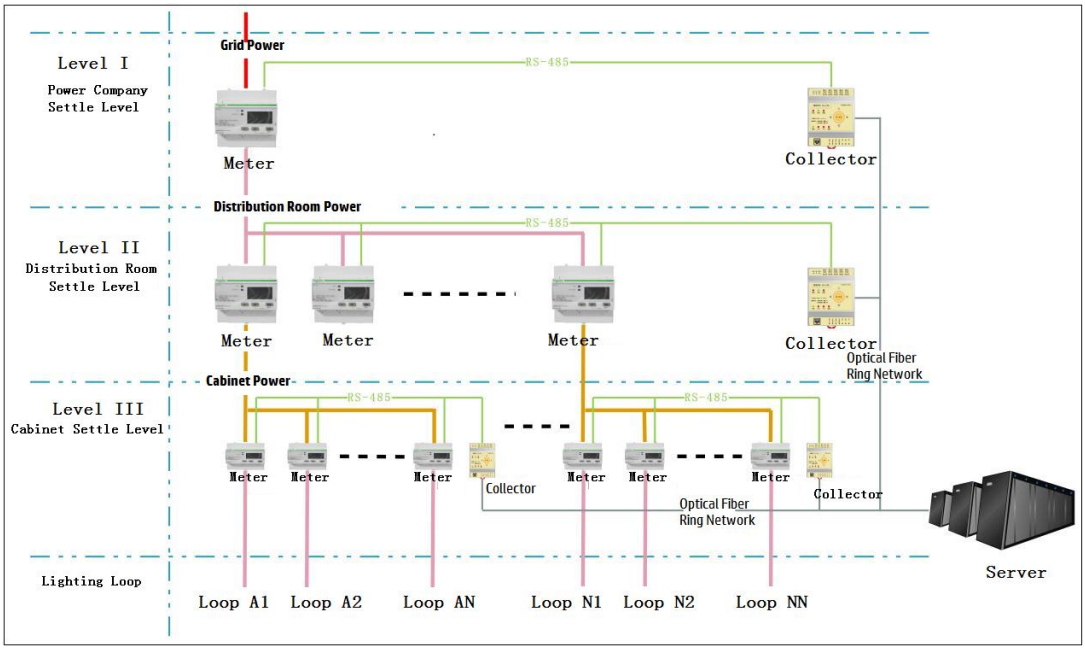
3.1.4.2 Power Saving Rate Statistics Module

Comparing the energy consumption of lighting fixtures with the actual electricity consumption, by calculating the daily, monthly, and annual electricity saving rate, the managers can understand the current and historical lighting energy consumption at a glance, and provide management basis for managers.

3.1.4.3 Fault Alarm Module

When the power-saving rate of a circuit is higher than the set power-saving rate, abnormal operation of the lighting device, lamp failure, abnormal power supply line or wrong lighting scheme will occur. At this time, the system will automatically generate alarm events to remind managers of risks; At the same time, based on the collected information of the system, problem points and causes can be located, providing managers with a basis for formulating solutions.

3.1.4.4 Line Loss Analysis Module



Collect all levels of electrical energy, calculate the line loss of each level, and find abnormalities in the Grid.

3.1.5 Expert Analysis Subsystem

3.1.5.1 Lamp Life time Warning

When the lifetime of the lamp is expired or is close to expire, the system automatically generates the warning message, and the maintenance personnel can centrally arrange the replacement according to the information to avoid abnormal accidents.

3.1.5.2 Light Attenuation Compensation Management

Through long-term sampling data, analyze the light attenuation of lamp fixtures, The system automatically compensates for light attenuation

3.1.5.3 Recommendations for the best Smart Solution.

Through the long-term sampling data, the optimization scheme of the original control scheme in some areas is analyzed to realize more optimized energy saving, such as reducing the frequency of people's passage and increasing the equipment to block the light, etc.

3.1.5.4 Equipment Abnormality Assessment.

Through statistical analysis, the system can calculate the failure rate of a single device in the same time period. When the failure rate exceeds the set value, the system will warn through the man-machine interface.

3.1.5.5 Staff Performance Evaluation

Through statistical analysis, the system collects statistics on the troubleshooting efficiency and removal rate, and collects statistics on the number of inspections and switch usage, so as to quantify the performance of the staff.

3.1.5.6 Grid Quality Analysis & Warning.

Collect and analyze the Grid, through the statistical analysis of data such as harmonics, reactive components, voltage, current, etc., when the data is abnormal, the system will warn through the man-machine interface.

3.1.5.7 Realization of Lamp Life Extension

Through real-time monitoring of the lamp temperature, the power will be automatically adjusted to prevent it from operating in an environment exceeding the design standard, so as to extend the lamp lifetime.

3.1.6 Asset Management Subsystem

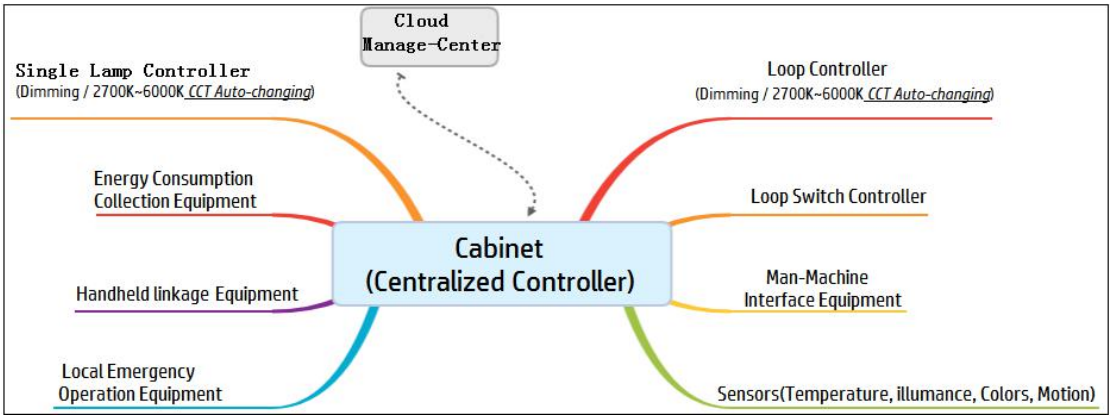
All equipment can be automatically managed by the system, indicating status (Fine or Failure, existence, etc.), and can exchange data with ERP and other systems.

3.2 Equipment Composition of the System

3.2.1 Equipment Composition of the System

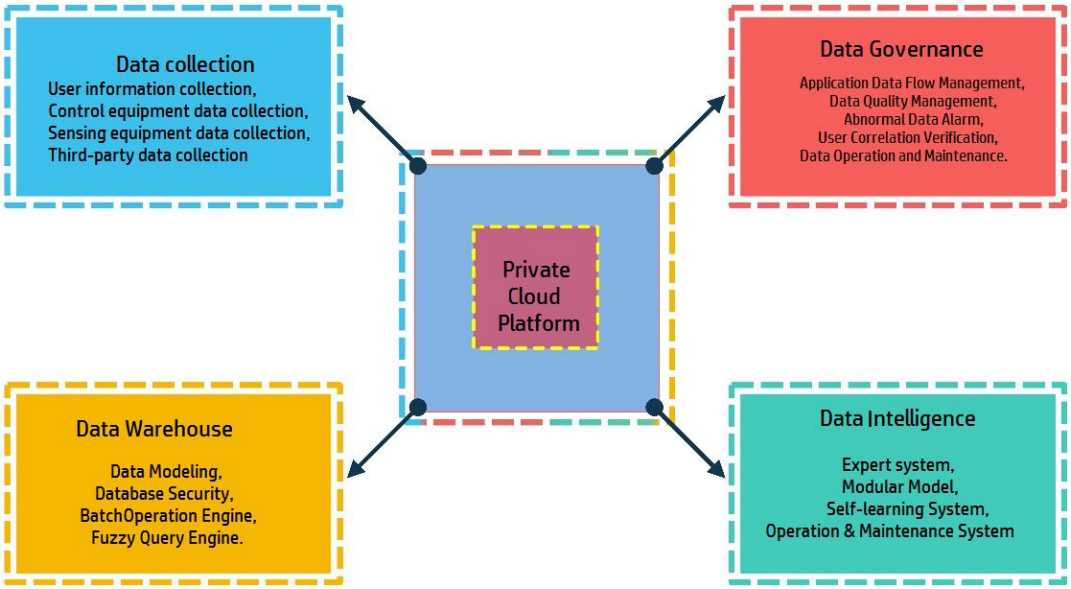
Server, workstation, on-site touch screen control, mobile(iPad) and other handheld devices, smart centralized controllers (or gateways), loop switch controllers, loop dimming controllers, single-lamp smart lighting management terminals, dual-lamp smart lighting management Terminal, dual-colors(2700K~6000K) intelligent lighting management terminal, dual-mode(hybrid of PLC+LoRa)

intelligent lighting management terminal, multi-functional intelligent lighting management terminal, smart panel switch, illuminance meter (or brightness meter), motion sensor, linkage sensor, gas sensor, weather sensor, etc., and emergency Or supporting professional equipment (repeaters, copy controllers, monitors, debugging equipment, etc.).



Generally speaking, the system are divided into cloud management center equipment, human-machine interface equipment, local management center equipment, lighting fixture control equipment, sensor equipment, and debugging equipment.

3.2.1 Cloud Management Center Equipment



The core of cloud management center is system software, hardware carrier is server or server group. The cloud management center relies on the private cloud platform to collect the needed information, integrates through the big data component, uses the data collection, the data governance, the data warehouse, the data intelligence four big function modules to realize the concrete function.

Server

Server is generally installed in the monitoring center and the core of the whole system. All the man-machine interface equipment access to the field equipment, long-term data storage of the field equipment, data statistical analysis and other related operations need to be coordinated and managed through the server, which is the link and bridge between the workstation, device and field equipment.

3.2.2 Human-machine Interface Equipment

On-Site Touch Control Screen:

As a supplement to the workstation, simple operation and convenient installation location make the on-site touch control screen an indispensable part of the system.

The on-site touch control screen can operate independently from the cloud management center equipment to achieve the smallest control system; in the event of a cloud management

Workstation:

A high-efficiency work platform with a friendly man-machine interface for workers in the field of industrial control applications.

Under the B/S architecture, the system supports parallel operation of multiple workstations (multi-users), which is flexible and convenient.

Handheld devices:

As a supplement to the workstation, simple operation and convenient installation location make the on-site touch control screen an indispensable part of the system.

Mobile /IPAD Moving Control Device:

As a supplement to the workstation, simple operation and convenient installation location make the on-site touch control screen an indispensable part of the system.

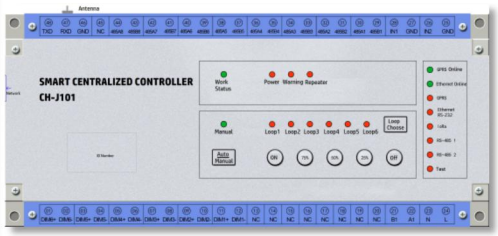
Inspection panel switch:

In maintenance or emergency use, it can also replace the original circuit switch.

3.2.3 Local Management Center Equipment

Centralized Controller CH-J101:

As a management device connecting the previous and the next equipment, to realize the conversion of communication channels and the operation and management of local devices.
It is mainly used for loop dimming, multi-module integration, bus single-lamp controller control, etc.

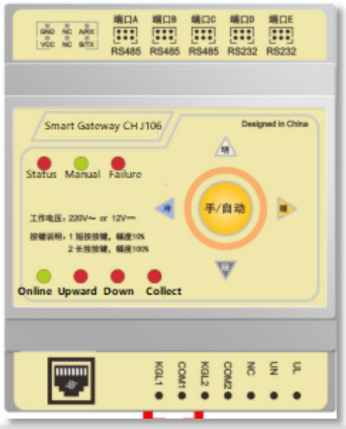


Centralized controller CH-800:

As a management device connecting the previous and the next equipment, it realizes the conversion of communication channels and the operation and management of local devices.
Mainly used for energy consumption management, PLC single-lamp controller, wireless single-lamp controller control, Hybrid PLC + LoRa Controller, 2700-6000K CCT Auto Changing Single Lamp Controller.

Smart Gateway:

As a management device connecting the previous and the next equipment, it realizes the conversion of communication channels and the operation and management of local devices.
Mainly used for switch circuit control, loop dimming control, lamp dimming control, lamp colors control, sensors control, etc.

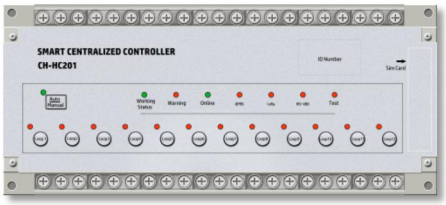


3.2.4 Management & Control Equipment Terminal

3.2.5.1 Loop control level equipment

CH-HC201:

The max. control current (resistive load) of each loop is 30A. Multiple loops can be correlated with each other and can operate according to input signals from multiple sensors, with loop fault detection.



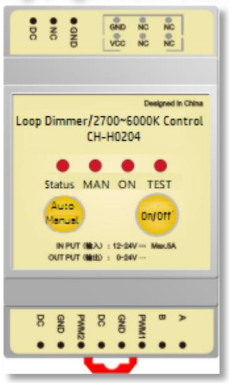
CH-H0102:

Single-loop switch control, to control the 3-Phase power line, needs to be used with an AC Contactor.

The maximum loop control current (resistive load) is 5A. Can be cascaded, with loop fault detection.

CH-H0204:

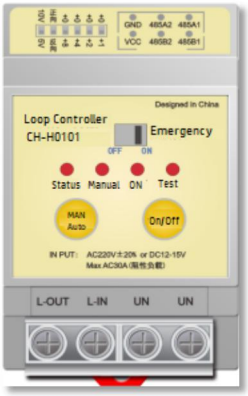
Loop dimming; 2700-6000K CCT colors Auto-Changing; control DC-powered lamps without using a light controller.



CH-H0101:

Single-Loop switch control, control single-phase line directly, no need AC Contactors.

The max. control current(resistive load) is 30A. There are emergency switch levers, E-energy and parameter collection, multiple communication interfaces, cascade connection, with loop/lamp failure detection.



CH-H0202:

Loop Dimming,2700K-6000K CCT Colors Changing, control Dimmable driverdirectly without using a lamp controller.

The max. control current of the loop is 100mA. Strong applicability (constant or variable power for colors changing between 2700-6000K; dimming output amplitude & direction is adjustable), multiple communication interfaces, Cascadable, fault detection.

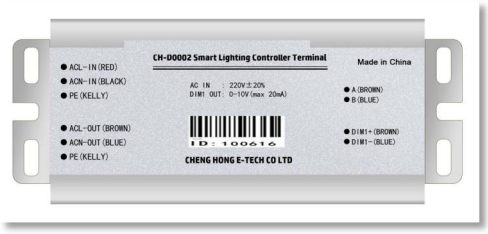
3.2.5.2 Single Lamp Control Level Equipment

Individual lamp controller:

CH-D0001, CH-D0002, CH-D0004, CH-D1001, CH-D1002, CH-D1006, CH-D2001, CH-D2002, CH-D2005, CH-D5001, CH-D5002, CH-D5004, CH- D7001, etc.

Switching, Dimming the single lamp according to different models, will choose Industrial Bus, LORA, NB-IoT, power line-communication, and other channels.

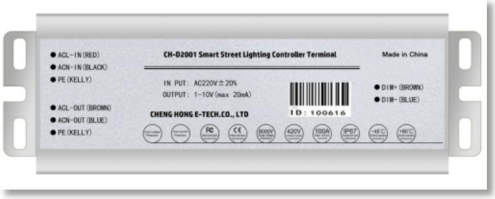
With multi-functions on Fault detection and reporting, such as: lamp failure, communication abnormality, power supply failure, led chip failure, high temperature, etc. And functions of collecting electric parameters and measuring electric energy.



Dual-lamp controller,
Multi-lamps controller:

CH-D0601,CH-D1601,CH-D1606,CH-D260, CH-D5601,CH-D2604,CH-D7601,etc.

Same function as the single lamp controller, which can control two or more lamps at the same time.



Dimming & 2700k~6000k CCT auto changing controller:

CH-D0201,CH-D0202,CH-D0204,CH-D120, CH-D1202,CH-D2201,CH-D2202,CH-D520, CH-D5204,CH-D7201:

On the basis of the individual-lamp controller, adding the function of dual colors(2700~6000K) auto-changing in different environment.

Hybrid PLC+ LoRa Controller:

CH-D6001, CH-D6002, CH-D6004, CH-D7401, etc.:

On the basis of the individual lamp controller, one or two communication channels are added to realize the simultaneous operation of multiple communication interfaces.

3.2.5 City Sensors:

Illuminance Sensor (or Brightness Meter) CH-C201:

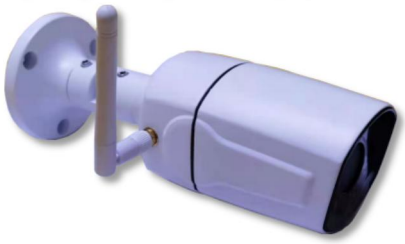
Collect the natural light or the illuminance (brightness) of the working surface, report it to the superior management device, and finally link with the lamp, or directly control the lamp management device.

Linkage Sensor CH-T401:

Realize the lighting linkage with cameras, conveyor belts, gantry cranes and other equipment, that is, when the linkage equipment moves, the lighting fixtures in the corresponding area will automatically fill light.

Motion Sensor CH-H0101:

Realize the moving monitoring of people, objects, and vehicles, and directly control the lighting management equipment.



Gas Sensor CH-T902:

Realize the collection and monitoring of multiple gases, upload the converted data to the upper-level equipment, and finally link with the lamps.

Weather Sensor CH-T906:

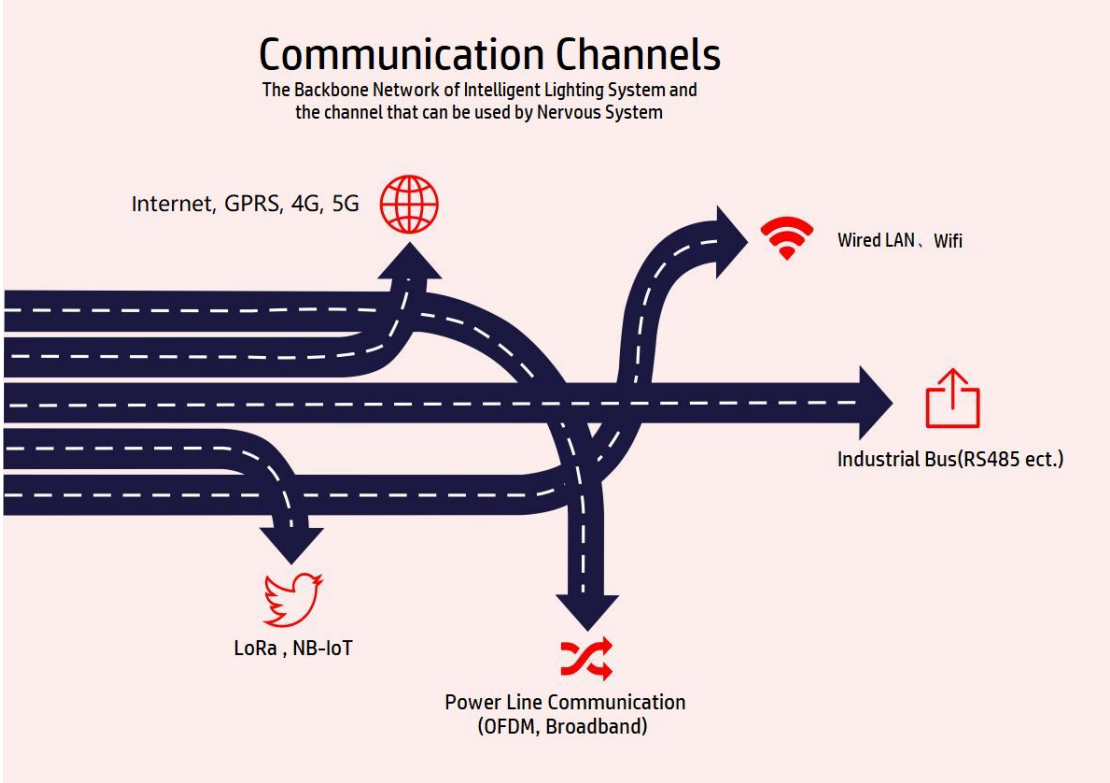
Realize the collection and monitoring of weather information, and upload the data to the upper-level equipment, and finally link with the lamps.

3.2.6 Debugging equipment

A variety of Repeaters, Copy Controllers, Monitors, and Debugging Equipment.

4. Communication Topology Diagram

4.1 Communication channel fusion technology



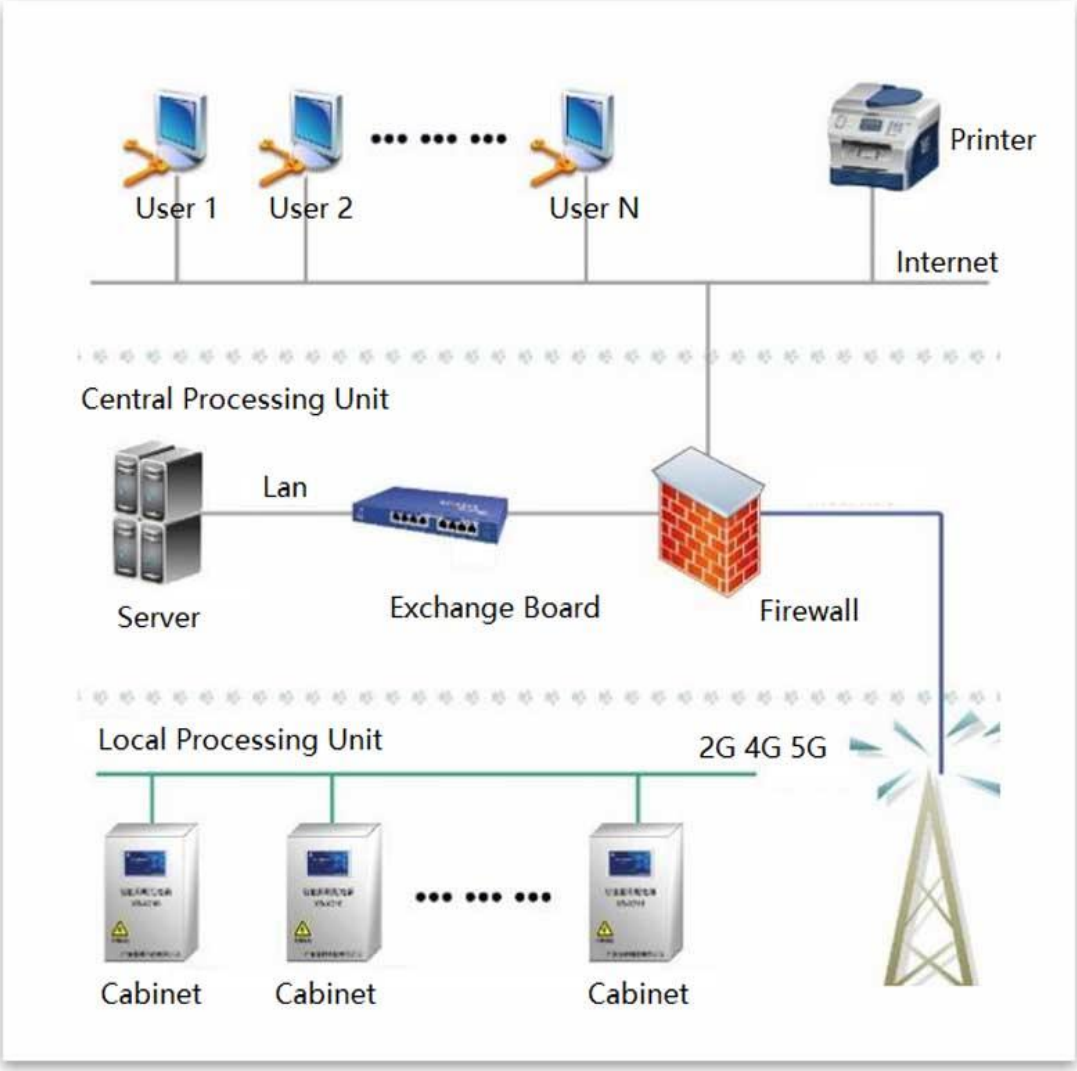
The communication performance of the main communication interface are as following:

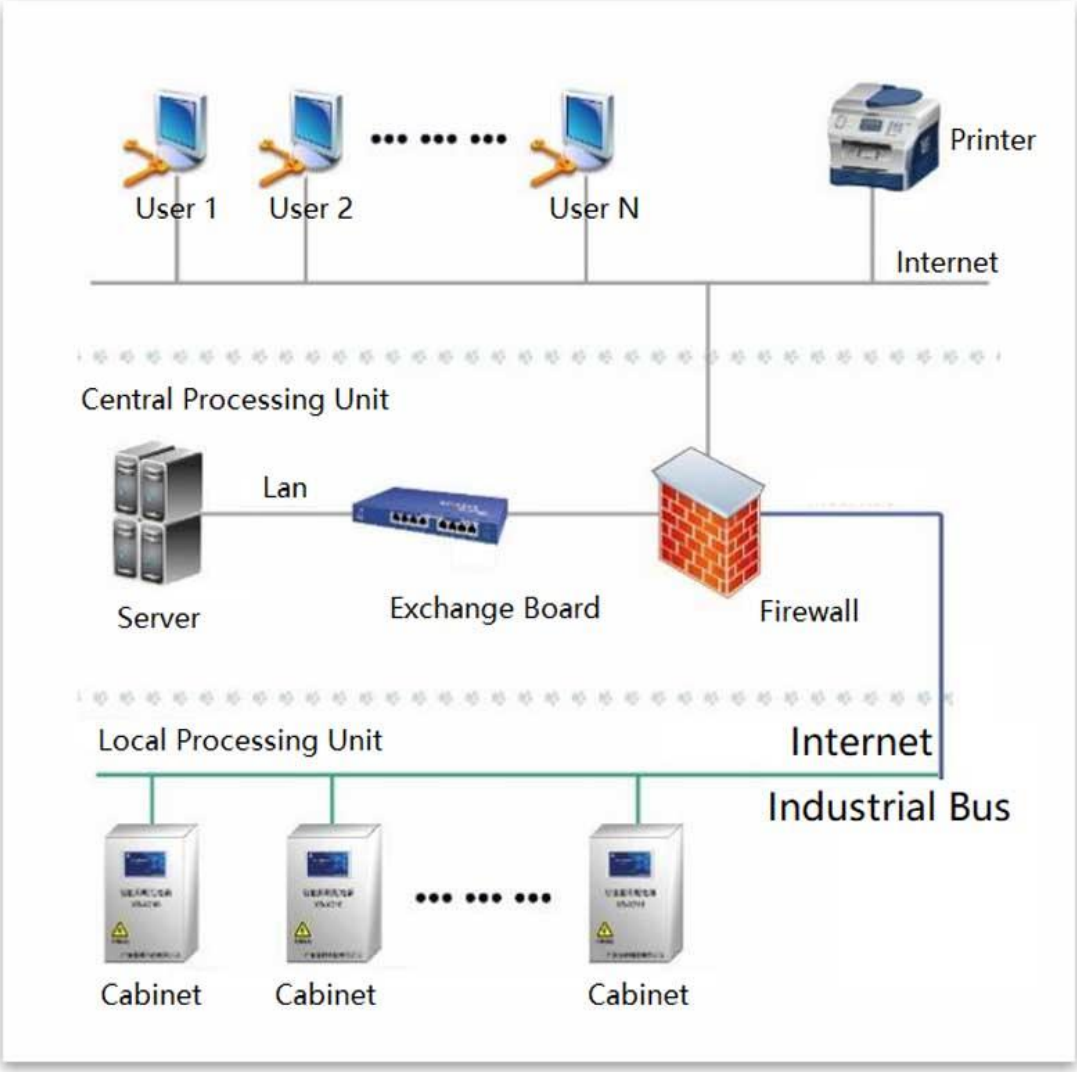
1): **RS-485 Industrial Bus** communication distance can reach 2km without repeater , 7 level gateway can be set up in the scene, the max. distance can reach 7km according to 1km of each stage gateway, and the equipment capacity in the gateway can reach 255 units.

2): **LoRa** communication interface, the communication distance can reach 2km without relay, and the communication distance can reach 10km with repeaters;

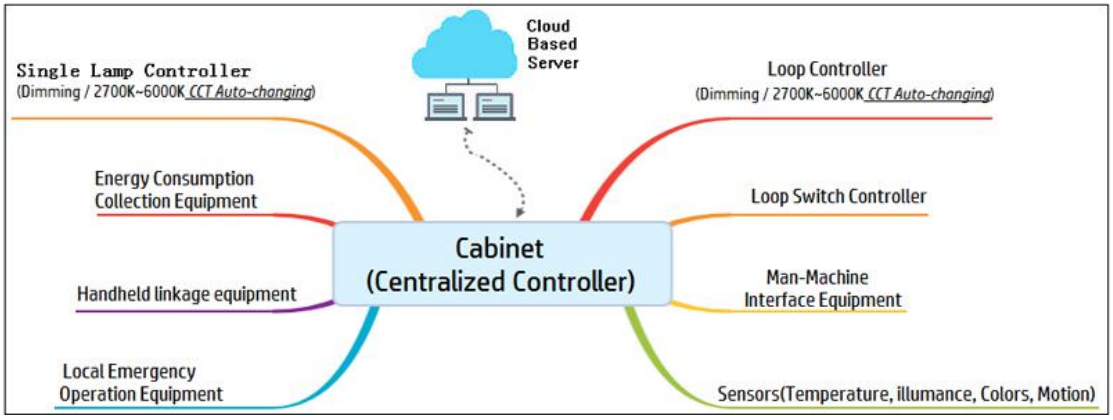
3): **PLC** communication interface, the communication distance can reach 400m without repeater, with repeater in this case, the communication distance can be up to 4km.

4.2 Backbone Network Communication Topology Diagram

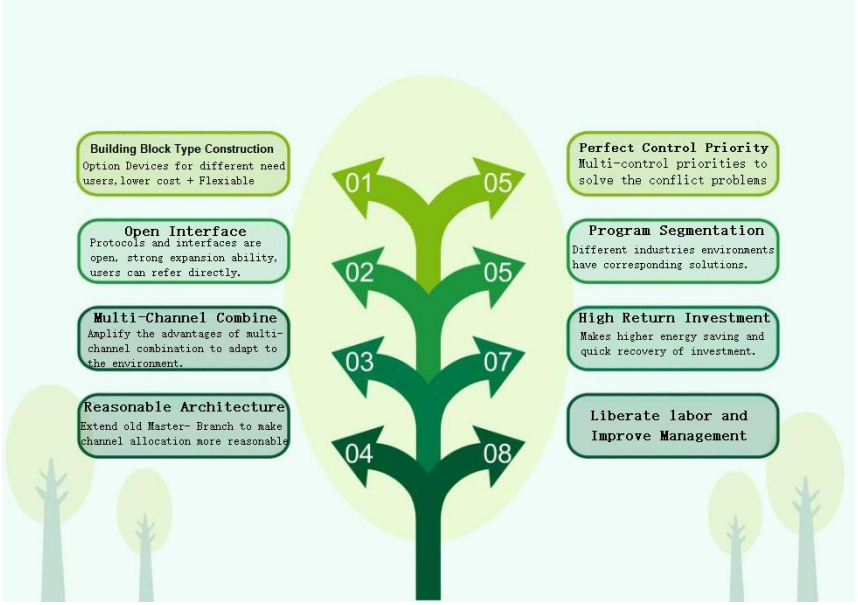




4.3 Neural Network Communication Topology Diagram



5. System Advantages:



5.1 System Modular Design

5.1.1 Composition system equipment

The equipment building block of the system can run independently and can be combined arbitrarily, which not only reduces the cost, but also is easier to meet the users demand.

5.1.2 Reliability

Because of the modular design, any device can store operating parameters and can run independently, avoiding system crashes caused by damage to a device or node.

5.2 Strong System Expansion Capability.

The system can be docked with other systems with an open protocol.

Terminal equipment can be linked with various equipment.

The internal equipment of the system can be cascaded without being limited by the project scale.

5.3 Personalized Customization

The man-machine interface interface accepts customization requirements and can be customized according to user requirements.

5.4 High Economy (input-output ratio)

Through years of data statistics, using this system to manage energy saving, the energy saving ratio is generally between 50%-60%, and most projects can recover the initial investment cost within 1 - 2 years.

5.5 Management Advantage

Reduce the work intensity of management staff and improve work efficiency; provide management staff with operating data as a management basis; thereby greatly reducing management costs.

6. Case Analysis

6.1 Power Plant Scheme

6.1.1 Work mode statistics table

Mode	Day		Night		Default	Auto-Mode	Group	Manual	Sensor	Touch Screen	Inspection		Repair		No-Man State
	Power Loop	Lamp	Power Loop	Lamp	Bright-ness						Bright-ness	Control Method	Bright-ness	Control Method	
Mode 1	Live	Off	Live	On	100%	—	One	Dimming	—	—	—	—	—	—	—
Mode 2	Live	On	Live	On	100%	—	One	Dimming	—	—	—	—	—	—	—
Mode 3	Live	Off	Live	On	30%	Schedule	Multi Group	Dimming			70%	Remote	100%	Remote	With human sense, unmanned low power can be realized.
Mode 4	Live	On	Live	On	30%	Schedule	Multi Group	Dimming			70%	Remote	100%	Remote	
Mode 5	Off	Off	Live	On	30%	Latitude & Longitude + Timetable	Multi Group	Scene / Dimming			70%	Remote	100%	Remote	
Mode 6	Off	Off	Live	On	30%	Latitude & Longitude + Timetable	Multi Group	Scene / Dimming	—		70%	Remote	100%	Remote	—
Mode 7	Live	On	Live	On	100%	—	Multi Group	—		—	—	—	—	—	—
Mode 8	Live	Off	Live	—	0%	—	—	—		—	—	—	—	—	With human sense, unmanned low power can be realized
Mode 9	Live	Off	Live	—	0%	—	—	—		—	—	—	—	—	Off
Mode 10	Off	Off	Live	On	100%	Latitude & Longitude + Timetable	Multi Group	Dimming	—	—	—	—	—	—	—
Mode 11	—	On	—	On	100%	—	Multi	Scene	—		—	—	—	—	—

6.1.2 Working mode corresponds to working area

6.1.2.1 Scene Mode 1:

The lighting of corridors in key areas or important equipment that needs video recording.

6.1.2.2 Scene Mode 2:

The corridors of key areas or the lighting of important equipment requiring video recording, and other power distribution rooms in the factory area except GIS.

6.1.2.3 Scene Mode 3：

The operating floor for Turbine Room , outdoor equipment area, coal conveying trestle.

6.1.2.4 Scene Mode 4：

Below the 0m floor, middle floor, and boiler operation floor of the steam engine room.

6.1.2.5 Scene Mode 5：

Steam engine room 0m level, middle level, boiler operation level and below, transformer area, hydrogen station, GIS power distribution room, boiler operation level and above.

6.1.2.6 Scene Mode 6：

Behind the furnace (supply, primary fan, etc.), denitrification and air preheater platform.

6.1.2.7 Scene Mode 7：

Outdoor equipment area, coal conveying trestle.

6.1.2.8 Scene Mode 8：

Walkways, stairs.

6.1.2.9 Scene Mode 9：

Walkways, stairs, power distribution rooms other than GIS in the factory area.

6.1.2.10 Scene Mode 10：

Street Lighting.

6.1.2.11 Scene Mode 11：

Conference Room, Centralized Control Room.

Conclusion:

With the in-depth binding of strategic policies such as Smart City and Smart Manufacturing Industry 4.0, these strategic policies have been promoted as an important part of many countries. Although the lighting industry is only a small part of the whole industry, it is an indispensable part and a solid foundation in the strategic layout and also the easiest link to achieve. We hope that our intelligent lighting solutions can contribute to the development of end users, and we warmly welcome the user's valuable suggestions. Let us contributing to create a greener world!